Chimia 55 (2001) 938–941

ISSN 0009–4293

On the Painting Techniques of Ancient Egyptian Funeral Artefacts

Anne Rinuy*

Abstract: The painting techniques of several ancient Egyptian funeral objects were analysed, prior to conservation treatment. To determine a conservation treatment, it is a priority and necessity to identify the binding media (and possible consolidants). The results indicated a very fragile technique, used throughout centuries, and revealed the finest methods for modifying the hue of the blue pigment.

Keywords: Analysis · Ancient Egypt · Binding media · Colour · Painting

1. Introduction

Shrouds, sarcophagus, cartonnages, and other funeral objects which accompanied the deceased in his eternal life, were painted in the ancient Egyptian upper classes. Represented were the deceased, the funeral masks, the protecting divinities. The paintings are impressive, and these objects have been very much appreciated since their discovery.

The paintings of funeral objects are often very fragile. Taken out of the relatively constant climate of the tombs, and with the passage of time, they became very friable. Therefore, they have been submitted to many conservation treatments. These were not always very appropriate, and now the objects need new intervention.

Seven painted items: wooden sarcophagus, wooden chest, linen mummy shrouds, a cartonnage, belonging to the Musée d'art et d'histoire of Geneva (with the exception of a linen shroud, property of the Musée des Beaux Arts of Lyon, inv. 1982-100, [1]), came to our laboratory for examination and analysis prior to conservation or purchase.

In the literature, references on the painting techniques of such objects were found regarding the pigments either for the symbol of the colour in ancient Egypt [2], or their chemical composition [3], but relatively few gave information on the binding media [4]. It is true that the small quantities of material used, mixed later with consolidating varnishes or adhesives, complicates the analysis. The identification of the binding media is a priority and a necessity to determine a conservation treatment. So we concentrated on this aspect, not forgetting however to look at the pigments, and at the conservation materials used. Among the objects, three had not been consolidated at all, allowing us to analyse real original material.

The results obtained are presented below, and are illustrated on a selection of three different types of painted objects: a wooden chest, a linen shroud, and a cartonnage.

2. Brief Description of the Items

a) Two painted sides of a small wooden chest, dating back to the 13th–11th century BC (New Empire). The front represents the deceased, the scribe Amen-

Fig. 1. Back side of a painted wooden chest, 35 x 19.5 cm, 13th–11th century BC. Amenemheb adoring Osiris and Isis. Musées d'art et d'histoire, Geneva

*Correspondence: A. Rinuy
Laboratoire de recherche
Musées d'art et d'histoire
CP 3432
CH–1211 Genève 3
Tel.: +41 22 418 25 22
Fax: +41 22 418 26 01
E-Mail: anne.rinuy@mah-ville.ge.ch

emheb, with a curly wig, adoring Osiris and Isis, and was recently offered by a generous donator (Inv. A 1998-110, 35 x 19.5 cm). The back represents the same Amenemheb, but with a shaven skull, like priests of the time, also adoring the divinities (inv. 19297, 35 x 19.5 cm) (Fig. 1). It entered into our Museum 50 years ago. The chest probably contained small figures which ancient Egyptians used to take with them for eternity, to protect them and do their work at their place, as explained by Chappaz [5], the curator of our Egyptian collection. The painting of the back side is very friable, the front one had been treated with an adhesive which has since turned brown, and which disturbs greatly. Both painted sides need a new conservation – restoration.

b) The *Shroud of Geneva* is more recent. The painted mummy, accompanied by protecting divinities is typically Egyptian. But the face is a real portrait of a woman, bearing a pearl necklace and earrings, with a nimbus. Its execution is very influenced by Roman painting (Fig. 2). It is dated about 100 AD. The shroud was bought in 1895 for the Archaeological Museum of Geneva and entered later into the Musée d'art et d'histoire. It was folded and packed in a small box, where it stayed until in 1997, when it was 'redis-

