E.2.1869; Pa Kepu

Inner coffin

Figure 1: E.2.1869, Pa Kepu, inner coffin

Contents

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

The preparation of the surface of the inner coffin was applied in several complicated layers. The interior of the inner coffin was first smoothed over with localised patches of pink paste (in knots and rough areas), followed by a layer of linen. This was covered in a layer of sparitic-type calcite.

The exterior of the inner coffin was filled with pink paste in the damages and knots before the application of a layer of thick, fibrous glue. There is evidence for a char black layer in some places on top of the glue but it is not clear what this material is for. This was covered with a textile layer (with glue) and was smoothed out with a layer of natural chalk (micritic calcite). This was covered by a further textile layer, and then covered with sparitic-type calcite.

The inner coffin is thinly painted in probable gum Arabic-like binding media; the paints have a watercolour-like appearance, with some paint passages appearing more transparent. The motion of the paintbrush is visible in the paint; it is easy to see where paint brushstrokes begin and end. The palette is similar to that of the outer coffin – it is relatively restrained with a lack of mixtures (with one exception). It appears the coffin was closed, sealed and then painted – there are many paint strokes that cross the join (see Figure 2).

Figure 2: close-up of crown of inner coffin showing the paint strokes crossing the join

The drawing is executed in black paint. From the outward appearance of the coffin, this drawing paint underlies all of the coloured paint, which is messily applied within the lines (often overlapping the edges). The eyes and eyebrows of the main figure are probably painted in black in the final stages of the coffin – they are much more thickly applied and appear to be on top of the surrounding paint. The black scarab on the crown is also painted much more thickly and clearly than other areas (but in this case it is probably applied first). Some of the hieroglyphs and black decoration were possibly painted in last, or were reinforced after the upper paint had dried.

The upper coloured layers of paint were sometimes applied soon after the black drawing was laid down – as some of the black underdrawing has streaked in the direction of the upper paint (this is most visible in the yellow areas (Figure 12)). This suggests the black paint was either still wet or just not fully dry.

The background pale yellow was painted in orpiment; while the bright yellow passages were executed using yellow earth. The red areas were all painted using red earth. The red paint has an unusual change in appearance between the left and right sides of the coffin – the proper left side was abraded, but only in the red passages – there may have been some kind of change in binding medium between the two sides. The blue paint is Egyptian blue, and has discoloured to a dark green across the inner coffin. A separate green paint was tentatively identified as Egyptian green.

The white areas of the coffin (in the collar, some faces of birds and some hats) represent undecorated areas of white preparation layer (rather than a white paint).

Preparation

Table 1, below, shows the order of application of the preparation layers during the making of the inner coffin. The section for the preparation layers of Pa Kepu is divided into the interior and exterior of the coffin, and follows the order set out in Table 1.

Table 1: Pa Kepu inner coffin stratigraphy and order of application

exterior inner coffin (lid)	*interior inner coffin (box)*
white layer	
white layer	
linen textile layer	
white paste	
glue	
linen textile	
"black something"	
application of thick, fibrous glue	
C O F F I N C L O S E D	
	white paste
	linen applied
pink paste	pink paste
red paste/fill	red paste/fill
wood	

Interior of the inner coffin

The application of preparation layers in the inside of the inner coffin follows the right hand column of Table 1. A coarse crumbly pink paste is observed in small patches across the interior of the inner coffin. This material is applied over flaws in the wood and in the dowel holes (but is not a continuous layer). This pink paste (IL18 & IB04) was found to contain a mixture of sparitic-type calcite (colourless rhombic, smooth edged particles with variable relief, strong birefringence with 3rd order colours and straight extinction. No microfossils were found), quartz (very coarse colourless particles with cleavage planes and white birefringence with straight extinction) and earth pigments (including a very dense red earth) (Most particles were fine and found in aggregates (yellow and pink) with birefringence masked by the body colour, but there were occasional large aggregates of pseudo-opaque dark red particles with strong relief).

