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METAL SOAP DEGRADATION OF OIL PAINTINGS: AGGREGATES, INCREASED TRANSPARENCY AND EFFLORESCENCE

Petria Noble and Jaap J. Boon

ABSTRACT – Previous studies have revealed that lead- and zinc-containing oil paint layers in paintings and objects from different time periods, schools and collections, on varying supports, and including both treated and non-treated works, can undergo metal soap-related degradation that may affect their stability, appearance and interpretation. Depending on the composition and build-up of the paint layers this can be manifested on the surface in various ways: as protruding aggregates, increased transparency or metal soap efflorescence. These alterations are now recognized in thousands of paintings. This paper will give an overview of the surface defects that conservators can encounter. While the exact conditions leading to these changes are still not fully determined, many factors are now better understood.

1. INTRODUCTION

Lead and zinc soap aggregates are frequently observed in paintings. Since the characterization of metal soap aggregates in 1998, what we came to term *protrusions*, numerous studies into metal soap-related degradation have appeared (Heeren et al. 1999, Boon et al. 2002, Noble et al. 2002, Saunders et al. 2002, Higgitt et al. 2003, Robinet and Corbeil 2003, Weerd et al. 2003, Boon et al. 2004, Keune 2005). More recently, attention has focused on several associated phenomena (Van Loon et al. 2005, Noble et al. 2005, Shimadzu and Van den Berg 2006, Keune et al., this volume).

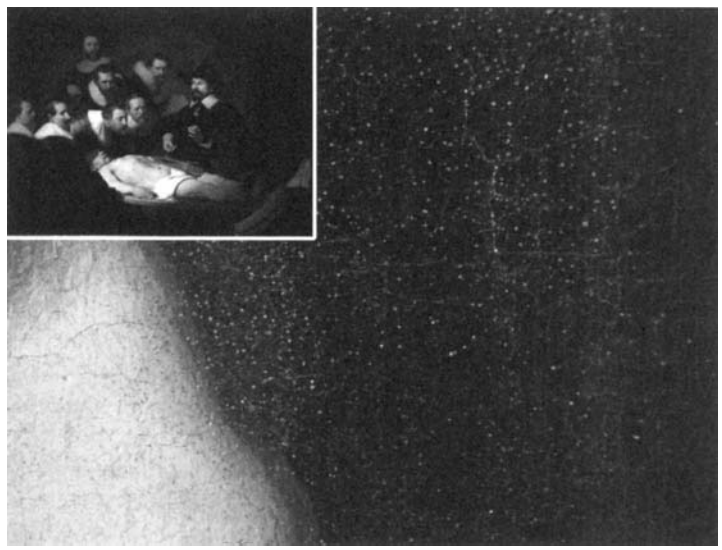

Fig. 1. Rembrandt van Rijn, *The Anatomy Lesson of Dr. Nicolaes Tulp*, 1632, canvas, 107 x 82 cm, Mauritshuis, The Hague, inv. 146. Overall, and detail of brown background at the upper left showing masses of crater-like holes caused by protruding lead soap aggregates. Here the visual effect is a lack of saturation in the background.

Metal soaps (i.e. metal carboxylates) are normal reaction products of metal (ions) from pigments or driers and fatty acids released during cross linking of the oil binding medium during hydrolytic ageing of the paint (Boon et al. 1997, Boon et al., this volume). When uniformly dispersed, metal soaps are thought to confer flexibility to a paint film. However, as paint ages, they tend (depending on conditions) to aggregate, grow and swell, or migrate inside the paint eventually pushing up through the surface causing paint loss and textural changes as well as other disturbing defects. Initially, research concentrated on characterizing protruding aggregates, but more recently attention has focused on associated changes in appearance: increased transparency resulting in darkening and metal soap efflorescence that results in the formation of insoluble whitish hazes and crusts. Since metal soap degradation can manifest itself on the surface of paintings in various ways, conservators should be alert that even more commonly encountered phenomena such as pinpoint paint loss or diminished gloss, as well as increased transparency, and whitening (usually perceived as 'blanching') may well be due to metal soap degradation (figs. 1, 2, 9 and 12).

In the past, lack of understanding of these phenomena has frequently led to misinterpretation of treatment history, condition, and artist technique. Lumpy surface textures resulting from the formation of very large lead soap aggregates below the paint surface has sometimes been interpreted as a textured ground deliberately chosen by the artist. The presence of aggregates in a paint layer was also thought to be indicative of the use of emulsion paint, since it is now known that cross-sections containing lead soap aggregates can give false positive results when stained for protein (Higgitt et al. 2003). In some samples, the presence of metal soap aggregates can also affect the fatty acid ratios,

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leading to misinterpretation of the nature of the binding medium (Higgitt et al. 2003, Keune et. al. 2005). Furthermore, reduced opacity of white pigment particles causing loss of detail, color change and darkening can now be understood as a change in appearance due to their dissolution, rather than darkening of the oil binding medium as previously thought. But, perhaps more importantly, it is the implications for long term preservation and conservation practices that the present paper seeks to address.

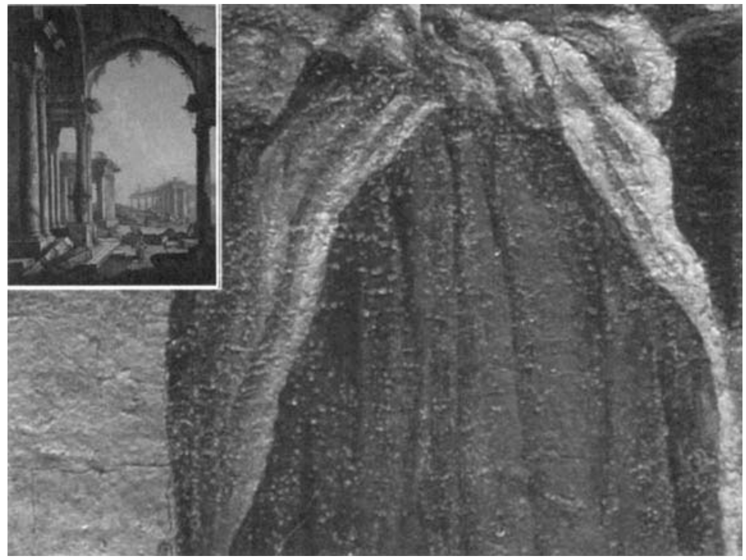

Fig. 2. Pietro Belotti di Canaletti, c.1750?, *Capriccio with ruins,* canvas, 75.5 x 56.5 cm, Mauritshuis, The Hague, inv. 308. Overall, and detail from (red) drapery of woman (bottom centre). Here the extensive pinpoint paint loss would not be immediately obvious as being due to masses of aggregates that have broken through the surface paint.

2. PREVIOUS STUDIES (1998-2006)

Although previously noted, metal soap aggregates were first properly characterized during the research associated with the 1996-1998 treatment of Rembrandt's - *The Anatomy Lesson of Dr. Nicolaes Tulp* from 1632 (The Hague, Mauritshuis). Here, the presence of crater-like holes over large areas of the painting was found to be due to protruding lumps formed as a result of reactions taking place between the oil binding medium and lead white-rich upper ground layer (Middelkoop et al. 1998; Heeren et al. 1999, Noble et al. 2000). The apparent dissolution of the original lead white pigment particles to form lead soap aggregates, their expansion, protrusion and remineralization were described in numerous subsequent publications on this painting (Boon et al. 2002, Keune et al. 2002), as well as several other paintings (Noble et al. 2002, Van der Weerd et al. 2003, Higgitt et al. 2003, Robinet and Corbeil 2003, Keune 2005).

Optical microscopy carried out in the Mauritshuis of paint cross-sections from this painting, provided information about the nature of the phenomenon. The cross-sections were then investigated with advanced analytical techniques at the Institute for Atomic and Molecular Physics (FOM-AMOLF) in Amsterdam. Imaging Fourier transform infrared (Imaging-FTIR), scanning electron microscopy combined with elemental analyses (SEM-EDX) and secondary ion mass spectrometry (SIMS) of the paint cross-sections, proved to be powerful means to demonstrate the distribution of chemical components throughout the paint layers. Subsequent analyses of several affected paintings in the collection of the Mauritshuis, as well as a number of examples which came to light as a result of an international survey (2002-2005), were investigated within the framework of the MOLART (1995-2002) and the De Mayerne (2002-2006) research programs, coordinated by Boon (FOM-AMOLF) to investigate the ageing of paint, and funded by the Netherlands Organization for Scientific Research (NWO).

Although the degradative processes involved, are still not fully understood, the paint layer build-up, with its relative concentrations of reactive components, lead- or zinc-containing pigments and driers and the fatty acids from the oil are considered to play an important role (Keune and Boon forthcoming). In this sense, they can be considered pigment specific reactions since different pigments require different amounts of oil. A relatively higher oil content may help explain why underlying lead white (containing) layers seem to undergo saponification more readily, and surface lead white layers do not. Previous study of lead white paints (Noble and Van Loon 2005) have shown that the dense packing of the lead white pigment particles, crucial for bodied highlights, contains much less oil than the broad distribution of particles that characterizes the cheaper variant of lead white often used in underlying layers. That at least two grades or qualities of lead white were available is referred to in the seventeenth-century De Mayerne Manuscript (Van de Graaf 1958). The paint layer build-up is also important, in that it determines the amount and availability of free fatty acids. In this sense, the absence of absorbent grounds, or the presence of poorly coordinated oil-rich layers, as well as the amount of reactive pigments present that help to form stable paint networks, play an important role. The reason as to why some metal soaps aggregate, and others migrate seems to be related to the degree of metal coordination (or lack of) within the layer and its susceptibility for acid hydrolysis. This also might explain why highly oil-absorbent porous paint layers that contain pigments such as chalk, lakes, carbon black and earth pigments are susceptible to metal soap migration/efflorescence. Temperature and moisture gradients, from the environment or past conservation treatments appear to drive these processes (Boon et al. this volume).

3. INTERNATIONAL SURVEY (2002-2005)

An international survey carried out in 2002-2005, designed to investigate the extent and occurrence of metal soap aggregation brought to light hundreds of examples of metal soap aggregates in paintings and objects from a broad range of geographical locations and dates (Noble et al. 2005). The questionnaire, which was sent out to museums around the world in the course of 2002, documented examples ranging from the fifteenth to the twentieth centuries, including both treated and untreated paintings on paper, canvas, panel and copper, as well as polychrome sculpture. That by far the largest group is canvas paintings, is also in accordance with the study carried out more recently at Tate Britain (Jones et al., this volume), but this also has to do with the increase in the use of canvas from the second half of the seventeenth century onwards. Of the paintings reported in the questionnaire, only a small proportion was analyzed, and in each of the cases studied, metal soap aggregates were identified as having originated in lead- or zinc-containing grounds or paint layers. In Old Master paintings, aggregate formation was found to occur most often in lead white/lead drier containing preparatory layers and in paint layers where it is associated with lead-tin yellow, and to a lesser extent, with red lead or in dark surface paints. In the more recent examples, both lead- and zinc-containing paints were affected. In many of the reported paintings, metal soap aggregates, increased transparency and efflorescence were found to occur simultaneously suggesting a possible link. This was also borne out by Van den Berg in his study of blooms, ground staining and protrusions (Van den Berg 2002). Recent investigation of several case studies of darkening has been found to be associated with increased transparency as a result of saponification of white pigment particles (Noble et al. 2005, Shimadzu and Van den Berg 2006). The variation in the quality of the data received during the survey made correlations difficult; in this regard the more quantitative study carried out by the Tate Britain is a valuable addition (Jones et al., this volume).

4. RECOGNIZING METAL SOAP RELATED DEFECTS AND CHANGES TO THE APPEARANCE AND CONDITION OF OIL PAINTINGS

4.1 METAL SOAP AGGREGATION

Surface features:
Metal soap aggregates can form in underlying or surface oil paint layers containing lead or zinc in the form of driers or pigments, as well as in poorly coordinated oil-rich layers as a result of migration of metal soaps. Aggregates appear as whitish or opalescent lumps with diameters between 50 and 500 µm, though diameters of 100-200 µm, which can easily be seen with the naked eye, are most common. They are essentially globular and when erupted produce slightly protruding crater-like edges on the paint surface as a result of pushing up through the paint. This physical expansion, which results in deformation and fracturing of the overlying paint, eventually leads to paint loss. Although aggregates can usually be seen with the naked eye, they are more easily distinguished under the stereomicroscope.

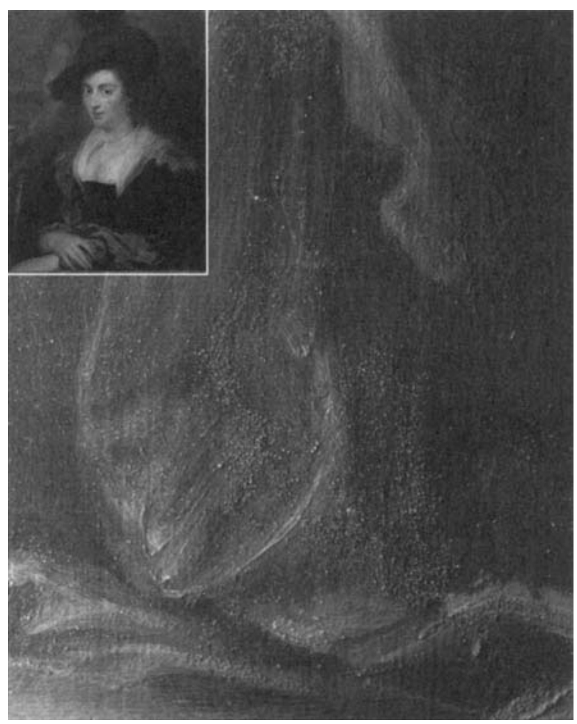

Fig. 3. Peter Paul Rubens, *Portrait of a woman,* 1627, panel, 78.2 x 58.7 cm, Museum Boijmans van Beuningen, Rotterdam, collection Willem van der Vorm Foundation, inv. 70. Overall, and detail of the left sleeve with gritty texture caused by masses of aggregates lying below the paint surface. Images: Annetje Boersma.

Although tiny, aggregates can affect the appearance of paintings: as a result, paint surfaces can appear dull, blanched, gritty, spotty, lumpy, unusually transparent, and in the worst cases, abraded and embrittled. Large areas of overpaint can be suspicious since it may hide extensive areas of pinpoint paint loss due to eruptions of masses of aggregates. Surfaces with passages of pronounced gritty texture, as seen for example in areas of curiously textured paint in a 1627 panel painting by Peter Paul Rubens - *Portrait of a woman* (Rotterdam, Museum Boijmans van Beuningen) - can also result from aggregates lying below the surface (fig. 3). This was also borne out in a study of John Singer Sargent's *Madame X* (New York, The Metropolitan Museum of Art) from 1883-4 (Mahon and Centano 2005). That they can appear on the surface as light spots, dark spots, protruding lumps or crater-like holes depends on the nature of the metal soap and the stage of development (on early, mature and late stages see Boon et al. 2002 and Keune et al. 2002), as well as the composition of the paint layer/s involved and the time scale of the reaction. These factors explain the different degrees of paint loss/damage observed, ranging from barely visible pinpoint losses, perceived as diminished gloss or contrast (fig. 1), to pinpoint loss, appearing as abrasion (fig. 2), to extensive paint loss (fig. 4), to severe embrittlement (fig. 5). Due to cleaning procedures carried out over the course of time, protruding aggregates may also have dissolved or fallen out, and the resulting voids filled with darkened varnish and dirt causing the resulting voids to appear as dark spots which are visually disturbing, especially in light areas. While lead soap aggregates exhibit a hard waxy appearance, in modern paintings, zinc soap masses are usually more brittle or softer. That the process can continue for some time is known, since there are several case studies where aggregates have broken through later applied paint and varnish layers (fig. 6). Where only crater-like holes are present, careful study of the paint surface is required to look for craters with residual aggregate material.

Fig. 4. Southern Netherlands, *The synagogue* (verso), c. 1500-1520, panel, 101 x 71 cm, Rijksmuseum Amsterdam, inv. A866. Overall, and detail from brown background with extensive paint losses due to protruding aggregates. Here the underlying white priming can be seen in the losses in the thin brown background paint.

When protruding aggregates have formed in underlying preparatory layers, they generally demonstrate a fairly even distribution over the whole painting independent of surface colour, though notably dark areas of paintings are usually more affected, and areas containing substantial amounts of lead white, hardly or not at all. Distribution can also be deduced from X-rays, where aggregates appear as either dark or light spots, depending on the radio-absorbency of the layer in which they are formed. Naturally, aggregates that have not protruded through the surface show no surface defects and are only visible in cross-section.

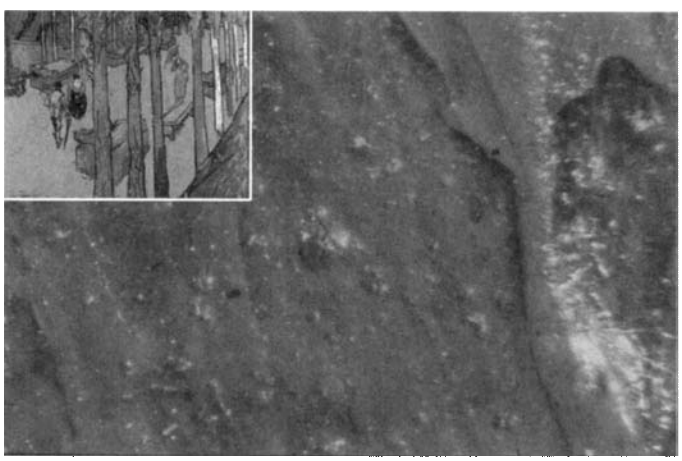

Fig. 5. Vincent van Gogh, *Falling leaves (Les Alyscamps)*, 1888, canvas, 73 x 92 cm, Museum Kröller-Müller, Otterloo, Km 224/F486. The extrusion and eruption of highly mobile zinc soaps has severely embrittled the orange lead chromate paint. Here the source of zinc is probably an added drier. Images: Leslie Carlyle.

Previous studies have also shown that mature aggregates can undergo remineralization, forming carbonates and oxides, although the degree and the nature of compounds formed varies from painting to painting, depending on the nature of the soap, maturity of the aggregates, the paint composition, treatment history and the environment to which the painting has been exposed. In the case of lead soaps, the formation of amorphous particles of red lead around and throughout the soap mass is a very common observation in paint cross-sections, and the red particles are also sometimes visible on the paint surface. The frequent observation of precipitation bands or rings, within the aggregate mass is associated with the remineralization of lead compounds, including lead carbonate, which is white. In Rembrandt's *Anatomy Lesson of Dr. Nicolaes Tulp*, lead chlorides were also identified. Remineralization accounts for the hardness and opacity of the lead soap masses and the reason why lead soaps seem more stable in comparison to the softer and more mobile zinc soaps (see Boon et al., this volume). This is in keeping with the hard waxy appearance of the lead soap aggregates on the paint surface. In the case of zinc soaps, it is the expansion and extrusion of the zinc soaps up through the cracks that can have a profoundly negative affect on the stability of a painting, resulting in severe flaking and cracking of the paint. This was demonstrated in Vincent van Gogh's, *Les Alyscamps* (Otterloo, Kröller-Müller Museum, see fig. 5 and Van der Weerd et al. 2003), and as recently reported in a painting by Joan Miró (O'Donoghue et al. 2006). That zinc soaps also remineralize to form zinc carbonates was also borne out by Keune (Keune 2005).

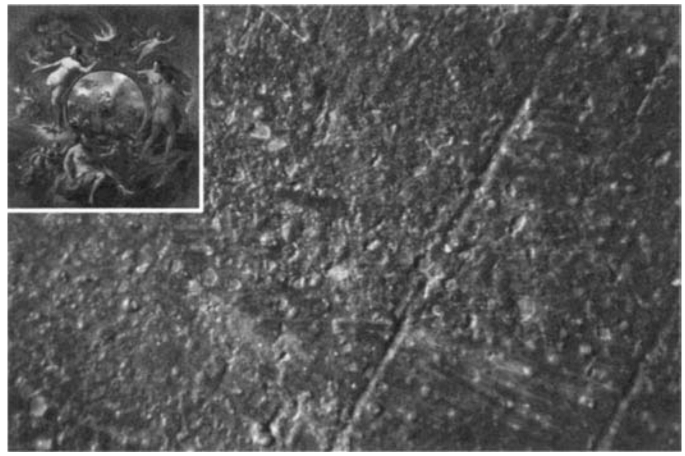

Fig. 6. Nicolaes Berchem (1620-1683), *Allegory of Summer,* c.1680, canvas, 94 x 88 cm, Mauritshuis, The Hague, inv. 1091. Overall, and detail from (red) drapery of standing figure (left of centre) where aggregates have broken through two layers of relatively recent overpaint.

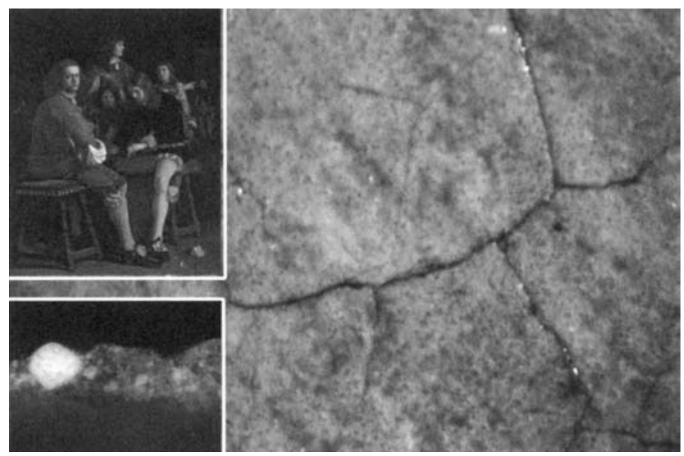

Fig. 7. Michiel Sweerts (1618-1664), *Draught Players,* 1652, canvas, 48 x 38 cm, Mauritshuis, The Hague, inv. 1121. Overall, and detail from the stocking of the right figure. Here saponification of lead-tin yellow type 1 has resulted in patchy translucent areas. In a cross-section (lower left) from this area the darkish (yellow) areas are intact lead-tin particles while the large translucent mass is the expanded lead soap mass.

The characteristic lumpy texture caused by masses of translucent lead soap aggregates is very common in lead-tin yellow type 1, and to a lesser extent in paint films where red lead is present. In lead-tin yellow surface paints, the lead soap formation not only effects volume expansion leading to grittier textures, but is considered to cause lightening of the colour as well (Boon et al. 2004). Lead-tin yellow has been found to consist chemically of a variable mixture of lead-tin oxide (lead stannate) along with residual yellow lead monoxide, red lead (lead orthoplumbate) and possibly also tin oxide. It is the reactive lead monoxide and red lead that are thought to react with the fatty acids from the oil binding medium to form whitish or translucent lead soaps that may subsequently also undergo remineralization. The proposed mechanism has been reported elsewhere (Keune 2005) and is shown schematically in a diagram (Boon fig. 6, this volume). Depending on the size, density and homogeneity of aggregate formation this can be manifested on the paint surface as masses of regularly sized translucent aggregates, lending a gritty texture and increased transparency to an otherwise opaque yellow paint layer, to translucent patchy areas, as seen for example in the lead-tin yellow stocking in Michiel Sweerts' *Draught players* from 1652 (The Hague, Mauritshuis) (fig. 7). Aggregate formation that occurs in lead-tin yellow underpaints naturally results in lumpy surface textures and is sometimes noticed in early panel paintings where lead-tin yellow is covered with a thin surface glaze.

In the case of red lead-containing paints, conversion of red lead to lead soap aggregates was also found to result in paint loss and textural changes (Higgitt et al. 2003). Lightening of red lead paints has also been reported; the pinker tonalities sometimes encountered a result of remineralization to white, lead carbonate (Saunders et al. 2002).

Unfortunately it is not always possible to determine the source of the lead or zinc involved in the soap formation, when lead- or zinc-containing pigments and driers are also (possibly) present in the affected paint layer. Lead- or zinc-containing compounds were often added to improve handling and drying properties of the paint; in seventeenth-century paintings lead-siccativized oil is often encountered. In nineteenth- and twentieth-century paintings, compounds such as lead acetate (sugar of lead) or zinc sulphate (white vitriol), which readily dissolve in the oil binding medium, were added. These have also been found to form soap aggregates (Plahter 1999, Van der Weerd et al. 2003, Keune 2005).

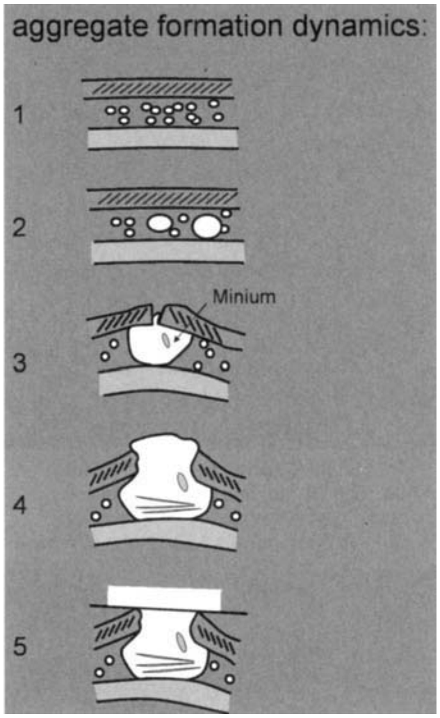

Fig. 8. Schematic diagram representing early, mature and late stages of lead soap aggregate formation. Stages 1-5: (1) intact paint, (2) early stage showing increased transparency, (3) expansion of the mature aggregate leading to eruption through paint surface, (4) protruding aggregate with remineralisation (5) late stage with mature aggregate partially dissolved/lost. See Boon et al. 2002.

Aggregation of metal soaps can also form in poorly coordinated oil-rich, often dark paint layers containing pigments such as chalk, earth pigments, lakes and bone black. In cases studied thus far, lead soaps are considered to have formed as a result of lead drier, particularly red lead, present in the layer, or to have migrated from lead-rich underlying layers, the oil-rich layers providing a source of mobile reactive fatty acids (Keune and Boon forthcoming, Noble and Van Loon 2007).

Occurrences:
Lead white-containing oil paint
Lead-tin yellow type 1-containing oil paint
Red lead-containing oil paint
Lead drier-containing oil paint
Zinc-containing oil paint
Dark, poorly coordinated oil-rich paint (as a result of migration)

Cross-sectional features:
Since microscopic examination of the paint surface provides no clear indication as to the layer of formation, cross-sectional analyses of an aggregate preserved in its paint matrix is highly instructive. Examination with visible and ultra violet illumination not only reveals the build-up of the paint layers, indicating the layer in which the aggregate has formed, but also its colour and fluorescence properties, as well as size and distribution. Cross-sections of mature metal soap aggregates demonstrate large globular, translucent or whitish masses with variable (strong) UV fluorescence, often showing opaque centers and translucent, more highly fluorescent perimeters. Mature masses that have erupted through the paint surface have notably larger diameters than the thickness of the paint layer in which they developed, though smaller masses can be present as well. Characteristic amorphous red particles of red lead are also observed in cross-sections, in or around the soap mass. Deformation of the surrounding and overlying paint layers due to swelling of the mass is also demonstrated. In early stages, regions of increased transparency exhibiting an unusually strong UV fluorescence, are noticeable throughout the layer. The different stages of aggregate formation are shown schematically in Figure 8 (Boon et al. 2002).

Cross-sections of lead-tin yellow type 1 paint layers often demonstrate a heterogeneous appearance due to the variable composition of lead-tin yellow pigment. In cross-section, the characteristically swollen lead soap masses can be seen to have pushed the lead-tin particles aside (Boon fig. 7, this volume).

Chemical features:
Metal soap aggregates can be investigated at a molecular level by different analytical techniques. Imaging-FTIR in reflection mode allows the identification and localization of different functional groups in the paint cross-section by their characteristic IR absorption, the presence of metal soaps being indicated by strong absorption in the 1510-50 cm^{-1} region. A FTIR spectrum can also be generated for a selected spot/s in the cross-section. When it is possible to obtain isolated material from the aggregate, transmission FTIR using a diamond cell can also be performed.

Detailed information on the morphology and distribution of the aggregates can be demonstrated with the scanning electron microscope (SEM); the backscattered electron images (SEM-BSE) of the cross-sections being particularly instructive in demonstrating the contrast between the amorphous aggregates and the particulate paint layer in which they have formed. The high resolution of these images makes it possible to recognize the precipitation bands or rings associated with remineralization. Micro-analyses can be carried out on areas imaged by coupling with energy dispersive X-ray analysis (SEM-EDX). This allows for identification and localization of different elements, confirming the metal involved in soap formation, as well as aiding in identification of the composition of the paint layer.

Secondary ion mass spectrometry (SIMS), can give a detailed spatially resolved mass spectrometric analysis of the inorganic and organic components of the different paint layers, and can be used to image the distribution of metal ions, metal soaps and fatty acids in the aggregates, as well as the paint layer in which they have formed (Boon et al. 2002). Raman spectroscopy, although not applied in the examples presented, can be used to identify the metal soaps and the red particles commonly associated with the masses (Robinet and Corbeil 2003; Boon 2006). Identification of inorganic compounds present in the mass can also be carried out with X-ray diffraction (XRD). The complementary nature of the information obtained by each analytical technique makes it possible to obtain better insight in these complex phenomena. Naturally, interpretation of analytical results should always be correlated with observations from optical microscopy of paint cross-sections, as well as with observations from the paint surface.

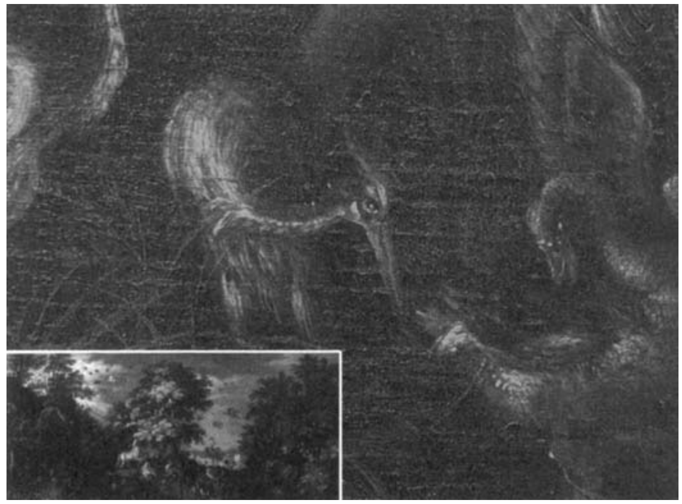

Fig. 9. Roelandt Savery (1576/78-1639), *Orpheus enchanting the animals with his music,* 1627, panel, 62 x 131.5 cm, Mauritshuis, The Hague, inv. 157. Overall, and detail of birds from center foreground. The darkening observed is due to increased transparency of the saponified lead white-containing brown paint that covers most of the foreground.

4.2 INCREASED TRANSPARENCY / LOSS OF OPACITY

The conversion of lead- or zinc white to amorphous metal soap complexes is now considered to play a major role in the increased transparency of oil paint films (Noble et al. 2005, Shimadzu and Van den Berg 2006). Due to saponification of the white pigment particles, their light scattering properties are reduced and light can penetrate deeper into the paint layer creating a perceived darkening effect. A color change can also be effected due to loss of opacity of the white component in the paint mixture. The presence of a dark paint layer (or panel) below the altered layer emphasizes the perceived darkening effect even more.

