E.2.1869 Pa Kepu
Outer Coffin Decoration Report

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Introduction

Pa Kepu is a nested set of coffins: an inner coffin and an outer coffin. The following report details the examination of the decorated layers on the outer coffin only. The examination of the inner coffin can be found in its own report. Further structural analysis of the outer and inner coffins can be found elsewhere. Some analytical results are found in more detail in separate, individual reports (i.e. FTIR, FORS).

Figure 1: Pa Kepu, E.2.1869, Outer Coffin (above), Inner Coffin (below)

The following examination of Pa Kepu was effected using a multidisciplinary, analytical approach. Visual inspection of the coffins was complemented by microscopic examination and technical imaging such as X-radiography, raking light photography, Visible-light Induced Luminescence (VIL) photography and UV photography.

Non-invasive analytical methods were used to identify pigments on the surface, including X-Ray Fluorescence (XRF) Spectrometry and Fibre-Optic Reflectance Spectroscopy.

Further examination of the pigments and paint layers was carried out using sampling methods: cross section analysis, Polarised Light Microscopy (PLM) and Fourier Transform Infrared Spectroscopy (FTIR) (which can be non-invasive or sampling, but in this case was sampling). Some additional analysis took place via X-Ray Powder Diffraction and some of the cross sections were examined with Scanning Electron Microscopy-Energy Dispersive X-Ray Spectroscopy (SEM-EDX).

Further experimental details about each of these techniques can be found at the end of this report.

Summary statements – visual examination of the surface and condition of the outer coffin

Figure 2: Pa Kepu Outer Coffin, View of Lid

The outer coffin is an anthropoid coffin, the outer part of a nested set of coffins. It is decorated on the exterior of the outer lid, and both the exterior and interior of the box. The coffin has suffered damage during opening and there are many damages to the paint layer, but the paint is secure (no flaking). The surface of the outer coffin is matte, especially on the front of the lid. There does not appear to be a varnish layer, and there is a layer of grey surface dirt present over the entire coffin. This is made more evident by the selective cleaning that has taken place on the white stripes around the edges of the outer lid. This surface dirt is much less pronounced on the coffin box. There are some consolidation residues from a previous conservation treatment which can be found under the chin. There is also some uneven texture in the paint underneath the beard, possibly suggesting that there was initially a larger piece to the beard that attached here. There are some paint and plaster losses to the area surrounding the removable beard. Further conservation details can be found in the conservation reports: E.2.1869 outer coffin 2015.doc and E.2.1869 outer coffin JU 2005.doc.

The outer lid and box were painted separately before closing. This can be seen on the box, where the calcite layer overlays the mortise holes. The paint layer on the exterior of the lid has dried before closing, creating a hanging layer of paint around the edges, almost like drops. There is no evidence that it was painted while shut – as this would cause characteristic damage to the paint layer when opened.

Figure 3: Detail of Outer Coffin Lid, showing the dried paint along the proper left hand edge, showing (despite some damages) that the paint dried before shutting

The exterior surface of the outer coffin is extensively covered with a pink paste consisting of calcite and an iron oxide- and quartz-containing material like an earth. On the proper right side of the lid, near the feet, there are two pink pastes, a slightly lighter more grey material overlaying the pink paste. In the interior of the lid the pink paste and a smaller amount of the paler paste was applied along the joins between wooden boards.

Figure 4: Damage in crown of outer coffin, revealing textile beneath

On the exterior surface the pink pastes were followed by a white calcite preparation layer across the entire surface. The coffin has occasional areas of textile found underneath the white preparation layer – these were found on the crown and on the face, but nowhere else (see Figure 4 & Figure 14). It is unclear what relationship the textile has with the pink paste.

The paint layers that follow are applied directly to the white calcite layer. The calcite is left exposed in many areas to stand in for the colour white. The palette is restricted – on the outer coffin lid there appears to be one shade of each colour: a single green, probably Egyptian green; a dark blue, Egyptian blue (although discoloured to a dark green); a deep brown red, red earth; a single white, exposed calcite from the preparation layer; and black.

While most of the colours on the lid have only one shade, there are two different yellows present: a pale and a saturated yellow. The pale yellow is almost white in colour, and it appears to be either a degraded orpiment or a mixture of orpiment and calcite. If it is the former, the coffin would have had a much more vivid, golden appearance.

The pigments and colours found on the outer coffin box are the same as those used on the lid, but with an even more restricted palette. There is no pale yellow orpiment or Egyptian green on the box, only the red, rich yellow and blue.

<u>Application of the paint layers: order and orientation</u>

The application of paint is thin and washy. There are no thick layers nor is there a building up of paint, although some of the blue paint along the broad collar appears to be thicker than the surrounding paint passages.[1] Several PLM samples present as mixtures with calcite, probably because the paint is applied so thinly it became impossible to sample only one layer.

There appears to be an order of application of the paint colours. From a close examination of the outer coffin, it was observed that each of the colours was applied one at a time. The order of the colours is listed in Table 1.

[1] No organic analysis was carried out on the outer coffin (i.e. GC-MS; FTIR). If this becomes available in future, it might clarify the binding media used on this coffin.

Table 1: Order of paint layers on Pa Kepu (E.2.1869) Outer Coffin

Outer lid	Outer box interior **	Outer box exterior **
Wood support	Wood support	Wood support
Pink Plaster	Pink Plaster	Pink Plaster
White calcite layer	White calcite layer	White calcite layer
Black drawing	Black drawing (on interior not exterior)	
Pale yellow	Yellow***	Yellow, red & blue (order of application unknown)
Yellow*	Red***	
Red*	Blue	
Blue	Black text (interior, head end)	
Black drawing: writing, reinforcing figures and characters		
Green		

* on the crown, the red was applied before the yellow (see Figure 5)
** The exterior of the outer coffin box has no black drawing. Furthermore, since none of the colours overlap in this area it is impossible to tell which order they were painted in.
*** The proper right and left interior sides of the coffin painted the red first, then the yellow; elsewhere on the interior of the outer box the yellow was first, then the red.

Figure 5: Detail of the crown of Pa Kepu's Outer Coffin Lid, showing the yellow paint overlying the red.

The lid looks like it was painted lying flat, as indicated by the direction of the dripping paint in the blue stripe.

Figure 6: Detail of Outer Coffin lid, proper left hand side, blue stripe with dripping paint

The interior of the lid is not fully coated or decorated, but there are black lines marking out the location of the tenon holes (see Figure 7).

Figure 7: Tenon hole marks on the underside of the outer lid

On the box, the red and yellow stripes and the blue text found on the exterior (around the sides and top of the head) were applied directly to the white surface without any underdrawing. The stripes appear to have been applied with a single thick brush line. There is no evidence of any aids being used to create a straight line. It is possible to see the break between single brushstrokes when looking at the exterior. The blue text has also been applied with a thick brush in a fluid motion. It is difficult to determine what orientation the box in was when the exterior was painted – the blue paint appears to pool slightly towards the base of the box, but it is not clear or strong evidence in this case (although painting the exterior of the box while lying flat on its base seems the most likely orientation). There is no overlap between passages on the exterior of the box and it is therefore impossible to determine in what order they were painted.

The interior of the box, by contrast, was moved around during painting. This is indicated by the orientation of dripping paint of different colours on different parts of the interior. Moving the box around during painting would make sense, as it would be awkward to gain proper access to all the surfaces inside the coffin if left in the same orientation. Each colour was examined on the different interior surfaces: which order they were painted in, and what orientation the coffin was in when it was painted (this was determined by the direction of the drips, where available).

The results are charted in Table 2. These suggest that the inner sides (proper left and proper right) were painted while the object was upright (standing on the footboard). The headboard was painted lying down, flat on the base of the box. The footboard appears to have been painted while the coffin was lying on its proper right hand side (although only one colour could be seen dripping on this part of the coffin). The base however appears to have been moved around, depending on the colour: the yellow was painted while the base was standing upright on its footboard, but the blue was painted while the coffin lay on its proper right hand side.

The order in which the three colours were applied changes depending on the interior surface. This is also labelled in Table 2.