Next the interior of the coffin was covered with a linen layer. The simple tabby weave linen is made from 2 s-plied fibres. The fibres come up to the edges of the interior of the coffin, but do not make a continuous layer with the fabric on the exterior as there are several fabric edges observable along the lip of the coffin. These edges appear to be part of the original construction, rather than as the result of subsequent damage. No glue was observed on the textile on the interior of the inner coffin.

The textile in the interior of the coffin was then coated with a white paste, made of sparitic-type calcite. This was found on the interior of the box and lid (PLMIL15 and IB01, respectively, and both found rhombic, smooth but irregular colourless particles which showed varied relief in plane polarised light with strong 3rd order colours in crossed polars and no evidence of microfossils). This layer contains small stony inclusions and small plant fibres can be seen embedded in the surface. The appearance of the plaster layers at the join between top and bottom seems to indicate that at

this stage this plaster layer was allowed to dry, the mummy placed inside the coffin and the two halves of the coffin fitted together. Tenons were placed inside the mortises and pegs inserted through the tenons on both the top and bottom to lock the coffin together.

Exterior of the inner coffin

A diagram of the layer structure of the exterior of the inner coffin can be found in Table 1. The wood was first prepared with pink paste in patches across the coffin, presumably to even out irregularities in the wood (such as knots). It was extensively used over the nose on the lid, also to create a smooth surface.

Figure 3: Black layer at head end of the Inner box

Areas of exposed glue can be seen in various locations across the surface of the inner coffin, but a damage on the bottom of the box was especially revealing, as its showed the textured nature of this glue layer. It is composed of a thick transparent layer containing fibrous material. FTIR spectroscopy (Fourier-transform infrared spectroscopy) and microscopic examination indicate conclusively that this material is a proteinaceous glue and that the fibres are characteristic of leather or animal hide.[1] The nature and purpose of this thick, fibrous glue is not clear, however it has been identified on other similar cartonnage fragments in the Fitzwilliam Egyptian collection (i.e. E.W.93). This unusual glue and fibre combination was found on the exterior of the inner coffin, but not on the interior.

Figure 4: Underside of the inner coffin box (head end) with exposed fibrous glue

There is an unusual black component found just above this pink paste (and presumably above the thick glue, but it is hard to tell). This black material is exposed along the damages at the join of the coffin, apparently on top of the pink paste and below the first layer of linen (Figure 3) and it does not form a full layer. A sample from this material (IB03) revealed it to be very hard, and containing charcoal black (the opaque particles have evidence of cellular structure) with micritic calcite in the mixture, presumably co-sampled from an adjacent layer. It is not clear what the function of this material is, nor what makes it so hard. The presence of this material on the lid and box suggests that it was applied once the coffin had been closed.

[1] Palmer, Ray. 2018. Report on the Analysis of Fibrous Material Recovered from the Cartonnage Coffins in the Fitzwilliam Collection [unpublished report].

The first layer of linen was then applied.

A white paste layer was found on top of this textile. (PLM IL16, IB02, IL14: all samples contained colourless bactereoid particles with variable relief and strong 3rd order colours in crossed polars with stationary crosses). These calcite samples were identified as natural chalk due to the fine morphology of the particles and the presence of microfossils.

There is then a second linen layer present. There is poor cohesion in some areas with this linen

layer and the natural chalk preparation below it, suggesting that the chalk was dry when the linen covering was applied. There are two linen layers in the structure, as indicate in Table 1, and from the x-radiographs, it is clear that one of the layers covers the entire inner coffin and is made up of bands of textile wrapped around the coffin. The other only covers the coffin in part, possibly along the centre of the base of the box. It is not clear which of these comes first in the layer structure.