Fig. 10. Aert van der Neer (1604-1677), *River Landscape,* c.1650, panel, 44.8 x 63 cm, Mauritshuis, The Hague, inv. 912. Overall, and detail of sky, centre right showing darkened lines that correspond to the ground-filled wood grain of the oak panel (cleaned state). Here the light brown priming layer has darkened becoming more visible than intended.

Surface features:

Loss of opacity/increased transparency due to the saponification of white pigments can occur in both light and dark paint layers, in surface layers as well as in underlying layers. Where saponification of lead white occurs in a mixture with dark pigments (such as carbon black and earth pigments) darkening of the layer occurs. This was demonstrated in Roelandt Savery's, *Orpheus enchanting the animals with his music* from 1627 (The Hague, Mauritshuis), where a color change from an opaque medium brown to a dark brown was effected (fig. 9). Since this brown layer covers most of the foreground this has resulted in loss of detail, as well as severe distortion of the original light/dark contrasts to the extent that the tiny animals and birds painted on top, are now only barely visible to the naked eye. Originally, the more opaque medium brown would have afforded greater contrast with the details painted on top. That the degree of darkening not only depends on the degree of saponification, but also the color of the affected layer, as well as that of underlying layers, was also found in a recent study of John Everett Millais' 1895, *Speak! Speak!* (London, Tate Britain). There, the changes in transparency were found to be due to the partial disappearance of zinc white pigment particles as a result of saponification, the formation of zinc soaps causing the underpaint layers to become more prominent (Shimadzu and Van den Berg 2006).

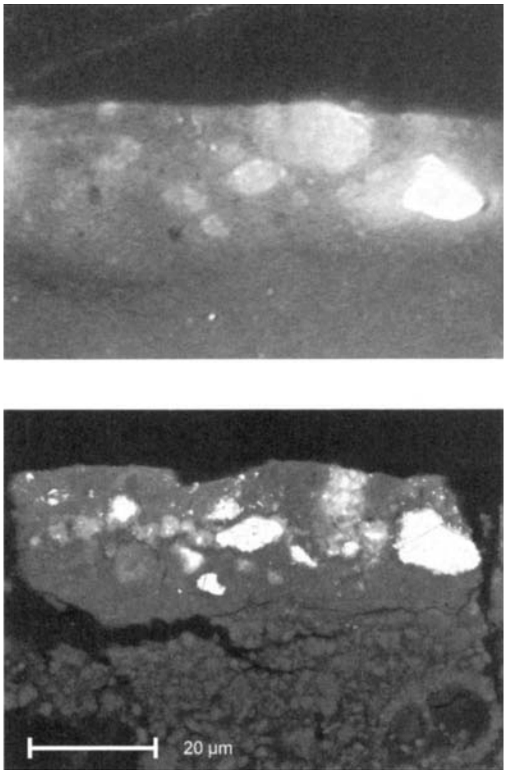

Fig 11. Cross-section (normal light) from darkened line in sky in *River Landscape* (paint layer is missing from this sample) and corresponding SEM back scatter image (below). The lower layer is the chalk ground and the upper layer the swollen and saponified lead white-containing priming layer. SEM image: Annelies van Loon.

When loss of opacity occurs in underlying layers, especially when these layers are of a medium tone this can have a strong visual impact due to the darkened tone becoming much more prominent than originally intended. This can also occur selectively, for instance when a lead white-containing preparatory layer only fills the deep channels of a wood panel. Here, the loss of opacity of the lead white causes these areas to appear as darkened streaks or lines. Not only do these darkened lines have a strong visual impact when they become partly visible through the overlying layers, but they can become more exposed as a result of flaking of the surface paint layer in these areas from swelling of the saponified layer. This was borne out in a previous study of a panel painting by Aert van der Neer (The Hague, Mauritshuis) where the saponified darkened lines were found to be related to the thickness of the lower chalk ground (Fig. 10 and Noble et al. 2005). That darkening of the ground is often observed in seventeenth-century panel paintings has to do with a number of factors: not only the preference for medium toned, lead white-containing grounds, but also the open brush work and often thin, translucent surface paint layers that permit these darkened lines or layers to become more prominent than intended (Noble et al. forthcoming 2007). See also section 4.1, for increased transparency in lead-tin yellow type 1 oil paints due to lead soap aggregate formation (fig. 7).

<u>Occurrences:</u>
Lead-containing oil paint
Zinc-containing paint

<u>Cross-sectional features:</u>
In the study of this phenomenon, it is usually instructive to compare paint samples from affected and unaffected areas in the painting. In paint cross-sections from unaffected areas where lead white is involved, paint layers typically show a broad distribution of both fine and coarse particles typical of seventeenth-century Dutch stack processed lead white. In samples from darkened areas, only the largest particles remain intact while all the fine lead white particles have reacted away forming large transparent regions throughout the layer. This gives the impression of a more transparent, medium-rich layer compared to unaffected layers. The altered layer can also be noticeably thicker than non-affected layers, due to diffusion and swelling of the saponified particles (fig. 11). For paint layers affected by zinc soap formation, cross-sections demonstrate transparent regions, either as large globular areas due to aggregate formation, or as masses of tiny transparent zones (Keune 2005).

<u>Chemical features</u>
Imaging-FTIR in reflection mode allows the identification and localization of different functional groups associated with the original paint and altered areas in the paint cross-section, the presence of metal soaps in the affected layer being indicated by strong absorption in the 1510-50 cm $^{-1}$ region. A FTIR spectrum can also be generated for a selected spot/s in the cross-section. When layers/areas of interest are below the detection limit it may be possible to obtain sufficient isolated material for transmission FTIR using a diamond cell.

Detailed information on the morphology and layer thickness of the affected layer can be demonstrated with the scanning electron microscope (SEM), particularly backscattered electron images (SEM-BSE). The difference in morphology is remarkable with the saponified particles/areas appearing less dense, greyer and amorphous, due to the higher organic content, as compared to normal, denser, intact white particles (Keune 2005). Some intact particles do, however, demonstrate greyer peripheries, corresponding to transparent perimeters seen in the normal light microscope images, areas that according to imaging-FTIR are rich in metal soaps, indicating the progressive transformation to soaps (fig. 11). Micro-analyses can be carried out on areas imaged by coupling with energy dispersive X-ray analysis (SEM-EDX) that allows for identification and localization of the different elements, confirming the metal involved in soap formation, as well as aiding in identification of the composition of the paint layer/s. Naturally, interpretation of analytical results should always be correlated with observations from optical microscopy of paint cross-sections, as well as with observations from the paint surface.

4.3 METAL SOAP EFFLORESCENCE: HAZES AND CRUSTS

Whitish surface hazes and crusts are often attributed to the migration of fatty acids and or metal soaps from within the paint matrix that subsequently undergo reactions at the paint surface to form insoluble semi-crystalline deposits (Ordonez and Twilley 1997, Van Loon and Boon 2005, Noble and Van Loon, forthcoming 2007). It is postulated that many efflorescent crusts on paints are mineralized by reaction of lead soaps with elements from the environment (Boon et al., this volume).

Whitening of bone black oil paint on a seventeenth-century ceiling (Van Loon and Boon 2005), as well as in dark paint layers in a painting by Pieter de Grebber from the Oranjezaal in the Royal Palace *Huis ten Bosch* in The Hague (Van Loon et al. 2006), was recently characterized where a mixture of several mineral compounds - lead soaps, lead sulfates, and lead chlorides - was identified.

Fig. 12. Rembrandt van Rijn (1606-1669), *Simeon's song of praise,* 1631, panel, 60.9 x 47.9 cm, Mauritshuis, The Hague, inv. 145. Overall, and detail of baldachin at upper right affected by a whitish haze.

Similar crusts have also recently been identified on two paintings by Rembrandt van Rijn in the collection of the Mauritshuis (figs. 12, 13). Here, the lead soaps are considered to have migrated to the surface from a saponified lead white layer below (Noble et al. 2006, Noble and Van Loon, forthcoming, 2007). Lead soap efflorescence was also demonstrated in several works by Frederic Church (Keune 2005, Zucker and Boon, this volume), as well as a nineteenth-century painting by Sigisbert Chrétien Bosch-Reitz (The Netherlands, private collection) (Keune et al., this volume). Previous studies in the National Gallery London identified the presence of 'smalt' crusts in several paintings, though there calcium and potassium soaps are considered to play a role in the degradative paint processes (Spring et al. 2005, Higgitt et al. 2005).

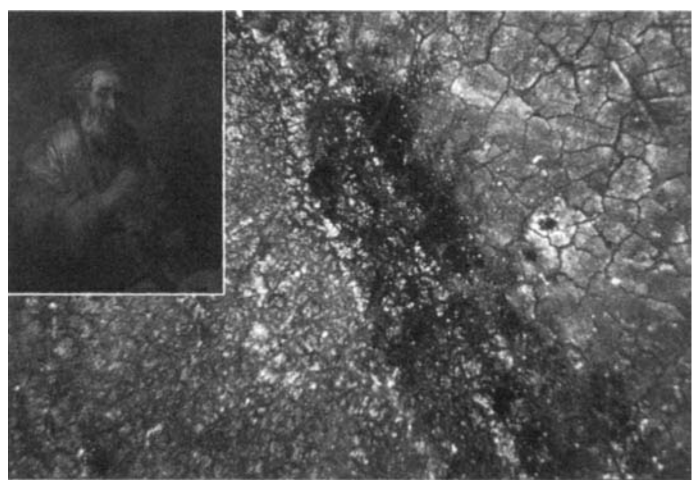

Fig. 13. Rembrandt van Rijn (1606-1669), *Homer,* 1663, canvas, 107 x 82 cm, Mauritshuis, The Hague, inv. 584. Overall, and detail from blanched black area of drapery at lower edge. Here lead soap efflorescence, at and near the paint surface has resulted in the formation of a whitish crust.

Efflorescent hazes and crusts are one of the most damaging of all metal soap-related alterations since the surface deposits that form are insoluble, and are often so intimately bound with the paint that attempts to remove them can physically damage the paint. This sort of surface whitening is optically similar to another white surface deposit known as bloom, where free fatty acid migration, exudation and crystallization have been found to be the mechanisms at hand. In a practical sense, the major difference is that bloom tends to be organic in nature and is therefore soluble, whereas mineralized crusts are not (on bloom, see for instance, Van den Berg 2002).

<u>Surface features:</u>
To the naked eye, metal soap efflorescence can appear as a barely perceptible haze, as distinct crystalline deposits or as thicker patchy crusts, all of which visually result in a 'blanched' appearance. These deposits can form locally, or over larger areas of the painting demonstrating a variable composition that can consist of metal soaps, sulphates,

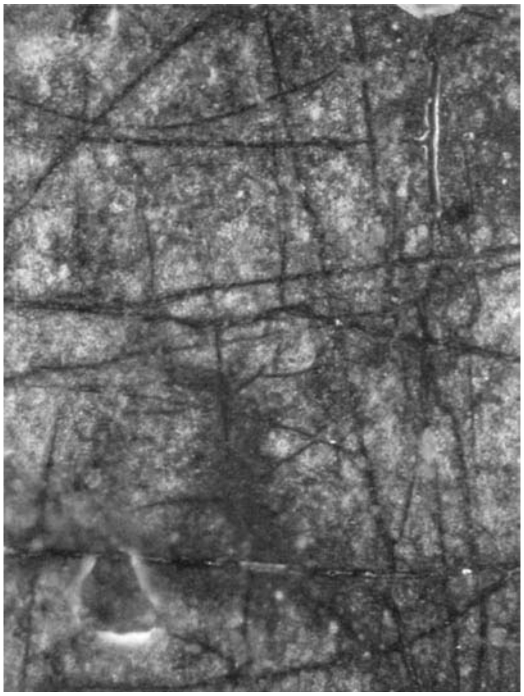
Fig. 14. Micro-photograph of the haze on the surface of the baldachin in *Simeon's song of praise* taken with the optical microscope (original magnification 100x). It is these whitish particles that account for the haze observed with the naked eye.

carbonates, chlorides and oxalates, depending on the composition and build-up of the paint, as well as external factors, such as treatment history and environmental exposure. In figure 12, we see a detail of a 1631 panel painting by Rembrandt, *Simeon's song of praise* (The Hague, Mauritshuis) where a whitish haze has formed only in the area of the dark reddish black baldachin at the upper right. Here, the paint layer consists of two similar dark layers containing carbon black, red lake, some earth pigments as well as a little lead white and chalk applied over a lead white-rich priming and lower chalk ground. In a later Rembrandt painting - *Homer* - from 1663 (The Hague, Mauritshuis), which is painted on canvas, a thicker crust has formed in patches over many areas of the smalt and lake-rich yellowish surface paint (fig. 13). Here, the crust, which has formed near the surface is intimately bound with the paint and cannot be removed without physical damage to the original paint. As a result of these alterations, areas that were originally intended to be translucent, have dramatically changed in appearance, which not only distorts the color harmony and spatial illusion, but also alters the surface texture and consistency of the paint.

That lead soap efflorescence can appear in different manifestations on the surface depends on the composition and build-up of the paint, and over how long a period of time the crystals have formed (Van Loon and Boon 2005; Keune et al. this volume). It can appear as an even, thin layer of white microscopic crystals (perceived as a haze), as localized crystals in the valleys of brushstrokes, as dense spots of white crystals, or as crystalline deposits in and near the paint surface. In the latter case, the crystal growth creates fine micro-fissures in the surface resulting in a crust. In this case, the 'blanching' effect is enhanced by light scattering as well. That such deposits sometimes appear patchy is due to uneven formation on the surface.

Since such small crystals cannot be resolved with the maximum magnification of a stereomicroscope it is instructive to use the optical (light) microscope to study the surface of affected paint samples prior to embedding as cross-sections. Under 100 or 200x magnification, the microscopic white crystals can usually be resolved. It is these crystals that account for the haze discerned with the naked eye (fig. 14).

Occurrences:

Poorly coordinated, oil-rich, often dark paint layers containing such pigments as chalk, carbon black, bone black, earth, smalt and lake pigments (as a result of migration).
Lead drier-containing paint
Zinc-containing paint

Cross-sectional features:

In cross-section, the haze or crust appears as a very thin continuous whitish surface deposit of barely a few micrometers. Paint cross-sections, which allow the paint layer build-up to be visualized, are instructive in revealing the possible source of metal soaps and facilitating characterization of the composition of the paint layers. In the case of *Simeon's song of praise*, lead soaps are considered to have migrated from the saponified lead-rich priming layer below to the paint surface, the binding medium-rich dark surface paint layer providing the source of reactive free fatty acids (fig. 15). Here, the presence of a large amount of dispersed lead throughout the layer is considered too much to be from an added drier (Noble and Van Loon, forthcoming 2007).

Chemical features

Imaging-FTIR in reflection mode is an effective technique to identify and localize the various functional groups directly on the paint cross-section as a result of their characteristic IR absorption. In this way, distinction can often

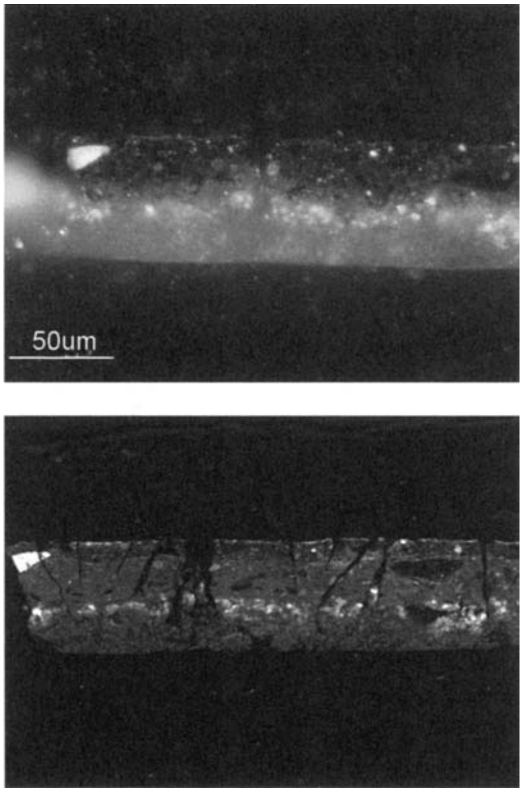

Fig. 15. Cross-section from baldachin (top) in *Simeon's song of praise* and corresponding SEM back scatter image (below). In the normal light image (top) the haze appears as a very thin (1 µm) whitish layer at the surface of the dark reddish brown paint. Below this are the preparatory layers: a lead white-containing beige priming layer on top of a chalk ground. The haze is more easily seen in the SEM image (below) due to its higher contrast compared to the paint layer. SEM image: Annelies van Loon.

be made between pigments and alteration products. When layers/ areas of interest are below the detection limit it may be possible to obtain sufficient isolated material for transmission FTIR using a diamond cell.

Detailed information on the morphology and thickness of the crust, and the paint layer build-up can be demonstrated with the scanning electron microscope (SEM), particularly backscattered electron images (SEM-BSE), which clearly demonstrate the contrast between the crystalline nature of the efflorescence and the particulate paint layer, in or on which, the deposits have formed. These high resolution images are highly instructive, often demonstrating well developed crystal structures and visualizing the relationship of the deposit with the paint layer. In this way it makes it clear whether removal is possible. When the deposits are intimately bound with the upper paint layer, removal of such a layer is not possible without physical damage to the paint layer. EDX/EDX mapping allows localization of different elements, confirming the metal involved in the efflorescence, and aiding in characterization of the composition of the paint layer/s. In both Rembrandt paintings mentioned above, the elements lead, calcium, sulphur and potassium have consistently been identified in the surface efflorescence (figs. 14, 15).

Raman spectroscopy and X-ray diffraction are currently being applied in further studies in order to better characterize these deposits (Annelies van Loon, forthcoming PhD Thesis, 2007).

5. IMPLICATIONS FOR TREATMENT AND DIRECTIONS FOR FUTURE RESEARCH

Although in practice, metal soaps do not seem soluble in commonly used cleaning solvents, according to the industrial literature and depending on their mode of occurrence, metal soaps are thought to be water, solvent and heat sensitive. As liquid crystals, they tend to form aggregate structures, and in dispersed form readily diffuse through the paint structure, which in part helps explain the driving force behind these alterations. Since metal soaps are also proposed to be able to move with moisture films (Corkery 2005; Corkery 1997, Boon et al. this volume) special attention should be paid to (the prevention of) relative humidity and temperature gradients occurring during conservation treatments, and especially in display and storage conditions. Future study of the effects of temperature and heat, as well as the reactivity of metal soaps with solvents and water would provide valuable insight for paintings conservators and their methods. Since free fatty acids play a pivotal role in the formation of metal soap-related defects, it is important to minimize the release of fatty acids from the oil paint network and their mobility between paint layers. Reducing exposure to solvents as much as possible during varnish removal is also recommended in order to diminish the penetration of solvent in the paint layer, and to lessen the mobilization and traffic of free fatty acids between paint layers. Cleaning, however, is not the only application of solvents; varnishing also involves the use of solvents that potentially could increase the mobility of fatty acids and metal soaps.

With respect to disturbing whitish surface deposits - hazes, crusts and bloom - it is recommended that the nature of the materials appearing at the surface be determined, and if possible their source. In this regard, the painting's treatment history, as well as its build-up and pigment and binding medium composition can provide important information regarding distribution of metal soaps and potential sources of fatty acids. It should be realized that even if mechanical or chemical removal proves feasible, the efflorescence or bloom will eventually return after a number of years given that the paint system will want to return to equilibrium. Considerable work remains to be done to determine the consequences of the loss of these materials from the paint. Innovative nano-techniques may provide treatment options in the future that could help stabilize such paint systems. At the present time, the most common treatment for such surface hazes/crusts involves improving the saturation with a low viscosity resin. By filling the micro fissures of the porous paint surface, some degree of saturation can be restored though it remains to be assessed whether the present conservation practices used to treat these surface deposits actually worsens the problem. From a preventative conservation standpoint, it is important to realize that since the transport and formation of metal soaps are thought to be promoted by humidity and temperature gradients, controlled environmental conditions should be maintained to minimize the process.

6. SOME CONCLUDING REMARKS

Microscopic examination of the paint surface prior to cleaning, as well as analyses of paint cross-sections with optical microscopy, and when possible with other analytical imaging techniques, particularly the scanning electron microscope, as well as imaging-FTIR and SIMS, provides invaluable insight into the condition of painted surfaces and the complex ageing processes that occur at, and below the paint surface. Improved cross-section preparation techniques (Van Loon et al. 2005; Boon and Asahina 2006), significantly increase the resolution of paint cross-sections making it possible to detect many features previously not possible. Paint should no longer be thought of as a static entity, but must be considered as a slow and continuously changing composite system that forms reaction products inside and sometimes on top of the paint surface.

Various degradation phenomena observed in oil paintings - protruding metal soap aggregates, changes in color and transparency, efflorescence and blooming are now beginning to be understood, not as independent phenomena, but as having one underlying cause, the reactivity of metal-containing paints and driers. As a result metal soaps are now generally considered to be a component in aged oil paint that is proving to be a problem for paintings conservators. In recent years a significant amount of research has been presented on their formation and behavior in paint layers. It is important to recognize the implications of these findings and pursue research directions that are of direct relevance for the practising conservator.

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CHEMICAL PROCESSES IN AGED OIL PAINTS AFFECTING METAL SOAP MIGRATION AND AGGREGATION

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ABSTRACT – The nature of the surface of the painted picture is determined to a large extent by chemical and physical processes underneath the surface of the paint. The binding medium changes from a chemically air drying viscous mass of polyunsaturated triglycerides "the oil" via slow hydrolytic processes to a metal bound ionomer. This network system in turn appears to be vulnerable to further environmental attack especially by acidification that is postulated to disrupt the ionomeric structure. As a result monocarboxylic fatty acids can be mobilized and reorganize in the form of liquid crystalline metal soap masses within the paint layers. When they expand beyond the paint layer, they distort the paint and may erupt at the surface where they protrude or even extrude. These deformations are now recognized in thousands of paintings. Many of these metal soap masses furthermore mineralize forming minium (lead orthoplumbate) and/or lead-hydroxy/chloride-carbonates in lead soap or zinc carbonates in the case of zinc soaps. Generally the volume changes due to these processes are minimal although the metal soap may grow into larger masses of 100-200 micron diameter. This theory could be developed by an integrated molecular level approach involving GCMS (gaschromatography mass spectrometry) and DTMS (Direct Temperature resolved mass spectrometry) work and various forms of chemical microscopy using imaging SIMS (secondary ion mass spectrometry), FTIR (Fourier Transform Infrared spectroscopy), Raman spectroscopy and Scanning electron microscopy with energy dispersed Xray analysis (SEM-EDX).

INTRODUCTION

Before a painting becomes a finished picture, it has to dry physically by evaporation of water or solvent, and chemically by reaction of air with the binding medium constituents to form a non-sticky viscous mass that keeps the pigment particles in place. So when the painter is satisfied with the picture, a lot of processes are starting up to solidify the painted creation. These same processes however are also responsible for undesirable changes that take place later on when the paint ages. These changes will require the attention of conservators in charge of maintaining the quality of the visible surface and the structural integrity of the paint layers and support. Research on the nature of these materials in paintings and their compositional changes with time i.e. the molecular aspects of ageing was at the centre of the attention of the MOLART programme supported by NWO and its sequel the De Mayerne Programme. Both research programmes were multidisciplinary in nature and were successful because of the close collaboration of art technical historians, conservators and art scientists interested in material science aspects of works of art.

This paper presents ideas on ageing oil paint and summarizes various aspects of the changing nature of the oil paint network in oil paintings. It especially points to some of the defects caused by chemical changes in the network which affect the stability of the metal coordinated structure, the mobility/reactivity of free fatty acids and the formation of metal soap liquid crystals. Phenomenological aspects of metal soaps presented by Noble and Boon in this postprint volume show the distortions in the paint layers due to metal soap aggregation and swelling, and other aspects of metal soap reactivity especially in surface layers that affect the transmission and reflection of light. An account of the chemical aspects of metal soaps in cross sections from a number of type-paintings has been given in Keune's PhD dissertation (2005) and in a forthcoming paper in Studies in Conservation (Keune and Boon, in press).

REACTIVITY OF OIL BINDING MEDIUM COMPONENTS

The awareness of the wide spread global occurrence of metal soap aggregates in paintings has developed in less than a decade. The restoration of *The Anatomy Lesson of Dr. Nicolaes Tulp* by R. van Rijn (pixit 1632; MH 146) was the start of a thorough investigation of the painting technique and its present condition (Middelkoop et al. 1998). The abundance of peculiar pustules was particularly striking. These had been reported before but they were attributed to fire damage

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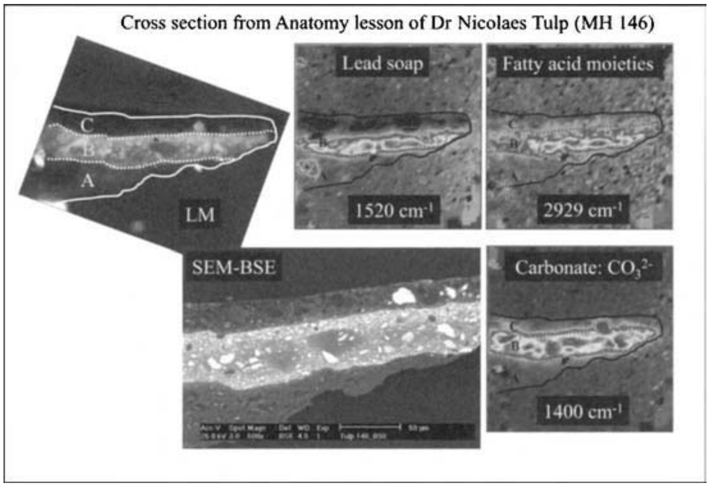

Fig. 1 Light microscopy, Scanning electron microscopy with back scattered electron detection (SEM-BSE) and Fourier transform infrared (FTIR) spectroscopy of a double ground from *The Anatomy Lesson of Dr.Nicolaes Tulp* painted by Rembrandt van Rijn in 1632 (MH 146). The cross section represents an early stage of lead soap formation in which smaller lead white particles are seen to dissolve and transparent lead soap containing areas appear.

that the painting endured in 1723 (De Vries et al. 1978). Investigation by imaging FTIR and SIMS microscopy demonstrated that these organic aggregates were composed of lead soaps (Heeren et al. 1999). The lead soap aggregates were present in large numbers as could be deduced from X-ray pictures examined under the stereomicroscope. FTIR imaging was especially useful in the detection of lead soaps in paint cross section as is demonstrated in Fig. 1 which shows a collage of light microscopic and SEM-BSE from a cross section of MH 146 in an early stage of metal soap formation and the corresponding FTIR maps of fatty acyl moieties (2929 cm^{-1}), lead carboxylates (1520 cm^{-1}) and carbonates (1400 cm^{-1}). In this cross section the lead white is affected and partially dissolved leading to large transparent regions in the lead white layer of the typical double ground employed by Rembrandt in that period. In more advanced stages, where lead soaps aggregate to form larger semi crystalline structures, the upper paint layer is often flacking off (see also Noble et al, 2002). These aggregates turned out to be present in more paintings of the Mauritshuis and are now recognised in many other collections as well (Higgitt et al. 2003; Noble and Boon, 2007). A recent survey of the Tudor-Stuart collection of Tate Britain presented during the AIC meeting 2006 shows lead soap aggregates in more than 60% of the paintings (Jones et al. 2007).

The occurrence of lead soap aggregates points to an oil paint defect. The MOLART working model on aging of oil paint (Boon et al. 1997) proposed a transition from a cross linked plant oil to a metal coordinated paint system, because a rather extensive hydrolysis had been observed of the biological ester bonds in the cross linked polyunsaturated triglycerides. Investigations by Van den Berg et al. (1999) on oil paint models and samples from paintings and recent studies on alkyd oil paints (Schilling et al. 2007) demonstrate the extensive hydrolysis that takes place in a time frame of 50-100 years. The process of degrouping of the cross linked oil components into their biochemical components of glycerol, fatty acids, diacids and possibly some cross linked moieties with multiple acid groups is now an accepted fact in the life time of oil paintings. We expected that this process would lead to a complete failure of the paint and loss of the picture. That this usually does not happen is caused by a self-repair mechanism in which lead binds these loose ends with limited volume change into a metal coordinated network. The hypothesis that the acid groups rapidly react with available metals present as driers or metal containing pigments like lead white was supported recently by NMR studies of reconstructed and aged oil paint reported by Verhoeven et al. (2006), by earlier FTIR and SIMS of similar reconstructions (Keune, 2005) and by chemical experiments. The NMR work suggests that acid groups forming from unsaturated C18 fatty acyl moieties in the stage of oxidative cross linking of the oil readily form metal soaps. In the case of diacids forming, their biological acid group can be still linked with the original ester bond to the network, whereas the other acid group is already present as metal soap.

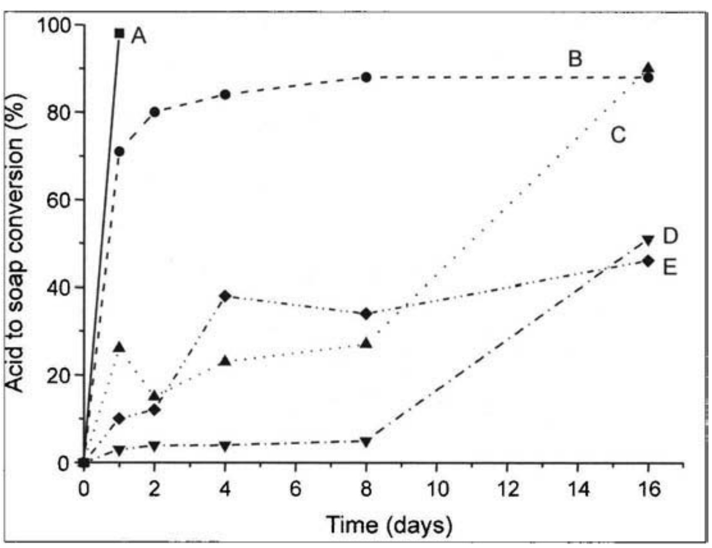

Fig. 2 Lead soap can form at ambient temperature by reaction of lead compounds and palmitic acid. Lead soap formation was monitored by FTIR spectroscopy (Lead soap (%) = 100% * I(1510 cm^{-1}) / [I(1510 cm^{-1}) + I(1705 cm^{-1})]). Leadacetate (A); Lead white (B); Litharge (C); Minium (D); Leadtin yellow I (E).

Acid groups in oil paint readily react to form metal soaps. Earlier Van der Weerd (2002) reported the dissolution of lead white in hot solutions of xylene to support the observation lead soap formation at the expense of lead white in ageing oil paint. More recent experiments with palmitic acid reacting with lead white in chloroform solution at room temperature - a more realistic scenario – demonstrate complete dissolution of lead white forming lead soaps (Hoogland and Boon 2005). Fig. 2 shows lead soap formation as a function of time for several lead compounds with palmitic acid as monitored by FTIR. Lead acetate (A) reacts most rapidly closely followed by lead white (B) while litharge (C), minium (D) and leadtin yellow I (E) take a little bit longer. Most of the mineral matter has reacted away within half a month. Control experiment with tripalmitate and lead white show no lead soap formation. Four-year-old lead white paint reconstructions made by Leslie Carlyle for MOLART in 1999 formed lead soaps under high relative humidity (80% RH) and at higher temperature (50 °C) in a matter of one month of exposure (Carlyle, 2006). The SIMS data of the surface of these reconstructions in Fig. 3 demonstrates the increase in lead soap mass peaks of palmitic and stearic acid while FTIR confirms an increase in the metal carboxylate absorption at 1520 cm^{-1} (FTIR data not shown; analytical conditions see Keune 2005).