Table 2: Orientation and order of the Outer Coffin Box during painting of different colours on the interior

	Yellow	Red	Blue
Base	1. Yellow was painted while the box was standing upright on the footboard – dripping paint towards footboard (Figure 8)	2. No clear evidence for orientation	3. Blue was painted while the coffin was laid on the proper right hand side – dripping paint towards proper right hand side (Figure 8)
Footboard	1. No clear evidence for orientation	2. Red was painted while the coffin was laid on the proper right hand side – dripping paint towards proper right hand side (Figure 9)	3. No clear evidence for orientation
Proper Left Side	2. Yellow was painted while the box was standing upright on the footboard – dripping paint towards footboard (Figure 10)	1. No clear evidence for orientation	3. Blue was painted while the box was standing upright on the footboard – dripping paint towards footboard (Figure 10)
Proper Right Side	2. Yellow was painted while the box was standing upright on the footboard – dripping paint towards footboard (Figure 11)	1. Red was painted while the box was standing upright on the footboard – dripping paint towards footboard (Figure 11)	3. No clear evidence for orientation
Headboard	1. Yellow was painted while the box was lying on its base – dripping paint towards base (Figure 12)	2. No clear evidence for orientation	3. No clear evidence for orientation

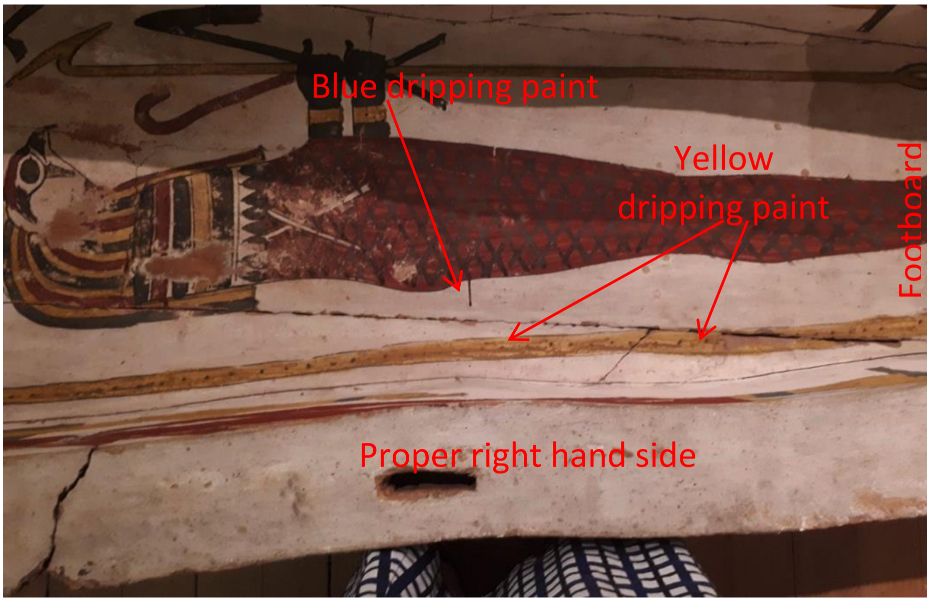


Figure 8: Interior of Outer Coffin Box Base, showing dripping blue paint towards proper right hand side

Figure 9: Interior of the Outer Coffin Box footboard, red dripping towards the proper right hand side

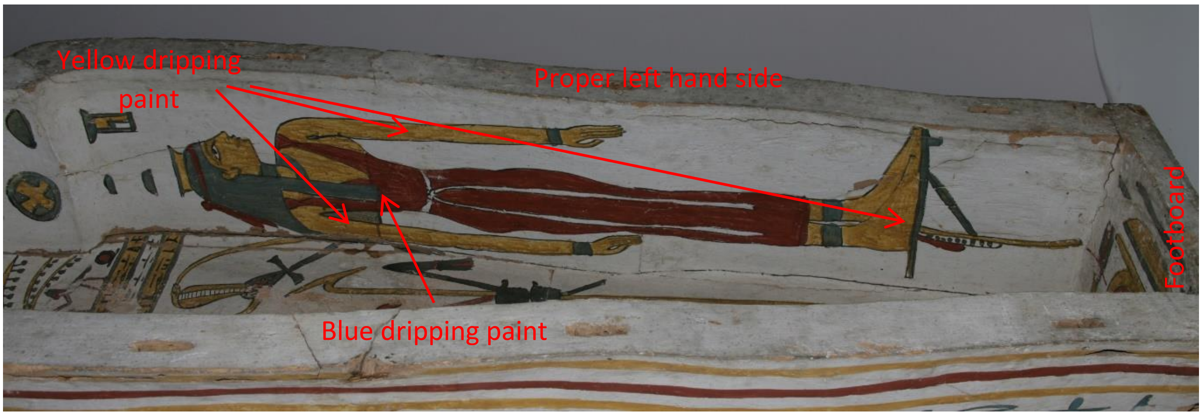


Figure 10: Interior of the Outer Coffin Box, proper left hand side, showing dripping yellow and red paint towards the footboard

Figure 11: Interior of the Outer Coffin Box, proper right hand side, showing dripping yellow and red paint towards the footboard

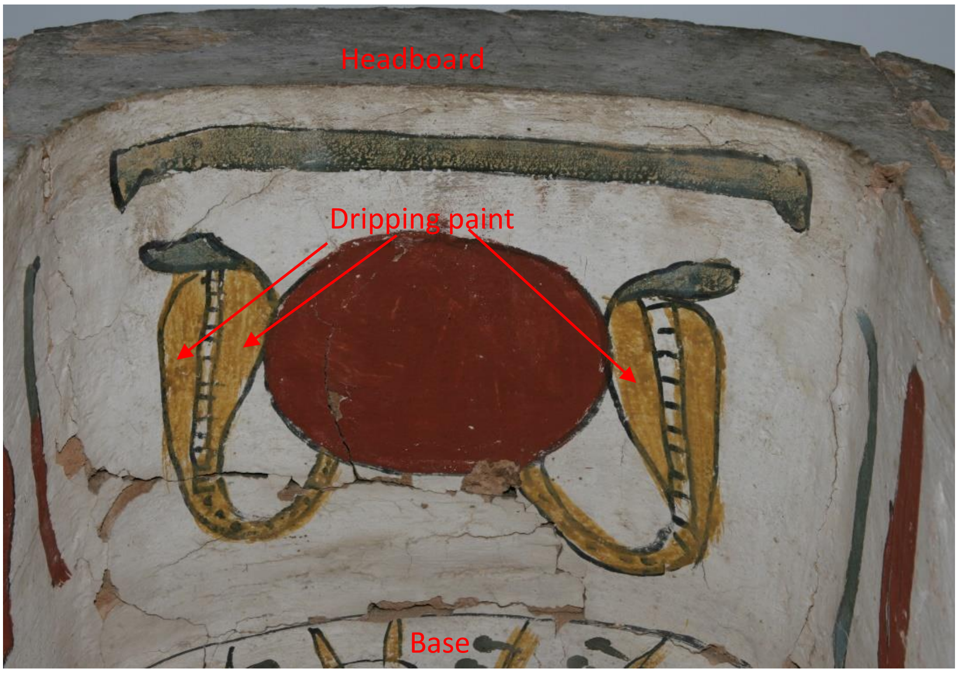


Figure 12: Interior of the Outer Coffin Box, headboard, showing dripping yellow paint towards the base

Outer Coffin Decoration: Discussion

Preparation layers

There is a pink preparation layer lying across the entire exterior of the outer coffin lid. It is found as a thick layer on the underside of the lid. This pink preparation is followed by a thin calcite layer on the exterior of the coffin lid (but not the interior). The pink preparation layer on the box presents as an uneven layer (sometimes very thick, sometimes barely present), across the entire surface of the box (interior and exterior). It is the same material used to bulk out and strengthen the joints where the wood has been constructed into the coffin shape.

Cross sections OB01, OB04, OL03, 09, 10 & 11 all show a double preparation layer: a white calcite preparation layer lying on top of a base pink paste layer. This appears to be the same for the lid as for the box. This pink, granular layer was applied across the wooden surface (sample OL09 actually has a small amount of wood in the sample, directly underneath the pink plaster) of the outer coffin and allowed to dry prior to the application of the white, calcium carbonate preparation layer. It appears to have been applied to smooth the irregularities in the surface as well as to fill gaps in joins and damages.

Joins between wooden boards on the box have been bulked out using the same coarse pink paste that is seen on the coffin lid. However, this has been used much more extensively on the box, particularly on the side panels where angled boards fit together very poorly and the paste has been used to fill the gaps. There is no evidence of a second pink layer. The pink paste has been partially smeared over joins between wooden boards on the underside of the box, but this area is otherwise not coated or decorated.

Figure 13: Pink paste on proper right hand side of the interior box (of the outer coffin)

There are some areas on the face and crown of the outer coffin where linen was used in the structure of the coffin and here the pink plaster seems to have been applied to smooth over the texture of the weave (see Figure 4 & Figure 14).

The pink plaster on the lid and the box seems to be broadly made of similar materials, but possibly different batches. The pink plaster in both cases seems to be a mixture of calcite and some iron-oxide earth-like material containing quartz. The PLM samples (OB02 AND OL13) do not yield clear results, both showing calcite and quartz particles, with additional pink-yellow tinged material (probably iron-oxide containing earth). In cross section, the paste is a beige-pink colour, semi-crystalline, with a mixture of white and pink pigment particles, with occasional brown and black

Figure 14: Damage to outer coffin face, in area of textile

inclusions. The plaster found in lid cross sections (OL03, 09, 10 and 11) seems to be more pink, uniform and homogenous than the plaster found on the box (OB01, OB04), which is more granular and darker in colour. The XRD results (Dr Trevor Emmett, 2015) revealed that plaster samples from the lid and box both contained a mixture of calcite and quartz (the latter is often found as an associated mineral in earths). "The results can be confidently described as conventional lime plasters". The sample from the box (XRD 04) presented an unidentified peak on the plaster sample from the box:

> *The intense peak at c. 28.0° 2ϑ in the pattern of XRD 04 is perhaps, though, a little problematic. It seems to match the COD quartz entry 96-901-2604 but this represents a rather unusual, experimentally-produced high pressure polymorph as described by Levien et al. (1980). In a repeat XRD analysis the peak presented at much reduced in intensity and is probably due to 'ordinary' α-quartz.*[2]

Analysis of pink plaster areas (for the lid and box) by FORS showed iron absorption bands, supporting the identification of an earth pigment. Further evidence is provided by the significant iron peaks found in the XRF spectra from the pink plaster (ARTAX S11). Cross sections OL09 and OL11 were examined via SEM/EDX (S. Bucklow, 01.05.2015) and the results presented Ca, Si, Al, Na, Mg, S, Fe; elements consistent with a mixture of earths, quartz and calcite.

