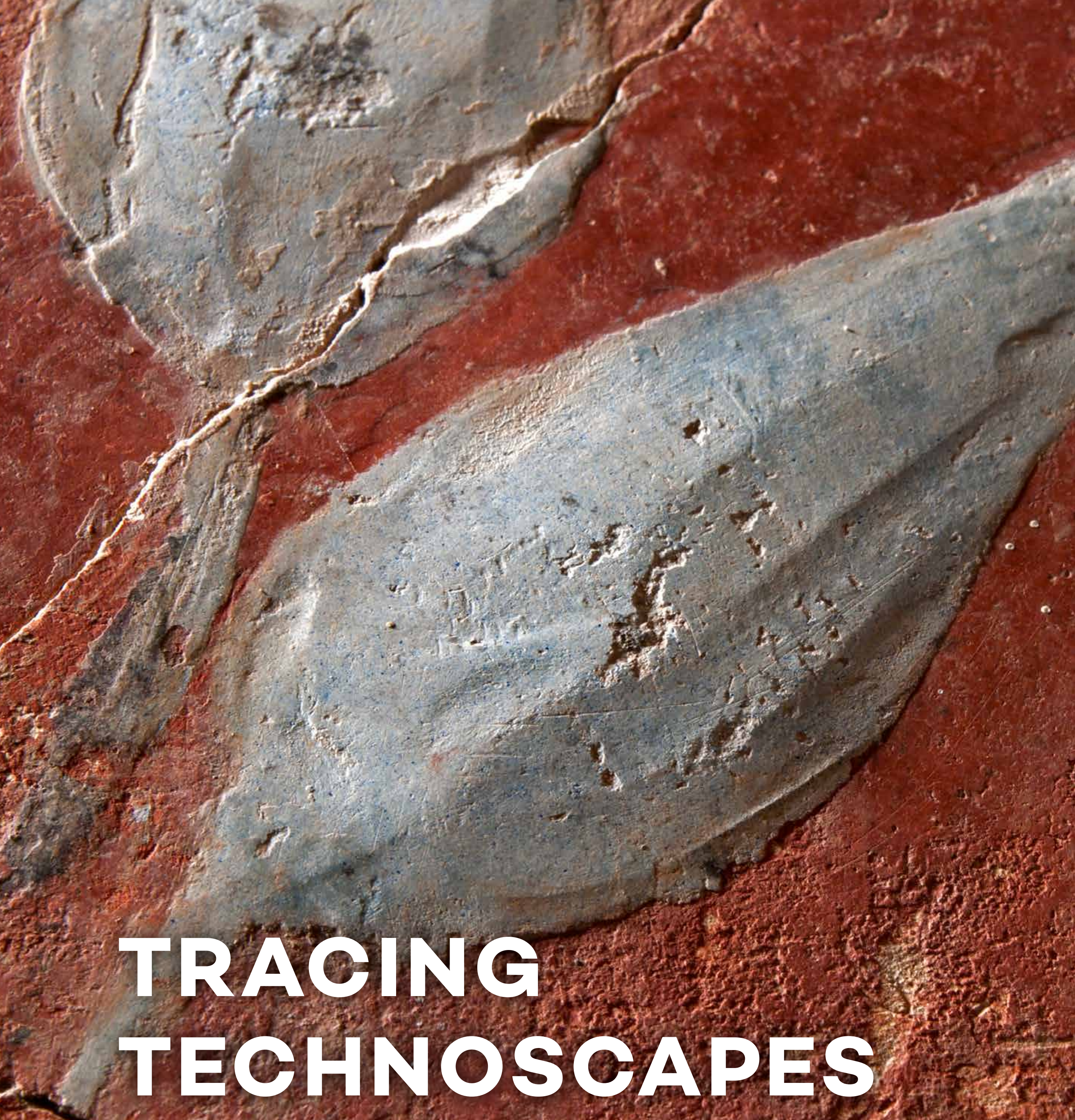

TRACING TECHNOSCAPES

THE PRODUCTION OF BRONZE AGE WALL PAINTINGS IN THE EASTERN MEDITERRANEAN

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Contents

Malqata – The Painted Palace

Peter Lacovara[1] *and Alexandra Winkels*[2]

Abstract

It is daunting to understand the nature and meaning of the various architectural components in the limited number of palaces we have from ancient Egypt. Aspects of their decoration can aid us in interpretation. The Eighteenth and Nineteenth Dynasties provide us with the greatest number of palaces to analyse and discern what are overall patterns in decoration and layout and what they might mean. The Palace complex at Malqata, and specifically Amenhotep III's Main Palace or the Palace of the King, as it is also known, gives us the most extensively preserved sections of wall painting in their approximate original position. As in Assyrian palaces, where the relief scenes were fitted to the function of each room, the decoration of Egyptian palaces may mirror the use of the rooms they decorate. This paper will try to suggest some possibilities for the Palace of the King at Malqata based on the Metropolitan and Tytus Expeditions and attempt to extrapolate that to other royal residences.

In addition, selected results of scientific plaster analysis implemented in a portable field lab present complementary information about ancient Egyptian plaster technology and wall painting techniques applied at the King's Palace and nearby Site K.

Keywords: Amenhotep III; palace; mud brick architecture; ancient Egyptian wall painting; wall decoration; plaster technology; mortar analysis; mobile field laboratory; conservation science.

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1. Wall Decoration and Purpose in Eighteenth Dynasty Royal Residences

> "*I made a palace decked with gold, whose ceilings were of lazuli* […] *The doors were of copper and the bolts were of bronze. It was made for everlastingness, at which eternity fears."* The teaching of Amenemhet (ca. 1991–1962 BCE).[3]

While it is difficult to discern much about the function of royal residences in ancient Egypt from the few surviving palaces we have, aspects of their decoration can aid us in their interpretation. The New Kingdom gives us the best-preserved and largest sample of palace structures, and comparisons between them can give us a better understanding of what were conventionalised as opposed to unique features. In particular, the painted wall decoration can provide us with some idea as to the purpose and function of some of the rooms within these royal residences.

The excavations of the palace complex at Malqata,[4] and specifically Amenhotep III's Main Palace or the Palace of the King, as it is also known, gives us the most extensively preserved sections of wall painting in their approximate original position, though their excavation was laborious and difficult as Winlock noted in his field diary for January 20–23, 1911:

> *"The work on the fragments of painted ceiling is the most difficult and thankless job I have ever seen. These four days have been spent entirely at it. We – White and I – have been attempting to take up the certain bits which have been found face down lying scattered in the thick redim.*[5] […] *It is taken up on a board and carried to a glass table.* […] *I lie on my back under the glass and White moves around the hunks to make the best fits possible, but as the friable edges are continually crumbling and the mud falling between the pieces it is a long and tedious job to get them together once their positions are known. It is almost impossible for a man to make himself understood to one looking down who is, moreover, entirely in the dark as far as fits go because he sees only the backs of the pieces.* […] *God have mercy on our souls!"*[6]

As in Assyrian palaces, where the relief scenes were fitted to the function of each room, the decoration of Egyptian palaces may mirror the use of the rooms they decorate. This paper will try to suggest some possibilities for the Palace of the King at Malqata based on the Metropolitan and Tytus Expeditions and attempt to extrapolate that to other royal residences.

The palace complex at Malqata appears to have gone through several stages of rebuilding, not only with additions, but even a complete re-orientation (Fig. 1).[7] In addition, an earlier royal palace may have been located to the south at a place known

3 Breasted 1906, 232.
4 Cf. Daressy 1903, 165–170; Tytus 1903; Winlock 1912, 185–187; Evelyn-White 1915, 253–256; Hayes 1951, 82–112; Kemp – O'Connor 1974, 101–136.
5 Can be translated as "debris".
6 Manuscript on file in the Department of Egyptian Art, Metropolitan Museum of Art.
7 On the chronology of the settlement, see esp.: Hayes 1951, 35–37.