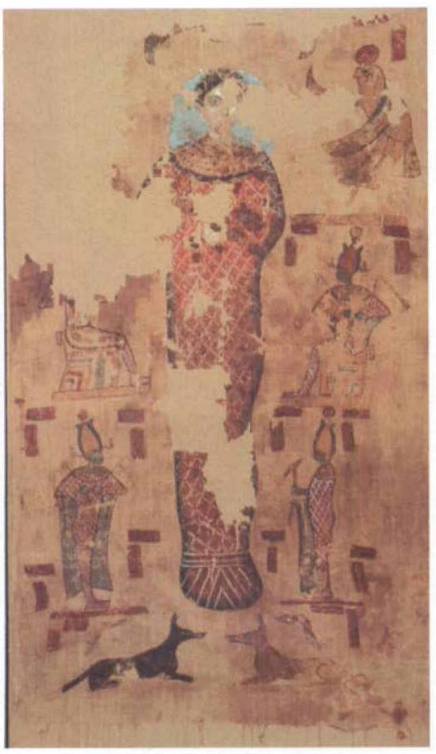

Fig. 2. The *Shroud of Geneva*, painted linen, 140 x 200 cm, about 100 AD. Egyptian mummy with adoring divinities. And a portrait of a woman with a pearl necklace and ear rings. Musées d'art et d'histoire, Geneva.

covered' [6] (inv. D 957, 140 x 240 cm). The painting was very fresh, but the shroud needed conservation treatment.

c) Finally, the painted and gilded feet of a mummy cartonnage, also attributed to the Roman period (2nd century AD),

Fig. 3. Painted and gilded feet fragment of a mummy cartonnage, 2nd century AD. Musée d'art et d'histoire, Geneva

(inv. A 1998-165) [7], had been largely consolidated with different adhesives and needed new conservation treatment (Fig. 3).

3. Experimental

3.1. *Analysis of the Binding Media*

Microscopic paint samples were embedded in a polyester resin [8] in order to prepare cross-sections. They enabled observation of the paint layers and pigments under normal and UV light.

Analyses with specific coloration and heating tests on the cross-section of the whole painting structure, indicate precisely in which layer each binding medium is present:

a) Fuchsin S, Amido Black and FITC (fluoro-iso-thio-cyanate) tests indicate the presence of proteins [9]. Fuchsin S is most appropriate for animal glue, the coloured protein is red. Amido Black II allows the detection of egg (white and/or yoke) and casein. The coloured proteins are blue. Therefore it is also useful for identifying animal glue mixed with red pigments. The different aspects of the resulting blue colour depend on the protein and on the possible presence of an emulsion. Both Fuchsin S and Amido Black II contain acetic acid and have a pH around 3.5. Acidic water-sensitive paint samples, *i.e.* containing a vegetable gum, can dissolve in the solutions. FITC is very appropriate for such cases, since it is dissolved in acetone. FITC becomes brightly fluorescent under 450–490 nm UV light exposure, when bound with proteins. So it allows the detection of a protein medium of even dark colours. Though all the proteins react the same way, very small quantities can be detected [9].

b) Heating tests characterise waxes, resins, oils, gums, or mixtures of them with or without proteins [9].

c) Specific coloration of carbohydrates indicates the presence of gums and thin layer chromatography (TLC) can confirm their presence [10].

3.2. *Analysis of Pigments*

a) Mineral pigments are identified by X-ray fluorescence spectrometry (energy dispersive, EDXS) and X-ray diffraction [11].

b) Scanning Electron Microscopy (SEM), coupled with EDXS, performed on paint cross-sections indicates more precisely in which layer they are present.

4. Results of Analyses

4.1. *Binding Media*

All the paintings analysed contain only a small quantity of binding medium.