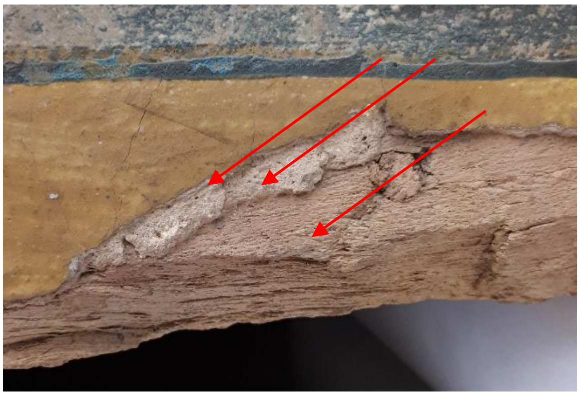


Figure 15: Detail of Outer Coffin lid with two pink plaster layers (arrows indicate lower, pinker plaster, grey-pink upper plaster and white calcite preparation layer)

Near the foot on the proper right hand side, there are a few areas where there is a second, lighter plaster layer present. This can be seen in Figure 15. XRD analysis of this layer (XRD 03) identified the same components (calcite and quartz) as the lower plaster from the lid and from the box. It is not clear why this is present, but it possibly meant to smooth out any irregularities in the original plastering.

[2] Emmett, T., 2015, pp. 7-8

Prior to painting, the exterior sides and the interior of the box were coated in a white preparation layer. This appears to be the same material used on the lid and has not been separately sampled. 'Combed' application marks are visible in places (see Figure 16), these can be seen on the x-rays and should not be confused with the grain pattern of the wood. It is likely that this texture is from the surface of the pink paste and it is made visible by the thinly applied white layer. The white layer appears to have been applied in a single phase. The mortise holes on the box were cut prior to its application; drips of this material can be seen running into the holes (Figure 16). There is no coloured decoration on the exterior footboard, this area is just coated with the preparation layers.

Figure 16: Textured plaster on proper right exterior shoulder under raking light (left); Mortise hole on proper left side of Outer Coffin box showing calcite dripping inside hole (right)

The surface of the outer coffin is covered in a white preparation layer – calcite, sparitic type (cross sections OL01, OL02, OL03, OL09, OL10, OL11, OB01 and OB04, PLM OL04, OL05 and OB05), found on top of the pink crystalline layer. This identification was made via PLM, but was confirmed via XRF.

Calcite particles were found in almost all the other PLM samples, and it is thought that these are coming from this white preparation layer as the rest of the paint was applied so thinly.

Drawing

The decoration and figurative elements are sketched in black in two steps. Examination of the outer coffin suggests that the black drawing was applied as initial sketches, and later as final details. The initial figures and broad outlines of the decorations were applied directly on top of the white preparation layer. These areas were then painted, and the edges of areas of coloured paint can be seen to clearly lie on top of the black drawing lines.

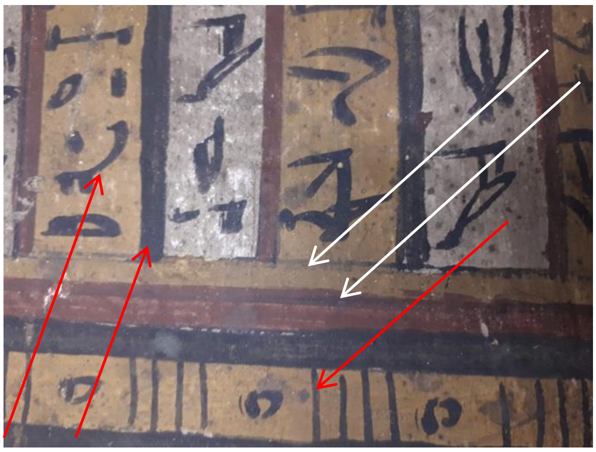


Figure 17: Outer Coffin Lid detail showing drawing lines covered with coloured paint (white arrows) and those on top of the coloured paint (red arrows)

Areas of the coffin were then reinforced with black paint as part of the final decoration, on top of the painted layers. (However this does not appear to be the final step, as green appears to have been painted on top of several dark black ‘reinforced’ black areas.)

Figure 18: Detail of Outer Coffin Lid (in headdress area) showing black laying out lines at the join of the wig to the neck (left) and at the bottom of the wig lappets (right).

The crown of the head does not have any drawing or outlined drawn figures, however the head and face have a few laying out lines (along the bottom of the head dress ‘pigtails’)

There is no outline drawing on the exterior of the outer coffin box – all the paint appears to have been painted on ‘freehand’. The box interior was sketched out in black before applying the other colours. For most of the interior of the outer coffin box, there is no final black detailing, with the exception of the text written in the head area of the base of the box. The black writing appears to have been painted on top of the yellow paint (see Figure 20).

No cross sections nor PLM samples were taken from any of the drawing areas.

<u>Black</u>

The black paint was not sampled, but is expected to be a carbon-based black. As mentioned above, black was used for the initial drawing but also later detailing on the text and eyes. It was also used on the upper surfaces of the beard. This was painted prior to the red of the face, as evidenced by smears of red paint on the lower edge of the beard.

Along with the drawing, black paint has been used on the interior of the coffin box on circular motifs on the box by the shoulders and the nearby text (Figure 20). The text was applied after the yellow background was laid down. There are black spatter marks on the interior of the footboard (Figure 19).

Figure 19: Interior footboard of outer coffin box, proper right corner: showing black spatter

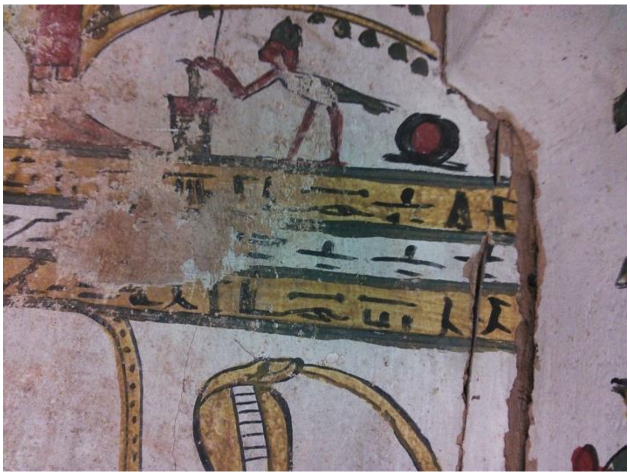


Figure 20: Black text and circular motif on the interior of the Outer Coffin box on the head end

White

The white areas of the outer coffin (for the lid and the box) were achieved by leaving the white preparation layer exposed without any further paint layers, and can be found in many of the white-grey background areas on the lid as well as in the white stripes along the edge. These white stripes look especially white because they were selectively cleaned in 2005 (Figure 21).

Figure 21: Detail of proper right side of the outer coffin lid showing the selective cleaning along the side white stripes.

Cross sections OL02 and OL03 were taken from white areas of the lid, and show an uncovered calcite layer, as does OB01, a white background sample from the box. PLM samples were taken from the white stripes (OL05) and compared to the background white (OL04) and there was no significant difference between the two: both showed the same calcite as found in the upper ground layer.

Red

Red is used across the coffin lid and box on the linear decorative elements, parts of the broad collar and the coffin mask. It is also used on the robes, wigs and skin of some figures, the feathers on winged figures and birds and on sun disks. The colour appears to be the same in all cases, but occasionally has a more brown hue, such as on the face. This appears to be due to the dirt layer on the surface (compared to cleaned areas on the side of the lid, or on the box, where the dirt is less conspicuous).

A PLM sample (OB03) taken from the red stripe on the box was found to contain red earth (with trace calcite, from the ground layer). A cross section taken from the face (above the eyebrow, OL01) shows a bright, opaque and sparkling red paint layer applied directly onto the white preparation layer. Under ultraviolet light, the red layer looks brown-black, as the fluorescence is quenched. This red is consistent with a red earth paint layer. Analysis of red areas on the lid and box using FORS showed strong iron absorption bands, consistent with red earth. XRF analysis of the red on the face also revealed significant iron levels (ARTAX S18). The red on the lid appears to be a more brown colour, due to the heavy dirt presence on the surface.

On the top of the head the red paint was applied prior to the dark yellow (Figure 5), however on the rest of the lid the red slightly overlaps the dark yellow.

Figure 22: Detail of Outer Coffin lid showing red overlapping yellow paint.