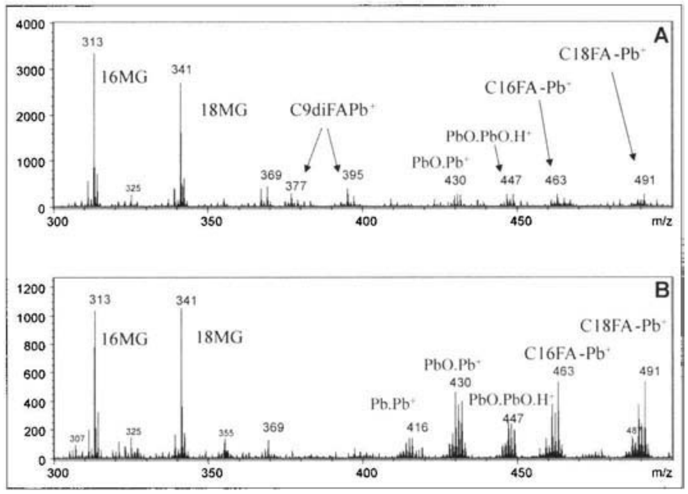

Fig. 3 Secondary Ion Mass Spectra of lead white paints (coded ZD prepared and aged by Carlyle in 1999) before and after a 30 day exposure to high relative humidity (80%) at elevated temperature (50 °C). See also Keune (2005).

How metal soap structures could form a metal coordinated ionomeric network in a mixture of oil and metal containing pigments is shown schematically in Fig. 4 where the diacids as dumbbells coordinated by lead (red crosses) link the various lead white crystals in a metal coordinated 3D network. We think that azelaic acids and related diacids (C6-C10 diacids are also present in oil paints) will form a relatively stable metal coordinated network because of their chain building ability in 3D. Monocarboxylic acids can only act as chain terminating units because they have only one acid group. If such a structure is compromised by acid from atmospheric environmental sources or by anions that compete with the relatively weak fatty acid carboxyl groups, the coordination of the diacid structure could be locally lost. While a diacid might re-establish its coordination because of the remaining metal carboxylate group still attached to the network on the other end of the molecule, monocarboxylic acids may loose their connection with such a network permanently and migrate more easily away as free acids. Such free acids can form separate apolar lead soaps elsewhere, but they can also remain as free acids appearing at the surface as films and blooms. Monocarboxylic acids are therefore a potentially more mobile phase than the - on a molar basis - equally important or even more abundant diacids. The ionomeric oil paint model of Fig. 4 is our present working model for understanding the condition of an oil painting and the basis for an analysis when oil paint defects are apparent.

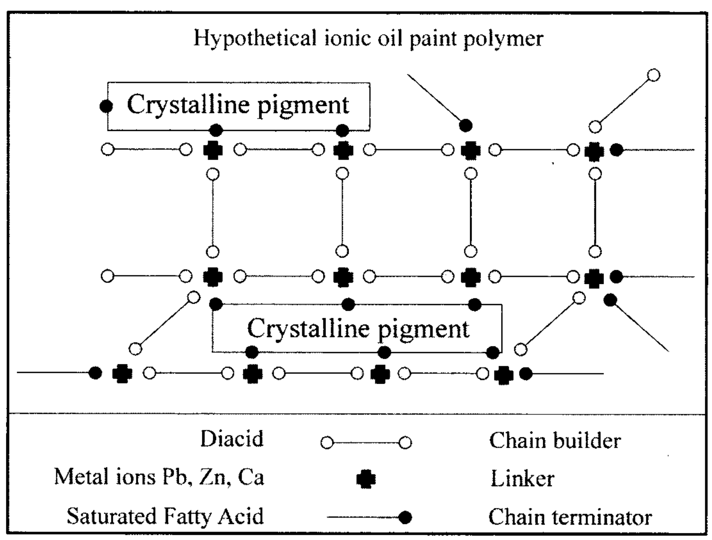

Fig. 4 Proposed structure of metal coordinated oil paint, in which diacids form a 3D structure when coordinated by lead. Monocarboxylic acids are chain terminators that limit the size of the ionomeric polymer.

METAL SOAPS AS LIQUID CRYSTALS

FTIR, Raman and XRD studies of synthetic lead soaps of longer chain fatty acids demonstrate that lead soaps organize themselves preferentially in liquid crystals as splayed chain systems (Corkery et al. 1997). This is possibly

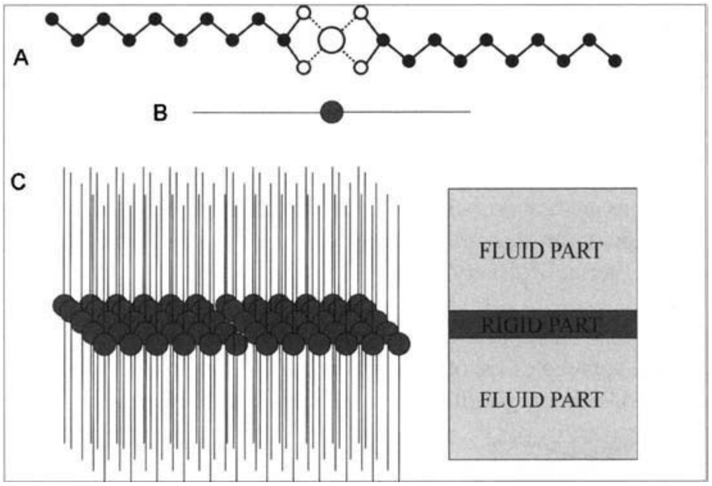

Fig. 5 Lead soaps form liquid crystals in which the metal coordinated carboxylic acids form raft-like structures with fatty acyl chains perpendicular to these rafts. This splayed chain structure has been proposed by Corkery (1997).

the reason why metal soaps tend to form aggregates in paintings that appear to grow as time progresses. This phenomenon of growth in stable aggregates is more typical for lead soaps than for some of the other kinds of metal soaps that occur in paintings (Corkery, personal communication in 2005). Metal carboxylates can form relatively stable rafts with long chain fatty acids closely packed by Van der Waals forces projecting above and below a rather stable metal carboxylate plane. This is shown in Fig. 5 in a simplified form. The lead soap molecules are schematically shown as a ball (the metal carboxylate group) with two sticks attached (the fatty acyl chains). At higher temperature these fatty acyl chains transform into relatively disorganized almost liquid-like cushions. The flexibility of such metal soap rafts provides a lot of potential for movement in and between paint layers and might explain the appearance of lead soaps at the surface of paintings. The apolar cushions of the fatty acyl chain forests appear to be ideally suited to accommodate solvent molecules. Solvents can therefore potentially promote swelling and slippage between the rafts in the liquid crystals. Although such effects remain to be quantified, it might explain the solvent sensitivity of some aged oil paintings. In retrospect, Rembrandts' *Anatomy Lesson of Dr Nicolaes Tulp* painting (MH146) that is so riddled with metal soap aggregates now, may have suffered quite a bit from the multiple hot relining operations in the 19^{th} century, the accompanying solvent exposures and alcohol vapor treatments (Middelkoop et al. 1998).

The key to understanding the lead soap behavior in paintings are the free reactive monocarboxylic acids. These either occur during the hydrolysis stage of oil paint or are released later on because of environmental exposure and acidification. Much needs to be learned still about these components in paint systems. Their reactivity can be understood locally within a single paint layer, but recall that paintings are multilayer systems where some paint layers may be medium rich but "underbound" with respect to coordinating metals, while others are lead (white) rich and presumably medium poorer. Lead poor paint layers are a potential source of mobile reactive fatty acids. Fatty lead white grounds are potentially an important source of lead soaps.

So some layers act as reservoirs of free or liberated acids while others are sinks which makes it clear why metal soap formation and behavior in multilayer paint system is so complex. Since we have so few data on the quantitative aspects of the distribution of mono and dicarboxylic fatty acids in paint layers, we propose that the stoichiometry and relative distribution of lead and fatty acids in paint layers with and without lead soap aggregates should be studied in detail to understand the various quantitative aspects of the phenomenon.

Lead is not the only metal of importance. Apart from lead, metals like copper, zinc, iron, aluminum, earth alkali elements like calcium and alkali elements like potassium can form carboxylates, which we may encounter in paint layers. Potassium leaches from smalt (Boon et al, 2001) and potassium soaps have indeed been demonstrated recently in paintings (Spring et al. 2006). Potassium soaps are of course water soluble. The thermally relatively resilient calcium soaps may play a major role in the stabilization of chalk containing paints but their presence remains to be demonstrated. Aluminum soaps are common additions to modern oil paints but a disadvantage is their hygroscopicity leading to hydroxy-derivatives (Corkery 1998). The saturated fatty acids in aluminum stearates do not contribute to the paint structure after hydrolysis. In fact residual hydroxy-aluminum soaps can form micelles that may be responsible for the recently observed water solubility of about 40-50 year old oil paints (Burnstock et al. 2007).

MINERALIZATION OF LEAD SOAP STRUCTURES

Metal soap aggregates undergo a process of mineralisation, which might be beneficial because it can stabilize them. Minium (lead orthoplumbate) has been identified in some aggregates (Boon et al. 2002; Van der Weerd et al. 2002;

Higgitt et al. 2003; Jones et al. 2007) and this mineral appears to form, in our opinion, when the aggregates are protected from a direct contact with the atmosphere. The penetration of carbon dioxide from the atmosphere or its reaction product with water (H_2CO_3) can thus be an important factor. Note that CO_2 can be limited in some layers by chemical trapping in other paint layers. Phase diagrams (Boon et al. 2002; Garrels and Christ, 1965) suggest that minium is stable only under relatively alkaline conditions even when carbonate ions are present. The conditions that determine crystal growth within lead soap crystals are presently completely unknown and need to be studied in experimental systems. Studies of the chemical phases in lead soap aggregates in paint cross sections are however vitally important at this stage to establish the variables that need to be considered. In general, mineralization of metal soaps is less surprising when seen in the light of metal soap structures used as templates for biomineralized materials (Corkery, 1998).

Many protruding aggregates that we have observed contain lead carbonates which appear to be in the form of hydrocerussite nanocrystals (leadhydroxycarbonate) but the aggregates are often also remarkably rich in chlorides so the presence of phosgenite (leadchlorocarbonate) must be considered as well. Phosgenite can epitaxially grow on cerrusite demonstrating their structural compatibility (Pina et al. 1996), and a similar compatability is expected for leadwhite. The chlorides are most easily detected with SIMS in the negative ion mode (see Keune 2005), but the nanocrystals still remain to be crystallographically characterized. Mineralising zinc soaps in paints on a Van Gogh painting *Falling leaves; Les Alyscamps* were found to contain zinc carbonate (Keune 2005) and not zinc oxide as thought earlier (Van der Weerd et al., 2003).

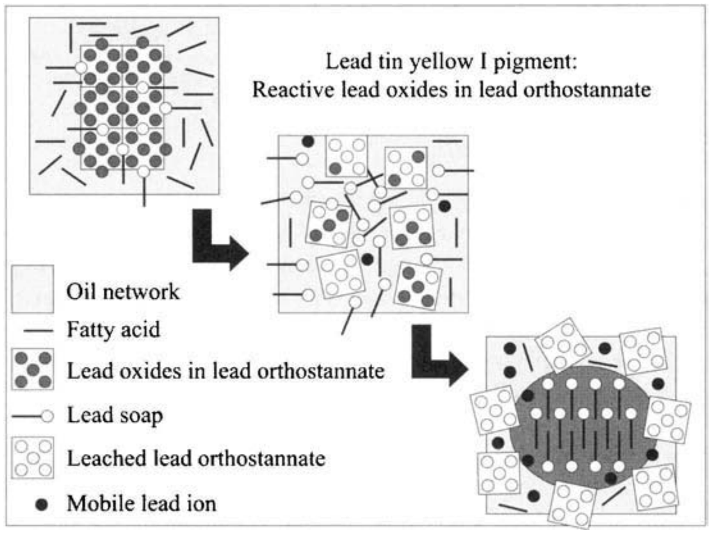

Fig 6 Schematic diagram of the partial dissolution of lead tin yellow I pigments by free fatty acids, the formation of lead soaps and their organisation into aggregates. Leached lead tin yellow I particulates remains are moved to the periphery of the aggregate (Boon et al. 2005).

Lead soap masses can be so forceful in their crystal growth that they separate the leached lead-tin-yellow I pigments into fragments that are oriented around the lead soap mass (Boon et al. 2004). The process is schematically demonstrated in Fig. 6 showing the hypothetical original state and two subsequent stages. Remineralization leads to very complex SEM-BSE pictures of such paints where the submicron crystals of the new minerals can be discriminated from the coarser lead orthostannate residues (highest BSE signal) of the original degraded pigment that have accumulated around the lead soap aggregates (Boon et al. 2004). Fig. 7 demonstrates this in a paint cross section from a 15th C triptych painting (Sherborne retable) possibly made by the Master of Alkmaar, in which the tin (Sn in Fig. 7c) marks the distribution of the residual leached lead tin yellow particles while the lead (Pb in Fig. 7b) is present all over in dispersed and more mineralized forms.

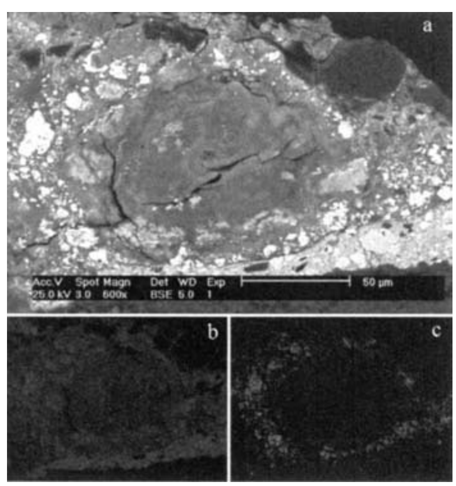

Fig 7 SEM-BSE (a) and the element maps of lead (b: PbM line) and tin (c: Sn L line) in a cross section of a lead tin yellow paint (LTY I) from the Sherborne Retable (Sherborne Abbey Almshouse, Dorset). Residual lead orthostannates are accumulated around the growing lead soap mass. Inside the lead soap mass new mineralization of lead white is visible with a medium BSE reflectivity. Most of the lead occurs in a finely divided form inside the lead soap structure. See also Boon et al. (2005) and Keune (2005).

Mineralization also occurs on the surface of the paint or even on top of the varnish when an efflorescing crust of lead soaps reacts with atmospheric gases obscuring the picture. SIMS studies of efflorescent crusts on a canvas from the estate of F.E. Church (Olana Estate; Zucker 1999) shows the presence of free fatty acids, fatty acyl monoglycerides and lead soaps (Van den

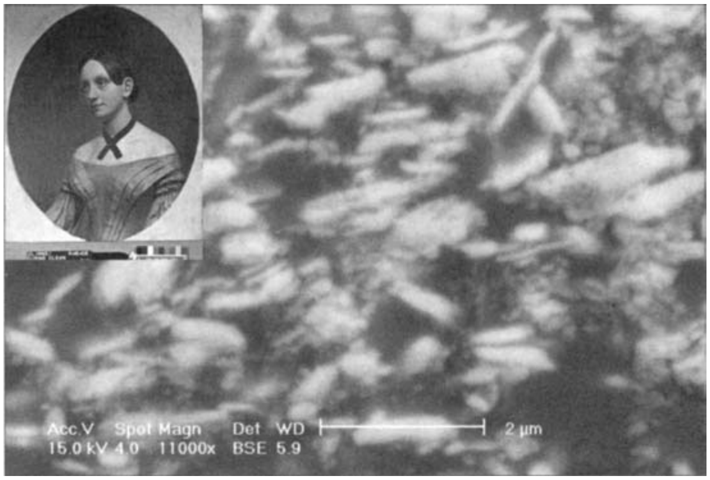

Fig. 8 SEM-BSE of a paint cross section from a lighter streak in the black background circle of sitter Susan Livingston (unknown Hudson River School painter c. 1850; CL1983.1). The originally dark bone black and earth pigment containing paint shows many random oriented micron-sized lead white crystals near the surface of the paint with a particularly high relative concentration of very small crystals where greying has taken place. It appears that neo-formation of lead white in the black paint is an important factor in a discoloration process that follows the canvas weave.

Berg 2002; Van der Weerd 2002; Boon et al. 2006). How the "ground staining" in the paintings by the Hudson River school is affected by the ground itself remains to be investigated in more detail. A preliminary study by SEM-BSE and EDX on cross sections in Fig. 8 from the background paint around the sitter Susan Livingston (c. 1850; CL. 1983.1) from the same period suggests that increased remineralization of leadwhite at the surface of the paint determined by the canvas weave plays a role. Tiny lead white crystals and smaller submicron flakes appear quantitively more in the now lighter parts of the bone black and earth pigment toned background.

Partially mineralized efflorescent crusts with lead soaps were found on the surface of a bone black paint on a 17th C ceiling in the Johan de Witt house in the Hague (Van Loon et al. 2005) and comparable lead soap crusts have been identified recently on a 19th C paintings by Bosch-Reitz (Keune et al. 2007). We postulate that many efflorescent crusts on paints are mineralized by further reaction of lead soaps with atmospheric gasses.

PHYSICAL EFFECTS

Lead soap formation inside paintings or near the surface has consequences for the stability of the paint layers and the reflection of light. Lead soap aggregation deforms the paint layers while protruding lead soap masses lead to a grainy sandy texture, paint loss, pitting and accumulation of dirt in local spots (Noble et al. 2002; Nobel and Boon, this volume). Dissolution of lead white leads to increased transparency of the paints and loss of reflected light, which may make the color darker (Noble et al. 2005; Shimadzu and Van den Berg, 2006; Noble and Boon, this volume). In the case of pigment mixtures, the color balance can be lost. Lead tin-yellow paints are known to form a lemon peel texture due to the abundant lead soap protrusions. Were some painters already aware of this effect and deliberately painted lemons with lead tin-yellow I paints? Lead tin yellow paints are lighter yellow than intended originally due to a loss of lead oxides from the pigment and the appearance of lead soaps that partially mineralize into a semi transparent white.

The mobility of fatty acids and metal soaps is largely a physical process that is driven by gradients in temperature and moisture. Since these are slow processes, they easily span the professional life of a conservator. Documentation of paint layers preferably by X-ray nanotomography would be a desirable way to monitor paintings, but we have to inventory on a much grander scale how many paintings are affected and why certain paintings do not show lead soap mobility at all.

CONCLUDING REMARKS

Painters could not anticipate how much their paintings would change because of intrinsic factors such as the paints, their working methods, the instability of the oil paint system and external factors like moisture, variable temperature, light conditions and noxious gases. Self-repair mechanisms in paintings discovered in the course of the two NWO supported research programmes in the last decade rescue the painting but do affect the picture. We still understand very little of the many slow processes that take place in paintings and how they change the pictures. The support of the MOLART and De Mayerne programme has enabled us to study these processes in a qualitative manner and has made it possible to estimate the magnitude of the occurrence of metal soap related defects in collections world wide. This is the tip of the iceberg. The main concern now is to find out how environmental conditions and conservation practices may accelerate or decelerate these processes that so deeply affect the quality of the picture and the properties of all the paint layers. This is a gigantic task that will need the combined efforts of conservators and art scientists in conservation research programmes and requires the support of the professional organizations like ICOMCC, IIC, AIC and money from national and international funding agencies.

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LEAD SOAP AGGREGATES IN SIXTEENTH- AND SEVENTEENTH-CENTURY BRITISH PAINTINGS

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ABSTRACT – Examination and technical study of over 100 paintings from the 16[th] and 17th centuries provided an opportunity to observe the occurrence of lead soap aggregates in different layers, and to relate it to support type, preparatory layers, pigments present, treatment history, and other factors. 60% of these paintings show aggregate formation in the lead-white-containing preparatory layers. 36% show the phenomenon in paint layers, mostly associated with lead-tin yellow, less often with red lead or very dark surface paint. Without the examination of cross-sections, the incidence of aggregates would have been assumed to be much lower.

1. INTRODUCTION

Tate has two separate collections: the UK's national collection of British art from the sixteenth century to the present, and an international collection of modern and contemporary art. In 2003, Tate obtained funding from the Getty Grant Program to provide technical assistance over a two-year period for the cataloguing of its holdings from the Tudor Stuart period, a growing collection which numbers 108 paintings at present. The date range of 1545-1735 for Tudor Stuart paintings in the collection is derived from the active working lives of artists born within the reigns of Henry VII to Queen Anne, that is, before 1675. The earliest painting in this group is *A Man in a Black Cap* by John Bettes (N01496, 1545), a finely-detailed, relatively small portrait painted on oak panel. The seventeenth-century works which make up a large proportion of the group are painted on canvas on a larger scale, and are predominantly portraits and family groups.

The catalogue will include a technical entry for each painting, in addition to tabulated results of their materials, and a study of British artists' techniques in this period. The description 'British' covers artists who were active in Britain for significant periods of their lives: in fact a number of these artists were born and/or trained in present-day Belgium, France, Germany, Italy and the Netherlands. Dutch and Flemish paintings of the period have been studied in more detail than British ones, so there should be interesting comparisons to be made.

The methodology for the study is standard: art historical research has been combined with imaging techniques such as X-radiography and infrared reflectography, dendrochronology of the panel supports, and microscopical examination to elucidate the painting technique. Cross-sections have been made from all paintings, and pigment identification has been carried out by a combination of polarising light microscopy and energy-dispersive X-ray analysis. Medium analysis was not appropriate for many of the paintings, since those on canvas have been lined, while all have been cleaned of varnish, re-varnished, and consolidated locally many times over the centuries, by a variety of undocumented methods.

Since 2000, studies have been carried out into the deterioration of seventeenth-century Dutch paintings due to lead soap formation (Noble *et al.* 2001, Boon *et al.* 2002, Keune *et al.* 2002, van der Weerd *et al.* 2002), and the changes in appearance caused by this phenomenon (Noble *et al.* 2005). The Tudor Stuart cataloguing project, which has resulted in moderately detailed technical studies of over 100 paintings made by artists trained in different countries, and painted over a period of more than 150 years, provides a good, random sample of paintings where the incidence of the phenomenon can be logged, and related to factors such as the support type, preparatory layers, pigments present, treatment history, etc. To further this, a number of cross-sections were analysed by means of static secondary ion mass spectrometry (SIMS) and FTIR mapping (Keune *et al.* 2005, Keune and Boon 2006), and images of lead soap formation in seventeenth-century paintings were examined and discussed with the Dutch researchers cited above, who have been elucidating the phenomenon. Then the cross-sections from each painting were re-examined for lead soap aggregates, using optical microscopy.

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2. SUPPORTS FOR THE PAINTINGS

Treatment histories have to be inferred from the paintings themselves, since detailed conservation records were started at Tate only in the mid-1950s.

Of 108 paintings, 79 have canvas supports and 27 have panel supports (oak in every case) 1 is on copper and 1 on paper (now lined to another support). For two canvas paintings, the original stretcher has survived, through it is not in use today. All but one of the canvas paintings have been lined, often with glue paste, except in the most recent decades when wax/resin was used. In 6 cases, the most recent treatment was strip-lining a previously-lined canvas support with BEVA 371.

In this paper, the preparatory layer on the support is called the *ground.* If a second preparatory layer is present over the entire support, it is called the *priming*.

The Tudor Stuart paintings on canvas have grounds that are warm-coloured, offwhite, grey or pink, and primings that are similar: grey, white, pink or brown. Less than half of the canvases have a priming. Both grounds and priming appear to be oil-based in nearly every case, when they always include lead white. For the 27 panels, the ground is generally white or pink, often chalk- and glue-based, while the priming is most usually grey, sometimes white or pink, always oil-based, and always includes lead white.

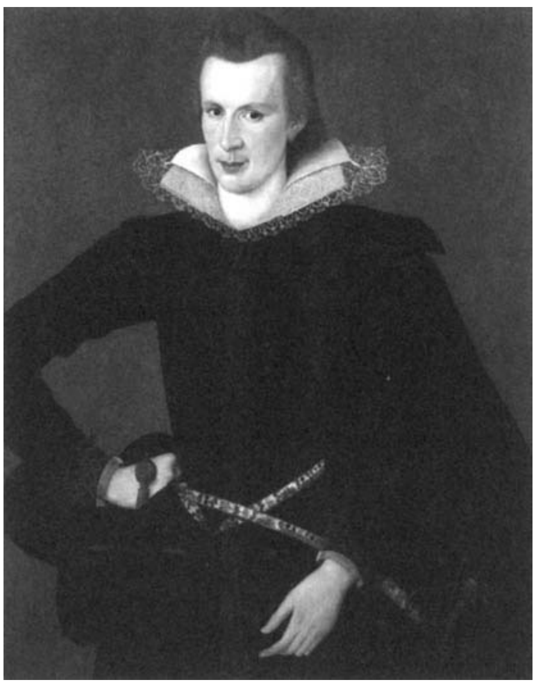

Fig. 1 *Portrait of a Man in a Slashed Doublet,* Segar, *c.*1605, oil on oak panel, 1000 x 806 mm, T03576. Copyright Tate. Reproduced in colour by Townsend and Keune (2005, Fig. 7) and also on www.tate.org.uk.

Fig. 2 Detail of the proper right lace cuff, Segar *Portrait.* Reproduced in colour by Townsend and Keune (2005, Fig. 8).

3. OBSERVATIONS OF METAL SOAP AGGREGATES

Metal soap aggregates are most obvious when they have broken through the topmost paint layer. When that layer is dark-coloured, and the aggregates have been truncated by a harsh cleaning treatment in the past, they are visible on the surface as white or occasionally orange spots up to 0.5mm (500μm) in diameter. Some past cleaning treatments have partly dissolved such aggregates, truncated or enlarged them, leaving a hollow in the paint, which has generally been filled with now-discoloured varnish and/or dirt. The result is yellow/brown spots on the darker paint surface. Such losses of lead-containing material appear as dark spots on an X-radiograph of the painting (Noble *et al.* 2001). When the spots are small, they have been described in Tate conservation records as 'surface blanching' or 'surface is rather/very worn', and when they are large enough to be visible without a microscope, they have often been called 'soft protrusions'.

Their presence can make images very difficult to interpret. One of the worst examples encountered in this project is *Portrait of a Man in a Slashed Doublet* (Segar, *c.*1605, T03576, Fig. 1). While the gentleman possesses a conventional lace collar, he seems from a distance to lack lace cuffs, and his black doublet appears excessively plain, lacking in embroidery and brocaded fabric. Close (Fig. 2) and microscopical examination reveals that he does in fact have cuffs, painted over the black fabric, but that white spots fill the areas of black between the white brushstrokes for the lace. Likewise, lines of spots follow and break up the grey and coloured linear brushstrokes that defined the costly black fabric of the doublet. The overall effect is to de-saturate the intense black of the surface, and to 'de-focus' the detail of the costume.

The observation of whitish, translucent spots in a lead-white-containing cross-section is not a new one. An inspection of Tate conservation records and associated analytical reports shows frequent mention of 'large translucent particles' and 'white boulders'. More recent observations, made since it became common to examine all cross-sections with ultraviolet illumination, refer to 'fluorescent inclusions'. Certainly, a moderate fluorescence, noticeably stronger than the fluorescence of an aged layer painted in drying oil, is characteristic for these 'inclusions'. Whilst diameters of 20 to 250μm are common, 100μm is typical in the cross-section.

The observation of such spots on the surface gives no clue as to the layer where they originated, and cross-sections are necessary to localise them.

3.1 AGGREGATES ORIGINATING IN THE GROUND OR THE PRIMING

Lead soap aggregates which have formed in the ground layer alone are often small, 50-100μm in diameter, and evenly scattered throughout the cross-section. Unless they are much larger than this, they would not be detectable from surface inspection, and their occurrence would be badly underestimated during surface examination. While they remain under the surface and not truncated, they tend to show as opaque, lead-rich spots in the X-radiograph (Higgitt *et al.* 2003). They appear to grow as circular individuals, and none have been observed merging to form 'twins'. The same is true for those forming in the priming alone.

From 73 canvas paintings examined in cross-section, 49 clearly show aggregate formation in the preparatory layers, and 4 more offer less convincing evidence, the rest being free of aggregates. 27 show formation only in the ground, 9 only in the priming, and 10 in both. (The balance of 3 could not be localised, due to incomplete cross-sections.) For 27 panel paintings, 9 show aggregate formation in the preparatory layers, while 2 are unclear and 16 do not – but many of these 16 grounds are in fact lead-free, being composed of chalk and glue. 5 of the 27 have aggregate formation in the priming, which always included lead white.

Aggregates occur more frequently in canvas paintings than in panel paintings. They are more common in paintings with a priming as well as a ground, than with a ground alone. More than half of the canvas and panel paintings with a ground but no priming do not show any obvious lead soap formation.

Formation in the ground is nonetheless the most prevalent. The majority of examples of formation in the priming only occurred in paintings which had a chalk and glue ground. In other words, the lowest oil-based and lead white-containing layer in the painting is the most likely one to show lead soap formation.

Since the panels in this study are generally painted more thinly than works on canvas, these observations show that formation in thick paint is more prevalent. This contradicts an earlier observation by van der Weerd *et al.* (2002), based on fewer paintings, that more aggregates form in thinly-painted layers.

The strongest correlation with a material in the ground is with lead white. It seems from the Tudor Stuart project that lead soap aggregates form more often in lead-based grounds that also contain appreciable amounts of chalk, visible in the cross-section. (In fact most of the grounds and primings in these paintings have many pigments in common: bone black, chalk, brown ochre, umber, and sometimes Cologne earth or red lead. This uniformity might imply that palette scrapings and any excess cheap pigment that had been ground in excessive quantities, would be used up in a preparatory layer. Expensive blue or green pigments are never seen in the ground, and rarely yellow ones except for yellow ochre.)

3.2 AGGREGATES ORIGINATING IN BOTH GROUND AND PRIMING

The typical ground thickness for a Tudor Stuart painting is 50-250μm, while the typical priming thickness is 50-150μm, the thinner layers being more common on panel supports. It is obvious that the largest aggregates might grow thicker than the paint layer in which they developed. Aggregates have always been observed to grow up into the layer above, not downwards, and the Tudor Stuart project has yielded examples in cross-section of aggregates that fit comfortably within a thin layer, some that match the original layer in thickness, others that have deformed the layer above into thin portions over the aggregate, and some large ones which have ruptured the upper layers. The larger the aggregate, the more likely that it will appear on the surface of a painting. If it is only a few micrometres below the paint surface, cracks and deformation are likely, and damage through over-cleaning is all too common an occurrence. This is not a criticism of the present generation of conservators: 250- to 350-year-old paintings have probably been cleaned several times in the past without the benefit of a microscope for prior surface examination.

When aggregates formed in the ground and/or priming have ruptured the surface, they have a fairly even distribution over the whole painting, independent of surface colour. The one place where they are more thinly scattered is the edges of the painting that are protected from light by the frame. Aggregates are evenly distributed in paint that overlies stretcher members, and in unsupported canvas.

3.3 OBVIOUS RED LEAD FORMATION IN AGGREGATES

It has already been noted that some aggregates have red lead (minium), with its typical finely particulate and orange appearance, round their outer perimeter, and suggested that this is indicative of a 'mature' aggregate (Noble *et al.* 2001, van der Weerd *et al.* 2002). Red lead within the aggregate is a very common observation in Tudor Stuart samples. Small aggregates, 30-100μm in diameter, with near-complete 'conversion' to red lead in every case, were sometimes found. Larger ones may have an incomplete perimeter of red lead particles, or a complete ring which is 2-3 particles thick, but they never show complete conversion. The common occurrence of red lead formation (over 50% of cases, as an estimate) in these relatively old paintings gives some support to the idea of their 'maturity'.