The same media were identified for all the objects:

- *animal glue* for the white ground, maybe with some *vegetable gum (probably gum arabicum)* (Fig. 4–7);
- *vegetable gum* for the glossy colours, some of them also containing a small amount of *animal glue.*

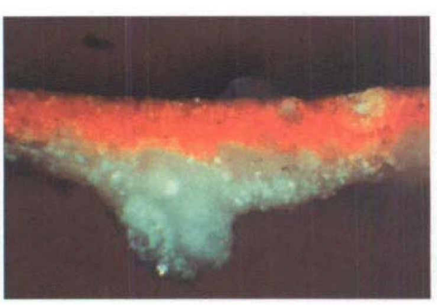

Fig. 4. Painted and gilded feet of a mummy cartonnage. Microsample in a toe, cross-section. Red colour: hematite, thickness 100 µm. On white ground: calcite, 250 µm. Optical microscope, original size: 0.60 x 0.90 mm

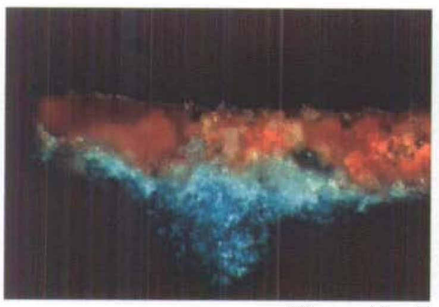

Fig. 5. Painted and gilded feet of a mummy cartonnage. Same cross-section as in Fig. 4. Specific coloration for proteins: Amido Black II. Indicating that the white ground medium is animal glue. The red colour is soluble in the acidic specific coloration, pointing to the probable presence of a vegetable gum. Optical microscope, original size: 0.60 x 0.90 mm

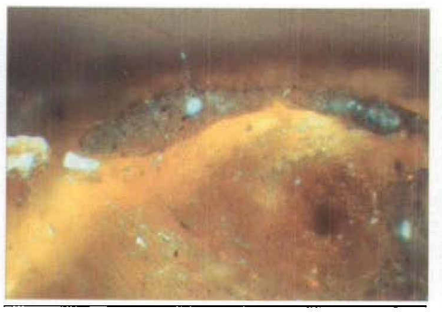

Fig. 6. Painted *Shroud of Geneva*, grey nimbus around the portrait. Microsample cross-section. The grey colour (thickness 60 µm) is painted directly on the primed linen textile. Optical microscope, original size: 0.60 x 0.90 mm

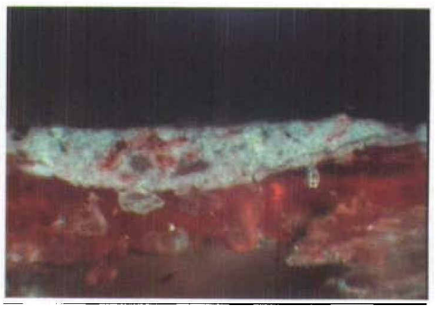

Fig. 7. Painted *Shroud of Geneva*, grey nimbus around the portrait. Same cross-section as in Fig. 6. Specific coloration for proteins: Fuchsin S indicating that the grey colour contains some animal glue (red filaments), and showing the animal glue primed linen textile (red coloured fibres). Optical microscope, original size: 0.30 x 0.45 mm

4.2. *Pigments*

- Calcite ($CaCO_3$) and gesso ($CaSO_4 \cdot 2\,H_2O$) for the white ground and white colour;
- red: hematite (Fe_2O_3);
- yellow: ochre (clay containing iron oxides, like goethite α-FeO·OH); orpiment (As_2S_3);
- orange: realgar (As_2S_2);
- blue: Egyptian blue (similar to natural cuprorivaite $CaCuSi_4O_{10}$);
- green: Egyptian green (cuprowollastonite $(Ca,Cu)SiO_3$); atacamite [$Cu_2Cl(OH)_3$];
- black: charcoal.

4.3. *Painting Techniques*

The paint of the different objects has been applied in a similar manner: usually one layer for the colour, lying on a white ground (Fig. 4 and 5).

The *Shroud of Geneva* differs in having no white ground: the colours were painted directly onto the primed linen textile (Fig. 6 and 7).

On the two sides of the wooden chest, the blue colour made of Egyptian blue – which now appears black due to a protective layer – (*e.g.* in the Osiris divinity) is applied onto a red ochre layer containing charcoal (Fig. 8). The painted side was also surrounded with a blue border of Egyptian blue. In this case the pigment is lying on a thin black charcoal layer (Fig. 9). So, the same blue pigment, painted on different places, had a different hue, due to the colour of the underlying layer.