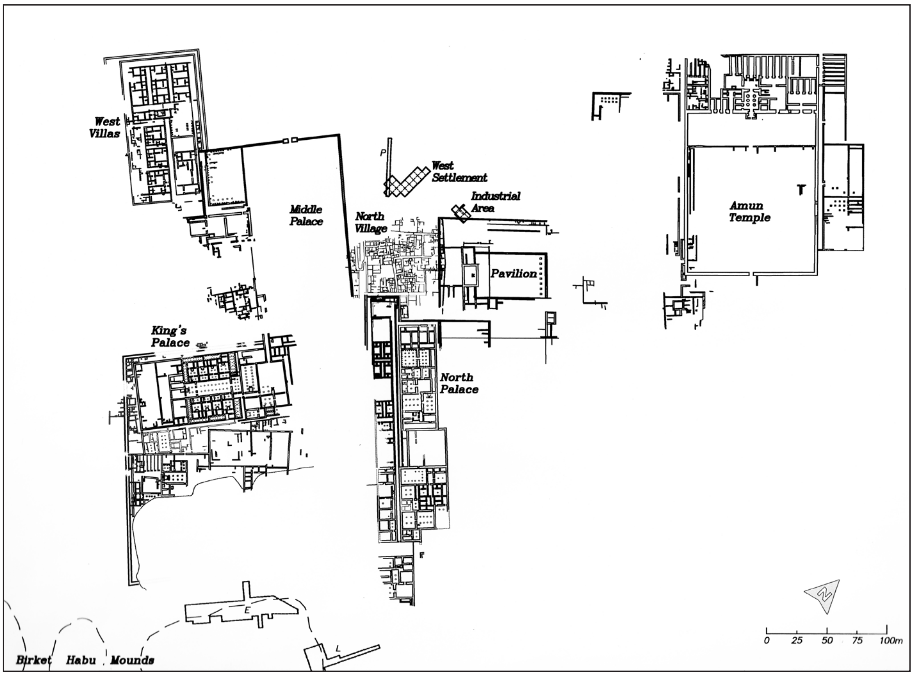

Fig. 1: Map of central quadrant of the Malqata Palace complex (by Joel Paulson; courtesy of the Metropolitan Museum of Art).

Fig. 2: Google Earth image of Malqata showing the location of Site K (by Joel Paulson; courtesy of the Metropolitan Museum of Art).

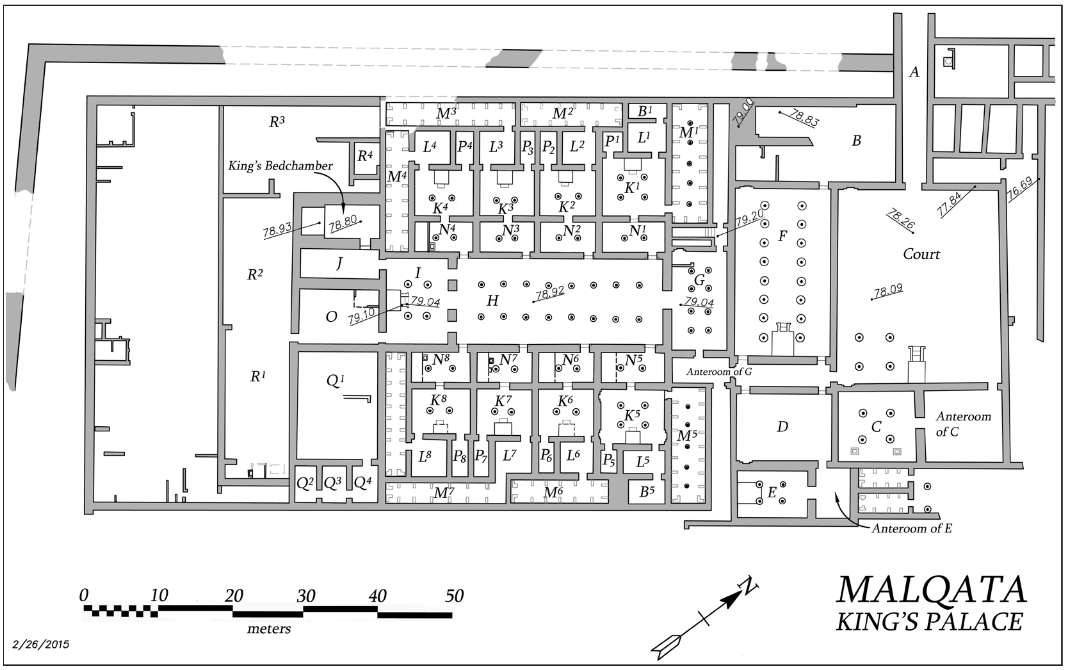

Fig. 3: Plan of the Palace of the King at Malqata (drawn by Andrew Boyce).

as Site K excavated by Kemp and O'Connor (Fig. 2).[8] And a number of painted plaster fragments with Aegeanising scenes were discovered there.[9]

The compound enclosing the Palace of the King covers an area of more than 150 by 100 meters, with the central palace being more or less symmetrical in plan with a long, narrow hall running along the central axis of the structure (Fig. 3). At the southern end of this hall was located a throne room and behind it, what has been identified as the private apartments of the King, which included a bedroom, antechamber and bath. At the northern end of the palace was another series of courts, many with a raised dais opposite the entrance.

The excavators of the Tytus Expedition attempted to assign functions to the rooms they uncovered,[10] beginning with the entrance corridor (A). Opposite this was a large 'hall' with a raised dais and flanked by tree pits. Behind the dais was another suite of rooms (D and E) taken to be an 'audience chamber' and its 'ante-room'. To the south of this was a small chamber with a raised floor (B) not unlike the 'bedrooms' at Tell el-Amarna.[11] This room is associated with the remains of a large court or hall (F), badly destroyed, but preserving a decorated throne base at its far end. A room to the south

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8 Kemp – O'Connor 1974, 101–136; Patch *et al.* 2012/2013, 76–84.

9 Kemp 2000, 45–46.

10 While many of these attributions seem whimsical at first, they are perhaps worth note, Tytus 1903, 14–25.

11 Tytus (1903, 15) refers to a parallel at Tell el-Amarna, which was clearly not one of the residential parts of the palace, one might suggest that this could have been a 'porter's lodge' as in the private houses at Amarna. Alternatively, Tytus suggests that it may have been a statue base for a shrine. This also would have parallels in domestic architecture such as the courtyard shrines at Deir el-Medina.

Fig. 4a: 'Wave Pattern' painted at the base of the interior west wall in the 'King's bedchamber' of the Palace of the King at Malqata (photograph by the author).

of this (G) had a painted 'false-door' niche and fronted a stairway giving access to the roof. Beyond this was the long, central hall (H) that the excavators compared with a 'feudal banqueting hall'. To the east of the central hall was a series of reduplicated suites of rooms (N, K, L and P). The rooms numbered N were taken to be 'bathrooms' and a stone tub still remained in situ in one of them. The central room of the suite (K) had a pair of columns flanking a raised dais. Behind this, it was suggested, was a 'bedroom' (L) and a lavishly decorated 'ante-room' (P). A room opposite the stairwell (M) had a series of columns running down the centre and a wood shelf supported on brick piers running along both long walls of the room at a height of 80cm above the floor.