The most visually disturbing aggregates are those where the red lead shows on the surface as orange spots, rather than translucent white ones. It is quite rare among Tudor Stuart paintings, and has not been noted with a consistent description by conservators.

3.5 AGGREGATES ORIGINATING IN TOP LAYERS OF A SPECIFIC COLOUR

The Tudor Stuart portraits abound in skilfully-painted and detailed depictions of embroidered gold threads, and finely-wrought gold chains and settings for jewels. Bodied paint as well as an intense golden colour is required for verisimilitude, and lead-tin yellow is generally the pigment of choice for such work, toned with red lead or vermilion as necessary. Early observations of such paint consistently include the description 'fizzy texture' (Noble *et al.* 2001). The 'fizziness' is in fact due to the formation of lead soap aggregates within these yellow layers. In the past, cross-sections of such paint have been interpreted as proteinaceous media mixed into the oil, as Higgitt *et al.* (2003) have noted. From 73 paintings on canvas, 13 of 24 examples where aggregates originated in the paint were in lead-tin yellow-containing layers. For panel paintings, 8 lead-tin yellow-containing paintings out of 27 had formed lead soap aggregates.

In the less common situation that lead-tin yellow has been used extensively on the surface, for shot-silk or flat-coloured fabric, aggregate formation is near or completely universal. The typical appearance is irregularly-spaced pimples on the paint surface, more common in the middle of a brushstroke where the yellow paint has the greatest thickness.

Areas of red lead do not occur very often in Tudor Stuart paintings, so there are few examples of red-lead-associated aggregates. From 73 paintings on canvas, 4 of 24 examples where aggregates originated in paint were in a red-lead-containing layer, and 4 more originated in a reddish underlayer that included red lead in its formulation. For panel paintings, only 2 out of 27 showed aggregate formation associated with red lead on the surface.

Higgitt *et al.* (2003) have also noted that lead-tin yellow is more commonly associated with lead soap aggregates than red lead, in a comparison of 35 paintings of varied date. Van Loon *et al.* (2006) have observed that yellow and red areas of paintings with lead soap formation in the paint layer often appear to have a textured surface.

Examples of aggregate formation in both lead-tin yellow and red lead areas of the same painting were rare. The single painting with a paper support is one, and the few others occur on both canvas and panel supports. In these cases, pimples and/or protrusions visible at the surface occur at different densities in yellow and red passages, an observation which suggests formation in the uppermost layer. This was confirmed by cross-sections.

One example, the broad red sash in *Portrait of an Officer* by Dobson (*c.*1645, N04619), painted in vermilion and lead white, shows aggregates on the surface only in the highlights, that is to say, only in the areas rich in lead white. Red lead seems to be absent here.

It is certainly true that white or orange spots are most visible in dark-coloured paint. In addition they seem to be more common in the dark areas of paintings than in the lighter areas. One of the present authors speculated that differential heating was responsible, and that this would account for many observations: '...the damage ... is of internal origin ...the paint has developed a rash of small, circular eruptions in the black and the underpaint, allowing the ground to show through ... it seems likely that the catalyst is strong sunlight, the dark areas of necessity absorbing more heat than the lighter tones ... ' (Jones 1999). Dark layers are often thinner than light passages that are modelled with several layers, so dark layers could be more easily ruptured by a large aggregate developing beneath.

Fig. 3 *A Lady of the Grenville Family and her Son*, Jackson, 1640, oil on canvas, 742 x 608 mm, T03237. Copyright Tate. See www.tate.org.uk for a colour image.

3.6 CHEMICAL MICROSCOPY TO STUDY AGGREGATES ORIGINATING IN GROUND AND PAINT INDEPENDENTLY

From the 49 of 73 canvas paintings with aggregates in a ground or priming layer, 17 show aggregate formation in at least one paint layer as well. One example will be discussed in detail: a sample taken from a yellow button painted over a crimson chair back, occupied by *A Lady of the Grenville Family and her Son* (Jackson, 1640, T03237, Fig. 3) made into a cross-section (Fig. 4).

Scanning electron microscopy (SEM) has long been used to study surface defects in well-dried paint, while energy-dispersive X-ray analysis (EDX) has been applied to paint fragments and to cross-sections coated with carbon or gold. Initially, EDX mapping was done on the cross-section. However, SEM/EDX is not a good method for the study of slow-forming deterioration products from pigments. The depth of sample analysed is 2-5 μm, depending on the accelerating voltage. Even using windowless detectors that permit the detection of elements of low atomic number, and fast area mapping, quantitative analysis of pigments is not easy, and is only interpretable when the pigment mixture is known and relatively simple, and reference standards of known proportions of these materials are available for analysis, presented in the same matrix (paint medium and embedding medium) as the unknown samples. The method has been evaluated for chalk/barium sulphate mixtures in the ground of van Gogh's paintings (Haswell and Carlyle 2006) but would be unlikely to succeed for the full range of white pigments available throughout history, still less for the full range of warm-coloured pigments found in the grounds of 17th-century paintings.

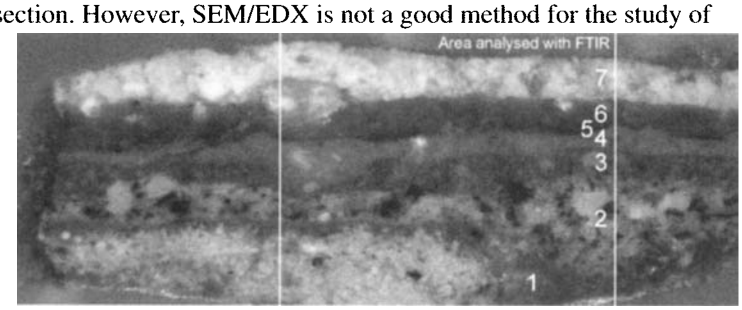

Fig. 4 Cross-section from a yellow button on the red chair, proper left edge, Jackson. Reproduced in colour in Townsend and Keune (2005) as Fig. 3.

In recent years, research has been carried out into the composition and deterioration of 17th- to 19th-century paints, as part of the MOLART (1995-2002) and de Mayerne (2000-2005) projects, funded by the Dutch Organisation for Scientific Research (NWO). These have involved the evaluation and development of a number of techniques such as Fourier Transform infrared spectroscopy (FTIR) mapping and secondary ion mass spectrometry (SIMS) applied to existing cross-sections, to identify chemical compounds (Keune *et al.* 2005, Keune and Boon 2006).

The first stage was a re-evaluation of the sample preparation methods used for traditional cross-sections. The human brain's useful ability to ignore 'foreign' material in a sample is not matched by a sensitive surface analytical technique. FTIR mapping has a spatial resolution of a few micrometres, and comparable depth resolution, while paint layers range in thickness from 10-150 μm, with varnishes having a typical thickness of 10-20 μm. Thus, smearing of organic material (the paint medium) by a mere 10 μm could re-deposit some of it onto a neighbouring layer. Aggressive surface preparation techniques such as ion milling, which produce excellent cross-sections for SEM mapping, might remove paint medium to

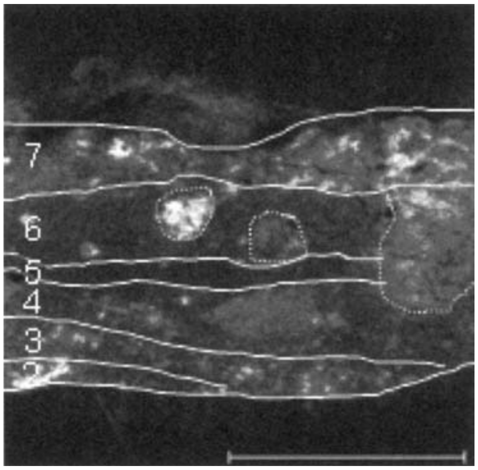

Fig. 5 SIMS map in positive ion mode, of the marked area of Fig. 4. Light areas have the largest amounts of lead. Fig. 5&6, and 7&8 are both reproduced in colour in Townsend and Keune (2005) as Figs. 4 and 5 respectively.

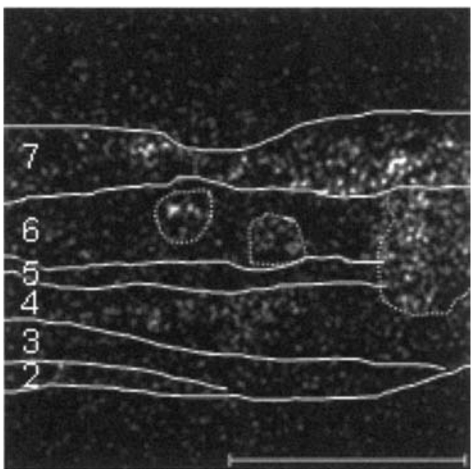

Fig. 6 SIMS map in positive ion mode, of the marked area of Fig. 4. Light areas have the largest amounts of lead soaps.

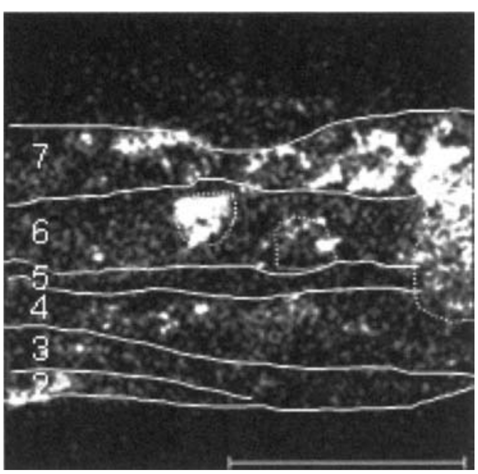

Fig. 7 SIMS map in negative ion mode, of the marked area of Fig. 4. Light areas have the largest amounts of fatty acids of length 16.

such a depth that only the pigment could be analysed. The solution was to use a polyester resin of appropriate hardness when fully cured, combined with dry polishing with cushioned silicone carbide paper to a much finer grit size than is required for optical microscopy. The same preparation method was found to be applicable for SIMS. Subsequent coating with gold enhances the detectability of some compounds (Keune and Boon 2004). SIMS can be used in positive ion mode, to detect elements such as Pb in lead white (basic lead carbonate, see Fig.5 for Pb map) and lead-based compounds (lead soaps, Fig. 6), and in negative ion mode, when organic compounds (such as fatty acids with a chain length of 16, Fig. 7, or 18, Fig. 8) can be detected, as well as light elements. When FTIR mapping (Fig. 9 shows lead carboxylates mapped at 1519 cm^{-1}, Fig. 10 shows carbonates mapped at 1472-1321 cm^{-1}), SIMS and EDX mapping (not shown here)[1] are carried out on the same cross-section, a great deal can be inferred about its original composition, as well as its present one. The yellow paint of the topmost layer includes Pb and Sn according to the EDX map, which implies it is made from lead-tin yellow, while Pb is also present in the two lowest layers, which constitute the 2 preparatory layers on the canvas. The SIMS map confirms the presence of Pb in these layers. The FTIR map shows that the upper paint layer contains lead carboxylate but no carbonates. Only the ground layers can include lead white at present, since they alone contain carbonates. The SIMS maps show that fatty acids, lead soaps and Pb are present in the upper layer. The original paint of the top layer would have included lead-tin yellow and oil. Optical microscopy does indicate to the experienced analyst that this layer has an unusual appearance, suggestive of lead-tin yellow but with a strong UV fluorescence. Yet this observation in combination with EDX would not have offered any explanation for the anomaly. The combined information from FTIR mapping and SIMS lead to the conclusion that lead soaps have been formed in this layer. A reactive phase in the lead-tin yellow reacts with fatty acids derived from the oil to form lead carboxylates and lead soaps. A possible degradation mechanism has been described before as a consequence of the manufacturing process for lead-tin yellow (Boon *et al.* 2004), and it is also described elsewhere (Keune and Boon 2006) and in this publication (Boon *et al.* 2006).

4. OCCURRENCES OF AGGREGATES

Most of the Tudor Stuart paintings have had several cross-sections examined. It is possible to select 100 where a minimum of 3 sections are available for comparison, including both preparatory layers and paint. From these paintings, ignoring their support type, 60% show lead soap aggregate formation in a preparatory layer: 29% only in the ground, 14% only in the overlying priming, 12% in both, and 5% with the layer not localised.

Lead soap aggregates associated with one or more colours of paint occur in 36% of the paintings, and are absent in 53%. In the balance of 11%, it is difficult to judge whether lead soaps are definitely forming – the proportion with lead soaps in the paint layers could thus be as high as 47%.

99% of these paintings have been lined at least once, mostly with glue paste.

5. CONCLUSIONS

Surface examination alone greatly underestimated the extent of lead soap formation, by a factor of roughly 3-5. It also considerably underestimated the number of paintings which show remineralization of the aggregates to form red lead.

A comparison of cross-sections with images from analysed paintings known to have lead soap formation soon leads to confident identification of the phenomenon, by means of examination of cross-sections at x100-500 in both visible and ultraviolet illumination.

5.1 CORRELATIONS AND DISCUSSION

Lead white is always present in preparatory layers that form lead soaps. On occasion red lead is also present as a minor component, but it does not seem to be a necessary ingredient for formation, if lead white is already present.

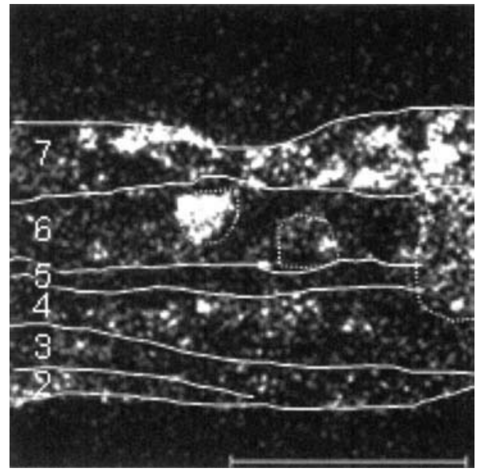

Fig. 8 SIMS map in negative ion mode, of the marked area of Fig. 4. Light areas have the largest amounts of fatty acids of length 18.

Multi-layered grounds tend to develop lead soap aggregates more often than single-layer grounds. This suggests that thickness of the paint – or a greater concentration of medium – is involved. It is also noticeable that formation occurs in chalk-rich layers, which means that it occurs in the medium-rich portions of the layer, since chalk has a lower oil absorption than lead white. Van Loon *et al.* (2006) carried out a study of predominantly unlined seventeenth-century paintings still *in situ* in the Orangezaal near the Hague in the Netherlands: these paintings have a common and unusually lean ground, and do not show any lead soap formation in this layer.

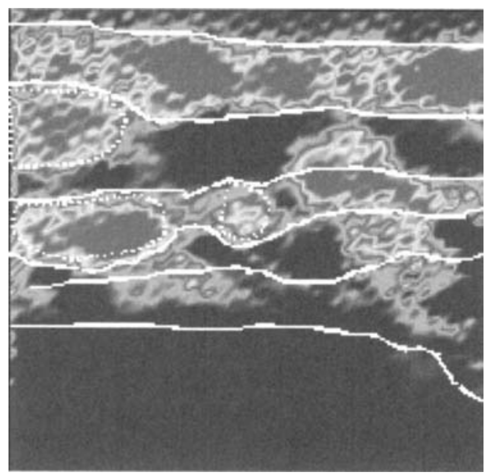

Fig. 9 FTIR map of the marked area of Fig. 4, with lead carboxylates mapped at 1519 cm^{-1}.

Impasted lead-tin yellow highlights are prone to lead soap aggregation, especially when the lead-tin yellow is quite pure, with little or no lead white included. Impasto is by definition also thick, but not necessarily medium-rich. It is not known if impasted Tudor Stuart paint contains any additional medium besides oil: no sample from these paintings has been sufficiently free of contamination by varnishes for detailed analysis. Lead-tin yellow used in larger areas such as costumes also forms lead soap aggregates in almost all cases, distributed most thickly where the paint is thickest.

Lead soap aggregates are more densely distributed in light-exposed areas than under the frame.

5.2 NEGATIVE CORRELATIONS

The largest aggregates see during this project occur in a painting not lined until 1986, using with a cold lining technique and Plextol 500 acrylic resin, *A Trompe l'Oeil of Newspapers, Letters and Writing Implements on a Wooden Board* (Collier, 1696, T03853).[2] Aggregates also occur in lead white-containing grounds in panel paintings as well as canvases, which indicates that lining (which involves heating and moisture) is not vital for their formation. Nonetheless, it may be conducive to the formation process, since more canvas supports (all lined) than panel supports in this group showed the phenomenon. The independent study of unlined seventeenth-century paintings on lean

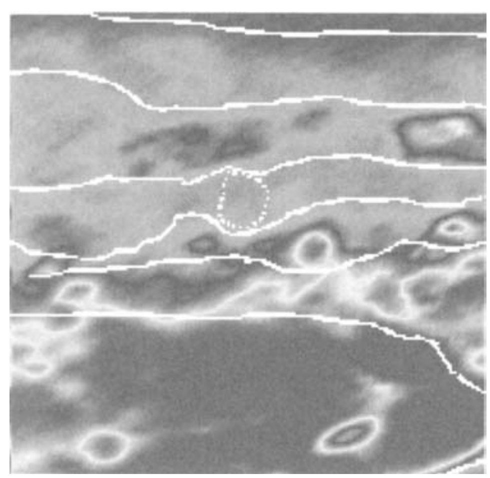

Fig. 10 FTIR map of the marked area of Fig. 4, with carbonates mapped at 1472-1321 cm^{-1}

grounds in the Orangezaal (van Loon *et al.* 2006) found no lead soap formation in these grounds. Since both the British paintings considered here and the Dutch paintings in the Orangezaal must have a common history of storage in a damp, maritime climate, lining with heat and moisture may well be important for lead soap formation. Noble *et al.* (2005) sought common histories among a group of paintings, and found that lining and/or known exposure to high relative humidity was common to those with aggregate formation.

Stretcher bars can be assumed to have a slower response to changes in relative humidity that canvas with an air gap behind, yet aggregates formed in the ground are distributed evenly over the whole paint surface. Neither the greater mechanical stability conferred by the stretcher bars, not their longer moisture retention once wet, have affected aggregate formation.

Lead soap aggregates occur in both 16th-century and 17th-century Tudor Stuart paintings, that is, over a period of more than 150 years. Thus, they cannot be related to a specific artist, or a specific source of supply. The artists in this group were trained in several countries, and only a few have known associations with any other in the group, for example having worked in the same studio, under the same master. This suggests that causes of lead soap formation should be sought through a study of environment and/or treatment history, rather than through common suppliers of pigments. However, it remains a possibility that the manufacturing process for the lead white (known as the Dutch process), unchanged over a period of 150 years, could be implicated.

5.3 EFFECTS ON APPEARANCE AND CONDITION

Tudor Stuart paintings with aggregate formation are not more damaged or over-cleaned than aggregate-free ones. The paintings seem in poor condition now, only when the aggregates are manifested as protrusions on the surface causing minor crack formation or pimples, or increased visibility of underlayers. The altered transparency matters in paintings of this period because the preparatory layers are usually mid-toned or darker, hence aggregate formation in underlayers can lead to an impression of overall darkening. This is a very common phenomenon in 17^{th}-century paintings.

The impression of a 'worn' or 'blanched' surface that cannot be improved by the application of a clear varnish is also fairly common. Protruding lead soap aggregates cause the greatest changes in appearance. A recent paper has related the formation of whitish or grey crusts on dark paint to the same phenomenon (van Loon and Boon 2005).

In light-coloured layers at hiding thickness, such as impasted lead-tin yellow used to depict gold threads and gold jewellery, any texture conferred by aggregates breaking the surface probably enhances the depiction of a three-dimensional surface of finely-tooled or stitched gold, and works with the artist's intention rather than against it. Increased transparency of smaller aggregates is not too obvious in paint at hiding thickness. The changes are not readily perceived by the viewer.

ACKNOWLEDGEMENTS

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ENDNOTES

1 Reproduced in colour in Townsend and Keune (2005) as Fig. 6.
2 See www.tate.org.uk for a colour image.

OPAQUE TO TRANSPARENT: PAINT FILM DEFECTS IN THE WORK OF FREDERIC CHURCH AND THE HUDSON RIVER SCHOOL

Joyce Zucker, Painting Conservator
Jaap Boon, Head of Molecular Paintings Research

ABSTRACT - Degradative phenomena in oil paintings on canvas are prevalent in the paintings of the Hudson River School. Visual manifestations of these conditions vary. Bloom, haziness and variable translucency are often misunderstood as part of the intended design. The difficulties of interpreting changed visual information and treating these changes are considered. Damaging historical treatments are briefly reviewed. Examples of various conditions are illustrated in paintings by Frederic Church and Hudson River School painters. Research carried out by the Molecular Paintings Research Group on samples from the archive at Olana reveals the mechanism for understanding bloom, haze, protrusions and variable translucency. Their findings are discussed. Oil sketches from the Church archive provide additional information. One particular sketch shows protrusions and bloom visible in a distinct pattern suggesting a brush application of an unknown substance. Archival materials from Olana State Historic Site, including letters, receipts and books, support lead acetate as the probable cause. Areas for future study are suggested.

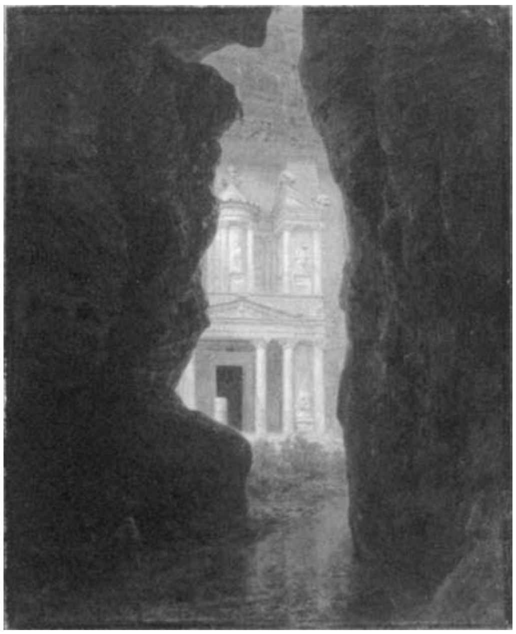
Fig. 1 Frederic Edwin Church, *Petra*, (1874), oil on canvas, 60 ½ x 50 ¼ (153.7 x 127.6) New York State Office of Parks, Recreation and Historic Preservation, Olana State Historic Site, Hudson, New York

In a recent review of the Olana Treasures catalog and exhibit at the National Academy, John Updike writes of Frederic Church's *Petra* (1874) (fig. 1), *"The stony curtain is being drawn back on a mystery, a piece of pillared architecture as lovingly rendered in its capitals and tympanum as the shadowed rock slabs taking up two thirds of the canvas are dull, dark, and scrubby"* (Updike 2006).

This is not the first 19th-century American painting to be misunderstood as a result of inherent paint film defects. This paper explores the visual impact of these defects in Hudson River School paintings and the alterations that occur.

In Frederic Edwin Church's *Petra,* there are patchy, white vertical lines in the doorway that extend above the molding. In the lower left corner, the figures are barely visible. The darks in this painting are difficult to read. The painting did not always look this way. Inherent paint film defects have caused dramatic visual changes, of which we need to be aware. In the work of Frederic Edwin Church (1825-1900) and other Hudson River School painters, paint film defects are common, including significantly increased translucency. In these pictures, original compounds, which are the materials used to make these paintings, may react to become new compounds that can produce optical changes. There is a complex of problems and gradients in these structures that ultimately effect appearance.


Fig. 2 Martin Johnson Heade, currently titled *April Showers*, (1868), oil on canvas, 19 7/8 x 40 1/4 (50.48 x 102.23) cm, Museum of Fine Arts Boston

Years ago during a visit to the Museum of Fine Arts in Boston, I saw a painting by Martin Johnson Heade (1819-1904) and wondered about the name. It was titled *Spring Showers* (fig. 2), but I recognized that the "showers" were what we then called "ground staining." Currently this condition is called variable translucency. When the records were checked, we discovered that the painting had come into the collection titled *Apple Blossoms.* The presentations in the Painting Specialty Group

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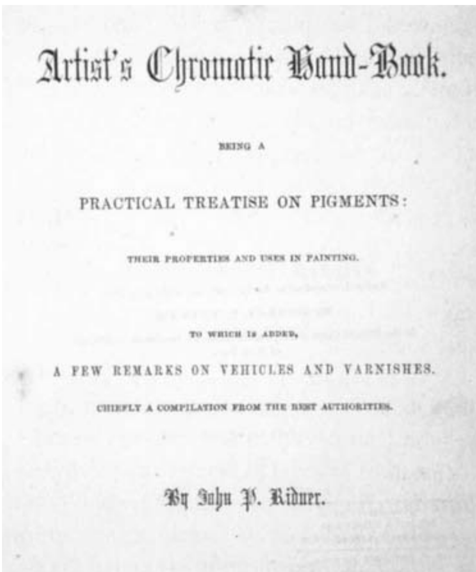
Sessions at the 2006 AIC Annual Meeting in Providence, Rhode Island, shed new light on these defects. In the US, these conditions are often found in the Hudson River School and manifest in dark vertical and horizontal lines that seem to follow threads or brushstrokes. In landscapes that are about atmospheric effects, they are particularly ruinous. Why is there this hot spot of defects in American art?

In Annette Blaugrund's dissertation on the 10th Street Studio Building, there is a long roster of artists (Blaugrund 1987). Among those names are many whose works show the effects of particular paint film defects. Artists were in and out of each others studios and bought materials from many of the same artist colormen located nearby on Broadway in lower Manhattan.


Artist's Chromatic Hand-Book.

BEING A

PRACTICAL TREATISE ON PIGMENTS:

THEIR PROPERTIES AND USES IN PAINTING.

TO WHICH IS ADDED,

A FEW REMARKS ON VEHICLES AND VARNISHES.

CHIEFLY A COMPILATION FROM THE BEST AUTHORITIES.

By John P. Ridner.

Fig. 3 Title page to J. Ridner, Artist's chromatic handbook, New York, 1850

As we know, the nineteenth century was a time of great experimentation and change in the use of artist materials (Carlyle 2001). Artists who previously were grinding and preparing their own paints were now purchasing ready made paints from colormen. Recipes for preparing white lead changed through the century. There were many patents for various processes to improve opacity, and working properties (United States Patent Office, 1835-1866). For suppliers in England like Winsor and Newton and Rowney who had export markets, it was a challenge to make materials and supplies that would produce profits. White lead grounds in damp conditions could take 6 months or more to dry (Merimee 1839). Prepared canvas could not be stacked touching and needed a good deal of room. It is likely that drier was added to the priming materials to promote more rapid drying (Church 1890). For transport, the damp, fetid air in the hold of ships provides less than the ideal environment.

Will we ever know for certain whether colormen were intentionally sending poorer quality or tainted materials to the US? The finger is pointed at the colormen who prepared the canvas for four paintings exhibiting severe variable translucency: Frederic Church's *Niagara* (1857) Olana State Historic Site; Church's *Tamaca Palms* (1867) Corcoran Gallery of Art; William McCleod's *Great Falls of the Potomac* (1873) Corcoran Gallery of Art; and an unknown artist's *Susan Livingston* (ca.1840) Clermont State Historic Site. In correspondence between Frederic Church and the curator at the Corcoran Gallery Church says that two of his paintings painted on Winsor and Newton Roman canvas have *"obnoxious streaks"* (Church 1885). The curator responds, *"and it is rather remarkable that the only picture of my own at this Gallery shows a frightful condition of the same kind, and it was painted on Windsor & Newtons Roman Canvas! It is the only work of mine that ever was so affected"* (MacLeod 1885). Susan Livingston's portrait retains a visible canvas stencil, on the reverse, from London artist colorman George Rowney (fig.12a). From the archival information, the case is built.

At Olana State Historic Site, the home of Frederic Church, there are the contents of the artist's studio. In the site's archive there are hundreds of oil and architectural sketches from across his working lifetime, bills and receipts from many of his purchases, and Church's personal library. His library containes Ridner's well used Artist's Chromatic Handbook of 1850 (Ridner1850) (fig 3). Ridner recommends using a pale drying oil made by mixing oil with $1/8^{th}$ its weight in litharge, yellow monoxide of lead or lead acetate. According to modern paint chemists when drier is added above 2% of the oil there is no further increase in drying and in fact the excess is detrimental (Heaton 1940). Also noted is the fact that in excess of 1% litharge darkens oil (Tumosa and Mecklenburg 2005). However, in the mid 19^{th} century Ridner recommended using a far greater quantity. Some manuals recommend applying the pale drying oil directly over the ground (Carlyle 2001, 42).

Church's library also contained G. Field's *Chromatography, salter's edition* (Field 1869) (fig. 4). Field discusses the use of sugar of lead (lead acetate dryer) incorporated with resins to give paint a buttery, workable texture particularly useful in glazing. Later he notes, however, that an excess of dryer renders oil "saponaceous," and that the "inexperienced" ought to be careful about the practice of "strewing pictures while wet with acetate of lead." Field knew what we now see–though lead acetate may promote quick drying, it "will ultimately effloresce on the surface

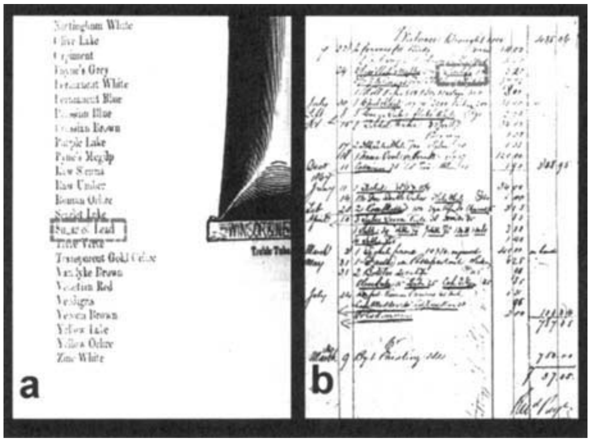


Fig. 4a G. Field. Chromatography, salter's edition, 1869 London: Winsor and Newton page 3 List of colours and materials) b. New York State Office of Parks, Recreation and Historic Preservation, Olana State Historic Site archive, Hudson, New York, [receipt for artist materials July 22, 1867, Goupil's artist colormen]

and throw off the color in sandy spots" (Field 1869, 52). This is an almost perfect description of two degradative phenomena associated with metal soap formation: aggregate formation or protrusions, and efflorescence or bloom (Boon, Keune and Zucker 2005).

At the back of *Chromatography, salter's edition,* is a catalog of artist materials, including pigments ground in linseed oil. In spite of Field's warnings, on the third page of the list of colors sugar of lead is listed along with tubed paints (fig. 4a). It is entirely possible that artists were strewing lead acetate over surfaces and mixing it with their colors. Church frequently purchased siccative or drier as evidenced by various receipts in the Olana archive (fig. 4b).

This means there are at least 3 potential sources for excess lead: added to the white lead grounding, brushed over the ground after it has dried, and added to the paint itself.