Figure 5: close up of head of inner coffin showing some of the layer structure with textile

Figure 6: closeup of damage revealing the textile underneath

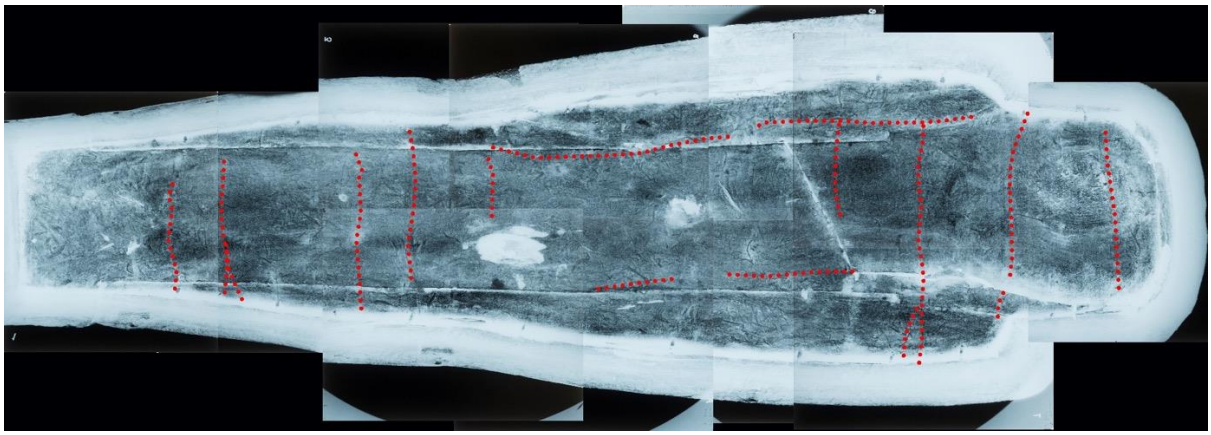

Figure 7: x-radiography of the box showing edges of textile in red.

The textile was then covered in a thick white preparation layer. It is not clear from the cross sections taken (IL04, 05, 08 & 10) whether this is one or two ground layers. IL04, 05 and 10 also show a lower layer which is brown and transparent in visible light but is bright white and creamy looking in UV light. It lacks the crystallinity of the above white preparation layer. This is probably the glue from the textile layer – however protein tests using copper (II) sulphate were inconclusive. SEM/EDX

analysis of cross section IL10 did not show any elemental difference between the lower white and upper white preparation layers. Both contained Ca, Si and Al.

PLM samples taken from the uppermost preparation layer showed sparitic or limestone-type calcite (PLM IL17, IB05, IL06: all samples showed rhombic, varied, colourless particles exhibiting variable relief and strong 3rd order colours in crossed polars, with no microfossils).

It is difficult to identify the exact type of calcite (i.e. sparitic vs micritic) calcite from the morphology without strong evidence such as stationary crosses; however the calcite is of the same kind of morphology in the uppermost preparation layers and on the interior.

It is interesting to note that two different types of calcite were used in specific layers in this inner coffin. Natural chalk (micritic calcite containing microfossils) was used in between the linen layers, and is also found in the black sample (found lower down in the layer structure), while limestone type calcite (sparitic-type calcite) was found on the uppermost surface of the inner coffin, as well as in the interior of the coffin. This suggests that these two types of calcite had different properties or functions (or both) and further investigation is necessary. This was sampled a few times, on the lid and box, and this division of sparitic/micritic calcite was reproducibly found. The same layer structure was not used for the outer coffin.

Table 2: PLM samples identifying calcites in the inner coffin layer structure (see Figure 13, Figure 14 and Figure 15 for sample locations)

Exterior upper white paste layers	IL17, IB05, IL06	Sparitic-type calcite (Limestone-type calcite)
Between linen layers, white paste	IL16, IB02, IL14	Micritic calcite (Natural Chalk)
Interior white paste layer	IL15, IB01	Sparitic-type calcite (Limestone-type calcite)

Drawing

The drawing was executed in black, after the application the white preparation layers. Examination of the straight lines shows that a rule or other straight edged object has been used to aid application. The point where each portion of the long lines along the sides overlaps can be seen in Figure 8. The shorter lines and figure work is applied in a more fluid style.