The later excavations of the Metropolitan Museum exposed much more of the palace area and called into question some of the interpretations of the Tytus Expedition. At least nine other rooms similar to M were found placed at the periphery of the structure. Their position and design suggests they may have been storage magazines for palace goods. An additional set of rooms mirroring the suites N, K, L and P were found opposite the central hall, making a total of eight groups. William Stevenson Smith suggested that these were chambers set aside for the royal harem.[12] They do resemble, on a smaller scale, the 'Kings's bedchamber' and its associated rooms in the southwest corner of the palace. The first court (C) was double the width suggested in the Tytus plan. A corridor, running at a lower level and parallel to the western wall of the palace, gives access to the kitchens and magazines to the south.

12 Smith 1998, 285.

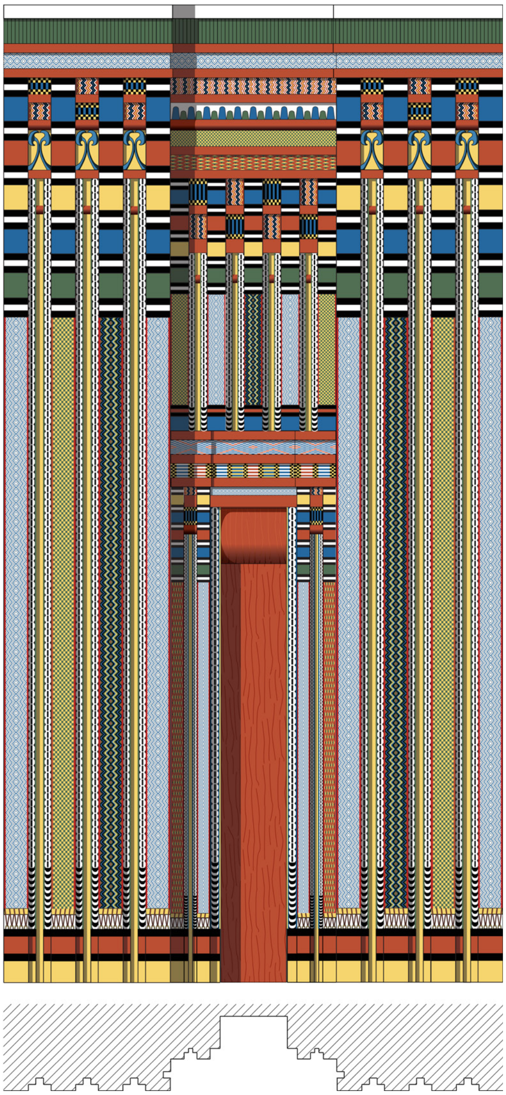

Fig. 4b: False door pattern (drawn by Franck Monnier; courtesy of Franck Monnier).

Fig. 4c: Origin of 'Wave Pattern' in a representation of rope tier for coloured mat panels at the base of a painted false door pattern from the Tomb of Hesy (Quibell 1913, pl. IX).

While little artifactual material was recovered or recorded that can shed light on the function of these rooms, many fragments of the decorative elements of the structure were noted.[13] The palace had been embellished with an elaborate series of wall murals, painted pavements, ceilings and inlays. No trace of the decoration of the entrance corridor is mentioned. The first room with decoration recorded was the hall C that had a ceiling of vultures with outstretched wings. A small fragment of painted pavement was also found in this area, but the details of it were not reported.

13 Nishimoto 1990a, 58–79; Nishimoto 1990b, 111–121; Nishimoto 1991a, 9–13; Nishimoto 1991b, 101–112.

Room D appears to have had a wall painting of 'dancing girls' above a dado consisting of panels of 'false door' blocks set between alternating *sa* and *ankh* signs with an undulating line at its base. This motif is repeated throughout the palace. The pattern is a simplification of a very ancient type of decoration known in Egypt as 'palace façade'. This design in a much more elaborate form, is found decorating the mud brick tombs of the First and Second Dynasties.[14] It is an imitation of coloured woven matting that would have been used to embellish early structures of reed and wood. The undulating line represents the rope that would have secured the matting to 'curtain rods' running above and below the matting (Fig. 4).

In the small 'audience hall' beyond this room, fragments of the decoration were recovered by Daressy's earlier expedition, including pieces of a pavement consisting of a pool with swimming ducks and fish surrounded by a border of papyrus with flying birds.[15] The throne base had steps decorated with bound prisoners and representations of the 'nine bows' and was faced with sandstone blocks painted yellow with inscriptions in red and blue. The ceiling in this room was decorated with running spirals in yellow alternating with blue and red rosettes.[16] No trace of any wall decoration was found in this room.

The floor in the next large court (F) was poorly preserved, but much of the rest of the decoration of the court was discovered.[17] The throne base was again decorated with the captive and bow motif and above it was a 'canopy' or 'half-roof' with the flying vulture pattern. The rear wall behind the dais was decorated with what appeared to be a scene of hunting in the desert, and fragments of a large female figure were found in the court.

The great central hall (H) had another painted pavement with a pond and marsh scene. There were eighteen limestone column bases supporting two rows of wooden columns with lotus-bud capitals. A dado of painted panels ran around the walls of the central hall and a figure of the king seated on his throne was painted on the southern wall.[18] No decoration was reported from the throne room beyond this.

The 'antechamber' and the 'King's bedchamber,' however, were lavishly decorated. The ceiling of the 'antechamber' was decorated with an elaborate panel of running spirals, buchrania and rosettes (Fig. 5). The walls were covered with the panel decoration with undulating line base, that we have already seen in some of the other rooms of the palace. The 'King's bedchamber' had a ceiling decorated with flying vultures and the panel dado as in the antechamber. In this room it was surmounted by paired figures of the god *Bes*.[19]

The 'Harem suites' were also lavishly decorated with ceilings painted with flying pigeons, ducks or song birds.[20] Even the magazines had elaborate mural decorations depicting tables heaped with food, papyrus plants and leaping calves. These magazines

14 E.g. Tomb 3070 at Saqqâra. Cf. Emery 1968.
15 Egyptian Museum, Cairo, Special Register number 3+5+27+4.
16 Tytus 1903, 17.
17 Tytus 1903, 17–18.
18 Tytus 1903, 20–21.
19 Smith 1998, 166–167.
20 Tytus 1903, 22.

Fig. 5: Portion of ceiling painting from the Palace of the King at Malqata with repeating pattern of rosette-filled running spirals alternating with bucrania from the antechamber to the 'King's bedroom'; h. 140cm (55 1/8in), w. 140cm (55 1/8in) (Metropolitan Museum of Art Rogers Fund, (1911) MMA 11.215.451; photograph courtesy of the Metropolitan Museum of Art).

had shelves with cavetto cornices modelled in mud plaster.[21] Fragments of other sculptural elements in mud plaster, wood and faience used as architectural decoration were found throughout the palace (Fig. 6).

Although many earlier expeditions had worked here – Tytus in 1901–1902, the Metropolitan Museum in 1910–1911, and Waseda University in 1985–1988 – still an enormous number of fragments of painted mud plaster remain at the site and one of the goals of the current Joint Expedition to Malqata[22] is to document and preserve not only the remaining in situ paintings but also the fragments scattered in the fill throughout the palace. Although many have been disturbed by the earlier archaeological work, much can still be gleaned about their original context and their place in the overall decorative scheme.