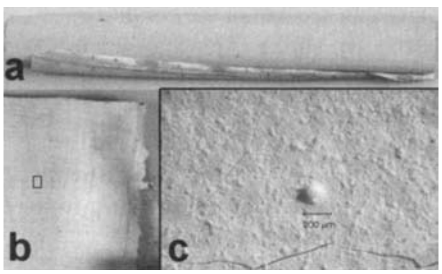


Fig. 5a Frederic Edwin Church, [n.d.] primed canvas roll, New York State Office of Parks, Recreation and Historic Preservation, Olana State Historic Site, Hudson, New York b. detail of variable translucency along the threads, c. photomicrograph of surface showing protrusions

Primed canvases in the Olana archive, never used by Church, present intriguing information. Figure 5a shows the particular rolled canvas that provided samples for extensive analysis in the Netherlands (Boon, Keune, and Zucker 2005).

At one point the piece of fabric was tacked to a stretcher, since tack holes are visible. Church chose not to use this canvas, perhaps because oil staining is clear (fig. 5b). Was the ground already too medium rich? Was the priming brushed with drying oil?

In the photomicrograph (fig. 5c) a pattern of large and small protrusions and efflorescence is visible on the surface. The unpainted, pre-primed canvas already manifests the problems we see in finished works of art, namely variable translucency, efflorescence, and protrusions. Exhaustive analysis at AMOLF (FOM Institute for Atomic and Molecular Physics) has determined that the efflorescence consists mainly of lead metal carboxylates, free fatty acids, Monogylcerides, and lead soaps of Palmitic and Stearic acid. The artist's use of lead driers likely exacerbated existing conditions in the pre-primed fabrics. The irregular absorbance of size, linseed oil, additives, and diluents along strong, thick warp threads and relatively thin weft threads, may help to explain, in part, variable translucency along the canvas weave. The brushed application of drier or drying oil over the ground appears to be another factor. The local permeability of the canvas under fluctuating, humid conditions is thought to drive the process, thus transmitting a canvas weave pattern into the ground and paint.

Apparently, as paint films dry, there are low molecular weight materials that continue to move in the structure (fig. 6). Since 1998, analytical research has been able to establish that reactions taking place over time, between constituents of the oil binding medium and a metal source in excess in the paint (often lead or zinc containing pigments or drier), can lead to metal soap defects that alter the original appearance of works of art (Boon, et.al. 2002) (Noble, van Loon, and Boon, 2005). In medium rich primed canvases that have had lead driers applied, the development of paint film defects, such as variable translucency, efflorescence, or bloom and protrusions, appears to be enhanced.

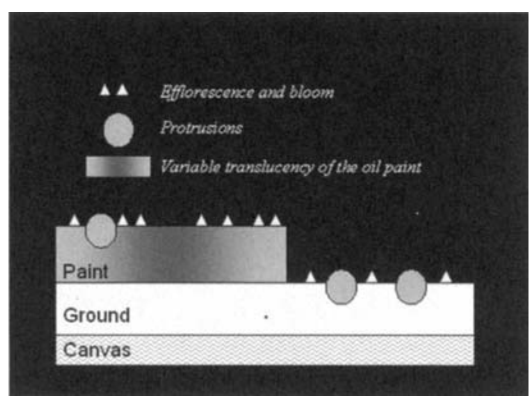


Fig. 6 various problems in paintings by F.E. Church

Fig. 7 Frederic Edwin Church, *Twilight in the Wilderness* (1860), oil on canvas, 40 x 64" (101.6 x 162.6) Cleveland Museum of Art

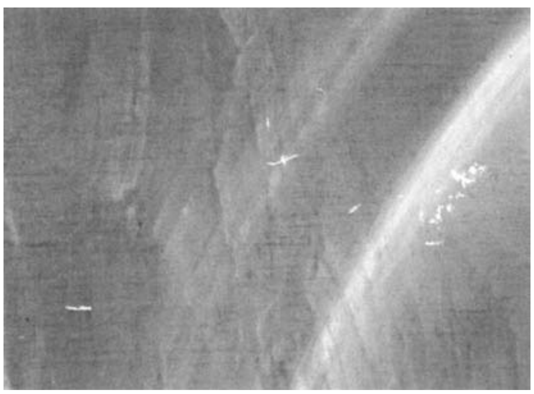


Fig. 8 Frederic Edwin Church, *Rainy Season in the Tropics* (1866), oil on canvas, 56 1/4 x 84 3/16" (142.9 x 213.8). The Fine Arts Museum of San Francisco

Fig. 9 Frederic Edwin Church, *Ixtaccihuatl* (c. 1884-85), oil on paper, 9 7/16 x 11 3/8"(24.0 x 28.9). New York State Office of Parks, Recreation and Historic Preservation, Olana State Historic Site, Hudson, New York

Many of the icons of American painting are afflicted. It is important to acknowledge that many of these pictures have been treated in the past and disfiguring changes have been retouched out. In Cleveland's *Twilight in the Wilderness* (1860) the defects in the sky are clear. The dramatic color and layout of the brilliant sky is compromised by predominant vertical lines and dark patches in the upper right quadrant (fig. 7).

More transparent lines of paint produce an additional pattern that was never intended by the artist. Understanding exactly what should have a dark appearance and what should have a light appearance can be a challenge. As white lead paint changes to lead soap, transparency is increased. In this detail of San Francisco's *Rainy Season in the Tropics* (1866) we can see one of the conditions clearly (fig. 8). Variable translucency in paint has altered the painted composition and has been mistaken for abrasion. Translucency follows the top of threads where paint is thinly applied. It is difficult to ascertain mist from defect and mist from unintended haziness.

In a survey of 167 of Church's oil sketches on paper, 53% had evidence of bloom or efflorescence. Of 74 sketches painted after 1870, 66% showed bloom. In *Ixtatiawatyl* (fig. 9), the lines of efflorescence clearly follow brushstrokes as though some reactive material were brushed on the surface of the ground. Indeed, Church would have wanted oil sketches to dry quickly; he stacked them. It makes sense that he would brush drier or drying oil over the surface of the ground, and he didn't necessarily care about the long term stability of sketches. With magnification, the protrusions on the surface of the oil sketch *Ixtaccihuatl* are clearly visible in the detail (fig.10a). These protrusions have often been misunderstood as coarse textured paint or intended texture in the paint. They rise up out of the surface, with the appearance of added sand. In the process of cleaning or with other contact, the protrusions can be lost, forming a gap or hole. It can leave the surface pitted. (fig.10b). This makes the affected pictures vulnerable to cleaning, since solvent or any liquid used would form a pool in this area.

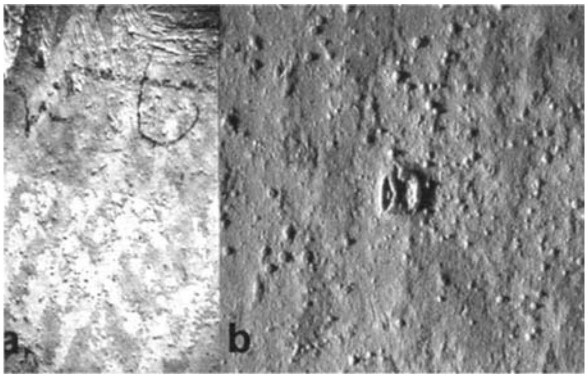


Fig. 10a *Ixtaccihuatl*, (detail) protrusions and efflorescence (6x); b. (detail) large pit left by protrusion void (30x)

Fig. 11 Frederic Edwin Church, *The Afterglow* (1867), oil on canvas, 31 ¼ x 48 ½ (79.4 x 123.8). New York State Office of Parks, Recreation and Historic Preservation, Olana State Historic Site, Hudson, New York

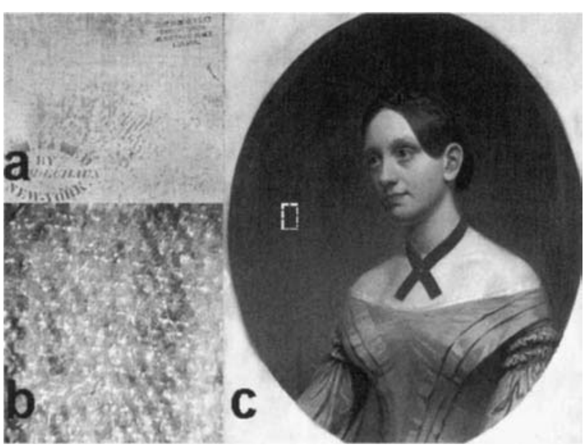


Fig. 12 artist unknown, Susan Livingston ca. 1845, oil on canvas, 30 x 24.5" (76.2 x 62.2), New York State Office of Parks, Recreation and Historic Preservation, Clermont State Historic Site, Germantown, New York, a. canvas reverse (detail); b. canvas weave and paint (detail); c. portrait with detail location

Sometimes the design intent is almost impossible to read as with Church's *The Afterglow* (1867). It appears as though we may be seeing broken scumbles. Often this is attributed to over cleaning, but with many of these pictures it can be difficult to tell (fig. 11).

Here in a photomicrograph taken from a mid century picture of Susan Livingston, the twill weave is visible, the white ground shows through at the high points along with protrusions, but the paint is dark and light in the areas where thicker paint would build up (fig.12 b). The dark paint is a mix of bone black, earth pigments and iron oxide on top of a lead white containing ground. Light areas appear to be caused by submicron sized particles of lead white that are growing in the top layer (Boon, 2006). The dark lines seem to follow the brushed application of some material more than the canvas pattern itself as it did on Church's oil sketch. How many curators might think that this painting had been skinned? The primed canvas used for Susan Livingston has a stencil on the reverse from another British supplier George Rowney (fig.12a). A second stencil tells us that it was sold by Dechaux, artist colorman, at 306 Broadway. It is unclear at this time whether the priming was applied by Rowney or Dechaux. While we have used the paintings of Frederic Church to reveal paint film defects, the number of 19th century artists whose work is afflicted with these conditions is large. I have seen examples of problems from the 1830's through the 1890's. A short list of the artists whose work is affected would include luminaries like Thomas Cole, Fitzhugh Lane, John Frederick Kensett, Jasper Cropsey, Martin Johnson Heade, Sanford Robinson Gifford, and artists such as Montgomery Livingston, Aaron Draper Shattuck, Jared B. Flagg, and the list goes on.

Nationwide there are many more examples of these conditions. In your own collections or in collections with which you are familiar, there are paintings hanging on the walls that need to be looked at in a new light. Conditions that you may have called something else or attributed to over cleaning in the past should be re-evaluated to determine the probable cause. The following paintings may be used as examples:

Fig. 13 Fitzhugh Lane, title unknown, [n.d.]. private collection

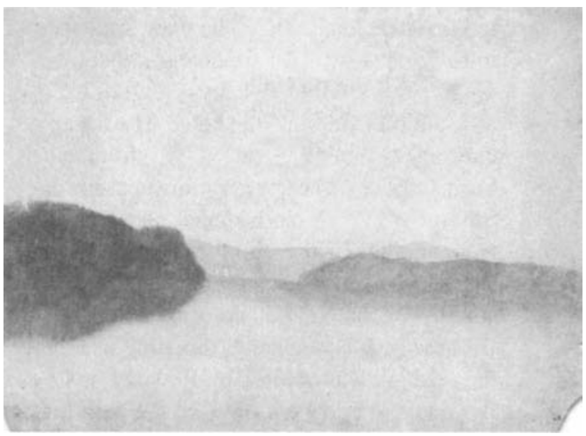


Fig. 14 Montgomery Livingston, Landscape, (c. 1840), oil on paper, 10 x 12" (25.4 x 30.5). New York State Office of Parks, Recreation and Historic Preservation, Clermont State Historic Site, Germantown, New York

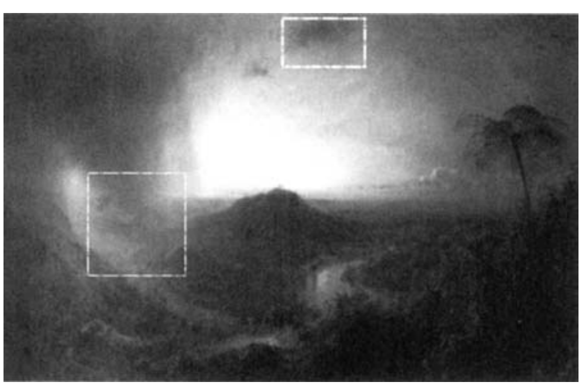


Fig. 15 Frederic Edwin Church, *Vale of St. Thomas, Jamaica,* (1867), oil on canvas, 48 5/16 x 84 5/8" (122.7 x 215), Wadsworth Atheneum, Hartford, Connecticut

A painting by Fitzhugh Lane from a private collection shows extreme variable translucency following predominantly vertical threads (fig.13). Efflorescence is the predominate problem in an oil sketch on paper by Montgomery Livingston (fig. 14).

Details allow us to see that these conditions manifest in complex, variable, visual forms. In the *Vale of St Thomas, Jamaica,* another painting by Church (fig. 15), the storm coming across at left is broken by horizontal and vertical lines (fig. 16) that make no sense to the composition. The clouds blocked off and shown in detail (fig. 17) have a dark, heavy, greasy appearance that breaks the atmospheric nature of the evanescent event.

We know that these problems showed themselves in the nineteenth century. Dare Hartwell of the Corcoran Gallery, brought a series of letters, noted previously, to my attention (Church, 1885). Frederic Church and the curator at the Corcoran, William MacLeod, corresponded between 1873 and 1886. They discussed the paint film defects that we are concerned with today. Old treatment photos in black and white from the Corcoran archive document changes that have occurred in the more recent past. Remarkably, Frederic Church painted the sky on his large *Niagara* 3 times! One might wonder how long it takes for these conditions to show themselves.

Based on the Church-Macleod correspondence, *Tamaca Palms,* owned by the Corcoran, had developed streaks within 23 years of its creation. This is not to say that the streaks were not visible before this time. In the case of *Niagara,* the sky was re-painted 2 times in just 29 years because of "streaks" (severe variable translucency).

Fig. 16 Frederic Edwin Church, Vale of St.Thomas, Jamaica, (1867) (detail). Vertical and horizontal lines

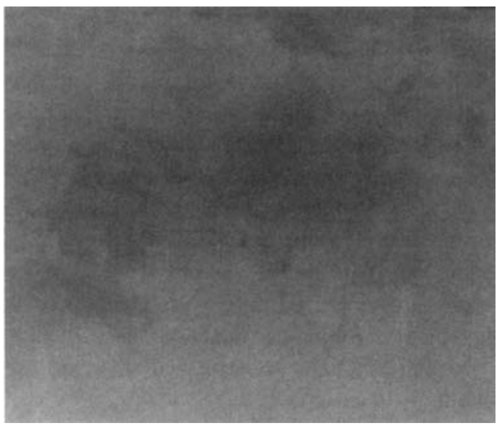


Fig. 17 Frederic Edwin Church, *Vale of St. Thomas, Jamaica,* (1867), (detail). Clouds with a greasy appearance

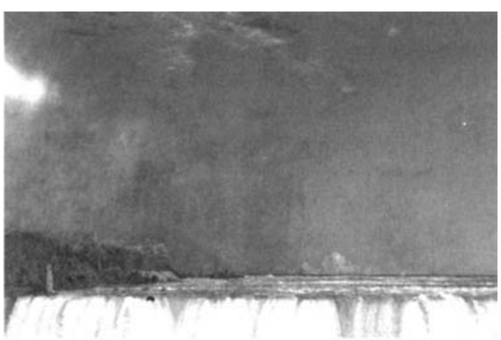


Fig. 18 Frederic Edwin Church, *Niagara* (1857), oil on canvas, (detail). Streaks

Church writes, "I am very sorry to hear that the obnoxious streaks (fig. 18) have appeared in the *Niagara.* ...it is due to the canvas maker. I was always very careful in the choice of canvases and strove to secure the best. I think the *Niagara* was painted on Winsor and Newton Roman Canvas, the best they professed to make at the time I painted the picture. A canvas maker once informed me that the streaks were owing to the use of sugar of lead in the preparation of the canvas-used I suppose to promote haste in drying-it seems very strange that often years may elapse before the pernicious dryer works through to the surface. They appeared many years ago in the *Niagara* while it was in the possession of Mr. Johnston. I then carefully repainted the sky and supposed I had covered up the mischief forever." (Church 1885)

Church continues "Once I had the streaks in a picture removed by Mr. Oliver, and as far as I knew they did not reappear. I should not be surprised if he could eradicate those in the *Niagara.*" MacLeod hired Oliver.

Oliver's treatment went badly and Church received the painting at Olana for re-treatment in the summer of 1886. Church was horrified that Oliver cleaned off glazes and scumbles. He found he must paint the sky for the third time (fig. 19) and opined *"some parts were cleaned down to the preliminary painting, thus removing the transparent tone which nothing but time can give."* He says that the restoration that he undertook required much *"time, care, and patience." "To bring all together and reconcile discrepancies, keeping an eye on changes that time will make in the future, less in the old work, more in the new was very difficult and in a sense experimental."*

In a detail of the sky from *Jerusalem from the Mount of Olives* (1870) we see an important area of roiling clouds. Thanks to Scott Heffly of the Nelson Atkins Gallery, we have black and white photos that document the slow process of recovery of this area (Fig 20). The vertical and diagonal lines pose an impediment to reading the clouds clearly (fig. 21). Slowly, as the retouching proceeds, the linear distractions are removed and the purer cloud formation remains (fig. 22).

After retouching, the painting is now closer to the artist's original intent. He did not want vertical and diagonal lines marring the composition. He did not want a confusion of design. As we look at these 19th-century American pictures we need to apprehend changes that may have occurred in transparency, darkening, lightening, and surface texture. The treatment of these pictures must be very carefully considered. They are vulnerable, and the treatments are challenging.

John Updike closed his article with these words, [Church's] *"passionate cloudscapes are in fact moving; they speak of beauty that is evanescent, be it in clouds or mountains, and of the helpless act of witness which the painter wordlessly achieves"* (Updike 2006). We witness change. The painterly effects themselves can

Fig. 19 Frederic Edwin Church, *Niagara*, (1857), oil on canvas, 42 1/2 x 90 1/2"(108 x 229.9). The Corcoran Gallery of Art, Washington, D.C.

be transitory, and we must try to understand, save what we can, and see beyond the opaque and transparent. We need to ask ourselves what can be done to understand and more completely document the harmful effects of driers and oil rich mediums in the aging characteristics of 19th-century American paintings. We need to be aware of these conditions as we approach the treatment of these paintings. Eventually, we must determine whether specific treatment protocols are in order. To begin:

- Design reconstructions testing selected lead driers added to the white lead ground, drying oils applied over the ground, and lead driers added to paint to determine the long term effects of excess lead in oil rich mediums in controlled conditions.
- Test the efficacy of using synthetic resins for inpainting, over time, in areas of increased translucency and opacity.
- When dealing with 19th-century. American paintings, carefully consider the necessity of cleaning. Use heat, water, water based cleaners, and solvents with caution.
- Check for protrusions and make certain that mechanical action used does not dislodge them.
- Reduce exposure to high Relative Humidity and fluctuations.

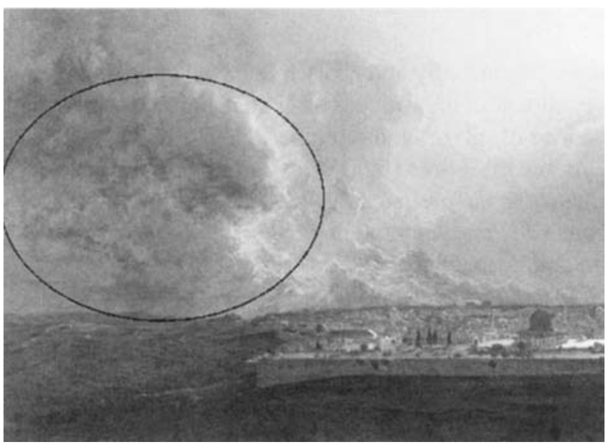


Fig. 20 Frederic Edwin Church, *Jerusalem from the Mount of Olives*, (1870), oil on canvas 54 x 84 (137.2 x 213.4). The Nelson-Atkins Museum of Art, Kansas City Missouri

Thanks to colleagues Charlotte Ameringer, Alex Katlan, Katrine Keune, Dare Hartwell, Scott Heffly, Steve Kornhauser, Dorothy Mahon, Travers Newton, Marcia Steele and Dennis Bove.

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Fig. 21 *Jerusalem from the Mount of Olives,* (detail) Disrupted clouds before inpainting

Fig. 22 *Jerusalem from the Mount of Olives,* (detail) After inpainting

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IN PURSUIT OF LINING OF A LARGE CEILING PAINTING BY JACOPO TINTORETTO

Serena Urry, Detroit Institute of Arts

ABSTRACT - *The Dreams of Men* was removed from view in the 1970s and unlined in an early 1990s treatment. The compromised structural integrity necessitated its lining. Considerations included: a) the previous paste lining applied to the painting; b) preserving autograph sketches on the reverse; and c) imperfect environmental conditions at the gallery ceiling. Recent fellowship and workshop experience convinced the author to research Italian *pasta* lining, modified to eliminate heat and pressure. *The Dreams of Men* was pasta-lined by Matteo Rossi Doria and attached it to a new self-adjusting aluminum stretcher.

I. INTRODUCTION

This paper deals for the most part with how I arrived at a particular solution for lining a large ceiling painting in our collection. I'm going to start with the history of the painting both before and after its acquisition. Then I'll discuss the issues the painting presented with respect to lining, and I'll describe the investigations I did before making a decision. Finally, I'll give a brief presentation about the actual lining itself, which took place in May 2005.

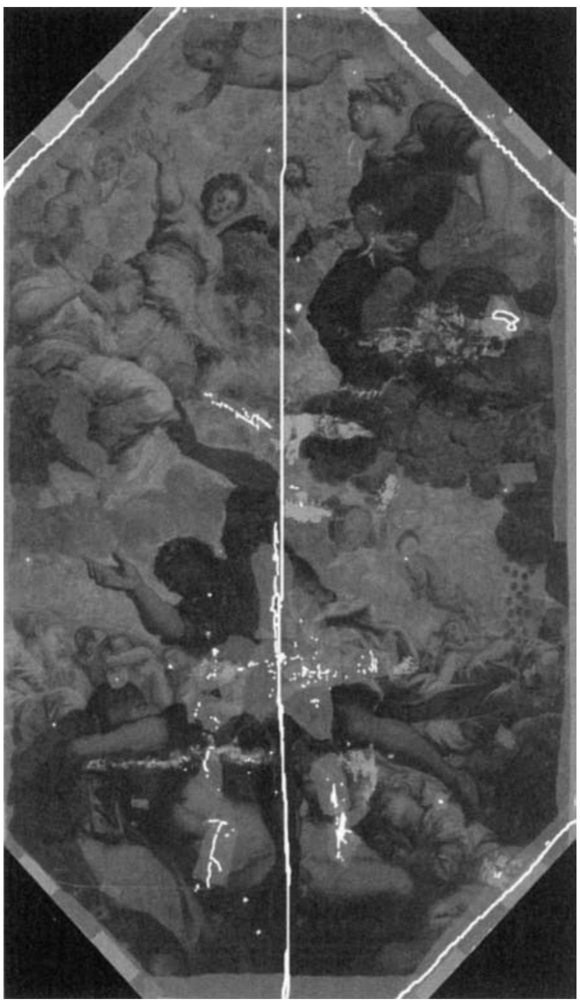

Fig. 1 Jacopo Robusto Tintoretto *The Dreams of Men*, c. 1545. Approximately 149" x 85-3/4". Transmitted light during 1990s treatment, seams and losses highlighted in white. City of Detroit Purchase, 23.11.

II. HISTORY

The Detroit Institute of Arts was founded in 1885 and its collection quickly grew. By the 1920s a new larger building was in the planning stage. Among the ideas discussed was the possibility of buying a ceiling painting by the sixteenth century Venetian artist Jacopo Tintoretto. In fact, one of the renderings from 1923 by the *Beaux-Arts* architect, Paul Phillippe Cret, shows a just such a work installed in the ceiling of one of the new galleries. It is not, however, the painting the DIA eventually acquired that same year which was a secular work entitled *The Dreams of Men*[1].

Currently dated to around 1545, *The Dreams of Men* was probably commissioned by the Barbo family for their *palazzo* in the San Pantalon parish of Venice, perhaps for a bedroom. It shows the classical figures who might appear as one dreams of one's fate. Fortune, a young man, balances on a crystal globe beside his father, the bearded Saturn, who holds an hourglass as the personification of time. In the heavens above, Jupiter, Cupid and the personification of Fame, holding a trumpet, occupy the heavens, along with the signs of the zodiac and several figures whose iconography has been lost. A mask and red poppies reiterate the idea of sleep, while a shower of gold coins speaks to fortunes.

The Dreams of Men was installed in the purpose-built ceiling in the Italian galleries when the DIA's new building opened in 1927. In the 1970s the galleries were renovated and the painting was removed. In the early 1990s when it was treated by Mellon fellow Julie Moreno. She undertook a full cleaning of the painting, removing varnish, overpaint and fills, as well as cross-sectional analyses, x-radiography, etc. I invite you to read her 1995 postprint from the AIC Paintings Group about the project[2].

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During the course of treatment, Julie removed a paste-lining from the painting. At which time she discovered two large brush sketches by Tintoretto on the back of the original canvas[3]. Though the canvas was stained and damaged, the sketches were still quite legible. The original canvas was in fairly good condition, but it did have many isolated structural problems (fig. 1). First was the long original whipstitched seam down the center of the oblong octagon. Second was the addition of strips to three of the four corners. And third were the numerous losses and tears to the canvas, many of them filled with old, misaligned inserts. Julie removed and replaced all inserts and mends in the course of her treatment, strip-lined the painting and attached it to a new expansion bolt stretcher.

In 1994, as a final wrap-up of the project, *The Dreams of Men* was given a special exhibition at the DIA. For five weeks it hung face down in a gallery with no ill effects. After the exhibition it was returned to storage, where it leaned against a wall or hung on a screen for the next 11 years.

III. LINING ISSUES

In 2003, the Tintoretto project loomed as it had for years, as unfinished business that we might be called upon to conclude at any moment. The DIA had begun a major building renovation and the possibility of renovating the unregulated ceiling space in order to reinstall this major work had been raised. Because of the compromised structural integrity of the canvas, it was understood that the painting would have to be lined in order to hang face down for any length of time.

At the time of Julie's treatment, lining the painting with Beva to a translucent synthetic sailcloth had been discussed. In fact, the fill and mending materials had been chosen with the idea that the painting would eventually be lined on a vacuum hot table. One thought behind this idea was of course to allow the sketches to remain visible. I have observed such a lining, of a sixteenth century Italian painting at another institution, and found that while an inscription on the reverse did remain visible, it was quite dark. The Tintoretto sketches were already darkened by staining, and I was concerned that they would be impregnated to some irreversible degree with Beva.

The other thought behind doing a synthetic lining was to reduce the reactivity; clearly a synthetic backing and adhesive would react to changes in the environment to a far lesser degree than the lining that had been removed. However, I was concerned that the conditions in the ceiling would be so adverse that stresses would actually be induced between the ways the original canvas and the synthetic fabric reacted. Though the environment will improve after our renovation, the temperature and humidity will still be monitored and regulated at floor level. I thought there was the potential for delamination over time because of ambient cycling.

On further consideration, I recognized that the paste lining that had been removed had in essence been reversible. Certainly the sketches remained intact after the lining removal. The organic paste had not been victim to a fungal or insect attack. Staining on the canvas all appeared to originate from varnish applications on the front. And the canvas itself had suffered no ill effects from the aqueous lining, remaining rather supple even after five hundred years. I began to consider paste-lining the Tintoretto.

IV. INVESTIGATIONS

In 1999, I was awarded a fellowship to work in Venice, where I gained some experience of *pasta* lining, particularly works by Venetian artists. Of course, some parts of the process could be rather extreme. The technique typically included ironing the painting on the front, using a significant amount of pressure, to drive the paste into the painting as it dried under the iron. In defense of Venetian practice, I will point out that most of the works being lined were by 16^{th}-18^{th} c. Venetian artists. They had oil grounds, were painted in oil, and had minimal impasto. More importantly, almost all of them had been *pasta*-lined before. And almost all of them were headed back to be installed in unregulated, generally cool, and always humid sites in Venice.

All this being said though, I would certainly not contemplate ironing *The Dream of Men*. Which leads me to Matteo Rossi Doria, a paintings conservator who practices in Rome. In September 2003, a workshop on the structural conservation of oversize Italian paintings was given by Matteo at Westlake Conservation in Skaneateles, NY. Over the course of four days, Matteo took us through the basic Roman recipe for pasta-lining, and many modifications of the recipe and the technique that he has developed during his years of experience. For me, one of the most interesting modifications was the idea of using the very strong *colla di pasta* alone, as a means of adhesion. In other words, letting a lined painting dry at room temperature and not ironing it at any stage. During the workshop I showed photos of *The Dreams of Men* to Matteo, and we discussed its structural problems. He considered it a relatively small ceiling painting that would be possible to line in this non-invasive manner.

After the workshop I still had some questions about the efficacy of *colla di pasta* lining. I decided to try Matteo's recipe and technique myself. I chose to use every ingredient in the basic recipe he had supplied at the workshop, except the fungicide, phenol. It was fairly easy to collect most of the materials for the adhesive. They were flour, water, hide glue, honey, white vinegar, oxgall, Venice turpentine and alum. I used an Italian brand of flour, like Matteo, since I wasn't sure if American flour was identical.

It was a little difficult to get a suitable linen fabric. It must be quite an open weave linen, which of course is not an artist's material. In the end I bought it on-line from a drapery company that imported Belgian linen. The fabric had a small amount of aqueous sizing in it and the manufacturer did not recommend washing it by machine. I wet it by hand and measured it after drying under tension. It did not shrink.

Matteo had brought to the workshop some of his fully adjustable aluminum strainers. Metal teeth along the sides grip the fabric, and the corners and crossbars can be cranked to adjust the tension. I had no equivalent for this clever mounting system and used a keyable wood strainer and pushpins.

The final step of course was to obtain a painting to line. I was given a *genre* oil painting from the first half of the twentieth century that had two old and complex tears, and some minor cupping (fig. 2). I deliberately did not do a lot of preparatory structural work on the painting. I took the painting off its stretcher and minimally flattened the damaged areas and tacking margins. I did some minor alignment of the broken threads on the front, but did not mend them. I wanted to see what would happen with absolutely no tear repair.

I mixed up the *colletta*, or glue base for the paste, and brushed it through tissue paper to face the painting and at the same time adhere the edges to a board. I put a silicon Mylar mask under the canvas and brushed the adhesive through wet strength tissue paper (fig. 3). This was a technique from the lining workshop that I wanted to try. As the glue dries, the paper contracts and the tacking edges and the painting are pulled flat against the board. It's also the first application of water to the painting, which of course should already have been tested for sensitivity.

Then I mixed up the *pasta*, really just water and flour, according to directions. I added the *colletta*, alum and Venice turpentine and mixed it to form the *colla di pasta* (fig. 4). I spread the spread the adhesive with my hands over the back of the painting (fig. 5). I placed the painting face up on the stretched lining

Fig. 2 Anonymous *genre* painting, before treatment.

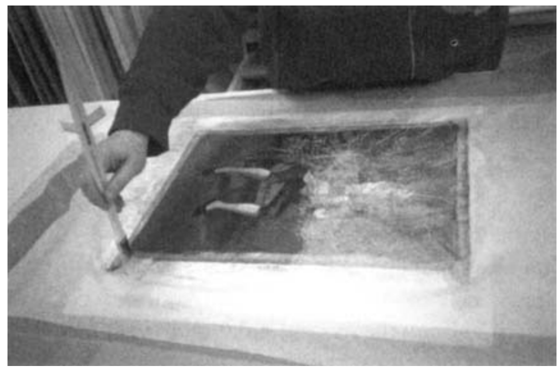

Fig. 3 Applying the facing.