The cartonnage mummy has been partly gilded. The 3–4 micron thick gold foil has been applied onto a fine pink bolus (about 15 micron thick), made of a small quantity of red ochre mixed with fine ground calcite. The binding medium of the bolus is probably egg white, while the white thick calcite ground is bound with animal glue.

5. Conclusion

The palette of pigments used corresponds to former analyses of similar Egyptian objects [2][3]. Most interesting was to discover that the finest techniques for obtaining different values of colour – *i.e.* the Egyptian blue hue varies according to the composition of the underlying layer – already existed 32 centuries ago. As was recently published by Klocke and Lehmann [12], and nearly a century ago by Raehlmann, who also analysed wall paintings and mummies of the New Empire (around 1200 BC) [13], this method of intensifying and modifying the blue colour of the coarse ground blue pigments has been known for many centuries. It was believed to have appeared in Europe during the 12th century AD, since Theophilus described the way of applying a grey or black layer, which he called 'Veneda'. But as Klocke and Lehmann, and Raehlmann mention, Plinius already wrote about it in his *Historia Naturalis*, in the 1st century AD.

We could also confirm the use throughout centuries of animal glue (mainly in the white ground) and, probably, the vegetable gum arabicum (mainly for the more glossy and translucent colours; animal glue gives a matt aspect) as binding media of Egyptian paintings.

The quantity of medium used is so scarce that it has been difficult to identify. The use of small quantities, and of water-sensitive media, like gum arabicum, has a great influence on conservation treatments: painted textiles like the shroud of Lyon [14], and the so-called *Shroud of Geneva* cannot be washed! We thus had to locally treat the Museum label which had been glued onto the textile just above the head of the portrait with enzymes [15].

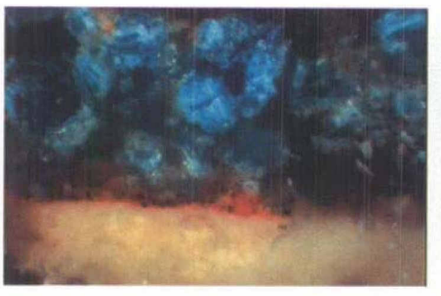

Fig. 8. Back side of a painted wooden chest. Microsample from Osiris' throne. Cross-section of the blue colour. Egyptian blue (>150 µm) on red ochre mixed with charcoal (10–15 µm). On a thick layer of a mixture of calcite and gesso (100–150 µm). Optical microscope, original size: 0.30 x 0.45 mm

Fig. 9. Back side of a painted wooden chest. Microsample in the left blue border. Cross-section of the blue colour. Egyptian blue mixed with gesso (100 µm) on a charcoal layer (10µm). On a thick layer of a mixture of calcite and gesso (100–150 µm). Optical microscope, original size: 0.30 x 0.45 mm

The low quantity of binding medium also leads to the loss of the painting material. Most different water-sensitive consolidants or adhesives like animal glue, PVA [16] or gum arabicum were applied onto the painting in thick layers which have now turned brown. They penetrated into the water-sensitive painting, probably mixed with the original binding medium, and now probably cannot be removed from the paintings without causing further damage.

The analyses of the binding media (and of possible consolidation material) prior to any conservation treatment seems to be an everlasting necessity. As already stated, the methods used do not need very sophisticated equipment and provide the conservator with sufficient information to carry on his intervention.

Acknowledgements

I warmly thank Jean-Luc Chappaz, curator of the Egyptian collection of the Musée d'art et d'histoire of Geneva, and Dr Christoph Herm, of the Swiss Institute for Art Research in Zurich, for his helpful remarks while reading my manuscript. I would also like to thank the following people for taking the photographs: Thérèse Flury, laboratoire des Musées d'art et d'histoire, Geneva (Fig. 1–7), Patrizia Roncadi, laboratoire des Musées d'art et d'histoire, Geneva (Fig. 8) and Christine Dufresne, laboratoire des Musées d'art et d'histoire, Geneva (Fig. 9).