21 Tytus 1903, 22.
22 Lacovara 2014, 28–33.

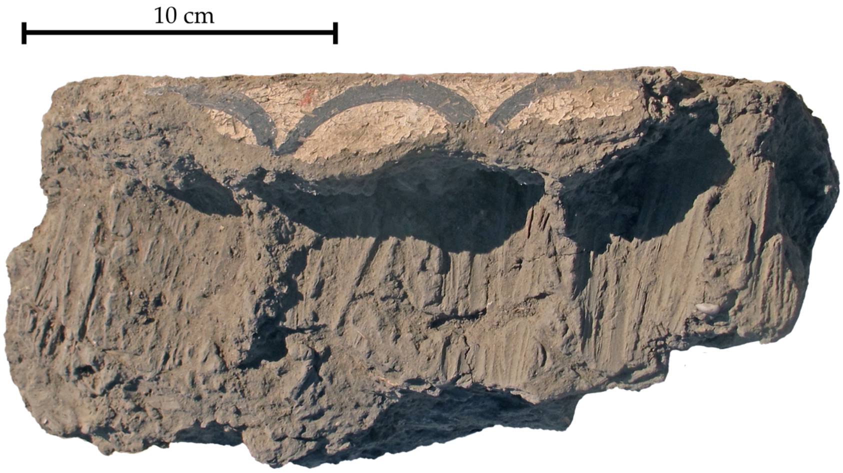

Fig. 6a: Fragment of a cavetto cornice modelled in mud and painted from the Palace of the King at Malqata (photograph by the author).

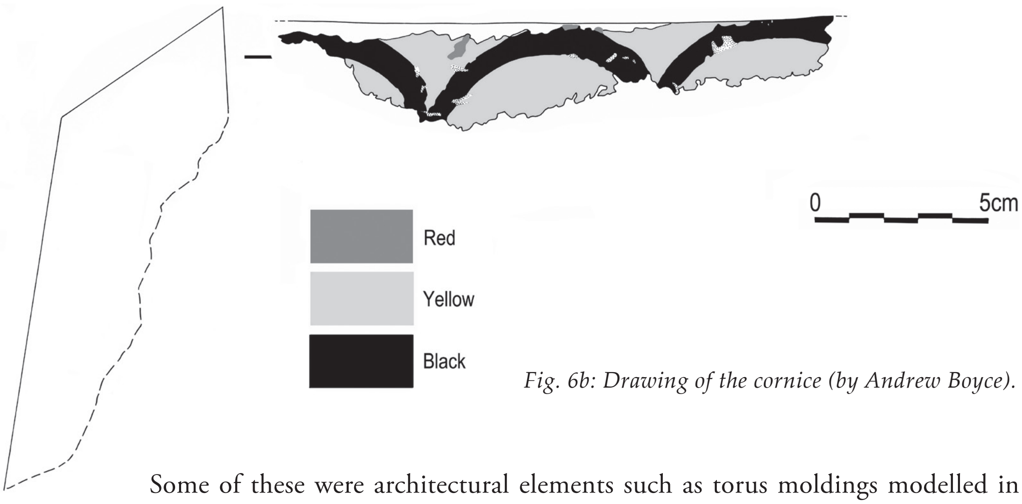

Fig. 6b: Drawing of the cornice (by Andrew Boyce).

Some of these were architectural elements such as torus moldings modelled in mud and then painted or even a cavetto cornice set into the wall on wooden sticks driven in at an oblique angle and then the cornice modelled in mud and painted (Fig. 6). Other, purely decorative painting included elements of ceiling patterns, floral swags and even figural decoration. While much of the ceiling and floor paintings survived intact, preserved when the roof of the palace 'pancaked in', far less of the wall decoration remained so it is still unclear what the extent and composition of these decorations were like. Both the surviving architectural embellishments and the mural decoration in the Palace of Amenhotep III are, by far, the most completely preserved of any Egyptian royal palace and suggest aspects of both the symbolic and actual function of the royal residence.

Peter Lacovara

2. Analysis of Painted Floor- and Wall Plasters from Malqata and Site K in Western Thebes

To obtain detailed knowledge about the original materials used for the construction and decoration of architectural surfaces in the King's Palace, conservation- and natural scientific mortar analysis was implemented on selected plaster fragments[23] during the 2015 and 2016 field season of the Joint Expedition to Malqata.[24] This paper presents preliminary results from the recent analysis of the palace's mortars and plasters and the applied plaster technology and wall painting technique.

Based on prior visual-phenomenological investigations of the site's archaeological mud brick architecture and its fragmentary preserved plasters and wall paintings, various mortar- and plaster materials could be differentiated. Representative small mortar and plaster fragments with different technological functions were then sampled from floors, walls, daises and collapsed ceilings of different rooms within the Malqata palace. For comparison further small samples could be collected from the stratigraphy of the remaining excavation sections of Kemp and O'Connor at nearby Site K,[25] especially in trench Ka and Kb.[26]

Besides the determination of the chemical-mineralogical composition and a categorisation of the different mortar and plaster types according to their main binders another focus lay on the documentation of technological features that reveal the applied plaster and wall painting technology at the royal residence and the probable earlier palace at Site K.

Considering the restrictions of sample export and transport from and within Egypt all material analysis had to be conducted on site. Therefore a 'mobile field laboratory' assembled for the plaster research was set up in the old mud brick guardhouse next to the King's Palace. With portable photographic and analytical equipment it was possible to perform essential natural and conservation scientific investigations under challenging circumstances. The implemented methods included stereo and digital microscopy on Cyclododecane[27] cross sections, histochemical-staining techniques, wet chemical analysis, digital multispectral imaging and image analysis (including 'visible-induced

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23 The analysis is carried out as part of an ongoing research and PhD project of A. Winkels on: "Mortars and plasters in ancient Egyptian wall painting and architecture. A comparative study of the materials and technology using conservation and natural scientific methods" based at the Conservation Department of the Academy of Fine Arts Dresden, Germany. The project investigates the spectrum of ancient Egyptian mortars and plasters with different technological functions that were processed for architectural construction and surfaces on mud brick, stone and rock-cut architecture from the Predynastic, Pharaonic towards the Greco-Roman period, at significant archaeological sites in Egypt.

24 Directed by Dr. Diana Craig Patch (Metropolitan Museum of Art, New York) and co-author Dr. Peter Lacovara (Ancient Egyptian Heritage and Archaeology Fund).

25 The work at Site K was possible through a generous grant of the Institute for Aegean Prehistory, Philadelphia, USA.

26 Kemp – O'Connor 1974, 101–136, 122, fig. 19. The painted plaster fragments, found at the earlier excavation have been described by Kemp 2000 and Nicolakaki-Kentrou 2003.

27 Cyclododecane is a volatile binder used for temporary conservation purposes. Melted or dissolved in non-polar solvents it can be applied on or soaked in different materials or objects and thus be used for temporary structural consolidation, as well as for the recovery of archaeological finds. When exposed to the air it changes slowly from a solid into a gaseous state and sublimates again from the structure of the treated objects without residue, see Stein – Kimmel no date; Hangleiter *et al.* no date.

 

Figs. 7 and 8: Fragments of ceiling- and wall plaster, uncovered in room K[1] of the King's Palace.

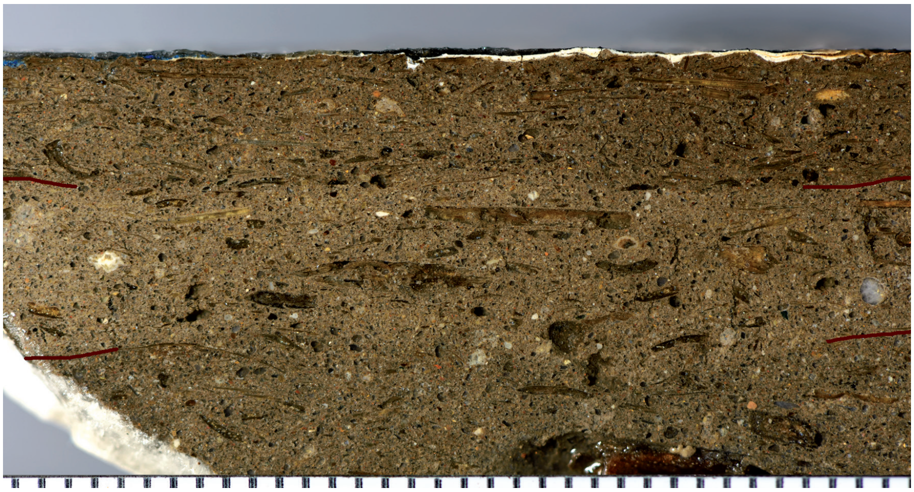

Fig. 9: Ceiling fragment with three layers of dark brown Nile clay plaster (red lines mark the borders). The composition of the plasters varies slightly in the content of mineral aggregates and organic fillers made from finely chopped and coarser plant fibres. The upper plaster carries a polychrome ceiling painting. Scale 1mm.