Yellows

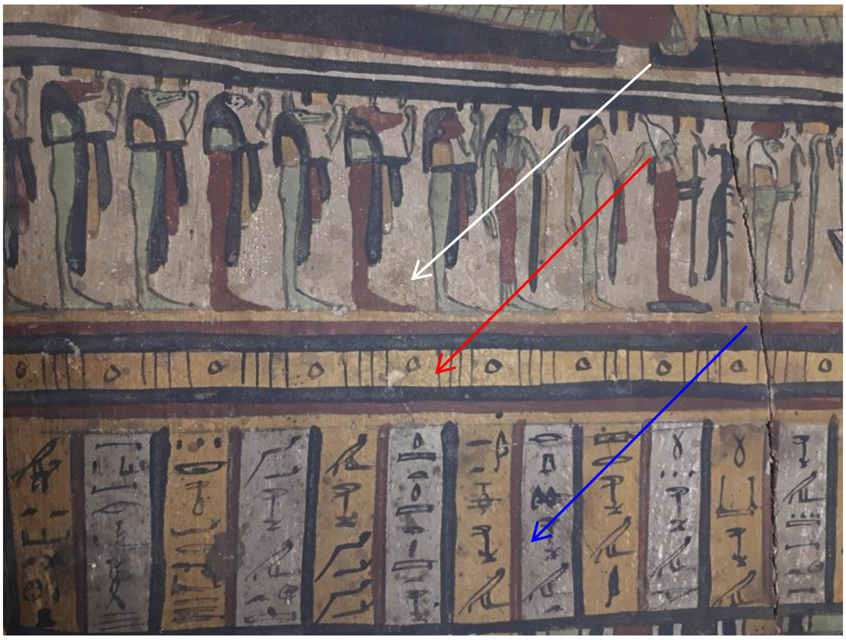


Figure 23: Detail of Pa Kepu Outer Coffin Lid showing two different yellow pigments: yellow earth passages (red arrow and similar areas) and orpiment/arsenolite passages (white arrow and similar areas). The blue arrow shows the exposed calcite layer, to provide contrast to the pale yellow.

There are two different yellow passages on Pa Kepu's outer coffin. This is the only colour to have more than one pigment represented. One is vivid yellow (almost a mustard colour) and the second is so pale it is almost white (both of these colours are shown in Figure 23).

One passage of vivid yellow was sampled for PLM (OL08), and was found to contain yellow earth (with some calcite, from the preparation layer). Analysis of this yellow via FORS had strong iron absorption bands, also indicating a yellow earth. However, they also had a sharp absorption band at 1414 nm that is found in jarosite.[3] XRF analysis of this yellow (ARTAX 15) indicated significant iron, probably signifying yellow earth.

[3] This might be jarosite, but would require some other analytical identification to confirm. Other techniques of analysis that might provide that confirmation (Raman, for example) were not available; however if in future new techniques become available, this would be an interesting potential case.

The pale yellow is found in several of the background areas on the lid, but is not found at all on the box. A cross section was taken from one of the pale yellow areas in the background (OL09), and revealed a very thin layer of bright, pale yellow particles applied directly to the preparation layer. The appearance was consistent with orpiment, which was confirmed via SEM/EDX (S. Bucklow, 01.05.2015). A dispersion sample from a similar area confirmed the identity of these particles as orpiment (OL06). These yellow pigment particles were highly ground (with a coarse texture (10-40 µm), but not the very coarse particle size (>40 µm) often seen with this pigment). There was a large amount of calcite present in the PLM sample, and it is possible it was mixed in with the orpiment to create a pale shade of yellow.

Another explanation is that it was painted with pure orpiment and the calcite is present (as in all the other samples from this object) from the ground due to the paint layer being so thin. Orpiment, As_2S_3, is known to degrade over time to As_2O_3, which is white (Fitzhugh, 1993) – this combination is consistent with the very pale yellow colour of these background passages. The FORS analysis from these pale areas (FORS 10 and 8) found no evidence of either iron, showing that this yellow is not due to a yellow earth. The XRF data indicates significant arsenic levels and there is only a small sulphur peak in the XRF spectra for ARTAX S07-10. (These background areas also have small iron peaks present. These peaks are due to the underlying pink plaster and are present (in roughly similar intensity levels) in all the XRF spectra from this object.) Perhaps the reduced S peak suggests that the material has incompletely degraded to arsenolite.

If the yellow is due to degraded orpiment and is not adulterated with calcite, then this coffin must have once had a very different appearance, with several different types of yellow adorning the surface. Orpiment makes a very golden yellow, which is more lemony in hue than the yellow earth found all over the surface of the lid. Together, the two colours would have given the coffin a very vivid, almost garish appearance.

A PLM sample from one of the green figures (PLM OL07) in an area with this pale yellow background (PLM OL07) showed only green pigment and calcite particles, with no orpiment/degraded orpiment particles present. This suggests that the background paint was applied around the figures, rather than as a thin wash over the whole area. Close inspection of these areas shows how the small white details in the figures (like white faces and headpieces, these can be seen in Figure 23) in these registers are also made by leaving the white preparation layer exposed. This is further evidence that the orpiment layer was selectively applied, and clearly after the initial black drawing was carried out.

Blue

The blues present on the outer coffin are painted in Egyptian blue, identified via VIL. A cross section was taken from a blue stripe in the wig (OL11), showing the characteristic large, glassy particles with blue-green semi-translucent colour. The blue paint in this cross section was confirmed as being Egyptian blue by SEM/EDX analysis (S. Bucklow, 01.05.2015). This cross section also shows a scattering of black particles lying underneath the blue paint layer and above the ground layer. It is not clear what these particles represent here, although they might be some remains of the initial sketch – they could not be distinguished from the blue paint around them in SEM-EDX and therefore it is thought that the black particles are carbon-based.

FORS analysis of the blue paint also showed results consistent with Egyptian blue. XRF analysis indicated that, in addition to calcium, copper and silicon (which are characteristic of Egyptian blue), there were low levels of lead and zinc in the blue pigment (ARTAX S14). This may be a sign that bronze scrap was used at the source for copper during pigment production (although it should be noted that there are very low levels of zinc in the white preparation layer (ARTAX S03, S06)).

The appearance of the blue passages has altered over time to a dark green (distinct from the pale Egyptian green) to black, depending on the area. Few of these areas are currently recognisable as blue passages. This is at least partially attributable to the presence of surface dirt in the case of the lid, and the blue on the box is less dirty and more blue than on the lid. However it is also probably due to the discolouration of Egyptian blue, a well-known but incompletely understood phenomenon. Green (2001) describes the degradation of this pigment as the result of alkali leaching from the glass pigment particles and reacting with the medium (but the actual mechanism of darkening has not been fully determined). Daniels *et al.* (2004) describes this darkening as the result of the darkening of the medium combined with the poor covering power of Egyptian blue, in conjunction with the accumulation of surface dirt, resulting in a green-brown to black colour.

The blue appears to have been painted after the yellow and red, but prior to the final black and pale green layers.

Greens

Pale green paint was applied very thinly on parts of the register of figures, the horizontal block borders and parts of the broad collar. The washy paint overlaps the other colours in most areas.

A sample was taken from the pale green boat on front of the lid (PLM OL07). PLM identified this tentatively as Egyptian Green; showing pale green, low relief particles unevenly distributed with brown, translucent inclusions and a spongy appearance. The particles had minor birefringence in crossed polars. The FORS results indicated copper-based pigments in these areas (and do not indicate malachite or green earth), supporting the Egyptian Green attribution. An XRF spectrum from a green area (ARTAX S19) showed calcium, copper, iron, sulphur and some minor arsenic.

The green paint appears to have been painted last. It can be seen overlapping the edge of areas of black drawing, which appears to have been painted after everything else.

Figure 24: detail of Outer Coffin Lid, showing the green paint on top of most of the other pigments.

Possible repairs

The 2005 conservation report identified three possible areas of contemporary repair on the coffin lid; on the foot, to the proper right of the eye and on each of the wig lappets. These were thought to be repairs due to their darkened colour. The paint in these areas was applied directly to ancient plaster, as can be seen in cross section OL10. XRD analysis of the plaster from the area of repair (XRD 02) confirmed that it contained the same materials as the plaster from other areas of the lid, so there is no distict fill material. The cross section showed a thin dark blue/black layer lying directly on top of the white preparation layer. The dark 'paint' layer does not have any of the characteristic large particles associated with Egyptian blue (which can be seen in cross section OL11, which is taken from the nearby blue in the wig). This may suggest that there is not much Egyptian blue in this area and that what is visible in the cross section is largely dirt. The cross section was examined via SEM/EDX and did not find any copper present in this layer, so there cannot be any Egyptian blue. Instead it found calcium, sulphur, silicon, aluminium and iron. A PLM sample was taken from the repair (PLM OL12), but the results for this were inconclusive – an unusual, aggregated material with moderate relief was found.

VIL imaging on the wig lappets suggest that there is some Egyptian blue on these areas, but only in very low levels on the proper left lappet. Figure 25 and Figure 26 show the repairs in VIL and visible light photography, and the VIL photographs show only a faint sparkle.