Fig. 4 Mixing the *pasta* and *colletta* together.

Fig. 5 Applying *colla di pasta* to the back of the painting.

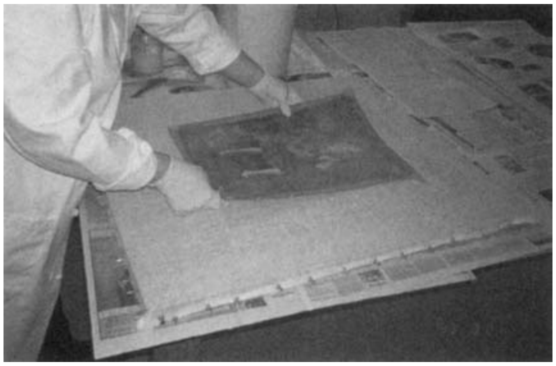

Fig. 6 Placing the painting on the stretched lining canvas.

Fig. 7 Applying *colla di pasta* through the lining canvas.

Fig. 8 Removing excess *colla di pasta* with the trowel.

Fig. 9 The lined painting drying face up on its stretcher.

fabric, and pressed it down with a damp sponge (fig. 6). I turned over the lined painting so that it was face down on a pad of newspaper and applied more adhesive through the open weave lining canvas using a wooden trowel (fig. 7). Then I used a trowel to move the adhesive around the back, and to remove a significant amount of it (fig. 8). I turned the painting over, keyed out the loosened wet fabric a bit and let the lined painting dry face up at room temperature, occasionally spraying the edges of the stretched lining canvas to see if it would pull tighter as it dried (fig. 9). After a couple of days, I removed the facing, cut the painting off the strainer and attached it to its stretcher (fig. 10). I thinned the varnish, filled and inpainted the tears, and put a final varnish on it (fig. 11).

I considered the test lining a success. The painting is securely adhered to the lining canvas and in plane. There is very little adhesive present, and I believe it would be easy simply to pull the lining off. And, as I suspected, I would have gotten a better result with respect to the tears if I had done more prep work before lining.

So, having tried the *colla di pasta* lining from Matteo's workshop, I was still interested in pursuing it as a solution for *The Dreams of Men*. In July 2004, I was able to spend a few days with Matteo in Rome. He led me on a whirlwind tour of large paintings, ceiling and otherwise, that he has lined with *colla di pasta*. They dated from as far back as twenty years ago and comprised a significant amount of acreage. I won't go into details because Matteo will be speaking about his projects, but it was an edifying experience. It was also at that point that we began discussing other variables with respect to installing the Tintoretto in the DIA's ceiling, for example, the possibility of attaching it to a self-adjusting stretcher, where some kind of spring system would respond to changes in the dimensions of the canvas, as the environment cycled.

V. LINING

In late 2004, I wrote up my reasoning and my research for the Tintoretto project, and began speaking with Matteo about an actual treatment proposal for coming to Detroit to line *The Dreams of Men*. With administrative approval of the project, and funding from our Mellon conservation endowment, Matteo committed to a week and a half in Detroit, while I scheduled a few weeks of prep work before his arrival in May 2005.

Of course, the biggest drawback to lining the picture was that Tintoretto's sketches were going to be covered. They had been very thoroughly documented during the 1990s treatment with color transparencies and b&w and infrared film. However this was all before we were able to do digital photography. So most of my prep work involved additional documentation of the drawings. I removed the painting from its stretcher and

Fig. 10 The lined painting restretched, varnished and filled.

Fig. 11 The lined painting after treatment.

attached it face up in a temporary strainer. Our photographer took high quality digital photos of the sketches, which are the ones I have been showing here.

Given that Matteo had committed to a treatment proposal without ever having seen *The Dreams of Men*, he was fortunately not too surprised by the painting when he finally saw it. His only comments were that he had expected the canvas to be a lighter weight, and the paint layers thinner. The pre-lining prep work was as he expected: removing or reducing all the Beva-adhered repairs on the reverse of the canvas. The Reemay patches and silk thread mends, and the strip-lining, were removed with either solvents or heat. The mends were re-done more minimally with Beva-impregnated silk strips. Small damages were not re-patched.

Additional preparation for the lining included: making the *colletta*, *pasta* and *colla di pasta*; stretching the open weave lining canvas on the aluminum strainer; and preparing the floor with a pad of newsprint and brown Kraft paper. The painting was placed face down on the floor and Matteo began applying the *colla di pasta* by hand (fig. 12). After the canvas was thoroughly covered, the stretched lining canvas was laid over it and its weave carefully aligned with the painting's. More adhesive was troweled through the lining canvas (fig. 13). When it was fully covered, it was sprayed with water to keep it moist. Then the trowel was used to move and remove *colla di pasta*. Finally, the reverse was squeegeed to remove

Fig. 12 Rossi Doria applying *colla di pasta* to the reverse of *The Dreams of Men*.

Fig. 13 *Colla di pasta* being troweled through the lining canvas.

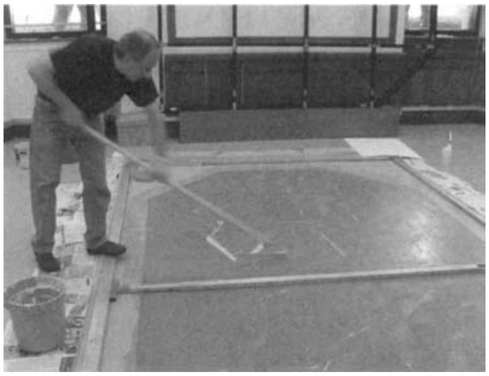

Fig. 14 The reverse of *The Dreams of Men* is squeegeed to remove excess *colla di pasta*.

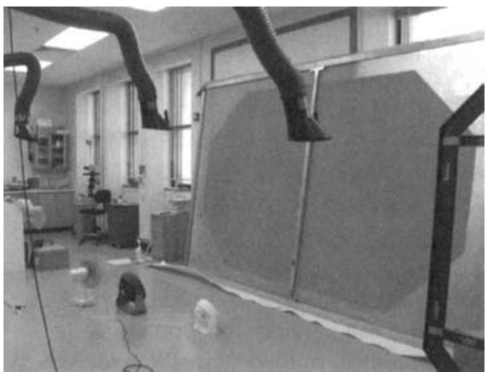

Fig. 15 During drying, reverse side out.

Fig. 16 During drying, front side out.

even more adhesive (fig. 14). After about thirty minutes of drying face down, the lined painting was picked up and leaned face in with a number of exhaust trunks and fans moving the air around its reverse (fig. 15). It was quite a dry day, and the lining had dried almost to the touch after about four hours. The painting was turned face out and left over the weekend (fig. 16)

Because *The Dreams of Men* was lined to just one layer of open weave canvas, the tacking fold needed to be reinforced before stretching. Matteo attached a strip of tightly woven linen, flocked with Beva 371, to the reverse of the lining canvas's edges using a tacking iron. The painting was cut from the strainer and the new stretcher positioned on top of it. The tacking margins were wrapped around the edges of the stretcher, into a channel, and clipped into place with small toothed metal pieces (fig. 17). I'll let Matteo talk more about the adjustable aluminum stretcher he provided, but I will point out that adjustment of the tension was done by Matteo over a couple of days.

And here is the painting in its current home, one of our basement storage rooms (fig. 18). We do plan to return it to its ceiling space in our post-renovation reinstallation.

VI. CONCLUSIONS

In conclusion, I was quite pleased with the lining, and its relative benignity. Given the history of *The Dreams of Men*, and its proposed installation, a *colla di pasta* lining was an appropriate solution to the question of how to strengthen it sufficiently so that it could be viewed as it was originally meant to be, in the ceiling. Of course, the biggest drawback to lining the picture is that Tintoretto's sketches were covered. However, I believe that lining can be removed as easily in the future as it was in the late 20th century. And that when the reverse of *The Dream of Men* is revealed again, Tintoretto's sketches will be as legible as they were in early 2005.

ACKNOWLEDGEMENTS

Many thanks to Matteo Rossi Doria, Julie Moreno and Kim Muir, to my colleagues at the DIA, Alfred Ackerman, Paul Cooney, Tom Dickinson, Barbara Heller, Iva Lisikewicz and Jim Storm, to Save Venice, Inc., and to the Andrew W. Mellon Foundation.

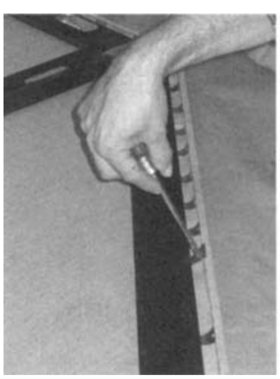

Fig. 17 Inserting clips along the edge of the stretcher.

Fig. 18 *The Dreams of Men* in paintings storage, after treatment.

ENDNOTES

[1] Moreno, J, "Tintoretto and *The Dreams of Men* at the Detroit Institute of Arts", *AIC Paintings Specialty Group Postprints, 23rd Annual Meeting*, St. Paul, MN, 9-10 June 1995, pp 73-83, fig 1.

[2] Moreno, op. cit.

[3] Moreno, op. cit, fig. 2

MODIFICATION TO THE STRUCTURAL CONSERVATION METHODOLOGY OF LARGE FORMAT PAINTINGS: SOME CASE STUDIES

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Cesmar7 Project Manager

INTRODUCTION

It has been a long time that I have been thinking about participating in an AIC annual meeting, and today I'm really happy to be here and to feel part of your community. The AIC meetings represents a great opportunity for all conservators who want to update their knowledge, and who want to have an understanding of the most topical current issues, both in the general session and in the paintings specialty group.

Starting in 1994, after a great workshop held by Gustav Berger and organized by the West Lake Conservators in Skaneateles NY, I felt that it was time to create a deeper link between my Italian reality and my American background. My good friends Susan and Margaret Blakney and John Sutton gave me the opportunity in 2003 to lead a five day workshop that demonstrated the developments and perspectives of my personal experiences as well as those of the Italian community of paintings conservators. During that workshop I met Serena Urry and we went deep in discussion about the beautiful Dreams of Men by Tintoretto on display at the Detroit Institute of Arts. Thanks to the curiosity and professionalism of Serena, and the trust of Barbara Heller, it was possible to propose a project for the treatment of this big, ancient, and fragile painting.

For many years a general review of all of the methodologies applied to the conservation of paintings on canvas has been going on in Italy, and in the past few years a good partnership has been built between the Opificio delle Pietre Dure, university research centers, private scientists, and conservators, with most of them actively involved in Cesmar7 programs. Cesmar7 is a group of conservators, scientists, and art historians, that focus their interests on polychrome surfaces, with a special interest in materials research for paintings on panel and canvas. Our common objective is to systematically face the issues and the methodologies that drive conservation treatment towards a more gentle and respectful direction, looking at the philosophies of minimal treatment in a dynamic way. We organize an international meeting held every two years dedicated to specific problems in painting conservation with workshops, internships, courses and other initiatives related to specialized training programs. We focused our attention on cleaning issues, and the theory and practice of minimal treatment and in November 2006 our meeting in Milano will be completely dedicated to the consolidation of the painting structure and pictorial layers. Many important researchers will be with us, and several projects and posters will be presented on this very important and not particularly well studied topic. Also during the past few years, a small group of conservators and researchers started a collective review of the methods applied in structural paintings conservation, giving more attention to the re-evaluation and re-design of traditional methods and the uses of water based adhesives and glues.

The Italian artistic heritage is unbelievably rich and diffused throughout the country. In Italy we find large paintings decorating ceilings, walls, and altars, located in the historic towns and cities, in churches, convents, historical buildings, and in museums. The treatment of these kinds of objects pushes conservators to create case specific projects, many times using materials and supplies that they do not use everyday. With each of these projects we must change something in our procedures, and adapt the methods of treatment to the individual characteristic of the painting, related to the technique of execution and the state of preservation.

To represent the issues and discussions that I often have with my Italian friends and colleagues I chose to describe here the different ways in which we work, trying to design individual treatments that also take into consideration the other very important parameters: money, time, availability of materials , and quite often wrong mentalities.

Before getting to the technical descriptions I want to point out some information about how things work in Italy, otherwise it is not possible to understand how different our working conditions are.

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Fig. 1

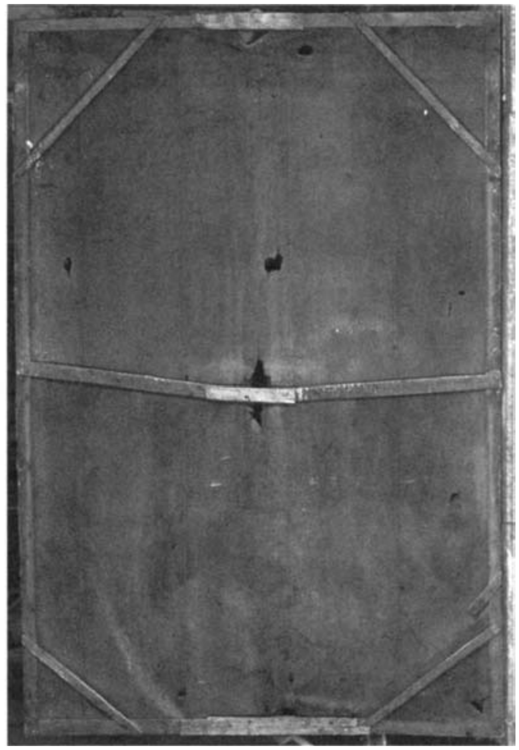

Fig. 2

As you probably know Italian cultural heritage is supervised by the Ministero Beni Culturali organized in local departments called Soprintendenze.

Every important painting is under the control of the state. Regulation and specific laws describe the process of a conservation intervention if needed. That means strict projects, designed by the technical offices of the Ministry, which are calculated by the square meter with no great difference if the painting is in good or poor condition, or if it is a masterpiece or a local minor painter.

It is therefore necessary to do a professional job and at the same time fit in low estimates and short working times. These conditions push conservators to find a satisfactory balance between each of the needs.

My technical presentation is divided in three sections:

No-lining, minimal treatment, and materials and solutions.

To cover the issues of no-lining and minimal treatment I chose two different projects to show.

The first involves a 500 year old painting that had never been restored, that was used by Cesmar7 as a case-study (fig. 1, 2). We organized two meetings, held before and during the treatment where all participants had the possibility to look at the condition and discuss and test several treatment solutions. It was decided to work inside the church and to not detach the painting from its. original stretcher.

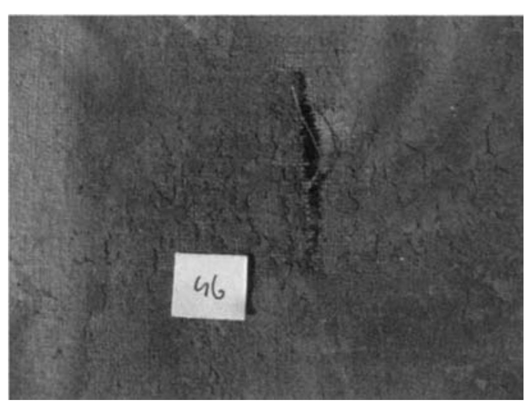

Fig. 3

The painting was in poor conditions. There were large tears and losses in the support. The paint layers were detached and large deformation were showing (fig. 3). The stretcher was broken and the tacking edges were damaged in many areas.

The first action was to reinforce the stretcher and to support the painting with a grid of thin polyamide cording on the reverse. Missing parts were temporarily reinforced with an open polyamide net applied to the reverse with Plextol gel.

Consolidation and flattening of the deformations was carried out with the use of a locally applied low-pressure vacuum. Klucel G from the front and Plexisol from the reverse was applied to consolidate the weak paint layers (fig. 4).

It was then possible to work on the tacking edges, reinforce the original nails, and apply a gradual tension (fig. 5, 6) The tear repair and reconstruction of missing parts were the part of the project that involved more people, and several repair solutions were tested including ones studied by Winfred Heiber. In the end it was decided to use EVA and Polyamide resin using hot tools. The end phase of the structural treatment related to the restoration of the original stretcher. It was then possible to finally approach materials the cleaning and the aesthetic presentation.

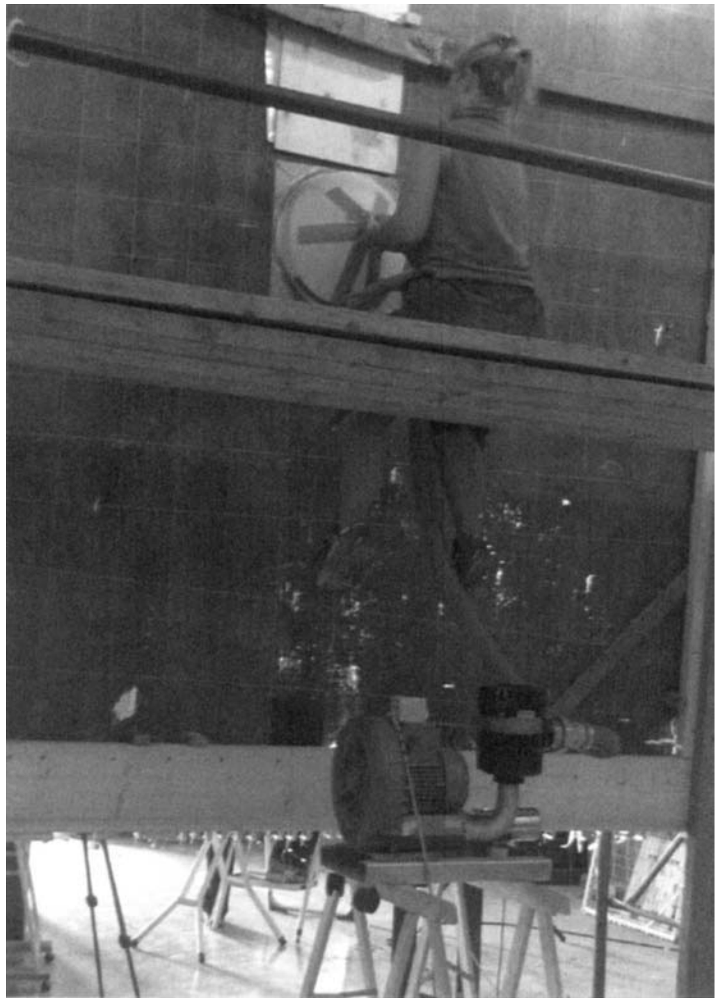

Fig. 4

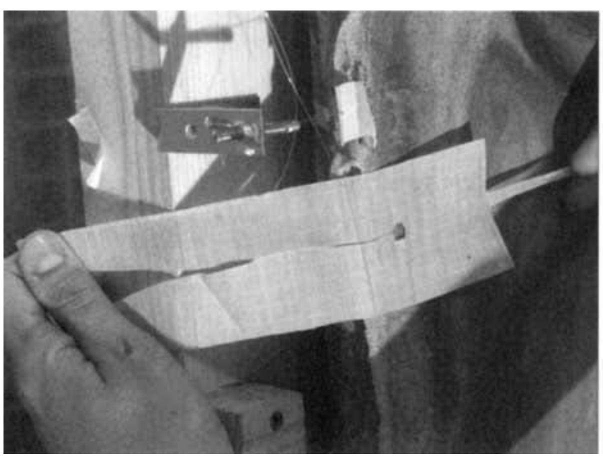

Fig. 5

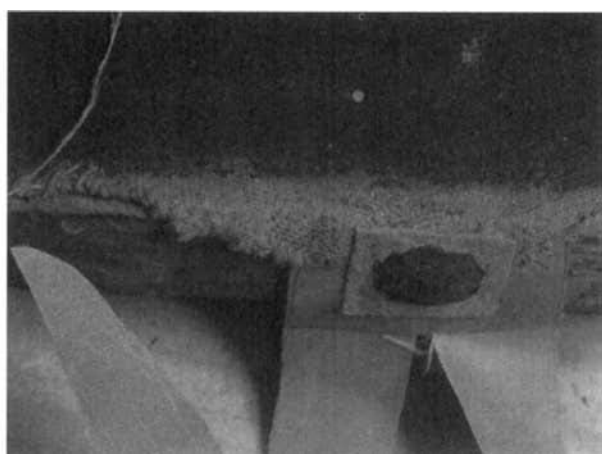

Fig. 6

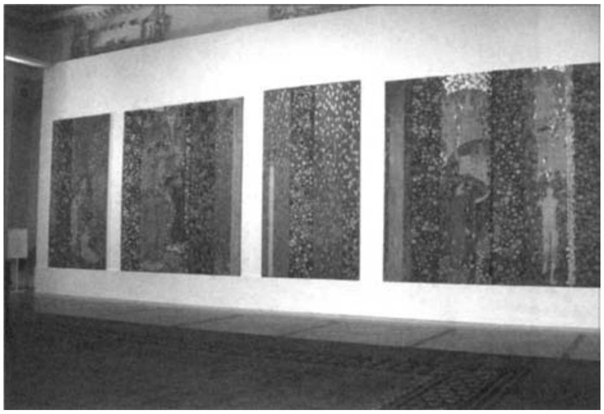
Fig. 7

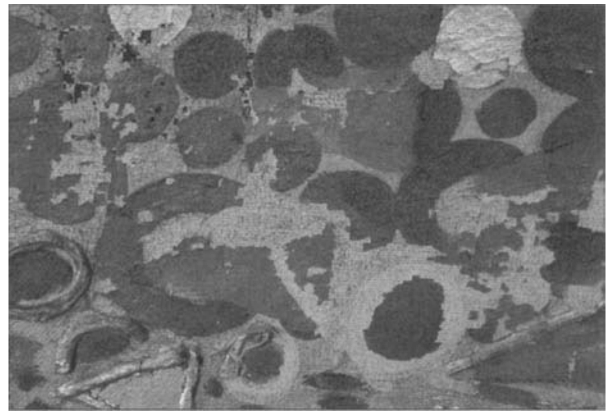
Fig. 8

The second case describes a no-lining treatment on five modern paintings (fig. 7), with mixed media techniques and very different consolidation issues (fig. 8, 9). The large paintings were part of a decoration of eighteen painted by Galileo Chini for the Biennale of Venice in 1914. They were painted following the vertical lines of the compositions using differently heavy impasto or very thin and sentive paint layers.


Fig. 9

To consolidate the paint layers we used Beva applied in different concentrations, application temperatures, and solvent mixtures, controlling in a selective way, the drying process of the consolidant (fig. 10). Heavy and rigid impasto was treated with a warm solution containing solvents with a slow evaporation rate and a higher penetration capacity. Thin and powdering paint layers were infused with a room temperature solution using highly volatile solvents such as hexane.

Structural reinforcement was achieved using monofilament polyester fabric pre-treated with diluted or flocked Beva, cut in strips and applied with a heated spatula. (Flocked Beva in various concentrations and quantities allows to control of the bonding capacity of linings, strip-linings, and local structural reinforcement).

Re-evaluation of water based lining adhesives.

As you all know *colla pasta* (or glue-paste) linings are still used in different countries in Europe, and in Italy many paintings are still lined following traditional methods. If we compare two traditional recipes and methods, the Roman and the Florentine, we can see that painting liners have historically adapted the methods of use and application to their needs in many different ways.

The first big advantage that traditional water based adhesive have is that they are non-toxic. Yet at the same time they can be exposed to biological deterioration under poor environmental conditions.

Many things can be said about this and other issues related to pasta linings, starting with the reactivity of certain type of painting supports to water. But, I want to focus on a re-

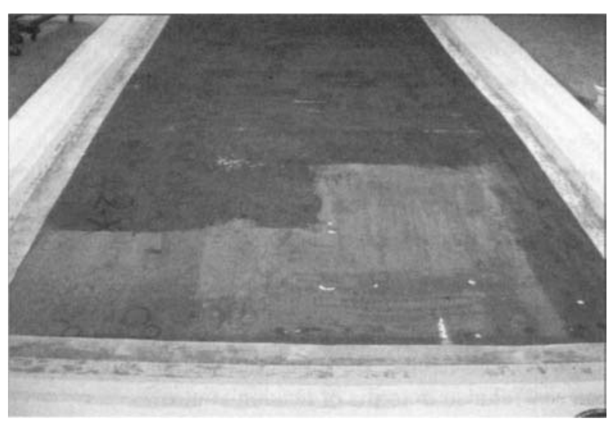
Fig. 10

evaluation of these methods, starting from the composition of water-based mixtures.

If we look at materials that have been traditionally used in historic recipes we find a short list of materials used as fillers, adhesives, and plasticizers. Wheat and rye flour, animal glues, molasses or honey or venice turpentine, a natural resin. Many of these materials are strongly hygroscopic and react quickly to environmental variations.

But we can include materials used in conservation that have different functions. They can be fillers but have also adhesive power, or be adhesives but also plasticizers. Wheat and rice starch, purified animal glues but also synthetic products such as carboxilmethilcellulose (CMCs), Klucel and acrylic dispersions such as Plextol 500.

Modified recipes that I have tested in the past years, demonstrate that it is possible to design a specific adhesive for the needs of the individual painting that has to be lined (fig. 11). The choice of the adhesive goes with the choice of the new support, and can be defined in many different ways. It is also possible to regulate the amount of adhesive to be applied using screens (fig. 12), and following the cold lining techniques developed by Vishwa Mehra.

Low-pressure vacuums can be successfully used to speed the drying process and allow for even adhesion. It then possible to work on superficial deformations when the painting is still slightly humid, with cold tools or hot spatulas (fig. 13).

If we also consider that it is possible to avoid high pressures and temperatures, to eliminate procedures that are not necessary, and to mix successfully mix synthetic and natural materials, we have to admit that we must pursue further testing and research in order to update our current knowledge of pasta linings.

Getting to the lining process that we applied to the large Tintoretto painting at the Detroit Institute of Arts we gently applied a new light support without using any pressure or ironing, while allowing the lining to dry quickly. It was important to work with freshly made materials, and to make adhesive of a certain density. By hand, using wood tools or squeegees, it is possible to apply the appropriate amount of adhesive, and then remove the excess (see images in Serena Urry presentation).

Certainly these methods are not always the best choice, and many oversize paintings are lined with synthetics adhesives. For example large tempera decorations were treated by spraying Beva on different fabrics. The manual re-activation with local heat, unfortunately working in poor conditions, gave us the opportunity work slowly during the adhesive process. Weight is also a big concern when restoring large format paintings (fig. 14), and flocked Beva on light weight supports seems to be successful also in terms of tension control.

Fig. 11

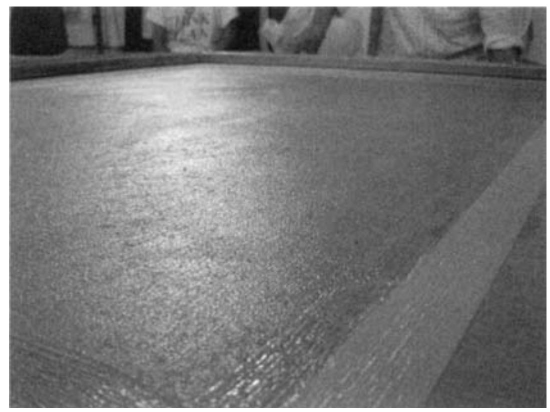

Fig. 12

Fig. 13

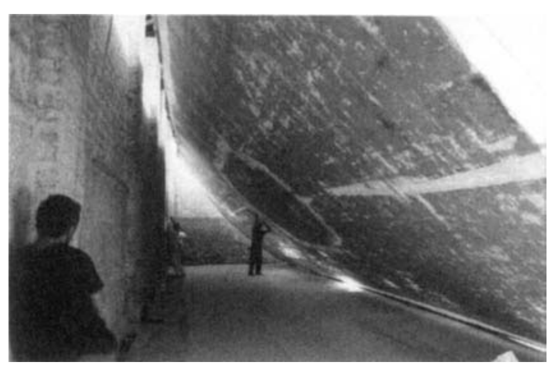

Fig. 14

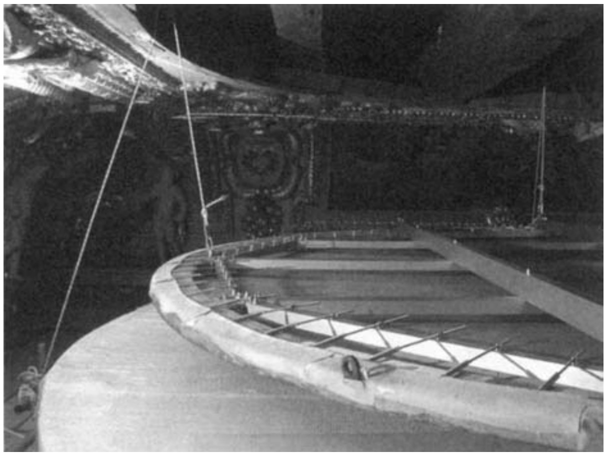

Fig. 15

Constant tension and stretchers.

One of the big issues of oversize painting conservation is the choice of a satisfactory way of applying tension. It is true that in my experience very irregular or curved surfaces were applied to a rigid support system, but primarily my concern is to find a good solution that is compatible with all conditions.

In Italy, in last 40 years many different models for constant tension stretchers have been designed by several manufactures. We still have big discussions about constant tension issues, and people still develop new ideas. I will describe only some solutions. The first ones, designed by Carlo Serino and Antonio Iaccarino, are very good when I decided to re-use the original stretcher. The desired tension can be accurately calculated and springs with different loading power are used depending on the size, weight, and shape of the painting (fig. 15).

The constant tension aluminum stretchers used for Detroit's Tintoretto (see Serena Urry presentation) and in many other cases is manufactured by Franco De Simone who bought Rigamonti firm. (Franco Rigamonti was the first Italian to design a metal stretcher. His stretchers were used for the Caravaggio paintings in S. Luigi dei Francesi in Rome, in 1963).

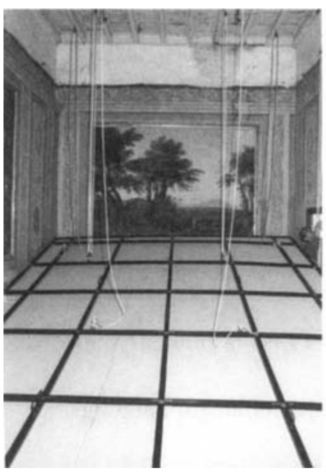

Fig. 16

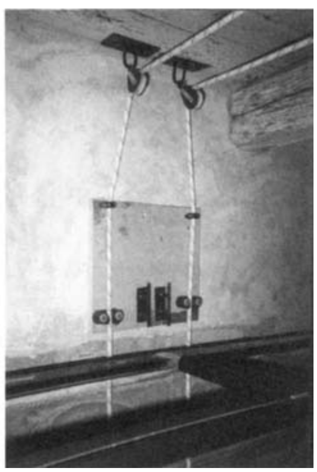

Fig. 17

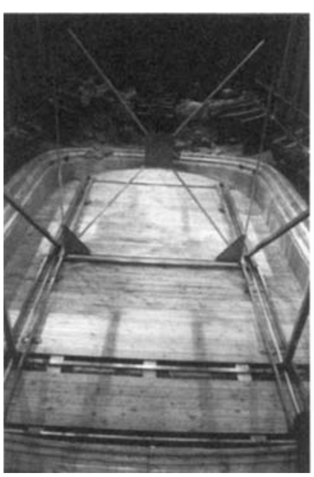

Fig. 18

Fig. 19

The central part of the stretcher is fixed and tension is given by spring with different loading power on the edges that can move easily.

Finally I want to discuss briefly the issues of re-installing large format paintings.