luminescence imaging' to detect faded Egyptian blue in the wall paintings) or the determination of the calcium carbonate content in the mortars.[28]

The analytic results revealed that four main mortar and plaster types were used for the construction and design of the architectural surfaces within the King's Palace. These were processed for individual technological functions within the architecture. The comparison of the representative Site K samples from the various plaster types give important evidence that nearly the same plaster materials were used for the construction of architectural surfaces as at the nearby ancient royal city Malqata.[29]

28 Concerning the methods, see e.g. Winkels 2007, 275–280; Winkels – Riedl 2015, 264–269.

29 Unfortunately, without further excavation the Site K plaster fragments cannot be related to a defined room, complex, or stratigraphic layer being from a demolished building and due to their burying situation.

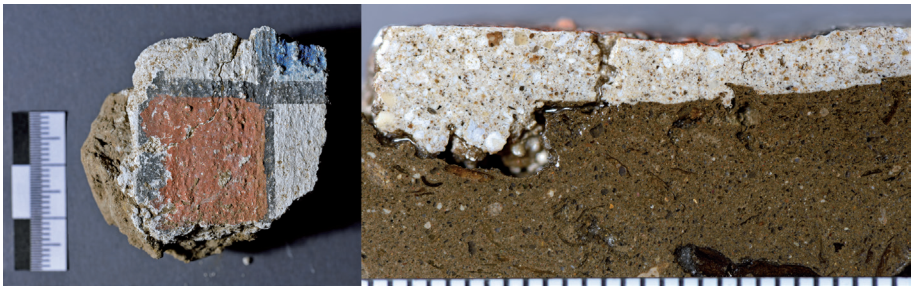

Fig. 10: Fragment of chequerboard frieze with two different plaster types; the cross section shows the first clay plaster layer and a thinner second gypsum-lime plaster that functions as wall painting support carrying the white ground colour with black outlined red and Egyptian blue cubes. Scale 1mm.

Most frequently dark grayish-brown clay plasters were used to construct and cover the floor, wall, dais and ceiling surfaces of the royal palace's mud brick architecture (Figs. 7, 8). The dark brown clay that functions as mortar binder is Nile clay from the alluvial flood plain. Main mineral aggregates of these Nile clay plasters are fine silt and quartz sand with few fossil and shell inclusions which are mostly a primary content of the natural clay. Yet certain amounts of sand appear to have been secondarily added to the raw mortar as additional mineral aggregate. Very characteristic for the Nile clay plasters is a higher content of plant fibres as organic fillers, primarily straw and leaf fragments or fibres, *e.g.* from shredded wheat or palm trees, functioning as material immanent reinforcement.

Often multi-layered plaster stratigraphies can be observed, as especially ceilings but also selected wall levels have been built with up to three plaster layers in one building phase (Fig. 9). The plant fibre content is mostly higher and coarser in the lower plaster layers. These contain also bigger plant fragments as rounded stem pieces, partly from the matting used as reinforcement of the ceilings into which the lowest plaster layer was pressed.

On painted surfaces the top plaster layer respectively carries the paint layer of the wall and ceiling paintings.

On single painting fragments of room K^1, uncovered in 2016, a yellowish white to reddish white mortar was applied on top of the clay plaster and carries the wall painting (Fig. 10). It occurred under parts of a blue, green and red chequerboard pattern frieze on white background, possibly from the room's ceiling.[30] The mortar material obviously functioned as a plaster repair and was apparently limited to certain areas of the ceiling. No widespread plaster application could be noted on other fragments of the frieze. But the same mortar was also used as stucco to form a small round bar that possibly ran around the upper wall or maybe a doorframe of the room.

A very similar yellowish-grayish white material functioned as setting mortar and partial plaster for the stones of a bathroom basin in room N^4.

30 Lacovara 1994, 18. A similar pattern was here reconstructed on a drawing of a "cross section of the ceiling in the 'king's bedchamber' at Malqata".

The analysis verified that these materials could be defined as gypsum-lime mortars and plasters. Though they contain higher calcium carbonate contents between 16% up to 74%,[31] gypsum (calcium sulphate) takes the main binder function within the mortars. It can occur in different variants called calcium sulphate dihydrate (gypsum), calcium sulphate hemihydrate (bassanite) or the anhydrous calcium sulphate form (anhydrite) that result in different solubilities and setting times.[32]

The binder of this mortar type appears to have been produced from a dry powder of decomposed limestone containing varying amounts of gypsum and the other calcium sulphate modifications bassanite and anhydrite as secondary efflorescent deposits.[33] Other impurities are reddish-brownish clay minerals and iron oxides. The raw material occurs below the surface of the Egyptian limestone plateaus and is also called 'gypsite'.[34]

The interacting binder types in the gypsum-lime mortars are therefore different gypsum modifications[35] and calcium carbonate – recrystallised from the fine stone powder.[36] So the calcium carbonate here did not develop in a chemical process like in a classical lime plaster (see below).

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31 Measurement result in mass percent.

32 The gypsum modifications with different contents of chemically combined water occur naturally or can be produced by firing quarried gypsum stone or gypsite material. During the firing process the gypsum raw material passes through a series of phase changes according to the existing firing temperature:

- Firing below 40°C: Calcium sulphate dihydrate ($CaSO_4 \cdot 2\ H_2O$ – gypsum, low fired gypsum)
- Firing above 40°C–110°C–200°C: Calcium sulphate hemihydrate ($CaSO_4 \cdot 0.5\ H_2O$ – bassanite; often called 'plaster of paris' or 'stucco gypsum').
- Firing above 200–1.180/1.200°C: Anhydrous calcium sulphate (different phases – anhydrite III-I). Between 200–300°C anhydrite III ($CaSO_4$III) is converted in anhydrite II ($CaSO_4$II).

With increasing firing temperature the water solubility of anhydrite II decreases, until it becomes hardly soluble. Above 700°C the so-called 'Estrich' gypsum is produced (still anhydrite II). Anhydrite I is built above 1.180°C. For listed reactions and chemical formulas see e.g. Bundesverband der Gipsindustrie e.V. 2013, 16–19; Lenz – Sobott 2008, 25–26.

The anhydrite-phases are also termed 'high fired gypsum'. They differ from gypsum/bassanite burned below 200°C by material properties, such as a much slower setting behaviour and an enhanced hardness.

33 Further detailed investigations on this mortar type and the related raw materials including firing processes are ongoing in the mentioned ancient Egyptiant plaster research project of the author. Especially in connection with the Great Aten Temple excavation by Barry Kemp (Amarna Project) where it was used in large scale and ongoing analysis of the painted floor plasters of the Amarna palaces, see e.g. Winkels 2014, 22–23. Detailed results will be published in the near future.

34 Concerning the raw material, see: Lucas 1924, 129–130; Harrell 2014, 25–26, 28.

35 In the setting process of gypsum mortars, the different gypsum varieties reform in contact with water. During this rehydration, the hemihydrate bassanite and the anhydrous anhydrite recrystallise to gypsum (calcium sulphate dihydrate) again and an intergrowth of new gypsum crystals is formed. The curing and hardening of gypsum-based plasters therefore occurs proportionally to the conversion of the bassanite or anhydrite into the calcium sulphate dihydrate. While the bassanite hardens very fast, the rehydration and hardening of anhydrite is slower and takes longer, extending several days, see Lenz – Sobott 2008, 25–28. Therefore, once this process is finished anhydrite-rich mortars build more stable mortars than those with higher gypsum or bassanite contents. This allows a longer processing time of the fresh mortar and affects a higher stability of the hardened material.

