Surface coatings and decorative scheme

E.1.1822 Outer Coffin Lid

Interior:

There is a partial covering of a mud paste over the interior of the lid. This is primarily found on the joins between the wood, but is also seen across the surface. There are small patches of red pigment on the proper left side near the toes, probably not applied deliberately.

This mud paste was examined via XRD (XRD 13). The diffractogram for this sample showed a mixture of quartz and calcite. There was no evidence for clay minerals but detection limits are likely to be poor (high). A quartz and calcite –bearing mudrock or shale cannot be ruled out as a possible source material.

On the upper part of the interior of the outer coffin lid, near the proper left shoulder, there are 5 parallel brush marks in pale green orientated along the length of the lid. This colour is not consistent with other areas of green on the coffin.

Exterior:

The exterior of the outer coffin lid has a similar palette and paint application to the exterior of the outer coffin base. The lid is disfigured by a large amount of surface dirt.

The exterior of the outer coffin was covered with two white preparation layers. Red paint (red earth) was used to draw in the figures and hieroglyphs. The outer coffin lid was painted using Egyptian blue, probable Egyptian green and red earth. There is occasional use of blacks used to paint in final details, but there are fewer of these black final details than on the inner coffin or the mummy board. A thick yellow organic coating (probably a natural resin varnish) was applied selectively but messily to the figures and to the text, leaving the white preparation layer exposed in the background.

Preparation layer

The outer surface of the coffin lid is covered with a coarse mud (?) paste[1], first applied selectively to bulk out wide joins between pieces of wood and smooth uneven areas. The surface of the lid was then coated with a white preparation layer. X-radiography shows that there are thicker areas of application, either of the white preparation layer or mud (?) plaster, on the top of the head, along the joins in the wood down the sides of the lid and building up the base of the sloped shape of the toes.

The white preparation layer was identified as sparitic type calcite (OL11). The dispersion sample presented large, colourless particles with variable relief and strong third order colours when viewed in cross polars. The ground is generally quite thinly applied, with texture marks visible in the surface and X-Ray image from either a comb or wide brush.

The preparation layer was left exposed in the unvarnished areas, providing contrast with the bright yellow, organic coated areas. There are no further paint layers in these areas (such as a further white paint), simply exposed ground.

[1] This paste was sampled for XRD analysis (XRD 08) but was not run in Trevor Emmett's 2015 XRD examination.

Drawing

The decorative scheme is applied with red earth directly on to the white preparation layer (identified as red earth based on large Fe content (XRF S25). This can be seen clearly in cross sections OL02 and OL14, where the white preparation layer is covered in a red drawing layer. This application contrasts with the other objects in this set of nested coffins, which were all observed to have a layer of yellow applied before the red drawing. The outer lid shows no evidence of a yellow layer intermediate to the white and red layers.

Bands of hieroglyphs run around the legs and down the front of the legs. These were first drawn onto the preparation layer and filled in with red, some areas were then painted over with blue and green paint. On the footboard, the hieroglyphs were partially drawn in red (some hieroglyphs were not filled in), prior to infilling with blue and green.

Yellow

XRF analysis detected arsenic in the yellow areas of the outer lid, suggesting the use of orpiment in these areas. The arsenic is not found in the white background between figures, and this suggests that the orpiment is used selectively on the yellow figures, not as a wash across the surface. There is no evidence of a yellow paint layer in the background areas around the figures.

A thick organic coating has been applied selectively to cover the painted figures and hieroglyphs and the upper rim the coffin base. This layer is consistent in texture, UV fluorescence and colour with a degraded natural resin varnish, which probably contributes towards the yellow appearance of the passages. This organic layer can be seen in cross sections OL02, 04, 12, 13 and 14.

NB it is clear from cross section OL02 and 14 that the red drawing was applied directly onto the white preparation layer – unlike other cross sections from other nested coffins within this set, which showed the red sketching was painted after a yellow wash was laid down across the surface.

It is probable that the varnish layer is the main cause of the yellow colour figures and text areas. While these areas also contain orpiment, it may have degraded to colourless As_2O_3, arsenolite, a common deterioration product. This is suggested by some of the cross sections, which show characteristic sparkle and particle shape, but lighter colour than expected for an orpiment layer. If this is the case, the natural resin varnish is the main cause of the coffin's yellow areas. There is no evidence for any orpiment present in the varnish layer.[2]

Blue and Green

The wig, eyebrows and eye lining are painted with Egyptian blue, and were identified through a combination of VIL imaging and PLM. Dispersion samples (OL5 & 8) were found to possess coarse, platy particles with moderate pale blue birefringence when viewed in cross polars, characteristic of Egyptian blue. Green dispersion samples were identified as Egyptian green: the almost colourless, spongy particles were consistent with other green passages, such as OB15 (from the exterior of the outer base).