Figure 8: Proper left side of lid

Pigment Identification:

The palette and decoration scheme for the inner coffin is similar to Pa Kepu's outer coffin, with a few exceptions. The pigments in the inner coffin were examined by FORS, XRF, as well as dispersion (PLM) and cross section samples.

Figure 9: Pa Kepu inner coffin lid, showing the difference in the red paint on the proper left and right sides of the coffin

Yellow

There are at least two yellows present on the inner coffin, a bright yellow, in the stripes across the coffin and for some of the text on the back of the box, and a very pale yellow/white, found in the background of the register of figures and the horizontal stripes on the inner lid. In places the pale yellow is pale yellow/peachy in colour this may be just a variant of the second yellow. The pale yellow is not present on the inner box.

The bright yellow in the stripes was sampled (PLM IL01) and was identified as a yellow earth pigment (the particles presented as rounded, fine yellow aggregated particles with birefringence masked by strong body colour in crossed polars). This identification is corroborated by strong iron reading in XRF (ATAX S21).

Orpiment has been identified in the pale yellow passages through PLM (sample IL02 was from an area of background and showed acid green, platy, micaceous coarse particles with bright pink and green interference colours in crossed polars). These particles represented a small proportion of the sample, meaning it was either a very thin wash, or much of the sample has degraded to arsenolite (looking very similar to calcite in PLM) - this is supported by the small arsenic peak in the XRF results (ARTAX S27). There are some opaque red particles present, similar to red earth particles – these are also found in the XRF data. The same composition was found in the 'peachy' coloured area of the inner coffin (IL03). This is supported by the XRF results in the same area, which show elevated arsenic with significant iron present (ARTAX S24). It is not clear whether the red earth was there to alter the colour of the paint to a pink-orange colour or if it is a contaminant.

Figure 10: Red from proper right side of inner coffin, magnified under dinolite

A cross section from an area of background (IL04) similar to the above PLM sample (IL02) shows a large yellow particle on top of the white preparation layer.

This particle has an appearance and a response to UV fluorescence consistent with yellow earth. This is slightly unusual given that this area was painted with orpiment and red earth, but it is possible this is due to a yellow earth contaminant or high concentration yellow earth.

The orpiment painted background is likely to have had a much more golden yellow colour originally, before it degraded to arsenolite. The two different yellows would have made this coffin look very different when it was originally painted.

Red

The red paint on the inner coffin is unusual as it is different on the left and right hand sides of the coffin. The proper right side of the coffin has a uniform layer of paint in the red passages, but on the proper left side the red has suffered some overall low-level abrasion and the brush marks are much more visible. The dividing line for this phenomenon is about ¾ across the body. The abrasion does not affect any of the other colours on the coffin. The division might have something to do with an obstruction to one side of the coffin while painting in the reds and suggests that the colours were painted one at a time. The variation in the look of the red areas may also suggest that a different batch of red paint was used on the proper left side. This does not appear to have been of the same quality as the proper right side and could suggest an apprentice mixed an inferior batch, possibly with the wrong amount of binder.

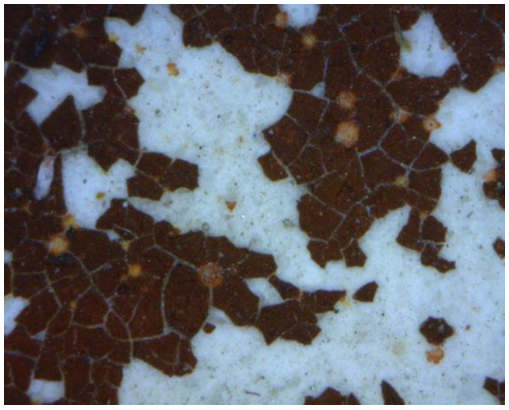

Figure 11: Red from proper left side of inner coffin, magnified under dinolite

The face is much more heavily abraded on the proper left side than the proper right, but the whole face appears to have been painted as one in the darker tone. This may suggest that the proper right side of the face was painting in the more hard wearing red, then over painted with the dark paint to prevent an obvious separating line down the face.