36 The raw material for the mortar binder production was apparently only heated enough, at estimated firing temperatures between 300 and 600°C, to burn and reduce the included gypsum minerals during the firing process, while the limestone powder remained unfired. The unburnt calcium carbonate has partly recrystallised, possibly in contact with carbonate water added during the mortar mixture or secondary moisture penetration by the capillary rise of ground water. The recrystallised calcium carbonate binds the aggregates together in mixture with the included rehydrated gypsum phases and partly only by mechanical adhesion. Accordingly the mortar appears softer as a carbonated lime mortar.

Fig. 11: *Thin gypsum-lime plaster with underlying first clay plaster layer on the dais in room K[1]. The thin plaster wash shows brush stroke impressions from the application. Scale 1cm.*

Fig. 12: *Unpainted white lime plaster floor fragment from palace room E with characteristic fine plant fibres as organic fillers. Scale 2mm.*

Main mineral aggregates are limestone and gypsum powder and particles, crystalline calcite and fewer amounts of quartz grains or fragments of other stone varieties. These could derive partly from a natural grain size distribution of the fine gypsite soil. But especially the medium and coarser grained aggregates to some extent must have been especially collected, processed and additionally added. No plant fibres as organic fillers are included.

The reasons why this mortar material was chosen for the purposes of setting stones and repairing wall plaster sections might be its higher structural stability, increased hardness and lower shrinking potential. Compared to clay plasters, gypsum-lime mortars or plasters are less sensitive in contact with water.[37] Based on its lower hygroscopicity and dense texture of non-swellable materials it does not swell and disintegrate immediately in contact with water as swellable clay minerals. It further matches the material colour of the used lime stones.

The application of comparable mortar and plaster material not only for floor, wall, and ceiling plasters but also for repairs in clay plaster or rock cut stone surfaces could be observed *e.g.* in many tombs of the nearby Theban necropolis.[38]

The good properties of the described gypsum-lime mortars were also used for another purpose: While in many rooms of the King's Palace the dark brown Nile clay plasters function as first ground layer on floors or daises, millimeter-thin brownish white plasters applied on top build the visible architectural surfaces (Fig. 11). Like on the dais of room K[1] sometimes up to four of such floor phases could be noted on top of each other, all having a first Nile clay plaster layer and a second thin gypsum-lime plaster wash as the upper, visible layer.

The plaster material could be categorised as 'gypsum-lime plaster' with higher calcium carbonate contents as it was also made of a finer gypsum-lime mortar. The binder and main aggregates of these plasters merely consist of fine to middle grained

37 That being an important aspect especially for features like the bathroom basin or floorbound aplications.
38 See e.g. García-Moreno *et al.* 2013, 101–102; Middelton 2008, 23–24; Miller 2008, 61–62.

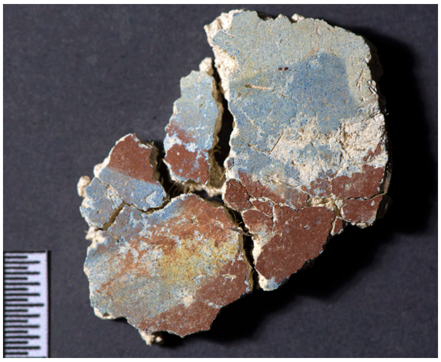

Fig. 13: Painted lime plaster floor fragment from room E. The evenly smoothed upper plaster layer carries polychrome painting and is only 2mm thin.

Fig. 14: Especially well-preserved painted floor or dais plaster fragment from Site K with a first clay plaster layer and a second thin lime plaster surface.

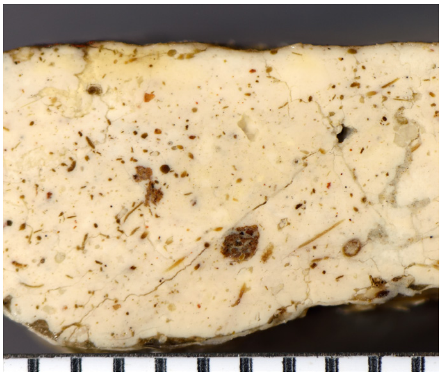

Fig. 15: Cross section of painted dais plaster from palace room F with fine brownish organic plant fibres and shrinking cracks within the mortar matrix. The evenly smoothed plaster surface carries a yellow paint layer with red colour fragments.

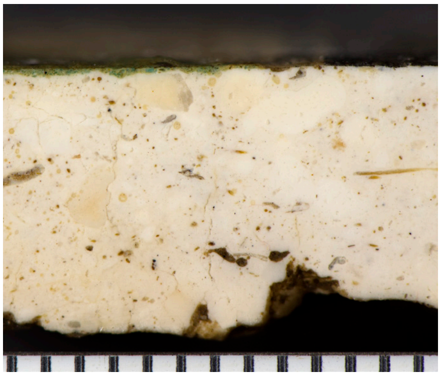

Fig. 16: Cross section of lime plaster with fine organic fibres and rounded "lime pats" from Site Ka. On the potential floor plaster green, yellow and black paint is preserved. The green colour was smoothed into the plaster surface after application.

limestone powder and different gypsum modifications with traces of clays and iron oxides. Unlike the alluvial clay plasters or the fine lime floor plasters described in the following (Fig. 12), no organic fillers are included. Further analysis will show if also kaolin or pale brown calcium carbonate rich marl clays, available in the nearby Theban Mountains and also called 'hiba' in Egyptian Arabic, have partly been processed for these thin floor plasters.[39] Fine impressions in the surfaces show that the millimeter-thin plasters have been applied with brushes like 'white washes' or rather fine 'plaster washes' onto the underlying clay plaster on floors and floor-bound daises (Fig. 11). Should the created bright coloured surfaces suggest or imitate the

39 In such 'hiba' or marl clay plasters the clay minerals or possible calcite-clay reactions would take the main binder function.

construction from more stable materials like stone daises or lime plaster floors that required more elaborate production processes?

However the lime plaster technique was indeed applied within the royal palace architecture to produce slightly more pressure-resistant white floor plasters: On floors and daises of selected rooms with apparently significant meaning the underlying Nile clay plaster layer[40] was covered with a millimetre thin bright white lime plaster[41] which received polychrome paintings (Figs. 13, 14).

The analysis showed that these lime plasters of *e.g.* the painted floor in the 'audience hall' of room E or the throne base in room F contain very high calcium carbonate contents up to 85% (Fig. 15). Small binder particles in the form of rounded 'lime pats' within the mortar matrix suggest that the lime binder was likely produced in a 'dry slaking' process.[42] The described 'lime pats' and the potential use of this lime binder production practice could also be observed in and for lime plasters from the earlier palace district of the 18th dynasty at ᶜEzbet Helmi, Tell el-Dabᶜa.[43]

Fine-grained limestone powder is the main mineral aggregate of the lime plasters but thicker plaster applications like the dais plaster can also contain rounded-sub-rounded unburnt to partly burnt limestone particles (Fig. 15). Very fine plant fibres function as organic fillers and reinforcement. Very different from the organic fillers used in the alluvial clay plasters, the often only 0.1–0.4mm thin fibres clearly have been especially prepared for this purpose. Microscopically they could be related to chopped palm leaf midrib fibres and sheath fibres from the netting around local date palm tree trunks and their leaf bases.