[2] A cross section from the inner coffin lid was examined via EDX for the presence of orpiment in the varnish layer. The results showed that the upper organic coating did not have any significant amounts of arsenic in the layer.

The green and blue pigments are applied more thickly compared to other pigments on the outer coffin, but do not show the extensive three-dimensional modelling seen in blue and green areas on the inner coffin and mummy board. The scarab in the centre of the chest is particularly thickly applied. The pooling of the blue and green paint passages suggests that the lid was painted when lying flat.

Unfortunately there are no successful cross sections from areas of blue or green.[3] The green and blue areas were applied prior to the varnish, it is unclear if they were applied before or after the yellow orpiment layer.

Black

Eyes and facial features on the animals are painted black after the application of other colours, but prior to varnishing.

Samples

Cross Sections

OL1	X	yellow	Varnish, yellow, ground	Not marked
OL2	X	red	PL ankle. Varnish, red, ground	front, lower half
OL3	X	Blue?	Centre of legs. Big bubble in sample	front, lower half
OL4	X	white	Face. Varnish and white	front, upper half
OL12	X	White and varnish	Face, to left of nose bridge	front, upper half
OL13	X		Flesh from face	Front upper
OL14	X		From white/yellow robe	Front upper

PLM samples x 7

OL5	PLM	Blue	Egyptian Blue	front, upper half
OL6	PLM	Blue	Egyptain Blue.	front, upper half
OL7	PLM	Black	Soot black. Much finer than the other blacks on this object	front, upper half
OL8	PLM	Blue	Egyptian Blue. Brownish, degraded.	Not marked
OL9	PLM	Red	Red earth	front, upper half
OL10		Green	Egyptian green. (and white?)Similar to OB15.	foot board
OL11	PLM	White ground	Calcite (sparite). + a little red earth.	Front, lower half

XRD samples

Analysed by Trevor Emmett in 2015

XRD08: exterior outer lid pink paste; not analysed

XRD13: interior outer lid pink paste

[3] Cross section OL03 was taken from the centre of the legs (knee area) in a discoloured blue area but the sample had a large bubble in the middle of the sample, rendering it unreadable.

Experimental Technique (XRD) (copied from Trevor Emmett's 2015 report)

For details of the theory and practice of the technique of powder X-ray diffraction (XRD) the reader is referred to Jenkins and Snyder (1996) and (Clearfield et al., 2008). No sample pre-treatment (e.g. grinding) was considered necessary. Each sample in turn was carefully loaded onto a Bruker 'zero height zero background' (ZHZB) sample holder for analysis. Details of zero background sample holders can be found in (Jenkins and Snyder, 1996, section 9.6.4) and Reibenspies and Bhuvanesh (2008, section 3.5.3). 'Zero height' holders consist of a wafer of non-scattering Si with no cavity – the sample simply rests on the surface of the wafer, which lies in the plane of focus of the X-ray goniometer. After analysis all the analysed powders were returned to their containers.

XRD analysis was performed using a Bruker D2 Phaser compact X-ray diffractometer located in the Forensic Laboratories of Anglia Ruskin University (Cambridge, U.K.). This instrument was fitted with a water-cooled 2.2 kW Cu anode X-ray tube operated at 300 W (30 kV, 10 mA), a Ni β-filter and a Bruker LynxEye™ silicon strip position-sensitive detector (operated in scan mode). The standard operating conditions are listed in Table 1 below. Interpretation was accomplished using the MATCH! software package in conjunction with the Crystallography Open Database (= COD). For details of MATCH! and the COD, see www.crystalimpact.com (accessed 17th August 2013). Details of the individual entries in the COD can be found by visiting the database homepage at www.crystallography.net (accessed 7th April 2015). Since the objective of this study was to obtain reliable phase identification, no data processing other than removal of background was undertaken prior to interpretation.

Results (also copied from TE report 2015)

XRD 13 OL (**Figure 3**) appears dominated by quartz. There is no evidence from any pattern for the presence of gypsum ($CaSO_4.2H_2O$), basanite ($CaSO_4.0.5H_2O$) or anhydrite ($CaSO_4$) but detection limits in terms of wt.% are certainly quite poor (see below)

Question: Is XRD 13 OL mud only? The diffractogram for this sample (**Figure 3**) shows a mixture of quartz and calcite. There is no evidence for the presence of clay minerals but detection limits are likely to be poor (high) – see the section **The ZHZB Sample Holder and Detection Limits** below. A quartz and calcite –bearing mudrock or shale cannot be ruled out as a possible source material.