Figure 25: Repair in the Outer Coffin Lid Wig (proper right hand lappet), in visible light (left) and in VIL photography (right)

Figure 26: Repair in the Outer Coffin Lid Wig (proper left hand lappet), in visible light (left) and in VIL photography (right)

This is supported by XRF analysis; comparison of the blue on the wig (ARTAX 14) and the 'blue stripe' in the repair (ARTAX 13, 17) indicated that the two areas had broadly the same elements present in both locations, but there are significantly lower levels of copper, zinc and iron on the possible repair. XRF readings on the yellow areas on the wig (ARTAX 05, 15) and possible repair (ARTAX 12, 16) are very similar.

The 2005 report proposed that the darkening of the paint could be due to the presence of a modern lead based overpaint. However since this report was written, the area has been examined by XRF spectrometry, and no lead components were found (ARTAX S12, 13, 16, 17).

X-radiography of the proper right lappet (Figure 27) shows that the darkened area is an area of thick paste filling a knot hole in the wood. The area on the proper left lappet and the feet are also areas of thick paste. It may be the cause of the darkening in these areas is additional binder added to the repair paint. This could be the same binder as used in the original paint or it may be a different material.

Figure 27: Detail of x-ray of proper right wig lappet

Results, Sample Maps and Experimental

Sample maps for cross sections (x) and polarised light microscopy (PLM)

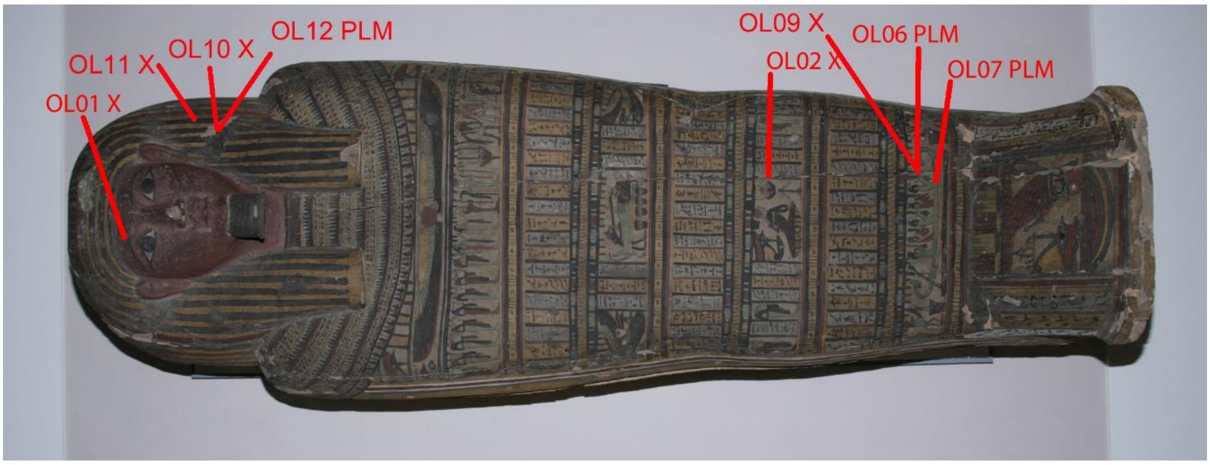


Figure 28: Sample sites for PLM and cross section analysis I

Figure 29: Sample sites for PLM and cross section analysis II

Figure 30: Sample sites for PLM and cross section analysis III

Figure 31: Sample sites for PLM and cross section analysis IV

Figure 32: Sample sites for PLM and cross section analysis V

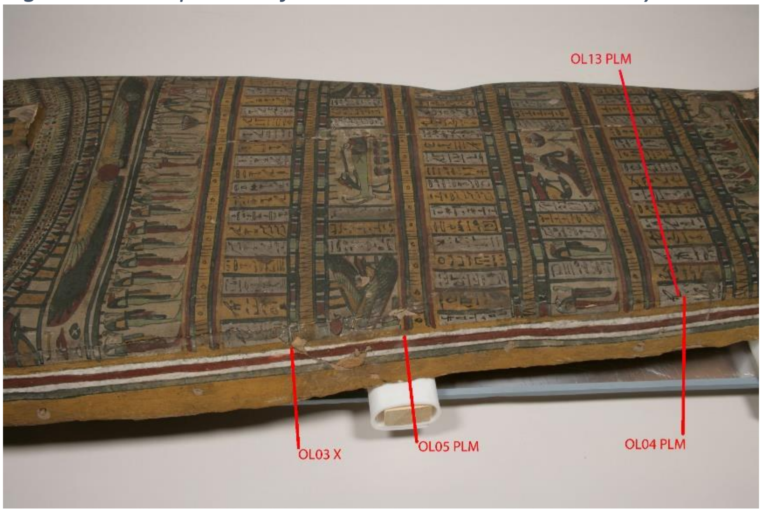


Figure 33: Sample sites for PLM and cross section analysis VI

Figure 34: Sample sites for PLM and cross section analysis VII

<u>Polarised Light Microscopy (PLM)</u>

Samples and results:

<u>PLM OL04</u>
Sampled: 12/2014
White background (Figure 33)

Identification: Calcite (sparitic-type)

The sample was taken from an area of grey (dirty white) background. The white areas of the outer coffin were achieved by leaving the preparation layer exposed without any further paint layers, and can be found in many of the white-grey background areas as well as in the white stripes along the edge (which were cleaned and therefore look much whiter).

Under the microscope, the particles are colourless, translucent and exhibit variable relief. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence with straight extinction. There is no evidence of microfossils.

<u>PLM OL05</u>
Sampled: 12/2014
White of stripe (Figure 33)

Identification: Calcite (sparitic-type)

PLM samples were taken from this area (OL05) and compared to the background white (OL04) and there was no significant difference between the two. The white in the side stripe has been selectively cleaned.

Particles are colourless, translucent and exhibit variable relief. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence with straight extinction.

<u>PLM OL06</u>
Sampled: 12/2014
Background near boat (Figure 28)

Identification: Orpiment (~30%) with calcite (~70%)

Pale yellow colour coming from orpiment. The very light shade of yellow might be due to the degradation of orpiment to arsenolite. However, there is a large amount of calcite present in this sample – this is probably due to the thinly applied paint resulting in the preparation layer being sampled simultaneously, but it might have been added as a mixture to lighten the colour.

The yellow particles in the sample (about 30% of the sample) were highly ground (with a coarse (10-40 µm) texture, but not the very coarse (i.e. >>40 µm) particle size often seen with this pigment), yellow and transparent, with a cross-hatched, platy habit with high relief and strong birefringence (red and green secondary colours).

The other 70% of the sample has colourless, translucent and variable relief particles. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence with straight extinction.

<u>PLM OL07</u>
Sampled: 12/2014
Pale green from boat (Figure 28)

Identification: Egyptian green? (~20%) with calcite (~80%)

The sample is a mixture of probable Egyptian green with calcite. The calcite is probably due to inadvertently sampling the ground layer with the thin paint.

The sample showed pale green, low relief particles unevenly distributed with brown, translucent inclusions and a spongy appearance. The particles had minor birefringence in crossed polars.

The other ~80% of the sample has colourless, translucent and variable relief particles. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence with straight extinction.

<u>PLM OL08</u>
Sampled: 12/2014
Yellow stripe (taken from edge of lid) (Figure 32)

Identification: Yellow earth (~70%) and calcite (~30%)

The sample was majority yellow earth, with some calcite (probably sampled with the thin paint layer).

The coarse yellow particles were present in aggregates and had moderate relief (with RI>1.66). They exhibited strong birefringence in cross polars that was masked by the bright body colour. They were consistent with a yellow earth, but further analysis via SEM/EDX would be required to provide a more specific identification.

There was also some calcite present: colourless, translucent and variable relief particles. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence with straight extinction.

<u>PLM OL12</u>
Sampled: 02/2015
Blue repair in wig area (Figure 28)

Identification: Unidentified material + calcite

Medium (1-3µm) particles, found in aggregates, exhibiting no change under a Chelsea filter and no pleochroism. The particles have moderate relief, no twinkle. PLM = inconclusive.

Calcite: colourless, translucent and variable relief particles. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence with straight extinction.

<u>PLM OL13</u>
Sampled: 02/2015
Pink plaster (Figure 33)

Identification: Calcite + quartz + earth (probably red earth)

Sample was mostly calcite (~70%) with some evidence of quartz (25%) and some iron-oxide earth-like pigment (5%). The PLM did not allow for clear identification of the colouring pigment.

Calcite: colourless, translucent and variable relief particles. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence in crossed polars with green and pink anomalous colours and straight extinction, no stationary crosses.

Quartz: Colourless, glassy and irregular particles (conchoidal fracture), only slightly larger than the calcite particles, around 10 µm. Low relief (< 1.66) with no twinkle. In crossed polars, weak, pale grey birefringence with no anomalous colours, and straight extinction.