Received: October 2, 2001

[1] J.-C. Goyon, 'Un linceul égyptien historié de la fin de l'époque ptolémaïque au musée des Beaux-Arts de Lyon', *Bulletin des musées et monuments lyonnais* **1996**, *4*, 14.

[2] a) S.H. Aufrère, 'Les couleurs sacrées en Egypte ancienne: vibration d'une lumière minérale', *Techné* **1999**, *9-10*, 19; b) S. Colinart, E. Delange, S. Pagès, 'Couleurs et pigments de la peinture de l'Egypte Ancienne', *Techné* **1996**, *4*, 29.

[3] a) F. Delamare, 'De la composition du *bleu égyptien* utilisé en peinture murale gallo-romaine', in 'La couleur dans la peinture et l'émaillage de l'Egypte ancienne', actes de la table ronde, Ed. S. Colinart, M. Menu, Edipuglia, Bari, **1998**, p. 177; b) F. Delamare 'Sur les processus physiques intervenant lors de la synthèse du bleu égyptien', *Revue d'archéométrie* **1997**, *21*, 103; c) C. Coupry, 'Apports spécifiques de la spectrométrie Raman à l'étude de la matière picturale égyptienne', in 'La couleur dans la peinture et l'émaillage de l'Egypte ancienne', actes de la table ronde, Ed. S. Colinart, M. Menu, Edipuglia, Bari, **1998**, p. 77; d) S. Pagès-Camagna, 'Pigments bleu et vert égyptiens en question: vocabulaire et analyses', in 'La couleur dans la peinture et l'émaillage de l'Egypte ancienne', actes de la table ronde, Ed. S. Colinart, M. Menu, Edipuglia, Bari, **1998**, p. 163; e) M. Blet, B. Guineau, B. Gratuze, 'Caractérisation de boules de bleu égyptien: analyse par absorption visible et par activation avec des neutrons rapides de cyclotron', *Revue d'archéométrie* **1997**, *21*, 121; f) S. Colinart, 'Jarosite et natrojarosite: pigment ou altération de la peinture de l'Ancienne Egypte?', in 'La couleur dans la peinture et l'émaillage de l'Egypte ancienne', actes de la table ronde, Ed. S. Colinart, M. Menu, Edipuglia, Bari, **1998**, p. 95; g) O. Rouchon, J. Fabre, M.-P. Etcheverry, M. Schvoerer, 'Pigments d'Egypte – Etude physique de matières colorantes bleue, rouge, blanche, verte et jaune, provenant de Karnak', *Revue d'archéométrie* **1990**, *14*, 87; h) H. Morgan, P. Cruickshank, 'The Conservation of the Shroud of Resti – an 18th Dynasty, linen *Book of the Dead*', in ' Conservation in Ancient Egyptian Collections', Ed. C.E. Brown, F. Macalister, M.M. Wright, Archetype Publications, London, **1995**, p. 1; i) L.R. Green, 'Recent Analysis of Pigments from Ancient Egyptian Artefacts', in ' Conservation in Ancient Egyptian Collections', Ed. C. E. Brown, F. Macalister, M. M. Wright, Archetype Publications, London, **1995**, p. 85.