The cross sections for the two different reds (proper right red: IL08; proper left, abraded red: IL10) do not show any appreciable difference in application, other than a lack of surface dirt on the abraded red. The white ground is thinner and has white inclusions. Both are composed of a bright, opaque red layer directly applied to a white preparation layer. The red does not fluoresce in ultraviolet light, exhibiting significant quenching (which is common for iron-containing pigments). SEM/EDX of these two cross sections (S. Bucklow, 01.05.2015) showed similar elemental composition (Si, Ca, Al, Fe) between the two red layers. There is no added inorganic component (pigment or drier) that has caused one side to react so dramatically differently.

Both dispersion samples (IL09 and IL11) showed fine, rounded red particles exhibiting high birefringence masked by strong body colour in crossed polars. The particles in IL11 were found to be finer than those of IL09.

XRF analysis (PR side ARTAX S31, 32, PL side ARTAX S23, 28) of the different reds suggests that more iron is present on the proper right (less abraded) side. However it is possible that the lack of abrasion may account for the difference in iron levels.

Blue

The blue areas on the lid and box have discoloured to a dark greenish blue. A dispersion sample taken from one such area (IL07) indicated the presence of Egyptian blue, with coarse, pale blue shards exhibiting pale blue birefringence in crossed polars. The green appearance of Egyptian blue is a well-documented if not very well understood phenomenon.

This colour was used on the stripes on the lid and box, the text on the back of the box, the upper side of the beard, the skin and wigs of figures, feathers, the lattice work pattern on the lid and other small decorative elements.

A cross section taken from an area of blue, IL05, shows a layer of blue-green-grey particles on top of a discoloured white preparation layer. This 'discolouration' resembles the ground layer, but may be a second layer on top of the white crystalline layer; it is yellow brown and fluoresces to a brighter yellow in ultraviolet light.

Green

Green was used to paint the broad collar, the skin and feathers of Isis, the skin and robes of figures and other small decorative elements. A green dispersion sample (IL12, taken from the green boat in the centre) was taken, and was tentatively identified as Egyptian green[2]. XRF analysis (ARTAX S26) of the green showed very similar results to the Egyptian green on the outer coffin. There are high copper levels and the presence of tin and lead; these materials may be from the copper source that was used to produce the pigment. The presence of tin and lead make it more likely that this pigment is Egyptian green than another copper green.

Order of application of paint layers

Drawing

Subsequent paint layers (red, blue, green and yellow) were painted messily on top of the drawing, often partially obscuring the black lines.

The black drawing was still wet when the yellow paint was applied – there are clear streaks in the yellow paint where the paint brush crossed the black line.

The black text and line and dot decoration on the upper side of the lid was applied after the yellow areas were painted and dry.

Figure 12: detail of yellow showing the smudging of the black drawing lines

Yellow

The bright yellow earth layer was applied while the drawing was wet – the smudging of the drawing lines (as seen in Figure

[2] The sample was of poor quality and it was difficult to separate out the green particles from the calcite; however the Egyptian green samples are often of similar quality and the identification of Egyptian green was influenced by the ARTAX results.

12) is observed in many of the bright yellow areas on the inner coffin.

Red

The next colour to be applied to the coffin was red. This is used for stripes across the coffin, skin and robes of figures, the background for the lattice panels on the lid, the text on the back of the box and other small decorative elements.

Blue

This colour overlies the two shades of yellow and the red.

Green

Green paint is only used on the lid of the inner coffin and appears to have been applied after the other colours.