Earth: Fine (0.3-1 µm) but irregular orange pink particles particles found in aggregates, mixed in with other colourless particles. This intimate mixture made it hard to distinguish Beckeline and relief. Low relief (?), no twinkle. In crossed polars, there is some faint birefringence but largely masked by the particle body colour. No anomalous colours or stationary crosses, and the extinction was not clear.

<u>PLM OB02</u>
Sampled: 12/2014
Pink plaster (Figure 30)

Identification: Red earth + quartz + calcite

The pink plaster seems to be a mixture of calcite (60%), quartz (30%) and some iron-oxide earth-like pigment (10%). The PLM (OB02) does not yield clear results.

Calcite: colourless, translucent and variable relief particles. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence with straight extinction.

Quartz: Coarse (10-40 µm), smooth, colourless fractured particles that have moderate relief and no pleochroism or change under Chelsea filter. RI<1.66. Low birefringence – pale white colour under crossed polars.

Red earth: Rust coloured fine particles in coarse aggregates (10-20 µm), translucent. No clear birefringence in crossed polars, but particles appear red and might just be the masking body colour. No clear extinction and no stationary crosses.

<u>PLM OB03</u>
Sampled: 02/2015
Red stripe (Figure 29)

Identification: Red earth + calcite

Sample was mostly red earth (~90%) with some calcite present (probably sampled through the thin paint).

Red earth: fine, high-relief, dark-red rounded particles were clumped into aggregates, with strong birefringence in crossed polars which was masked by the intense body colour.

Calcite: colourless, translucent and variable relief particles. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence with straight extinction.

<u>PLM OB05</u>
Sampled: 07/2018
White background (Figure 34) from the exterior of the box

Sample is entirely calcite, sparitic type.

Calcite: colourless, translucent and variable relief particles. Particles are 'large' (3-10µm) and are irregular, smooth and rhombic. There was no change in appearance with a Chelsea filter, no pleochroism and a RI<1.66. Strong white birefringence with straight extinction.

PLM Experimental Details

All PLM samples were taken, mounted and examined by Nelly von Aderkas

Samples were prepared using a Leica MZ95 stereomicroscope. Pigment samples were dispersed onto glass slides using Cargille Melt Mount (RI~1.66) on an SS3H hotplate stirrer at 75˚C.

All samples were examined using a Leica DMLM, with magnification objectives of 5x, 10x, 20x, 50x and 65x. Samples were examined via transmitted light with two polarising filters. The microscope was also equipped to examine the samples with reflected light. A Chelsea filter was used to distinguish blue mineral samples.

Cross Section Analysis

XS OL01
Sampled: 12/2014
Taken from face, red (Figure 28)

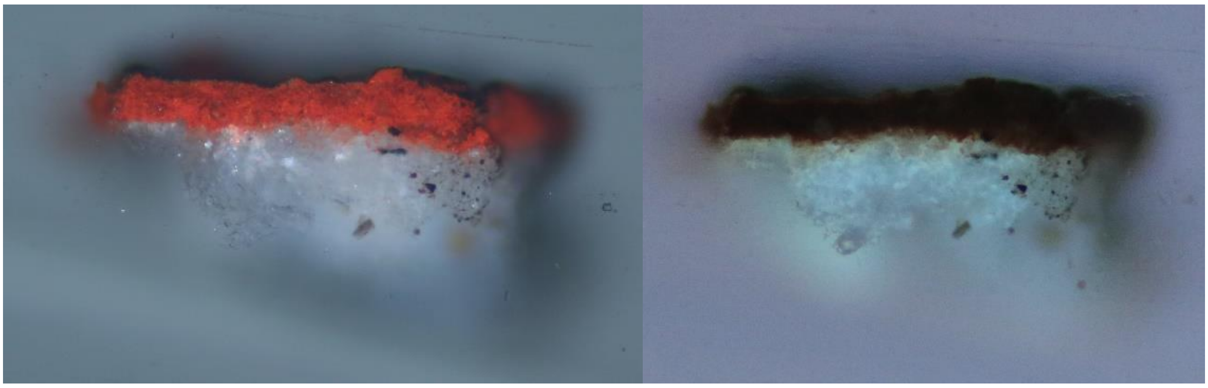


Figure 35: Cross section OL01 in visible light (left) and UV light (right), both at 20x magnification (white spirit)

Layer 3: Thin, dark surface layer – probably surface dirt. <5 µm.

Layer 2: 40-50 µm, vivid red layer. Sparkles under the microscope. Opaque, mineral in appearance. Quenches UV fluorescence (becomes black-brown). This red is consistent with a red earth paint layer, and analysis via FORS indicates the presence of iron oxide and XRF indicates significant iron levels (ARTAX S18).

Layer 1: white crystalline layer. ~60-100 µm.

(Pink plaster not sampled in OL01)

XS OL02
Sampled: 12/2014
White background (Figure 28)

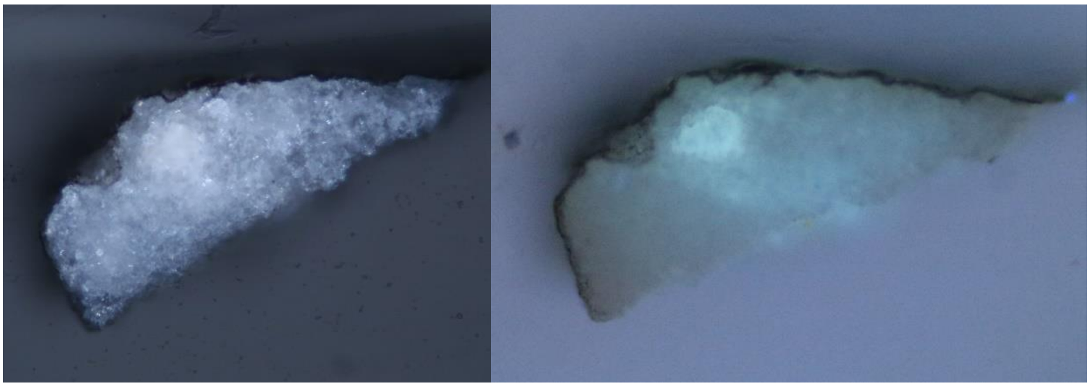


Figure 36: Cross section OL02 in visible light (left) and UV light (right), both at 20x magnification (white spirit)

Layer 2: Thin surface dirt layer, <5 µm.

Layer 1: white, semi-crystalline layer. ~150-200 µm. A large soap-like particle in the middle of the layer; otherwise relatively homogenous. Fluorescence blue in UV light.

(Pink plaster not sampled in OL02)

<u>XS OL03</u>
Sampled: 12/2014
White stripe along side (Figure 33)

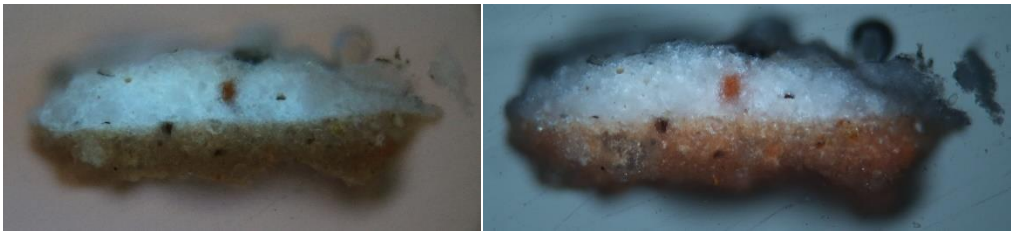


Figure 37: Cross section OL03 in visible light (left) and UV light (right), both at 10x magnification (white spirit)

Layer 2: white, semi-crystalline layer. ~160-200 µm. Pale blue fluorescence blue in UV light. Very thin dirt layer on top.

Layer 1: Pink, semi-crystailline layer. 160-200 µm. Granular in appearance. Does not fluoresce in UV (but neither is it quenching). Turns brown. Some brown, white and black particles included in the pink-beige layer.

White stripe appears to be uncovered white ground layer – i.e. there is no separate white paint layer on top of the ground.

<u>XS OL09</u>
Sampled: 02/2015
Yellow background (Figure 28)

Figure 38: Cross section OL09 in visible light (left) and UV light (right), both at 20x magnification (white spirit)

Layer 4: surface dirt – significant, 10-20 µm. Black in UV.

Layer 3: thin, ~10 µm, bright yellow particles scattered across the surface – a wash? Examination of this cross section via SEM/EDX (S. Bucklow, 01.05.2015) identified this yellow layer as orpiment.

Layer 2: white crystalline layer. ~130 µm

Layer 1: Pink layer, 260-300 µm. Plaster/ heterogenous particles which are invisible in normal light but which show up dark in UV. Semi-crystalline, mixture of white and pink pigment particles. Occasional black and brown inclusions (and occasional bright red particles which are quenched in UV. Analysis of this pink plaster areas by FORS has suggested the presence of an earth pigment this is supported by a significant iron peak from XRF analysis (ARTAX 11). Cross sections OL09 and OL11 were examined via SEM/EDX (S. Bucklow, 01.05.2015) and the results presented Ca, Si, Al, Na, Mg, S, Fe; elements consistent with earths and calcite.