The same fibres could be detected in several of the collected Site K fragments that also proved to be painted lime plaster (Figs. 14, 16). These show nearly the same mineralogical composition as the painted dais and floor plasters from the palace rooms at Malqata and consist of a calcium carbonate based binder matrix that contains rounded binder particles and fine-grained limestone powder, sub rounded limestone particles and very fine plant fibres as main mineral aggregate and organic fillers.

All evidence indicates that the small lime plaster samples also appear to be floor or dais plaster fragments on a partly preserved underlying dark brown Nile clay plaster.

At both sites the lime plasters received a very elaborate treatment. Very fine ridges and smoothing structures give evidence of a strong compaction and even flattening

40 These showed a similar composition as the wall or ceiling plasters from the palace (see e.g. Fig. 9), varying in the amount of contained mineral aggregates and usually a high content of plant fibres primarily chopped straw as organic fillers.

41 This plaster type requires a more complex binder production process: The firing of limestone at temperatures above 890–900°C and a subsequent slaking of the burnt limestone (CaO, calcium oxide/quick lime) in water. The hydrated, slaked lime ($Ca(OH)_2$, calcium hydroxide) can then be used as a binder for lime washes or lime mortars, when mixed with mineral aggregates and organic fillers. During the carbonation process, the slaked lime reacts with carbon dioxide (CO_2) from the air while slowly releasing water and hardening as it carbonates back to calcium carbonate binding the added aggregates in the lime mortar matrix. For the lime cycle, see e.g. Weyer *et al.* 2016, 383–384; Hughes – Válek 2003, 1–2.

42 In this burnt lime processing type the calcium oxide, is slaked without water surplus and only so much water that is stoichiometrically necessary for the hydration and formaion into calcium hydroxide, see Elert *et al.* 2002, 63–64. A predominantly dry, paste-like calcium hydroxide is produced that includes rounded pats of calcium hydroxide and non-hydrated remaining calcium oxide.

43 Winkels 2007, 287–288.

Fig. 17: *White lime plaster surface (see Fig. 14) with fine smoothing structures. The yellow paint was applied while the plaster was still slightly damp and plastic leaving brush scratches. Pastose black and red applications apparently followed with an additional organic binder.*

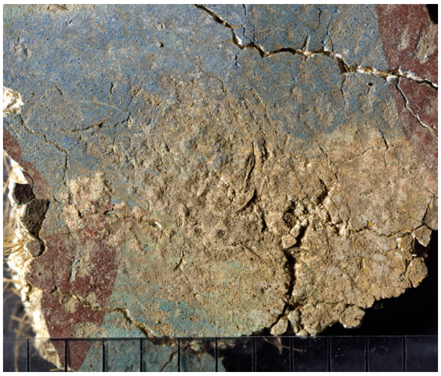

Fig. 18: Floor fragment from room E of the King's Palace. Fine textile impressions visible in the plaster surface and it's paint layer indicate the covering of the painted lime plaster floor during the plastering and painting process to ensure proper carbonation.

of the plaster (Fig. 17). During this process, a water-binder surplus is pressed to the surface of the fresh lime plaster. The fine smoothing structures then develop when flat trowel-like plaster tools are moved over the surface and through the surficially collected binder.

The colours were painted directly onto the evenly smoothed white plaster surface without noticeable underdrawing, including the bright white lime plaster tone as white background colour in the painting.

Very interesting is the occurrence of fine textile impressions in the surfaces of several lime floor plaster fragments from Malqata[44] (Fig. 18). Obviously, after the smoothing process the floors and possibly also the daises have been covered with fine woven textile that was supposedly moistened to ensure a complete carbonation process and prevent the premature drying of the lime plaster.[45]

The fact that some colour applications within such areas show impressions and tiny losses where the textile must have touched the surface suggests that floor parts were also covered with the textile after or in between the painting process. This suggests that the 'fresco' technique was intended for the floor bound paintings on lime plaster and the proper carbonation of the colours within the plaster surface should be aided. Other features confirm that certain areas and special colour applications were painted in the 'fresco' technique while the plaster was still damp and plastic. – These are *e.g.* brush strokes and streaks of thin brushes lightly impressed into the plaster surface during painting (Fig. 17).

44 Such impressions were also found by the author at the Great Aten Temple foundations at Amarna and on floor paintings of the Amarna palaces, see Weatherhead 2007, 367–368, pl. 67.

45 In this case the carbonation process cannot be completed and the lime based binder dries within the mortar to a fine white powder that has no or only a mechanical cohesive force.

However microscopic investigations proved no overall fresco bonding, especially not for the pastose colours. Most of the painting surfaces are strongly susceptible to moisture and not protected by a sinter layer of calcium carbonate.[46]

These observations indicate that the floor paintings were carried out in a mixed 'fresco-secco' painting technique.[47] It also could be noted that *e.g.* more pastose red and black colour applications or corrections with white colour fill these fine textile structures in the underlying plaster and the impressions cannot be found in the related paint surfaces. So parts of the painting were carried out afterwards in a 'secco' technique likely with an organic binder onto the dried plaster and painting surface.

Three main blue-green colour types could be observed on the painted lime plasters: The use of pure Egyptian blue in coarser and finer grained variations mixed in different pigment-binder ratios (Fig. 13), a mixture of Egyptian green with a low content of Egyptian blue and the use of a green earth pigment containing glauconite and a little content of Egyptian green and blue grains (Fig. 19).

Several of these Egyptian blue and pale green to pale bluish green colour applications appear to be strongly compacted and partially bound within the lime plaster surface during a supplementary smoothing and following carbonation process (Figs. 13, 19).[48]

In this respect it cannot be fully excluded that the calcium carbonate binder existing between the pigment grains is not only mortar binder pressed to the surface during the compacting smoothing. It partially could derive from an additional use of slaked lime as mineral binder for pigments. Resulting selected Egyptian blue and green colour applications could have been painted in a 'lime fresco' or 'lime secco' technique and additionally smoothed after application.

The wall and ceiling paintings preserved within the palace rooms were carried out in a clear 'secco' technique directly onto the dry, smoothed, dark brown clay plaster surface, without an all over interlaying white fine layer as we know it *e.g.* from painted tombs of the Theban necropolis (Fig. 7).[49] Compared to the painted floors, the wall and ceiling plasters were not always very thoroughly compacted and smoothed. While the described fine smoothing structures made by flat trowel-like plaster tools could also be observed on the clay plaster surfaces, many fine brush stroke impressions show that the finishing smoothing of the clay plasters was predominantly done with brushes. Leaving more uneven surface structures in large areas together surficially visible with organic fillers (Fig. 7).

46 Possibly a lack of moisture partly prevented the carbonation of the pigments within the plaster surface as it is characteristic for fresco painting. The arid desert climate on site with low relative air humidity could have caused a faster drying of the thin lime plaster layers. Additionally the underlying clay plasters prevented an extensive moistening before the lime plaster application because their clay binder dissolves in contact with too much water. Accordingly, a lot of the moisture from the fresh lime mortar might have easily been reduced by environmental conditions. Leaving no sufficient moist calcium hydroxide matrix to bind all colour applications into the plaster surface upon carbonation into calcium carbonate.

47 The relevant wall painting techniques that should shortly be differentiated here are the 'secco' technique or 'lime secco' (if lime is used as pigment binder) in which the paintings are carried out on a dry plaster. The painting on a fresh and still damp lime plaster is called 'fresco' or 'lime fresco' (if lime is used as additional binder for pigments before fresco application) and on half-damp lime plaster 'mezzo fresco'. See Weyer *et al.* 2016, 66.

48 The development of secondary lime crusts on the fragments during their long-term burial could only be observed very rarely due to the comparatively dry soil in the arid climate.