[4] a) S. Gottsmann, 'Investigation and Conservation of an Egyptian Mummy Board from the Royal Albert Memorial Museum, Exeter', *SSCR Journal* **1999**, *10 (2)*, 5; b) A. Rinuy, 'Etude de la technique picturale en vue de la restauration du linceul', *Bulletin des musées et monuments lyonnais* **1996**, *4*, 27; c) M. Elston, 'Technology and Conservation of a Polychromed Wooden Sarcophagus', in ' Conservation in Ancient Egyptian Collections', Ed. C.E. Brown, F. Macalister, M.M. Wright, Archetype Publications, London, **1995**, p. 13; d) T. Bilson, 'The Conservation of a Roman Egyptian Painted Shroud Fragment', *The Conservator* **1992**, *16*, 3; e) C. Viellescazes, D. LeFur, 'Identification du liant dans la peinture murale égyptienne (Temple de Karnak)', *Bulletin de la Société d'égyptologie* **1991**, *15*, 95; f) G. Laurin, 'Conservation of an Egyptian Mummy From Swindon', in 'Conservation in Ancient Egyptian Collections', Ed. S.C. Watkins, C.E. Brown, United Kingdom Institute for Conservation Publication, Bristol, **1988**, p. 85; g) L. Hillyer, 'The Conservation of a Group of Painted Mummy Cloths from Roman Egypt', *Studies in Conservation* **1983**, *29*, 1; h) S.P. Sack, F.C. Tahk, T. Peters, Jr., 'A technical Examination of an Ancient Egyptian Painting on Canvas', *Studies in Conservation* **1981**, *26*, 15; i) D. Le Fur, in 'La conservation des peintures murales des temples de Karnak, les matériaux et les techniques', Ed. Recherches sur les civilisations, Paris, **1994**, p. 30; j) A. Lucas, in 'Ancient Egyptian Materials and Industries', Ed. E. Arnold, London, **1962**, (4th Ed.), p. 1.

[5] a) J.-L. Chappaz, 'Fragments d'un bagage d'éternité', 'Objet du mois de mai 98', Musées d'art et d'histoire, en collaboration avec la Tribune des Arts **1998**; b) J.-L. Chappaz, 'Enrichissement du département d'archéologie en 1998, collection égyptienne', *Genava* **1999**, *XLVII*, 151.

[6] a) J. Chamay, 'Un linceul égyptien dormait au musée depuis un siècle', Tribune des Arts **1997**; b) K. Parlasca, 'Le linceul de Genève', *Cahiers de la Société d'Egyptologie*, to be published.

[7] J.-L. Chappaz, 'Enrichissement du département d'archéologie en 1998, collection égyptienne', *Genava* **1999**, *XLVII*, 151.

[8] Polyester Combi 24 resin, hardener CHP 24, from Bolleter & Co AG, 9320 Arbon (CH).

[9] A. Rinuy, L. Gros, 'Liants dans les peintures anciennes: méthodes d'identification et étude du vieillissement', in 'Methoden zur Erhaltung von Kulturgütern', National Forschungsprogramm 16, *Zeitschrift für Kunsttechnologie und Konservierung* **1989**, *1*, 1.

[10] a) R. Wolbers, 'Carbohydrates', in 'Cleaning Painted Surfaces', Archetype Publications, London, **2000**, p. 168; b) F. Flieder, 'Mise au point des techniques d'identification des pigments et des liants inclus dans la couche picturale des enluminures de manuscripts', *Studies in Conservation* **1968**, *13*, 49.

[11] A. Rinuy, 'Méthodes d'analyses', in 'L'œuvre d'art sous le regard des sciences', Musée d'art et d'histoire, Ed. Slatkine, Genève, **1994**, p. 221.

[12] J. Klocke, J. Lehmann, 'Technik des Unterlegens von grobkörnigen Pigmenten', *Restauro* **2001**, *5*, 373.

[13] E. Raehlmann, in 'Über die Farbstoffe der Malerei', Ed. von E.A. Seemann, Leipzig, **1914**, p. 4.

[14] a) A. Rinuy, 'Etude de la technique picturale en vue de la restauration du linceul', *Bulletin des musées et monuments lyonnais* **1996**, *4*, 27; b) M. Schoefer, 'La restauration du linceul', *Bulletin des musées et monuments lyonnais* **1996**, *4*, 24.

[15] a) A. Rinuy, 'Etude de la technique picturale du linceul de Genève', *Cahiers de la Société d'Egyptologie*, to be published; b) A. Fiette, 'Restauration d'un linceul peint redécouvert au Musée d'art et d'histoire de Genève', *Bulletin du CIETA* **2000**, *77*, 15.

[16] a) Identified by Lugol test (KI/I_2 0.1 N solution: pink colour if positive, dark blue-violet for starch); b) The presence of PVA was confirmed by FTIR analyses, conducted by Dr. Christoph Herm, Swiss Institute for Art Research, Zürich, whom I asked to identify possible synthetic consolidants. Unpublished report, 09/05/2001.