<u>XS OL10</u>
Sampled: 02/2015
Blue wig repair (Figure 28)

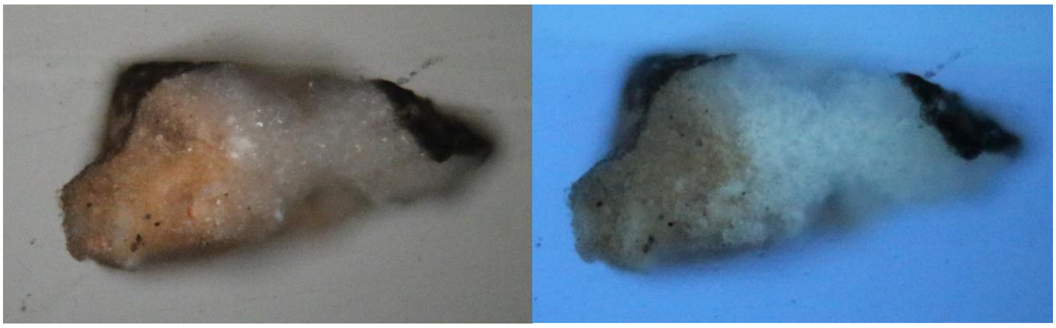


Figure 39: Cross section OL10 in visible light (left) and UV light (right), both at 10x magnification (white spirit)

Cannot see any surface dirt on this sample, it is indistinguishable from layer 3.

Layer 3: thin blue-black layer, 20-40 µm. Discontinuous on the surface of this cross section.

Layer 2: white crystalline layer, 200-400 µm.

Layer 1: pink-beige lower plaster layer, ~300 µm. Heterogeneous, crystalline. Occasional black particles that are dark in UV.

XRF analysis indicates that there are low levels of lead and zinc in the blue pigment (ARTAX S14), this may be a sign that bronze scrap was used at the source for copper during pigment production. Although there are very low levels of zinc in the white preparation layer (ARTAX S03, S06).

<u>XS OL11</u>
Sampled: 02/2015
Blue wig (Figure 28)

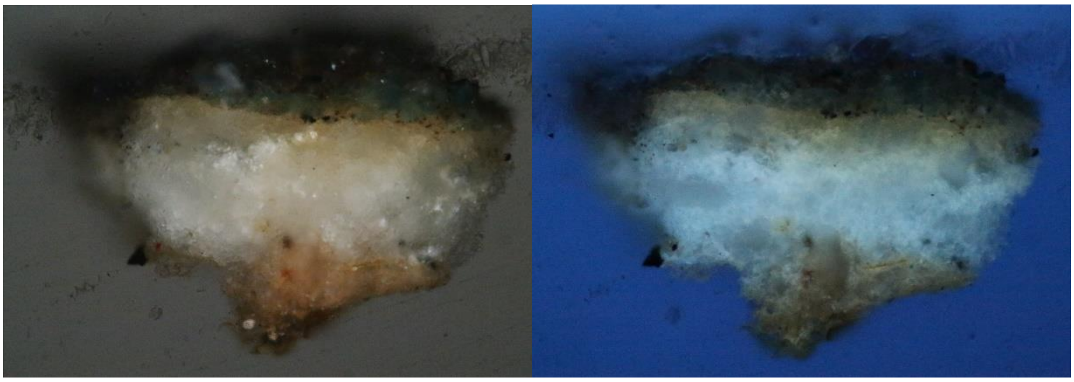


Figure 40: Cross section OL11 in visible light (left) and UV light (right), both at 20x magnification (white spirit)

Layer 6: Significant surface dirt.

Layer 5: Blue-green, heterogeneous layer, ~ 100 µm. Large pigment particles, occasionally glassy looking. The blue paint in this cross section was identified as Egyptian blue by SEM/EDX (Si, Ca, Cu, Al; S. Bucklow, 01.05.2015).

Layer 4: Black particles scattered at interface of layers 3 and 5. Possible dirt layer between upper pinky-yellow layer and blue paint.

Layer 3: Pinkish upper part of white crystalline layer – yellow in UV. ~60 µm

Layer 2: white crystalline layer. ~120 µm.

Layer 1: pink-beige lower plaster layer. Heterogeneous, crystalline. Occasional black particles that are dark in UV. Glassy particle visible in centre of layer. ~ 120 µm (but only a partial layer present. Cross sections OL09 and OL11 were examined via SEM/EDX (S. Bucklow, 01.05.2015) and the pink plaster results presented Ca, Si, Al, Na, Mg, S, Fe; elements consistent with earths and calcite.

The yellow-pink layer (layer 3) is difficult to interpret. It is not clear if it is a slightly different appearance of the upper part of the white ground (layer 2). If it is a separately painted layer, it would have been painted while the white preparation layer was still wet, as the two layers blend into each other. There are large black particles between the yellow layer and the blue stripes, which might suggest that significant time has passed between layers. SEM-EDX of these layers has not led to clarification of the paint materials or layer structure – the results did not identify the 'yellow' nor the black particles between the yellow and blue layers.

<u>OB01</u>
Sampled: 12/2014
White from background (Figure 29)

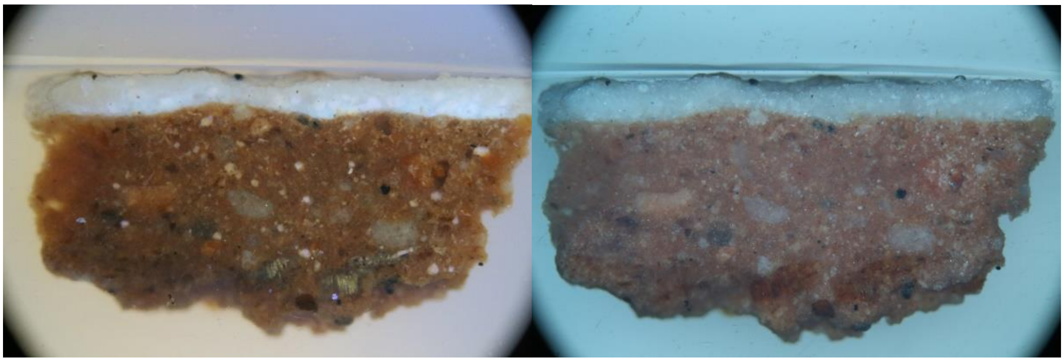


Figure 41: Cross section OB01 in visible light (left) and UV light (right), both at 5x magnification (white spirit)

Layer 2: White semi-crystalline layer. Mild blue fluorescence under UV illumination. Some large, white particles (soaps?). ~200 µm.

Layer 1: Pink semi crystalline layer. Wide variety of particles and associated particles. No fluorescence in UV light. Very thick, 1200 µm.

Ground layers (as suggested by the above cross sections):

In cross section, the pink paste is semi-crystalline, with a mixture of white and pink pigment particles, with occasional brown and black inclusions. Analysis of pink plaster areas by FORS has suggested the presence of an earth pigment this is supported by a significant iron peak from XRF analysis (ARTAX 11). Cross sections OL09 and OL11 were examined via SEM/EDX (S. Bucklow, 01.05.2015) and the results presented Ca, Si, Al, Na, Mg, S, Fe; elements consistent with earths and calcite.

The surface of the outer coffin is covered in a white preparation layer – calcite, sparite type (cross sections OL01, OL02, OL03, OL09, OL10, OL11 & OB01, PLM OL04 & 05), found on top of the pink crystalline layer. Particles are translucent with bright birefringence and exhibit variable relief. The white areas of the outer coffin were achieved by leaving this preparation layer exposed without any further paint layers, and can be found in many of the white-grey background areas as well as in the white stripes along the edge. These white stripes look especially white because they were selectively cleaned in 2005. However, PLM samples were taken from this area (OL05) and compared to the background white (OL04) and there was no significant difference between the two.

<u>OB04</u>
Sampled: 07/2018
Red from background (Figure 31)

Figure 42: Cross section OB04 in visible light at 5x magnification (white spirit)

Layer 3: Red, homogeneous layer. ~40 µm

Layer 2: White semi-crystalline layer. Mild blue fluorescence under UV illumination. Some large, white particles (soaps?). ~240 µm.

Layer 1: Pink semi crystalline layer. Wide variety of particles and associated particles. No fluorescence in UV light. ~420 µm in cross section, but expect it is thicker in other areas.

<u>Cross Section Experimental Details</u>

All cross section samples were taken and examined by Nelly von Aderkas

Samples were prepared using a Leica MZ95 stereomicroscope. They were mounted in polyester resin and wet ground using a Buehler Beta grinder-polisher. The final grinding stages were done dry, followed by polishing using fine grades of micromesh.

All samples were examined using a Leica DMLM, with magnification objectives of 5x, 10x, 20x, 50x and 65x. Samples were examined via reflected visible and ultraviolet light.

Scanning Electron Microscopy-Energy Dispersive X-Ray Spectroscopy (SEM-EDX)

Results:

OL09 Pink plaster - earth stained substrate, plus orpiment layer

Spectrum 2	Ca Si Al Na Mg S Fe	pink plaster
Spectrum 3	Ca Si Al	white layer
Spectrum 4	S As Ca Al	yellow layer

OL 10 Black - possibly carbon with extenders ?