I will describe two cases where the primary difference was the money available for the project. The first painted decoration was reinstalled in the ceiling using sailing materials and pulley techniques, and the cost of manpower and materials was fairly low (fig. 16, 17). The second case was a well-funded project where, with Franco De Simone's help, it was possible to design and create a mechanism used to move the painting up and over the restored altar in automatically (fig. 18, 19). Both these solutions were designed to facilitate control and maintenance as oversized paintings in many cases have less routine care than other formats.

In conclusion, I would like to re-emphasize the point that the Italian conservation community is actively working, meeting, and discussing these issues, regardless of the current working environment in our country.

I want to thank all my American friends who encouraged me to be at this AIC meeting and especially Serena Urry and Eowyn Kerr.

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DEMOCRACY IN CONSERVATION –
WALL PAINTING CONSERVATION AND CHURCH COMMUNITITES

Isabelle Brajer, Senior Research Conservator

ABSTRACT- Wall painting conservation in Denmark has been functioning within a democratically organized church infrastructure for more than 100 years, which permits an overview of community involvement in conservation over a longer period. The case stories presented here show widely varying attitudes held by the church communities, and how inconstant some value attributions are, particularly when compared to present day attitudes. The present situation is characterized predominantly by a one-way flow of information about conservation goals from the professionals to the community. Lack of knowledge pertaining to the general public's current values makes formulation of strategies that acknowledges this aspect difficult.

1. INTRODUCTION

Community involvement in the conservation of public art is a topic discussed in the field of conservation that has played an increasingly visible role in our profession over the past decade. Conservation of cultural heritage has taken on a social agenda, it has even been pressed into the service of social development (Calame and Sechler 2004). At the most recent ICOM-CC Triennial Meeting in The Hague (2005), the main theme of which was "Our Cultural Past – Your Future," several projects involving community participation were presented. These examples not only showed local community collaboration in the decision-making process, but also in the operations of conservation and restoration, as they performed treatments under the supervision of a trained professional. A generally acclaimed contemporary theory of conservation postulates that the ultimate goal of conservation as a whole is not to preserve the material aspects of a particular object, but to retain or improve the meaning it has for people (Avrami, Mason, and de la Torre 2000): "*The future challenges of the conservation field will stem not only from heritage objects and sites themselves but from the contexts in which society embeds them. These contexts – the values people draw from them, the functions heritage objects serve for society – are the real source of the meaning of heritage, and the raison d'être for conservation.*"

Values are attributed to objects as a result of interest-driven processes, and are dependant on *local (national)* tradition, *local* beliefs and *local* customs. Values are attributed through *local* societal and governmental influence. Moreover, these values have been inconstant in the past, and will probably continue to change as a result of general societal developments. Despite what seems to be the start of a global trend of including the public in the conservation process, most treatments take place without an investigation of the views and values of the local community prior to implementation, and little research is done on the subsequent impact of the project on their views and values (1). Do we really know what the users expect from a conservation/restoration intervention, and do we know what values the treated object represents for them, or are we imposing our (professional) values on them? And given how inconstant past generations were regarding value attribution, as will be demonstrated by some of the cases in this paper, how can we fulfill another postulate of modern conservation theory (Muñoz Viñas 2005): "*[Sustainability in conservation is] the ability to keep in touch with the current needs and feelings of society at large and to envision what our descendants might expect from the objects we are now taking care of.*"

To illustrate the problems of tackling inconstant opinions, the inadequacies of our present state of knowledge, and most importantly, the influence of local values on conservation/restoration decisions this paper focuses on the conservation of medieval wall paintings in Danish churches. Wall painting conservation has functioned in Denmark within a democratically organized church infrastructure for more than 100 years, which allows for the illustration of the benefits and difficulties of community involvement in conservation over a longer period. Although the specific cases presented in this paper are a result of local developments, this overview hopes to provide thought provoking material, which can be generally applied to the discussion of public participation in the conservation of cultural heritage.

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2. HISTORICAL BACKGROUND

Denmark is a small country, but richly blessed with a cultural heritage from the medieval period. The vast majority of the wall paintings that are referred to in this study were created in the Pre-Reformation period spanning the years 1080 – 1536, though a few cases deal with paintings from the Post Reformation period of 1536 – 1700. The churches house a wide range of decorations: non-figurative geometric patterns accenting the architectural forms; non-figurative floral and vegetal motifs; heraldic motifs and inscriptions; biblical scenes from the Old and New Testaments; scenes from the lives of saints; and non-religious scenes with moralizing content or folktales, which sometimes include fantastic figures and bizarre creatures. It is likely that every one of Denmark's approx. 1700 medieval churches had some form of wall decoration.

Contrary to the destructive events unleashed in the beginning of the 16th century by the Reformation in other European countries, the religious transformation in Denmark was not accompanied by the eradication of Romanesque and Gothic wall paintings. They survived for many decades afterwards. Some were "modernized," – Gothic figures, for example, were endowed with Renaissance dress. Gradually, as the older paintings became soiled and deteriorated, they were covered with limewash. Their falling out of fashion was also linked to an event that had the biggest impact on their demise: the 18th and 19th century Pietistic reform movement in the Lutheran Church, which strove to renew devotional ideals and prioritized the function of the sermon. At the onset of the 19th century, only a handful of decorations had escaped the limewash brush, the destiny that befell the vast majority of wall paintings. These exceptions had existed quietly for centuries in village churches. But, in the eyes of a vast majority of the public, a 19th century Danish church interior was a vast expanse of white, a backdrop, which framed and centered attention on the altar, pulpit and epitaphs. This white layer was renewed every so often with a fresh coat of limewash, and gradually, a thick brittle crust was built up, under which the wall paintings from the past were waiting to resurface.

In 1826, the limewash covering was hammered and scraped off one of the vaults in Roskilde Cathedral to partially reveal the first intentionally exposed wall paintings. However, this discovery did not initiate an immediate flurry of uncoverings in other churches. In fact, thirty years went by before the Roskilde painting was fully uncovered and restored, and other wall paintings started to be uncovered. The real public interest in wall paintings sprouted gradually in the first half of the 19th century, intensifying as more and more decorations were exposed and restored in the following decades. Interest in the Middle Ages was a parallel offshoot of a growing nationalistic feeling with its roots in neoclassicism and its general search for a common primordial past, and can be linked to the publication of such literature as B.S. Ingemann's *Valdemar the Great and his Men*, which depicted Denmark's days of glory and power when it emerged as a great nation in the 12th century (Kjær and Grinder-Hansen 1989). The numerous churches built throughout the medieval period testified to this period of magnificence, and it was only natural that these edifices and their contents became the focal point of national consciousness and solidarity. In the years after Denmark lost part of its southern territory to Germany in 1864, the feeling of fervor for preserving and restoring Danish monuments intensified.

The 19th century was also a period of growing democratization of the Danish society. The Danish Constitution of 1849 established the designated name for the religious institution of the country: *den danske folkekirke* – The Church of the Danish People. The official religion was Protestant Lutheran. In 1861 a law was passed that obliged church owners to abide by the recommendations of a committee of experts regarding the maintenance of the church building. In 1903 the parish members were given the opportunity to buy out the owners at a fixed price. Over the course of the next fifty years the status of churches gradually changed from private ownership into self-governing entities. From 1912 the practical leadership of individual churches was taken over by a church council, the members of which included the priest and 6-15 elected parishioners. In theory, the councils managed the churches in the name of, and for the good of the nation. The community had the right to use the building and the contents, but did not have the power of life and death over them (Roussell 1955). In reality, as several examples presented here prove, the opinion of the church council was paramount in contentious cases. However, on a daily basis, rural deans, deanery committees and diocesan authorities advise and control the local councils' management. This is supplemented by advice from a wide range of professionals (including employees of the National Museum) pertaining to questions of antiquarian nature, and to care and maintenance. The advisors, on the whole, strive to settle differences with the church community diplomatically, and in the majority of cases are able to do so without any disagreements. But cases presented in this paper also show that the antiquarian authorities were particularly sensitive to the church community's religious and moral values and did not override the councils' wishes regarding these issues. The subjectivity of artistic evaluation and aesthetic appearance has also played a role in conservation decisions, with the various parties involved sometimes differing widely on these matters.

3. APPRECIATION AND POSITIVE INTEREST FOR NEWLY UNCOVERED DECORATIONS

Within this framework, over 600 medieval wall paintings were uncovered and restored to this day. The predominant attitude of the church communities toward the newly found decorations was positive. One can almost say that wall paintings became a source of pride and prestige in some communities. The church councils were obliged (and still are) to report findings of wall paintings to the National Museum. Some did this with eagerness and excitement, indicating (sometimes mistakenly) that an important and interesting painting was uncovered in their church. For example, what the pastor in Skelum Church regarded as an interesting find was totally undecipherable to the conservator Egmont Lind, who even examined the scattered remnants and faint traces of color in UV light in 1958 (Lind 1958). Church community expectations were often great, as observed by Lind upon his arrival in Nørre Tranders Church in 1963 (Lind 1963a): "*During my visit I sensed that the discovery of the wall paintings had an exhilarating effect on the disposition [of the community], mostly as a result of the press that described the find as 'magnificent wall paintings.' It was my impression that several members of the church council expected 'the experts' to conjure up one superb painting after another.*" (2)

Inevitably, sometimes the church communities were disappointed in the results of some uncoverings, as in Hundborg (Lind 1963b): "*The church council would have very much liked to have seen the church enriched with some paintings, but it was apparent to all that a little piece here and a little spot there was very unsatisfactory, also when taking the expenses [of the conservation] into consideration. They had dreamed of a totally different outcome, and it was therefore not too difficult to reconcile themselves with the unavoidable whitewashing of the finds.*"

Other times it was more difficult for the community to resign the paintings to over-painting with limewash. The uncovering in Bylderup in 1922 was an eventful occurrence, involving the church council, local craftsmen and the local historian. When the art historian M. Mackeprang from the National Museum evaluated the painting as insufficiently worthy of conservation, there appeared an outcry in the newspaper, venting frustration at the loss of what the community considered to be a valuable find and calling for a more "scientific" examination (Jyllandsposten 1922). An attempt to find local funding for the conservation in the impoverished district was unsuccessful, and so the decoration was covered, as it remains today. The paintings in Ringe Church met a similar fate. The artistic evaluation was rather harsh (Nørlund 1914): "*The paintings are executed in a sloppy and tasteless manner... artistically, there is a complete lack of a sense of composition.*" Nevertheless, the church community was interested in keeping them, but was unable to come up with the money. They were covered up again.

When the investigating conservator, historian or archaeologist appraised paintings to be of little value from the antiquarian, historic or artistic point of view, public funds for the restoration were usually denied (public funding for wall painting restoration almost ceased after 1950), even though the church council agitated for their preservation. Occasionally, this interest was so strong that entire church communities successfully rallied for the preservation of fragments, even though they could not be integrated or reconstructed, as in Hover (Rothe 1908a). In the case of Voer Church, the priest was such a strong advocate for the crudely painted figures of Mary with the Christ Child and Jesus on the underside of the soffit of the chancel arch in the otherwise bare church that the conservator relented and recommended the allotment of funds for the restoration, "*as it would be the only decoration in an interior totally lacking the slightest form of artistic expression*" (Rothe 1898).

Priests often played decisive roles in the uncovering and restoration of wall paintings in their churches. Sometimes they were the only driving force behind the project that received a lukewarm reception from the rest of the church council (Lind 1955). In at least one case, the priest himself paid for the restoration of the paintings out of his own private funds (Kornerup 1875). Priests were better educated than most of the members of the church community, and many could appreciate the value of the uncovered paintings. In 1908, for example, the conservator Eigil Rothe recommended over-painting the newly uncovered decoration in Tornby Church due to its poor condition, but the priest convinced him to preserve a little fragment as a little window, testifying to the church's long history (Rothe 1908b). The parish priest in Skive Church, Pastor Lohmann, was fascinated with the historic and iconographic content of the wall paintings that were created in 1522. He wrote a book about them in 1890, entitled *The wall paintings in Skive Church, a monument to Danish life in the old days* (Skive Folkeblad 1903).

4. UNWANTED PAINTINGS, RELIGIOUS AND MORAL CENSORSHIP

However, not all wall paintings were received enthusiastically. There are many examples of uncoverings that happened unintentionally, while the interior was being renovated, that were hastily whitewashed over again against the directive, before anyone from the National Museum could inspect them. This was usually done because the owner or church council considered the find to be too troublesome, as in Lyderslev (Bergh 1886). Balancing the priests' positive contributions to the preservation and restoration of wall painting are many negative examples, in which the priests were negligent of their duties, or even agitated outright for the destruction of the paintings. The priest in Grinderslev Church admitted that he had not wanted to report the finding of wall paintings at all because it interfered with his project involving the installation of central heating, but was forced to do so when it turned out to be a major discovery (Rothe 1922). Another example from Tybjerg Church involved wall paintings from two different periods that were uncovered in the last decade of the 19th century. The Romanesque paintings in the apse were restored in 1889. In 1904, the church council led by the priest appealed to the conservator Kornerup not to proceed with the restoration of the Gothic decoration from 1430 in the nave, but rather limewash it over, as "*it was uncovered as a result of a misunderstanding*" – the church community only wanted the Romanesque paintings (Nielsen 1904). Kornerup did not oblige them. The Gothic paintings remained only partially uncovered and un-restored for the next 34 years, until the church council of the next generation decided to have them restored.

The biggest problems, however, occurred when the church council and community found the wall paintings objectionable for religious or moral reasons. Doomsday scenes, commonly presented in a Last Judgement cycle in contrast to the depiction of the Saved Entering Paradise, were sometimes considered to be too harsh in their graphic presentation of punishment. Typically, we see devils rounding up the damned souls and pushing them into the gaping mouth of a huge monster. The church community demanded the whitewashing of such a scene shortly after it was exposed in Sanderum (1881), and it remains covered to this day.

In 1888, the Ministry of Church and Education sided with the parishioners' demand, and instructed the restorer Jacob Kornerup to limewash over one of the newly uncovered scenes – that depicting the Holy Trinity on the east web of the vault directly over the altar in Femø Church (Kornerup 1888a). Kornerup obeyed, and then filled the "awkward" empty space with scrolling vines, which he copied from another church, altering the colors a bit. The explanation for this demand lies in the difficulty for some Protestant Church members at the end of the 19th and beginning of the 20th century to accept the depiction of such esoteric themes as the Holy Trinity, where God the Father is shown as one entity together with God the Son and God the Holy Spirit. They thought that such a theme was so mystical that the Catholic depictions were an unacceptable simplification, and thus sacrilegious. Similarly, the priest and church council in Tirsted Church found the "breath of God," portrayed as a stream pouring down over the figure of Mary in the Annunciation, unacceptable. After much correspondence between the bishop, Ministry of Church and Education, and the National Museum a compromise was found, and Kornerup agreed not to retouch the area – leaving it in a somewhat blurry state that would not attract attention (Kornerup 1892). Adjacent to this problematic scene was another, depicting the meeting of Mary and Elisabeth. On both of the pregnant women, a circle containing a little figure had been painted on their stomachs. The priest was particularly disturbed by this detail, which he described as "offensive," even though one of the "fetuses" was barely decipherable. Kornerup was instructed to not retouch or reconstruct the figures (as he did with other damaged parts of the decoration), leaving these details to slowly fade away. However, this only somewhat dampened the discontent, which flared up again when the decoration in the chancel was re-restored in 1929. The priest demanded that the circles be covered by painting the folds of the women's dresses over the little figures. The conservator Rothe, who was as adamant about preserving the figures as the priest was about obliterating them, called a meeting. The seven members of the church council met with the director of the National Museum (Mackeprang) and Rothe (Rothe 1929). The museum's standpoint was noted in the minutes: "*It was a duty of the National Museum to protect all of the medieval monuments in [Danish] churches in a way that preserved them for posterity in a true state, not falsified by means of additions or corrections. The Museum has to see beyond the opinions of the present time. Either the church community has to accept the paintings as they are, or else they should be whitewashed over in their entirety.*" The church community decided to vote. Three members voted to preserve the paintings as they were. The rest of the members (including the priest and the foreman of the church council) abstained from voting, probably wanting to mark their displeasure with the whole situation, but at the same time wanting to avoid an additional scandal and outright battle with the antiquarian authorities. Thus, these unique details survived.

In cases where the newly exposed figures were considered to be downright lewd and obscene, the church community was fully backed by the diocesan authorities and government functionaries. In 1907, the National Museum was directed to whitewash the web of the vault in Gerrild Church containing a scene where devils assist a woman churning butter – one of the devils is defecating into the churn (Nørregaard 1907). Somehow, this did not happen (actually two other webs containing no offensive images were mistakenly limewashed instead). Another scandalous painting was exposed at the same time in the Church of Mary Magdalene. Here, a woman with exposed buttocks was painted vomiting into a cup held by a devil. Behind her another devil is setting a torch to her anus. On the next web two grotesque figures are seen, with faces painted on their bellies. The local sentiment was so strongly against these figures that Rothe was forced to cover them with limewash in 1910 (Rothe 1910) (they were re-uncovered in 1963-64). The particularly provocative paintings in Råby Church met a similar fate. A Sciapod (a figure lifting his gigantic foot over his head) with an erect penis (Fig. 1), a Cyclops, pygmies fighting with cranes and a headless hairy monster with its face on its belly (Blemmya) were covered over with limewash in 1919 (Rothe 1919) (re-uncovered in 1976). In 1932, the priest in Ørbæk didn't want churchgoers to see a scene where a devil was pricking the buttocks of a woman with a knife, and so he had these figures limewashed (Fyns Amts Avis 1971). In all three of these cases only the repellent figures were covered – scenes on adjacent vaults with more traditional religious or non-offensive pictorial content were spared.

Fig. 1 One of the scenes in Råby Church that was lime-washed over in 1919 because of protests from the church community. In 1976 local sentiment changed, and it was uncovered again. (Photo: National Museum of Denmark).

One of the biggest disputes involving censorship took place in 1952-3 in Vivild Church. The late Gothic paintings on the vaults were uncovered by the local mason, who was authorized by the priest only to check a few places whether there was anything of note under the limewash layers (Lind 1952). Apparently, driven by curiosity and excitement, the mason was unable to stop, and ended up hammering off the entire limewash cover, exposing unusual paintings executed in a somewhat crude, but nevertheless charming style (Fig. 2). The church council, however, thought that the paintings were unacceptable. The Doomsday scene made particularly unpleasant impression. But what disturbed them even more were two non-religious figures – a man sitting on a stool, spreading his mouth open with his fingers and sticking out his tongue; and a Sciapod – lifting his oversized foot up over his head, as if it were an umbrella. After a meeting with an art historian from the National Museum, V. Hermansen, the church council agreed to the limewashing of only the objectionable figures, leaving the rest of the decoration intact (Hermansen 1953). However, the conservator Lind was unable to resign himself to the loss of these figures. At 2:00 at night he wrote an emotional appeal, addressing it personally to the foreman, pleading for tolerance and open-mindedness, comparing the difficulty of comprehending the paintings from the past to listening to modern music (Lind 1953). This irritated the council, who reneged on its agreement and insisted on a total whitewashing of the interior. All the outside authorities involved – the dean from the diocese, the director of the National Museum, and the official from the Ministry of Church and Education – agreed that it would be unacceptable to force the church community to look at paintings they did not care for. It is unlikely these paintings will ever see the light of day.

Fig. 2 Late Gothic wall paintings in Vivild Church that were rejected by the church community in 1953. They were limewashed over despite the persistent efforts of the conservator to save them. (Photo: National Museum of Denmark).

The re-uncovering of the obscene paintings in Marie Magdalene and Råby in the 1970s reflects the attitudes of a more open and better-educated society that recognizes the historical value of such images. And, it is hard to imagine that the depiction of an esoteric religious theme, such as the Holy Trinity, would provoke protests from the church community today. However, the discovery, or re-discovery and allocation of values to the wall paintings in churches seem to be very erratic processes. Even in the second half of the 20th century, we find enclaves hostile to the presence of any type of decoration, as, for example, in Ørum Church, where Lind reported that "*the priest was a sworn enemy of wall paintings*," who thought that "*a white church interior is the most beautiful and stimulating to religious devotion*" (Lind 1961).

5. ISSUES OF COMPLETION AND CHURCH COMMUNITIES

It is difficult to say whether, or how much, the church communities understood the historic value of the decorations. The case of Auning Church (1902) shows that the better-educated members of the church council (the priest and the chief administrative officer of the district) quickly grasped the significance of a clumsily painted decoration signed Rasmus Rytter and dated 1562, which included two figures of saints, a rarity in the Post-Reformation period (Hertzsprung 1902). However, it seems as if most church communities placed more weight on the appearance of the paintings than on the symbolic values they represented. In 1939, the conservator Lind summed up what he thought to be the general attitude of the church councils pertaining to wall paintings: "*The demands that satisfy laymen regarding the wall paintings' condition and artistic quality are not small....if one does not hide the paintings' defects and strengthen [over-paint] the colors to the highest possible degree, [the layman] will more often than not feel cheated*" (Lind 1939). These remarks, obviously, do not apply to all church communities, but probably give a general overview of the situation at that time.

Lind was not the only conservator to feel the mood of the church community regarding incomplete paintings. In 1888 Kornerup uncovered a Late-Romanesque painting on the visually prominent soffit of the chancel arch in Engum Church. The decoration originally portrayed Cain and Abel on the flanks, but only the upper part of Abel survived, and the entire figure of Cain was gone. Anticipating the church council's antipathy, Kornerup acted preemptively: he reconstructed the bottom half of Abel, and recreated Cain by copying the figure from a similar composition from another church (Tyvelse). He argued for this intervention, and received the blessing of the antiquarian authorities in the museum (Kornerup 1888b): "*...we cannot present this painting in such a fragmentary condition and on such a conspicuous place for the church community to see.*"

The attitude in the example of Engum represents a by-gone era of artistic restoration, which says much about the conservation profession at that time. This tradition in conservation slowly diminished, but also trickled on up to the middle of the 20th century (Brajer 2006). However, as much as speculative reconstruction and over-painting lost ground to inchoate perceptions of authenticity on the part of the conservator, the church communities in general preferred complete decorations that looked like they were just created, where every sign of deterioration was camouflaged by means of cosmetic interventions. In 1909, the rural dean responsible for Hover Church wrote the director of the National Museum (Mollerup) about the restoration of the wall paintings taking place at that time (Petersen 1909). He asked Mollerup to exercise his authority in order to change the restorer's plan not to reconstruct an ornament on the east wall of the nave, which could have been easily copied from other areas: "*It can hardly take more than a few more workdays to include this, and I think it would appear strangely unfinished if [this ornament] was missing.*" Mollerup directed the restorer to comply with the dean's wishes. This attitude can likely be linked to the phenomenon that Alois Riegl, the Austrian art historian, called 'newness-value' (Riegl 1903). "*The new, in its integrity and purity, can be appreciated by anyone, regardless of education. Newness-value has always been identified with art in the eyes of the masses...The masses have always enjoyed new things and have always wanted to see the hand of man exert its creative power rather than the destructive effects of nature. Generally, only new and whole things tend to be considered beautiful; the old, fragmentary, and faded are thought to be ugly.*" It would be interesting to investigate the current relevance of this statement, which was made over 100 years ago.

The conservators sometimes tried to challenge the community's intolerance for deterioration: In 1908 Rothe proposed to the church council in Ruts Church to leave fragments of Romanesque paintings he found in the altar niches without any retouching – according to his own criteria, they were un-restorable. This decoration was all that was left from the oldest period in the church; but preserved as an archaeological object it would stand in strong contract to the restored paintings from the Renaissance period on the vault. Rothe pleaded with the council not to make a hasty decision, hoping that after some time some understanding for its historic value would stir in their hearts (Rothe 1908c). They chose, however, to limewash the niches.

The battle fought between the church community in Hvorslev Church and the antiquarian authorities in the beginning of the 20th century demonstrates another case of intolerance for incomplete paintings. When Rothe removed the bricks in two niches in 1898 he found almost unscathed paintings from about 1125 that were an invaluable source of information about the original painting technique. One of the niches contained a picture of Mary, while the other showed St. Michael fighting a dragon. Unfortunately, half of the dragon's body was missing, and Rothe refused to reconstruct the missing part (Rothe 1904). The church council complained about the incomplete state of the dragon to the director of the National Museum (Mielche 1904), who backed the conservator, citing the historical and antiquarian value of the find (Mollerup 1905). Unable to accept defeat, the church council, supported by the Diocesan authorities, pleaded their case before the Minister of Church and Education. The bishop proposed a compromise that would involve recreating the missing part of the dragon with a simple black line (Rudbæk 1906a), but this was not acceptable for the National Museum. In Rothe's opinion this solution compromised the authenticity of the painting. The ministry then asked prominent members of the Royal Academy of Fine Arts to assess the severity of the aesthetic damage. The panel of experts thought it was entirely unnecessary to reconstruct the painting in order to appreciate its artistic qualities, and this was the final decision of the ministry (Rudbæk 1906b). So what did the church community do? The son of the parish priest, Johan Mielche, executed a large pseudo Romanesque painting across the entire wall above the niches so as to shift the attention away from the defective scene and compensate for its incompleteness (Fig. 3).

Fig. 3 A pseudo Romanesque painting was executed across the wall above the two niches in Hvorslev Church

Detail showng the incomplete dragon in the niche on the right side.

6. THE PRESENT SITUATION

From around 1970 one can mark the gradual transition of the conservation profession in Denmark from one that was dominated by the artist-restorer tradition to a profession in which scientifically founded *preservation* (i.e. material authenticity) is considered to be the supreme principle (Brajer 2006). As such, this latest trend is an "expression of its time", where the preservation of cultural heritage rests on the foundations of the general environmental movement, just as the speculative restorations of the 19th century are indebted to historicism (Petzet 1994). In the second half of the 20th century there has been a steadily rising popular interest in the wall paintings in Danish medieval churches, which corresponds to the public's general interest for "antiques". One might assume that church communities would also be more aware, if not appreciative of the historic value of medieval wall paintings.

Projects that would probably not have been possible in the past have taken place in the past three decades. For example, the simultaneous presentation of decorations displaying varying degrees of aesthetic processing (as the case that was rejected at Ruts Church) is apparently no longer such a controversial issue. In Nødebo Church there exist decorations from three different periods, which were uncovered and restored in different periods, each displaying the restoration trend of its time: the paintings on the tower vault, restored in 1894, were treated in the artist-restorer tradition, which included re-painting and reconstruction of missing fragments; the nave paintings were restored in 1955 in the same artist-restorer tradition; the re-restoration of the tower paintings in 1958 show the inchoate attitude characterizing contemporary restoration – the rejection of speculative reconstructions (damaged areas in the scrolling vines were reconstructed, but the missing part of the figure was not); finally, in 1982 paintings in the chancel were uncovered and conserved, but no integration was carried out – the decoration is presented as an archaeological find rather than a painting. In a similar way, we experience a strong contrast between the decoration on the soffit of the chancel arch in Gundsømagle Church, which was restored and heavily over-painted in 1899, and the preserved fragments on the chancel wall, uncovered and treated in 1987-92, where no retouching was carried out (Trampedach 2005). Another parallel case can be found in Høve Church, where fragments of wall paintings were found on the walls in 1991 (and left un-retouched), while the re-restoration of the vault decoration preserved the reconstructions and over-paintings from 1935. A more drastic example demonstrating modern conservation principles took place in 1981-83, when the Romanesque wall paintings in Måløv Church underwent a process of de-restoration. The aesthetic interpretation from the previous two restorations carried out in the artist-restorer tradition were removed, leaving the authentic fragments preserved as irregularly-shaped islands having no relation to the original composition or architectural space.

Whether it was possible to implement these projects due to changing attitudes, and whether the church communities are content with the "modern" approach of minimal aesthetic intervention is unknown – no investigation has been carried out regarding this issue. Acrimonious exchanges between the church council and outside authorities seem to be mostly a thing of the past. One can only speculate why this is so – possibly, the generally less religious society of today does not get so passionately involved in church matters; maybe the church community prefers to defer to professionals, perhaps feeling intimidated or inadequately prepared to discuss conservation and/or restoration issues with professionals. Although it has become common practice in the past decade for conservators to invite the local community on the scaffolding while conservation projects are being carried out, these contacts usually have a pedagogical purpose, and are usually a one-way form of communication conveying information from the conservator to the community. In rare cases, the opinion of the local community is actively sought out, usually when an atypical solution is being debated. For example, the church community in Tirsted Church rejected a proposal of de-restoration during the most recent re-restoration that took place in 1999-2000 (Brajer and Thillemann 2002). The paintings in the chancel had been completely re-restored three times prior to the most recent project, and approximately 50% of the pictorial content was reconstructed in the first half of the 20th century. Not only were these reconstructions highly fabricated, but also they were executed on non-porous plaster, which was detrimental to surviving original fragments, and therefore had to be removed. The proposal to display the authentic remains as fragmentary isolated islands was an attempt on the part of the conservators to make a presentation of the "true" picture. However, the conservators' concept of authenticity was far removed from the church community's, who considered the authentic state to be that which they had experienced for decades, from their childhood to the present time. A compromise was found wherein the missing pictorial content was reinstated on new plaster repairs using a monochromatic line, thus clearly differentiating the additions from the original. It is ironic that a century earlier a similar solution was rejected by the conservator employed by the National Museum (Rothe) in Hvorslev Church.

Perhaps the most controversial conservation project ever carried out in a Danish church took place in 1999-2001 in Vrigsted (Trampedach, Plathe and Bech-Jensen 2002). The renovation transformed the non-descript whitewashed interior into an archaeological display testifying to the building's rich history (Fig. 4). Disconnected fragments of paintings from at least seven periods, from the 1100s to the 1800s, emerged in bits and pieces everywhere on the walls and the vaults when

Fig. 4 The aim of the restoration in Vrigsted Church, which took place in 1999-2001, was to preserve all the historical layers as they were found. (Photo: Roberto Fortuna).

they were stripped of cement-bearing plaster of relatively modern date. The plan of preserving the interior in its "ruinous" appearance was conceived by the architect and approved by the church council. Danish conservation professionals hail this example as a testimony of a parish with the will and courage to implement unconventional solutions. On the other hand, one can say that this solution presents a special kind of elite or sophisticated modern aesthetic – a particular kind of fascination with deterioration displayed as a scenographic backdrop in a theatre – something a church community would hardly propose themselves.

7. CONCLUSION

The conservation profession probably (hopefully) has greatly changed in the eyes of the general public from the time when the restorer was an artist or craftsman, who primarily focused on remedial treatments affecting the paintings' appearance, to the present situation, where formal training prepares conservators to make scientifically founded decisions maximizing the preservation of the material substance. There has also been an enormous progress in the dissemination of conservation/restoration theory that guides professionals during decisions regarding aesthetic presentation. This change has to be visible to the members of the church community (when I recently executed a series of cleaning tests on the wall paintings in Undløse Church using cellulose pulp compresses and various chemicals, the older members of the church community told me that they remembered the previous cleaning in 1956, during which bread and skim milk were used). We enter into dialogs with the church community with the weight of professional authority. In these exchanges, we are usually dealing with a smaller group – the representatives of the local community elected into the church council. As is usual in the democratic system, these representatives do not solicit the opinion of all the members of the community before they make decisions. Because many of the discussions between conservation professionals and the church community center on aesthetics, we must contend with a deal of subjectivity. The radical decision that the council agreed to in Vrigsted Church might have just as easily been rejected by the next, newly elected council. Several cases presented here from the past demonstrate the widely varying reactions of the public and arbitrary nature of value attribution.