49 See e.g. Hartwig – Leterme 2013, 140–143.

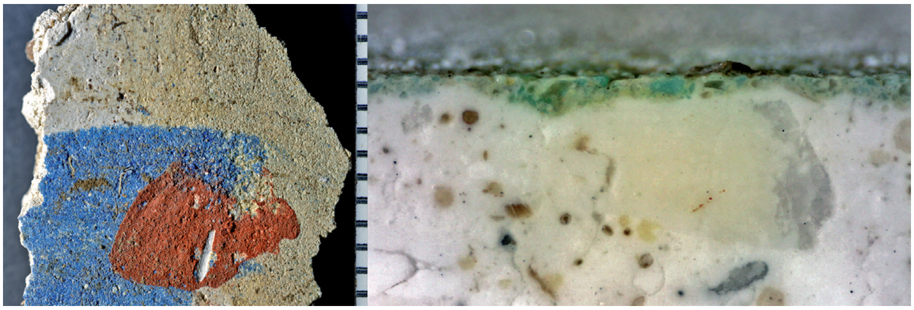

Fig. 19: Floor plaster fragments of Site K with Egyptian blue and light yellowish-green colour application that is strongly compacted and bound by a lime based binder. Width 4mm.

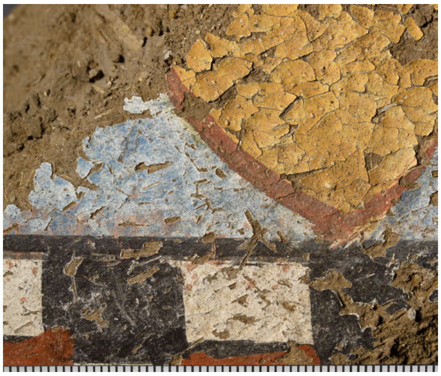

Fig. 20: Painted plaster fragment from the King's Palace showing lines and drips from a cord string that was soaked in red colour and then snapped onto the surface.

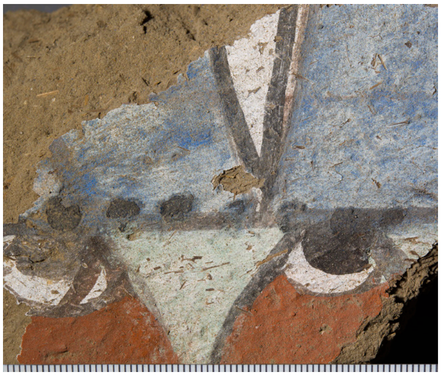

Fig. 21: Another painted plaster fragment from the King's Palace with traces of red outline and preliminary drawing that preceded the polychrome paint application.

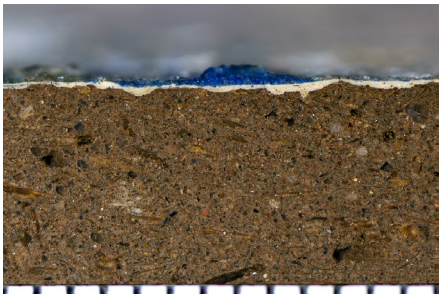

Fig. 22: Cross section of painted ceiling plaster with a calcium carbonate based first white wash on the plaster surface and a bright Egyptian blue paint layer.

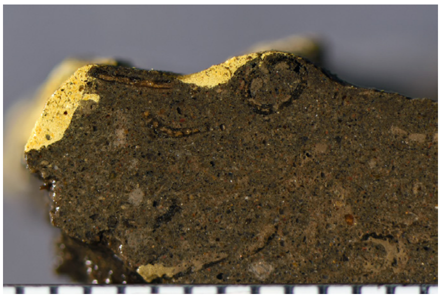

Fig. 23: Cross section of painted wall plaster fragment with a compact bright yellow paint layer directly on the clay plaster surface. The pigment appears to be Orpiment.

In selected areas of the decoration schemes, a white wash was applied that functions as background colour and further paint layer support (Fig. 10). On such white painted areas, some fragments show the use of red-coloured cord string marks and partial red preliminary drawings for the composition of the decorations on walls and ceilings (Figs. 20, 21). The polychrome painting of the surfaces was then implemented in different stages by a first application of the main colours, next to and partly overlaying each other. The succession of colours can often nicely be understood. Afterwards black and red contours were drawn as well as elaborate interior patterns. The application of Egyptian blue and green colour shades usually followed last but it could also be observed in places that last contours or corrections were painted over blue and green colour areas. The bluish green colour shades noted on the floor plasters are also included in the colour spectrum of the wall paintings. On selected fragments the differentiated use and mixture of green earth pigment with Egyptian blue and green could be investigated and verified in detail by 'visible-induced luminescence (VIL)-imaging'.[50]

The further colour palette used for the wall and ceiling paintings matches the pigments of the floor and dais paintings within the King's Palace and Site K, including different shades of yellow ochre, red iron oxide, manganese and charcoal black and calcium carbonate as fine grained white pigment applied as a lime wash or mixed with an organic binder (Fig. 22). One special pigment appears to have been used primarily in selected areas of the wall paintings within the palace rooms. The bright yellow pigment appears to be the arsenic sulfide Orpiment (Fig. 23). Further pigment analysis in the future will help to verify the determination of the different pigments.

Continuing the analysis and investigations of the painted plasters in the King's Palace and the Site K fragments alongside with emergency conservation treatment, promises not only to add our knowledge about the sophisticated work know-how and elaborately applied techniques. But as well about the function and program of the decoration, both in the context of the Amenhotep III's building program at Malqata and also providing an important comparison to Tell el-Amarna. Enabling us to address questions such as were the same artists involved and the same materials used? And what can the similarities and difference in the decorative schemes tell us about the nature of the Amarna palaces? Even in its destroyed state Amenhotep's palace can still offer so much information from the remaining architectural fragments and beautiful wall and floor paintings about three thousand years later and hopefully the ongoing conservation efforts will preserve this important relic of Egypt's grandest age for generations to come.

Alexandra Winkels

50 Egyptian blue emits a bright luminescence that lies in the infrared range when it is excited by visible fluorescent light. With a infrared-sensitive digital camera (modified through the professional removal of the integrated Infrared(IR)- and Ultraviolet(UV)-blocking filter) this luminescence can be photographed. As a special filter applied in front of the camera lens captures the IR-radiation but blocks out all visible light. Thereby also the tiniest traces of Egyptian blue that are not noticable anymore in visible light can be shown in the digital IR-image. See e.g. Verri 2008, 41–50.

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TRACING TECHNOSCAPES

Colourful surface treatments form an integral element of vernacular and élite architecture of ancient societies. This is also true for the various regions of the Eastern Mediterranean in the 2nd millennium BCE, where elaborate wall paintings furnished temples, tombs, palatial buildings, and in general more elaborate houses. From a present-day perspective, these rich images provide invaluable insights into past realities as well as interconnections between different visual systems. However, beyond stunning images, the materiality of wall paintings implicates a whole range of specific technical choices and gestures executed during the artistic process. The bodies of knowledge immanent in the practice of plaster and pigment preparation, in the application of paint and in the conception and execution of compositions allow us to compare the wall painting corpora of the Eastern Mediterranean on a technical level and to trace differences and similarities in a cross-cultural perspective.

Evolved from an interdisciplinary workshop held at the 10th ICAANE in Vienna, this volume provides insights into the various technical approaches and underlying bodies of knowledge in the different wall painting traditions of the Eastern Mediterranean and West Asia and throws light on the way and extent of their possible interwovenness. Moreover, it seeks to overcome regional as well as disciplinary isolation of technical studies by bringing together authors of different scientific backgrounds ranging between Conservational Studies, Archaeometry, Prehistory, Egyptology, as well as Western Asiatic and Classical Archaeology. In doing so, the book permits an interdisciplinary perspective on this field of study.

This book is equally intended for archaeologists, art historians, conservators and the interested layperson and hopes to stimulate more research in this direction in future.

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