Black

Parts of the black outlining were reapplied to better define the decoration.

Yellow

The pale yellow wash seems to have been applied last.

Table 3: Paint stratigraphy

	EXTERIOR	INTERIOR
15	orpiment wash	
14	black touching up	
13	Egyptian Green	
12	Egyptian Blue	
11	Red earth	
10	Yellow earth or yellow ochre	
9	Black marking out lines & underdrawing	
8	White paste (2 sublayers)	
7	Linen textile	
6	White paste	
5	Animal glue	
4	Linen textile	
3	Black layer or black patches	
2	Fibrous animal glue	
	Patchy pink paste and/or pink fill in gaps and wood	
1	Red paste / fill flaws	
0	Sycamore fig wood	
-1		Red paste/ fill flaws
		Patchy pink paste and/or pink fill in gaps and wood
-2		Linen textile
-3		White paste

Samples

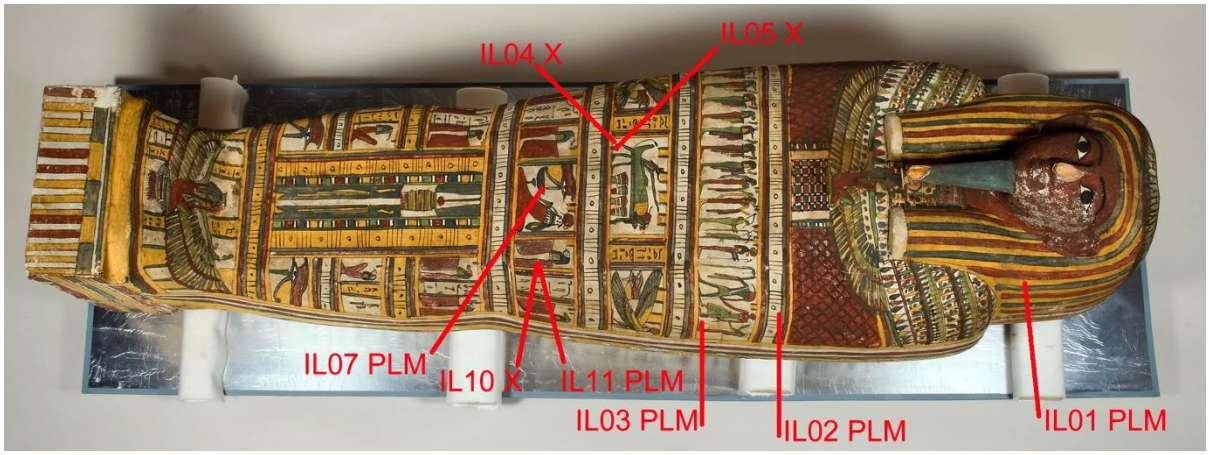

Figure 13: PLM and Cross Section Sample Locations on E.2. 1869 Pa Kepu Inner Coffin (front view)

Figure 14: PLM and Cross Section Sample Locations on E.2. 1869 Pa Kepu Inner Coffin (proper right view)