Spectrum 1	Ca S Si Al Fe	black layer
Spectrum 2	Ca S Si Al Na Fe	black particle

OL11 Pink plaster - earth stained substrate, plus carbon black ?

Spectrum 1	Si Ca S Al Fe	pink layer
Spectrum 2	Ca Si S Al	white layer
Spectrum 3	Si Ca Cu Al	blue layer
Spectrum 4	Si Ca Cu S	black (carbon?)

SEM-EDX analysis by Spike Bucklow 01.05.2015

Fibre Optic Reflectance Spectrosopy (FORS)

FORS analysis carried out by Jenny Marchant

Figure 43: FORS analytical sites on Outer Coffin I

Figure 44: FORS analytical sites on Outer Coffin II

Figure 45: FORS analytical sites on Outer Coffin III

Figure 46: FORS analytical sites on Outer Coffin IV

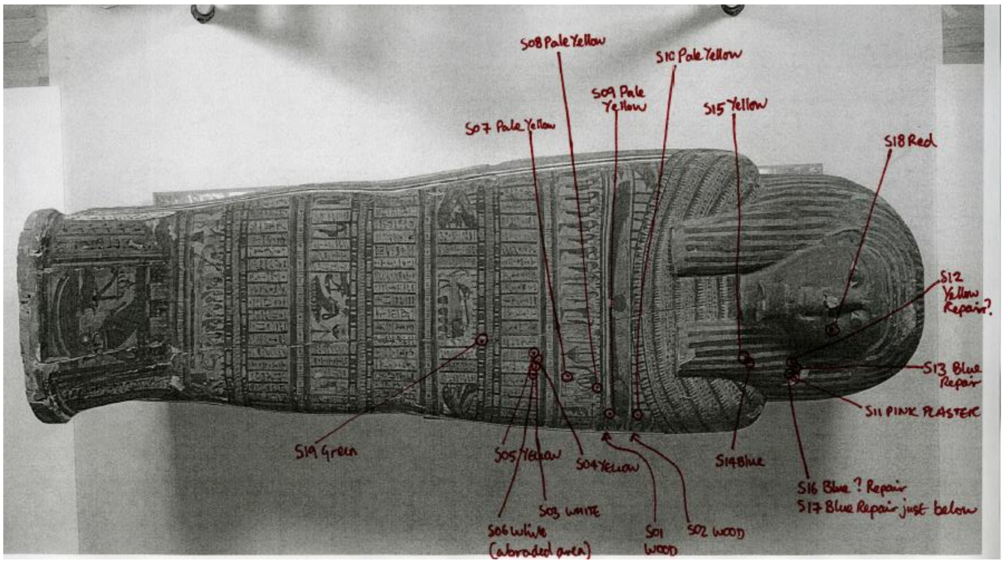
Figure 47: FORS analytical sites on Outer Coffin V

FORS Results (acquired by Jenny Marchant, 2015, copied here from technical report (found here: N:\ANT_conservation\Conservation Reports\Egyptian reports\1869\E.1869.0002 Pakepu\definitive outer coffin)):

> *There is no evidence of gypsum or bassanite on the coffin. The materials used on the lid and box appear to be the same.*
>
> *The coarse pink paste between joints has some Fe based material in it (red earth?).*
>
> *The red areas are consistent with red earth (fe absorption bands).*
>
> *The yellow areas are consistent with yellow earth (fe bands). Yellow areas also have a sharp absorption band at 1414nm that can be found in jarosite (uncertain if this is truly characteristic).*
>
> *Green areas look likely to be copper based. Spectra are not typical of green earth or malachite.*
>
> *Background around figures on lid (looks grey) have no evidence of ochres. This could be white or degraded orpiment (see XRF results below)*
>
> *Blue is consistent with Egyptian blue.*

X-Ray Fluorescence Spectrometry (XRF)

Sample maps for XRF



Results:

Pakepu xrf

Notebook: Coffin Book
Created: 02/03/2015 08:50 Updated: 02/03/2015 08:51

23/2/15 Jenny Marchant & Ellie Olivia Anderson
Pakepu Outer lid E.2 1869
50kV 600uA
S01 Wood Ca Fe S Cl K Ti Cr Sr Zr?
S02 Wood Ca Fe S K Cl Ti Cr Ni Cu Zn Pb? Zr -
S03 White behind hieroglyphs Ca Si Cl K Ti Cr Fe Cu Zn As? Pb? Sr Zr -
S04 Deep Yellow " " Ca Fe Si S Cl Ti Cr Mn Cu Zn As Sr -
S05 Deep Yellow" Fe Ca Si S K Ti Cr Mn Ni Cu Zn As Sr
S06 White " Ca Fe Si S Cl K Ti Cr Mn Cu Zn As Sr
S07 Pale Yellow Ca As Si S K Ti Cr Mn Fe Ni Cu Zn Sr -
S08 Pale Yellow Ca As Si S K Ti Cr Mn Fe Ni Cu Zn Sr
S09 Pale Yellow Ca As Si S K Ti Cr Mn Fe Cu Zn Sr Pb? -
S10 Pale Yellow Ca As Si S K Ti Cr Mn Fe Cu Zn Sr
S11 Pink Paste on wig Ca Fe Sr Si S Cl K Cr Ti Cu Zn As? Zr -
S12 Yellow on repair? Ca Fe Si S Cl K Ti Cr Cu Zn As Pb? Sr Zr -
S13 Blue on repair? Ca Fe Cu S Si Pb? Cl K Ti Cr Zn Sr -
S14 Blue on wig Cu Ca Si S Cl Ti Cr Mn As Pb Sr Zr -
S15 Yellow on wig Ca Fe Si S Cl K Ti Cr Ni Cu Zn As Pb Sr Zr -
S16 Yellow on repair? Ca Fe Si S Cl Ti Cr Mn Cu Zn As? Pb? Sr Zr
S17 Blue on repair Ca Fe Cu Si S Cl K Ti Cr Mn Zn Pb? Sr
3 - black stuff S18 Red face Ca Fe Si S K Ti Cr Cu Zn As Sr
S19 Green Ca Cu Si S Cl K Ti Cr Mn Fe As Pb Sr

24/2/15 Pakepu Outer lid continued E.2 1869
15kV 1200uA He
S02 Wood Ca S Al Si P Cl K Fe no Pb
S03 White behind hieroglyphs Ca S Al Si P Cl K Fe Cu Zn Ba Cr
S04 Deep Yellow Al Si P S Cl K Ca Ti Cr Fe Cu Zn
S09 Pale Yellow As Si P S Cl K Ca Ti Cr Fe Cu? Cu?
S11 Pink Paste Ca Mg Al Si S Cl K Ti Cr Fe Co Ni Cu Zn
S12 Yellow on repair Si Al As S Cl K Ca Ti Cr Fe Cu Zn
S13 Blue on repair Ca Al Si P S Cl K Ti Cr Fe Cu
S14 Blue on wig Al Si P S Cl K Ca Ti Cr Mn Fe Cu

X-Ray Powder Diffraction (XRD)

The samples were received and analysed by XRD on the 27th March 2015. A portion of XRD04 was analysed by EDS on the 12th May 2015. All XRD analysis performed by Dr Trevor Emmett. The following sample details are copied from his report:

Four samples, each consisting of small fragments totalling c. 10 mg and wrapped in Al foil were received with descriptions as follows:

- XRD 01 outer lid, pink plaster (mis-labelled E.2.1896).*
- XRD 02 outer lid, pink plaster wig restoration (mis-labelled E.2.1898).*
- XRD 03 outer lid, pale pink over other pink (sic) (mis-labelled E.2.1896).*
- XRD 04 outer base, pink plaster.

(*: the labels on these samples have been corrected by TFE.)

Figure 48: Samples taken from Outer Coffin for XRD analysis: Top row: Outer lid, pink plaster XRD 01 (left); XRD 02 pink plaster from area of historic repair (right);
Bottom row: Outer lid, second layer of pink plaster, XRD 03 (left); Outer box, pink plaster XRD 04 (right)

Results:

> *All the patterns are adequately explained by mixtures of calcite ($CaCO_3$) and quartz (SiO_2), though the patterns for* ***XRD 01*** *and* ***XRD 03*** *have an unassigned peak at 25.49° 2ϑ and*
> ***XRD 04*** *has one at 13.93° 2ϑ. The samples can be confidently described as conventional lime plasters (Hauptmann and Yalcin, 2000). Again, gypsum ($CaSO_4.2H_2O$), basanite ($CaSO_4.0.5H_2O$) or anhydrite ($CaSO_4$) appear to be absent (below detection limit). The intense peak at c. 28.0° 2ϑ in the pattern of* ***XRD 04*** *is perhaps, though, a little problematic. It seems to match the COD quartz entry 96-901-2604 but this represents a rather unusual, experimentally-produced high pressure polymorph as described by Levien et al. (1980). In a repeat XRD analysis the peak presented at much reduced in intensity and is probably due to 'ordinary' α-quartz.*

Dr Trevor Emmett, 2015

Full details for sampling, analysis, experimental technique and results are written in the XRD report.

<u>References</u>

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