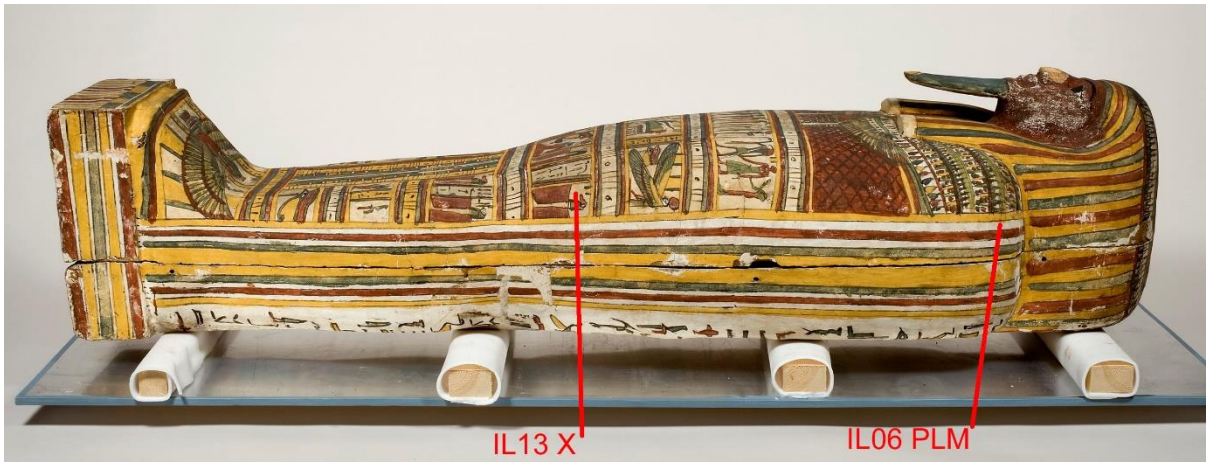

Figure 15: PLM and Cross Section Sample Locations on E.2. 1869 Pa Kepu Inner Coffin (proper left view)

Figure 16: PLM and Cross Section Sample Locations on E.2. 1869 Pa Kepu Inner Coffin (interior box view)

Figure 17: PLM and Cross Section Sample Locations on E.2. 1869 Pa Kepu Inner Coffin (interior lid view)

Figure 18: PLM and Cross Section Sample Locations on E.2. 1869 Pa Kepu Inner Coffin (top head view)

Figure 19: PLM and Cross Section Sample Locations on E.2. 1869 Pa Kepu Inner Coffin (footboard view)

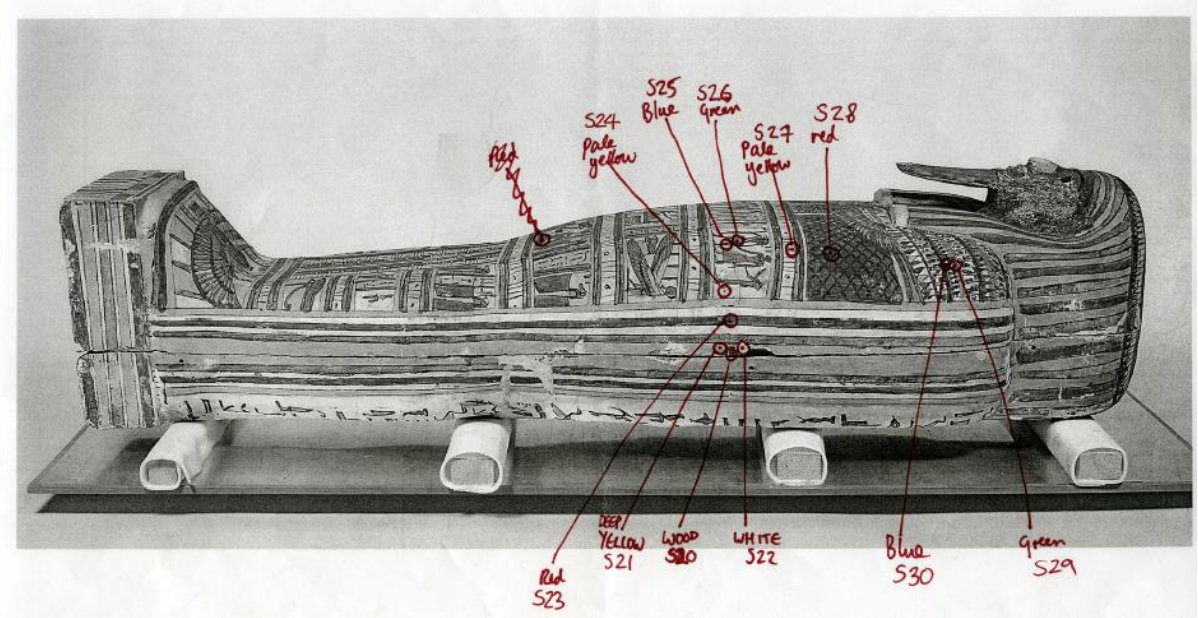

Figure 20: XRF locations on E.2. 1869 Pa Kepu Inner Coffin (proper left view)

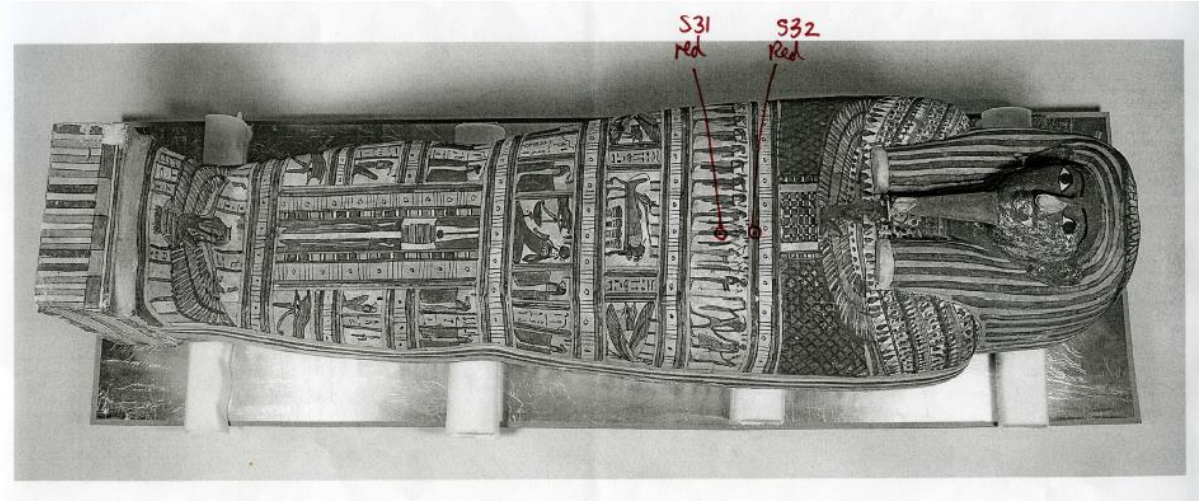

Figure 21: XRF locations on E.2. 1869 Pa Kepu Inner Coffin (front view)

Cross sections

IL04	Yellow background	24/02/2015
IL05	Black line/blue figure	23/02/2015
IL08	Red stripe	24/02/2015
IL10	Abraded red decor	24/02/2015
IL13	Yellow background (re-do IL04)	11/03/2015

Sample locations can be seen in the diagrams in Figure 13, Figure 14 and Figure 15.

PLM samples

IL01	Yellow in wig	23/02/2015
IL02	Yellow background	23/02/2015
IL03	Yellow-pink background	23/02/2015

IL06	White line	23/02/2015
IL07	Blue	23/02/2015
IL09	Red stripe	24/02/2015
IL11	Faded red décor	24/02/2015
IL12	Green	24/02/2015
IL14	White from lower preparation layer (below textile)	11/03/2015
IL15	Inner lid, proper right shoulder, interior corner - preparation layer	26/04/2017
IL16	Inner lid, exterior between layers of linen - foot; proper right hand side	26/04/2017
IL17	Inner lid, exterior top white layer	26/04/2017
IL18	Proper left hand side, knee area at lip	09/05/2017
IB01	Inner box, interior;half-way down, proper left hand side	11/04/2017
IB02	Exterior of inner box, head, white layer between textile layers	11/04/2017
IB03	Black layer under both layers of textile	11/04/2017
IB04	Interior of box, pink plaster	09/05/2017
IB05	Exterior - top layer of of plaster	09/05/2017

Sample locations can be seen in the diagrams in Figure 13, Figure 14 and Figure 15.