Conservation contemplated from the cost-benefit perspective says that the best conservation operation is the one that provides the most satisfaction to the most people (Muñoz Viñas 2005, 193). We must first decide if we want to embrace this idea in our conservation goals (many countries have already adapted capitalist marketing principles in the operations of conservation of cultural heritage). However, because the church communities' opinions are an unknown factor, there will be a great deal of unpredictability in this relationship, in a similar way as Jonathan Ashley-Smith demonstrated when he described uncertainties due to complex conditions affecting the performance of natural science services in conservation (Ashley-Smith 2000).

If we truly want to adopt the idea that conservation is a service for the general public, then we need to know much more about their values. Some research has been done recently in Denmark that focuses on values and functions of cultural heritage as a phenomenon experienced by the general public, and its impact on the quality of their daily life (Kulturarvsstyrelsen 2005). This type of research has yet to be applied as a tool to help formulate strategies in conservation for specific projects. This is an extremely difficult task since we want to respect all the tangible and intangible values pertaining to the cultural heritage of a given society, and is difficult even if we narrow our focus to a particular form of cultural expression (wall paintings, architecture, etc.) within a given society. But even if we gather all the information necessary to be able, as Muñoz-Viñas urges, "*to keep in touch with the current needs and feelings of society at large and to envision what our descendants might expect from the objects we are now taking care of*", then this would be applicable only at national level. And it is the local needs and values that would dictate, rather than current conservation practice, which follows more global trends. As things stand now, in lieu of knowledge of current attitudes of the church communities, conservation professionals are is setting the stage on which the main users play a minimal role. The question is whether the past track record of community involvement should give us cause to doubt their ability or willingness to play a more important role.

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9. ENDNOTES

(1) There are areas where this impact has been studied more carefully – the preservation of the cultural heritage of the indigenous people in the United States with the participation of members of the ethnic communities is a positive example (Welsh, Sease, Brown and Clavir 1992). In general, the study of public participation in the field of conservation of ethnographic objects is much more widespread than in the conservation/restoration of "high art" such as sculptures, paintings, murals and architectural structures, which is the focus area of this paper.

(2) This quote, as well as all others, have been translated from Danish by the author.

ACKNOWLEDGMENTS

The author thanks Lasse Bendsten, Steffan Kjældgaard-Petersen, Ulla Kjær, Kirsten Trampedach and Susanne Ørum for helpful advice and comments.

SALVAGING PUBLIC ART FROM CONDEMNED BUILDINGS WHEN INTENT, CONTEXT, AND USE CHANGES

Cary Beattie Maguire, Conservator in Private Practice, Rhode Island

Your local mill, bank building, or other historic site is the perfect piece of property for new, high-end condos. The property will most likely have been abandoned for years and is available relatively cheap to developers. The city endorses the project because it sees an enlarged tax base and, keep your fingers crossed, an influx of wealthy residents who will dispose of their income in local shops. Maybe the façade will be saved so that the new condo building blends with the rest of the city block, but all the interiors will be removed or demolished.

This kind of urban reuse is happening all over the country. In some cases the best of the interiors are salvaged and reused in new construction. Moldings, trim, copper, and even mill machinery are incorporated into the rebuilt entry ways and even into the condos themselves. This new spin on adaptive reuse loses the history and context of the artifacts, but preserves the pieces. In the case of the Providence Bank Building, Providence, Rhode Island, the interiors were stripped along with nine murals. The salvage company and developers intended to save the murals.

The Providence Bank Building murals were removed by the salvage company with the intention of incorporating the pieces into new construction. Two different conservators were consulted during this phase. After removal the company decided to conserve the murals and made an attempt to find appropriate homes for each one. Since the conservation of severely damaged and neglected murals was not in their budget, some creativity was required. A winter session class was developed in conjunction with The Rhode Island School of Design. Future adult classes are scheduled to follow at other locations.

The murals, painted by R. H. Ives Gammell (1983-1981) and J. Monroe Hewlett (1868-1941) depict scenes and buildings related to the history of Rhode Island. Because of the subject matter, the treatment has become a pet project for the city. Several donors have stepped forward to save the murals, but some of the donors are also developers. Issues of use are reoccurring as donors set requirements and desires for the murals that they financially support. "Can the panel be sized differently?" "Can the surface be treated differently?" And of course, "Can the mural be completed tomorrow so it can hang in our leasing office?"

What is a conservator to do? Do we stand idly by as they improperly handle art and historic artifacts? Or do we become involved with the salvage company? The ethical questions are broad, including art laws of ownership and use, to the effects of advisement to a salvage company on the reputation of a conservator. Ultimately the question is posed, "Should a conservator get involved in the preservation of artwork when the original intent and the original structure are lost in its preservation and reuse?"

Cary Beattie Maguire, Conservator in Private Practice, Rhode Island

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This paper has not undergone a formal process of peer review.

SIZE DOES MATTER: USING CONSERVATION TO FACILITATE CONTINUED USE OF STAGE SET LEGS

Erica E. James, Painting Conservator

ABSTRACT – The paper describes the 2006 treatment of thirty-four nineteenth-century theater set pieces in the collection of the Haskell Opera House in Derby Line, Vermont. The set pieces were conserved so that they could be shown in the future at special events. Although the conservation was successful, the permanent storage of the set pieces prohibited easy access in and out of storage. The permanent storage was appropriate, however, and allowed for the annual theater productions. The dilemma of the Board of Directors whether to store the set pieces permanently or utilize the objects is discussed along with the treatment undertaken.

The Haskell Opera House sits directly on the border between the United States and Canada at Derby Line, Vermont and Stanstead, Quebec. The majority of the stage and audience are in Canada and the remainder of the seating is in the United States. The focus of the Staff and Board of Directors of the Haskell Opera House is continually split between preserving the theater and keeping it active. The historic stage, original seating and the original plaster and paintwork were installed before its opening in the 19th century and it is in this environment that live theater is performed annually from June through October.

The Haskell Opera House stage sets and main roll-drop curtain were painted by a native Vermont artist, Erwin LaMoss (1854 – 1910). These sets are examples of stock sets that theaters would use repeatedly while others would be constructed as required for various performances. Part of the efforts to conserve the original physical elements of the theater included the conservation of thirty-four pieces of historic theater scenery (circa 19th century) also known as "legs", "ears" or "tormentors." The legs were placed in storage in 2003 with the intent of creating conservation-minded long-term storage while maintaining accessibility for future viewing of the legs. This storage included custom cabinetry as well as hanging storage. In early 2004, the first eight legs, stored in the custom cabinetry on the edge of stage right, were conserved by Erica E. James and two conservation assistants. In late 2005, Ms. James returned with two assistants to complete the treatment of the remaining twenty-six legs which were stored in cabinetry in the balcony as well as hanging storage in the eaves and below the catwalk.

The treatment of the set legs posed a variety of challenges. On average, each of the thirty-four legs was eighteen x five feet (height x width) and weighed approximately fifty pounds. Each of the legs in the 2005 treatment required extra consideration in their removal from storage and the contracting of outside rigging specialists was required for the hanging storage manipulation. The first week in the 2005 treatment was committed to the conservation of the set legs stored in the balcony in a large storage box.

Eight of the twenty-six legs were stored in the balcony. The balcony box was opened up and initial discussions began about the best way to move the legs in and out of the balcony. While lowering the untreated set legs, the conservation team had to consider the size and weight of the legs and their tendency to bow in the middle.

The legs were fabricated much like paintings with a painted cotton primary support attached to a wooden strainer. During treatment, the cotton primary support remained attached to the wooden strainer and, once lying flat, the verso was vacuumed with a Nilfisk GM80 HEPA vacuum to remove any accumulated dust/grime. Where appropriate, additional grime removal was performed with a Wishab sponge. After vacuuming, mends were completed using a spun-bonded polyester fabric. In rare instances, polyvinyl acetate emulsion was used to mend minor splits in the wooden strainers.

The application of polyester batting and the attachment of backing boards was the most critical step in the conservation of these set pieces. Not only did the backing boards prevent the possible piercing of the primary support from the verso but their use in conjunction with the polyester batting increased the rigidity of the individual pieces dramatically. A thin layer of polyester batting was cut out and laid on the verso in between the slats of the

Erica E. James, Painting Conservator, EEJ Painting Conservation, The Woodlands, Texas

wooden strainer. The polyester batting was held in place by backing boards that were attached with screws to the strainer. Each backing board was joined to adjacent boards with a high-strength archival tape.

The stains on the paint surface were minimally inpainted with LeFranc and Bourgeois Flashe Vinyl Colors that achieved the matt effect of the original distemper surface. Much of the inpainting reduced the appearance of water staining that had occurred in the past.

After treatment, the legs were returned to their position in balcony storage. Each day of treatment, discussions occurred within the conservation team on how best to return the legs to storage. In the end, each movement of the legs was carefully considered and elements such as the stage and steps were used to full advantage to avoid torque of the structures.

After the first week, two professional set riggers were contacted and contracted from the Burlington, Vermont Riggers Union to come and lower the legs from the catwalk and the eaves. In summary, the lowering of the catwalk legs required using scaffolding to get to the three points where each leg was attached. Each point was unattached and secured to a rope. Once all the points were unattached, the leg was lowered to the stage with a person manning each rope. The same method was used for lowering the legs from the eaves although since the attachment points for the eave legs were so high up one of the riggers wriggled through a crawl space to get onto the grid and unattached the legs from above.

The remainder of the second week and the entirety of the third week were spent working on the catwalk and eave legs. Each leg needed to be unwrapped, taken out of its frame and treated in the same manner described above. Once all the legs were treated and placed back in the order in which they had been lowered, they were prepared for future raising by the riggers.

There are many questions that remained after this treatment, however. The Board of Directors desperately wanted the legs to be seen but the permanent storage situation was prohibitive and required rigging expertise to manipulate the legs in and out of storage. Still, it was the only storage situation that provided enough space for the annual theater presentations that took place at the Opera House. The end result was a bit of a draw. If the Board wanted to have the stage sets set up for special occasions, they could, but annual displays were unlikely and difficult to manage with the staff on-hand. The legs were treated so that they could be displayed, however, and their long-storage is acceptable.

RAISING A RENAISSANCE STANDARD: CONTEXT AND CONSERVATION OF LORENZO D'ALESSANDRO DA SANSEVERINO'S *THE CRUCIFIXION; ST. MICHAEL*

Sue Ann Chui, Assistant Conservator

ABSTRACT - Lorenzo d'Alessandro da Sanseverino's *The Crucifixion; St. Michael* is a rare surviving example of an object type relatively common in Italy during the fourteenth and fifteenth centuries: the processional standard. The conservation treatment of *The Crucifixion; St. Michael* provided a unique opportunity to give a better context to the painting by studying the painting technique of Lorenzo d'Alessandro and the construction of processional standards on panel. Also to be addressed is the complex balance sought between conserving a sense of the painting's long history of use and respecting the artist's original intent in the treatment of *The Crucifixion; St. Michael* which had been altered and restored on various occasions by the time it entered the Walters collection.

Fig. 1 Lorenzo d'Alessandro, *The Crucifixion*, 1480-1490. Tempera, gold on panel. Before treatment. The Walters Art Museum, Baltimore. 37.496.

Fig. 2 Lorenzo d'Alessandro, *St. Michael Archangel*, 1480-1490. Tempera, gold on panel. Before treatment. The Walters Art Museum, Baltimore. 37.496.

1. INTRODUCTION

To celebrate the 100th anniversary of its groundbreaking, the galleries of the Palazzo building, which house the Walters Art Museum's Renaissance and Baroque art collections, were to be re-installed in 2005. This was an opportunity for curators and conservators to re-evaluate and treat objects that had formerly been off-view in storage so that they could be exhibited in the newly refurbished galleries. One of the objects chosen for re-installation was a double-sided panel painting, dated around 1480-1490, by Lorenzo d'Alessandro da Sanseverino, which had not been exhibited since 1977 because of its condition which I will describe later. The panel depicts the Crucifixion with the Virgin Mary and St. John on one side; and on the other is St. Michael Archangel trampling the devil adored by confraternity members. This is a rare exemplar of an object type popular in the fourteenth to fifteenth centuries: the processional standard, which was conceived to be carried in religious rituals.

The Crucifixion; St. Michael is one of the few works by the Marchigian artist Lorenzo d'Alessandro da Sanseverino located outside his native Italy (fig. 1, 2). Bernard Berenson was the first to attribute *The Crucifixion; St. Michael* to the Italian Renaissance painter Lorenzo d'Alessandro da Sanseverino. Serra, van Marle and Zeri agree with this attribution.[1] As his name suggests, Lorenzo d'Alessandro da Sanseverino was from the town of Sanseverino Marche, located in the central part of the Marches. Born in 1445, Lorenzo d'Alessandro spent his entire life in and around his city of birth, where he worked as an artist and public official. Both Federico Zeri and Paciaroni have noted that Marchigian painters of previous generations, especially Girolamo di Giovanni da Camerino (active ca. 1449 - 73), had a role in Lorenzo's artistic formation. He was strongly influenced by Niccolò Alunno (active ca. 1420 - 1502), who worked in Sanseverino from 1466 to1468, and later Carlo Crivelli (ca. 1430 - 1495).[2] Archival sources document that d'Alessandro worked not only on prestigious commissions, but also, on a more modest scale, designing coats of arms, making scenes for sacred, and painting processional standards.[3] He died in 1501.[4]

Sue Ann Chui, Assistant Conservator, Paintings Conservation, The J. Paul Getty Museum

The Walters standard can be associated with the confraternity whose members are depicted worshiping St. Michael Archangel, the saint to whom the confraternity was dedicated. Until recently, the provenance of *The Crucifixion; St. Michael* could be traced back only to the early twentieth century, when Henry Walters acquired it around 1915 from the Renaissance scholar Bernard Berenson.[5] In his recent monograph on Lorenzo d'Alessandro, Raoul Paciaroni suggests that the Walters panel originally belonged to Sant'Angelo, an important confraternity dedicated to St. Michael Archangel, in the town of Matelica. This confraternity commissioned the painting *Saint Ann, Madonna and Child, Saint Sebastian, and Saint Roch* from Lorenzo for the church of Sant'Angelo; it would not be unreasonable to suppose he had other commissions from the confraternity.[6]

Confraternities -- religious organizations consisting of lay members of the church who promoted acts of devotion and charity -- were an integral part of life during the Middle Ages and Renaissance, as can be attested in Florence, where by 1450 almost every adult male citizen was a member of one of the almost one hundred confraternities in that city. Confraternities met often for prayer and special feasts. They maintained altars, sponsored Masses, and commissioned music and works of art. One of the most important and most widely recognized duties that they assumed was to perform the burial rites for their fellow citizens.[7]

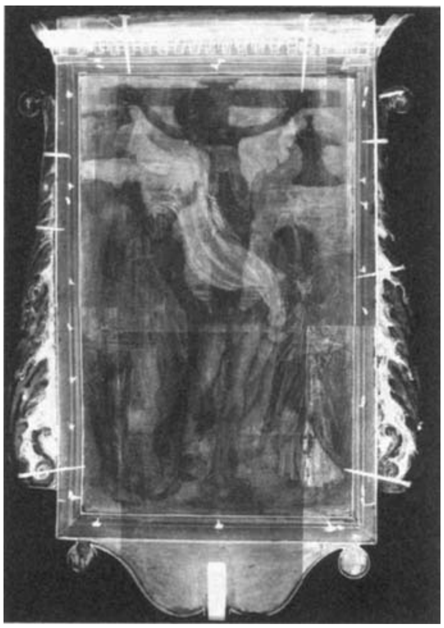

Fig. 3 X-radiograph of *The Crucifixion; St. Michael*, The Walters Art Museum. 37.496.

2. PROCESSIONAL STANDARDS: MATERIALS, CONSTRUCTION AND USE

Processional standards were made on canvas as well as wood supports. Through out the fifteenth century canvas was used concurrently with wood panel as a support. Over time, panels were gradually phased out, to the point that by the late fifteenth century, canvas had become the exclusive support for such objects, allowing the dimensions of the processional standards to grow without adding burdensome weight to an object that needed to be portable. During the period 1470-80, Umbrian processional standards on canvas imitated the form of those on panel, the most well-known example being Niccolò Alunno's *St. Anthony Abbot, Saints Giles and Bernardino da Siena* in the Pinacoteca Comunale, Deruta, painted in the 3rd quarter of the fifteenth century.[8]

The Walters processional standard is painted on a wood panel, 2.3 cm (7/8 in.) thick, characterized as poplar,[9] which was a common support material for such paintings in the fourteenth and fifteenth centuries.[10] An assembled x-radiograph of the painting (fig. 3) reveals the painting's original construction and shows how the gilded engaged frame is attached. The panel consists of a single board from which the painted antependium is also formed. Four separate wood molding strips, mitered at the corners, are attached to each face of the panel with small, evenly spaced nails to create the engaged frame. The same construction was used for a processional standard by Nobile di Francesco da Luca (active 1490-1513).[11] The dentilated cornice in *The Crucifixion; St. Michael* was also nailed into the main support. Hidden by the cornice is a block of wood of horizontal grain attached to the panel with very long nails about 12.5 cm (4 7/8 in.) from head to tip. This separate block of wood, which appears to be original to the structure, probably serves the purpose of holding the entire cornice construction in place.[12]

Other elements, now lost, were probably attached to the panel, as attested by the presence of empty nail holes and nail shafts in the panel. *Drappelone,* or fringes attached to the processional standard, were not unusual additions.[13] Another element was also probably attached to the top of the block inside the cornice, since the top surface is smooth and finished, creating an excellent join. The presence of nail shafts seen in the x-radiograph close to the top of the block suggests that another object had been previously attached and then removed, perhaps another painted scene or a candelabra.[14] Iron rings, probably used as candleholders, are found on the right and left sides of a large processional standard on panel by Venanzo da Camerino (active 1528 - 30). There are in fact burns mark the sides of this panel.[15] In the Walters' standard, the loss of gilding and exposed darkened wood on one the acanthus leaves could have been the result of exposure to an open flame.

Federico Zeri first proposed that the carved, gilded, and painted acanthus leaves attached on the sides are later additions.[16] There are several reasons to support his theory. Stylistically, the acanthus leaves appear to be sixteenth century and must have been added very early in the painting's history.[17] In the construction of Renaissance mirror frames with decorative side elements like the Walters painting, these "ears" are elegantly dovetailed into the structure of the frame.[18] In the Walters standard, however, the acanthus leaves are butt-joined to the panel with three large nails, a sign that they were an afterthought to the standard's construction. A third point to take into consideration is presence of red paint on the sides of the panel that extends beneath the joins of the acanthus leaves. Preexisting paint, a slightly later style, and the method of the acanthus leaves' attachment indicate they are later additions.

Metal plates, estimated to be iron,[19] were built into the base of the antependium under the gesso preparation on both sides of the panel, evidently to reinforce the join of the painted panel to the now-lost carrying pole. The integral construction of panel and carrying pole appears to be a not uncommon practice for processional standards, as can be demonstrated by the earliest known surviving carrying pole in the Museo dell'Opera del Duomo, Florence. In 1507 - 8 a new frame with accompanying carrying pole was made for the Sant'Agata processional standard, whose faces were painted in the thirteenth and fourteenth centuries. Radiographic analysis shows a U-shaped metal plate nailed into the panel to attach the carrying pole to the painting.[20] Though not executed at the same time as the Sant'Agata panels, this carrying pole corroborates the construction practice: the date is very close to that of the Walters standard.

Fig. 4 Anonymous, *Madonna della Misericordia*, fifteenth century. Detached fresco. Detail. Pinacoteca Civica, Ascoli Piceno. Sue Ann Chui.

An alteration observed in the *Coronation of the Virgin* by Gentile da Fabriano (ca. 1370–1427) in the J. Paul Getty Museum, which is one face of a processional standard,[21] also seems to support the theory that metal reinforcement plates were normally built into the original structure of these processional standards. An x-radiograph of the Getty *Coronation* reveals a small rectangular section cut out of the center of the base of the panel that was later infilled. This missing area of the original panel corresponds to the area where a carrying pole would have been attached. But why was the carrying pole not cut flush to the bottom of the panel, eliminating the need to later fill the loss? A plausible explanation for the awkward cut is the presence of metal reinforcement plates like those in the Walters painting, which would have been very difficult to cut through. Instead the carrying pole was more easily separated from the painting by cutting around the metal plates.

The only visual evidence found by this author for the use of processional standards in the Marches during Lorenzo d'Alessandro's lifetime is a small, detached fifteenth-century fresco depicting the Madonna of Mercy in the Pinacoteca Civica di Ascoli Piceno (fig. 4).[22] In the lower right corner of the painting, a kneeling man holds in both his hands a tall pole with a standard bearing an image of the Madonna of Mercy. He appears to be associated with three other male citizens and a small group of kneeling confraternity members in traditional sackcloth robes. The Madonna of Mercy is rectangular, almost square, in format, surrounded by a thin decorative frame with a cross above it.

Fig. 5 Cola di Pietro da Camerino, *Processione dei Bianchi*, 1401. Fresco. Detail. Church of S. Maria, Vallo di Nera. Sue Ann Chui.

The clearest and most interesting representation of a standard in use is found in a fresco painting, dated 1401, by Cola di Pietro da Camerino showing the Processione dei Bianchi, in the Church of S. Maria, Vallo di Nera in Umbria (fig. 5). A section of the painting shows a group of men in white-hooded habits, one of whom is carrying a standard aloft. Remarkably, no detail of the processional object's decoration was neglected: even the carrying pole is completely covered in a multicolored pattern of horizontal lines and triangles. The practice of painting the

Fig. 6 Cola di Pietro da Camerino, *Processione dei Bianchi*, 1401. Fresco. Detail. Church of S. Maria, Vallo di Nera. Sue Ann Chui.

carrying pole is documented even in the case of Titian's standard on canvas for the Compagnia del Corpus Domini of Urbino; payment was made expressly for painting the pole in June 1544.[23] A larger standard depicting the Madonna and Child and two figures in the Vallo di Nera fresco indicates the carrying pole was also treated like the frame, and was gilded (fig. 6). This evidence suggests that the Walters standard not only had a carrying pole, but one that was decorated as well. Larger and heavier processional standards might have been supported by two poles.[24]

When not in use, processional standards could be displayed in a purpose-built chapel, tabernacle, or cupboard that could be closed.[25] The processional standards in Montefalco and Assisi are mounted on pedestals for a more-or-less permanent display.[26]

2.1 OTHER PROCESSIONAL STANDARDS BY LORENZO D'ALESSANDRO DA SANSEVERINO

In addition to the Walters painting, three other panels by Lorenzo d'Alessandro are documented as having been used as processional standards. The one that most closely resembles *The Crucifixion; St. Michael* is *Christ on the Cross Adored by Sts. Thomas Aquinas and Catherine of Siena; St. Domenic and Worshipping Nuns with an Unidentified Saint and St. James Major* in the Brooklyn Museum of Art. The other two paintings by Lorenzo d'Alessandro, his *Madonna del Monte* and *St. Anthony of Padua*, are not in the traditional formats of processional standards and may not have been conceived as such, but their use in processions was well documented.[27]

Fig. 7 Lorenzo d'Alessandro da Sanseverino, *Christ on the Cross Adored by Saints Thomas Aquinas and Catherine of Siena*, circa 1500, Brooklyn Museum. 41.894a.

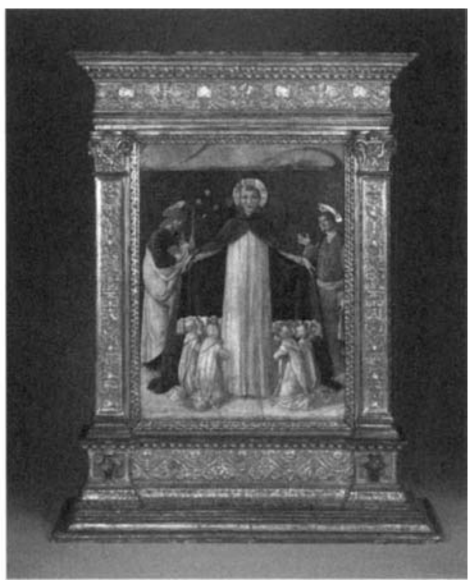

Fig. 8 Lorenzo d'Alessandro da Sanseverino, *Saint Dominic with Saints and Worshipping Nuns*, circa 1500, Brooklyn Museum. 41.894b.

In iconography, format, and dimensions, the Walters standard most closely resembles d'Alessandro's *Christ on the Cross; St. Domenic* in the Brooklyn Museum of Art. (fig. 7, 8). Dated ca. 1500,[28] one side of the work depicts the Crucifixion. On the other, paralleling the iconography of the Walters panel, is the large standing figure of St. Dominic with adoring nuns. Lacking an engaged frame, the Brooklyn panel has been trimmed on all four sides. The dimensions of both painted surfaces, not including the frame on the Walters panel, are very similar. The width of the Brooklyn panel is slightly smaller than the width of the painted scenes of the Walters processional: 32.4 cm (12.75 in.) versus 34.9 cm (13.75 in.). The asymmetry of the composition, which would have been centered, suggests that an estimated 2 cm (3/4 in.) has been trimmed from the side of the Brooklyn panel. The original width of the Brooklyn panel would almost be identical to the Walters processional. The most notable difference between the two standards, besides the lost framing, is the thickness of the panels. At 0.8 cm (5/16 in.) the standard is less than half the thickness of the *The Crucifixion: St. Michael Archangel,* making it an unusually thin wooden support for an Italian painting of this period.

The rectangular format and framing of the Walters standard are rare. According to Vittorio Sgarbi, based on what has survived, both the Walters and the Brooklyn paintings belong to a type particular to the Sanseverino area. Other than the two by Lorenzo just mentioned, the only other examples from Sanseverino are those by Bernardino di Mariotto (1478-1566). One is in the Accademia Carrara, Bergamo, and the other is divided between the Pinacoteca Vaticana and the Museo Ca' d'Oro in Venice.[29]

3. PAINTING TECHNIQUE OF LORENZO D'ALESSANDRO DA SANSEVERINO

Lorenzo d'Alessandro's choice of materials is typical of fifteenth-century Italian painting practice. In the Walters standard, he layered the paint in different ways to achieve specific effects, and employed an array of decorative gilding techniques that lend an archaicizing richness to the surface.

As was mentioned before, d'Alessandro chose a poplar panel as the support of *The Crucifixion; St. Michael.* No fabric layer is present in the standard except for remnants at the bottom of the antependium by the metal reinforcement plates that probably served to isolate the metal and protect the paint layers from potential rust problems. A traditional gesso ground of calcium sulphate was identified through scanning electron microscopy (SEM) in conjunction with energy dispersive spectometry (EDS).[30] SEM also revealed that the ground was applied in two layers, first a coarse *gesso grosso*, then a final layer of *gesso sottile* consisting of very fine particles.

In *St. Michael*, incisions were made in the gesso to indicate the boundaries where metal leaf was to be laid: around the figure's head, collar, arms, chest plate, skirt, and sword. Incision marks were also made around the tops and sides of St. Michael's wings, but the brocade background was painted on, not gilded. The presence of these incision marks might suggest that the brocade was originally intended to be gilt; luxurious brocade was often imitated by glazing colors over a gold ground and/or sgraffitto. D'Alessandro made some adjustments to the original design when he painted the wings; they do not correspond exactly to the incisions. The use of incisions to indicate forms in the composition is present in numerous works by d'Alessandro such as the folds of the Madonna's robe in the Yale University Art Gallery.[31]

The underdrawings in Lorenzo d'Alessandro's paintings appear to be executed in brush and ink. The lines swell in the center and taper toward the ends. This practice can be observed in many of his paintings, the lines defining contours and parallel marks indicating shadow. In *The Crucifixion* underdrawing is visible under normal light in the arms and body of Christ. With infrared reflectography, other areas of underdrawing become visible, such as parallel hatch marks indicating the shadows in the Virgin's pink robe. The contours of the folds of St. Michael's pink mantle beneath his right arm are underdrawn with parallel hatch marks indicating the shadow. A similar style of underdrawing can be observed in Niccolò Alunno's *Coronation of the Virgin* in the Pinacoteca Vaticana.[32] Here in Christ's red mantle, the outlines of folds are underdrawn, and parallel brush strokes indicate shadow. In the grand polyptich in Serrapetrona, d'Alessandro used *spolvero* to lay out the architectural elements by pouncing pigment through a pricked cartoon.[33]

Lorenzo d'Alessandro's palette, consisting of earth and mineral pigments, is typical of the period. The binder is estimated to be traditional egg tempera.[34] The artist applied his paint thinly, usually in characteristic parallel, mostly short, diagonal brush strokes starting from the upper right and ending at the lower left. This way of applying paint likely derives from the techniques of Niccolò Alunno and Carlo Crivelli. This style is particularly noticeable in the way that Lorenzo d'Alessandro paints flesh. Under the flesh tones, a green *verdaccio* layer was applied to give depth to all the faces and hands in *The Crucifixion; St. Michael*, except in the figure of Christ. The absence of a *verdaccio* layer gives Christ the rather pale appearance associated with the dying and lifeless.

Areas of flesh (faces, hands, and legs) are sharply defined by a dark, reddish brown line around the outer contours. This type of outlining can be seen in Lorenzo d'Alessandro's fresco painting as well, for example in *Madonna and Child with Musical Angels* in the chapel at S. Maria di Piazza Alta, Sarnarno. Sometimes a very lightly colored line is placed just inside the dark line to better model the form. D'Alessandro sometimes represents shadows outside of his figures with sets of small, fine, parallel lines stacked on top of each other, creating a sort of outline. These marks are painted outside of Christ's proper left leg in *Christ Baptized by St. John*, Galleria Nazionale delle Marche, Urbino. This shadowing is also observed around halo of St. John in the *Pietà with Saints John and Mary Magdalene*, Galleria Uffizi, and around the staff of the bishop saint in the Cleveland Museum of Art.[35]

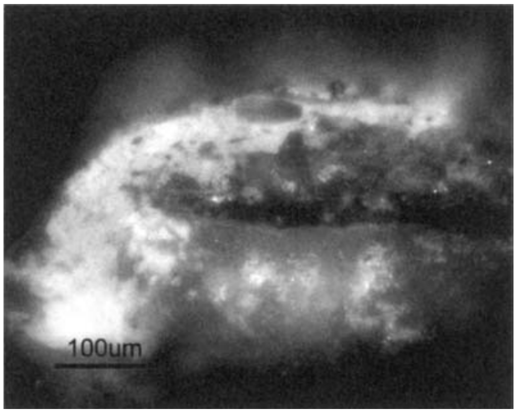

Fig. 9 Cross section taken from the background of St. Michael showing a black preparatory layer under azurite. The top most layer is later overpaint. Museum Conservation Institute, Smithsonian Institution/The Walters Art Museum, Baltimore.

The landscape of *The Crucifixion* incorporates a natural malachite pigment overlaid with copper resinate, undoubtedly to modulate and intensify the hue. In a cross section a few carbon particles constituting the underdrawing are present below the malachite. Copper resinate, now discolored to a dark brown, was also used by itself in the landscape overlapping the distant mountains. Traces of copper resinate were identified in areas where there were once green linings in the mantles of St. Michael and St. John.

Azurite is present in the blue backgrounds of the Walters standard, but it was used in two different ways. In *St. Michael*, a black layer was laid under a pure azurite layer to create a dark, solid field of color (fig. 9). This practice of using a dark preparatory layer for blue areas is described by Cennino Cennini in his early fifteenth-century treatise on painting:

> If you wish to make a mantle for Our Lady with azurite, or any other drapery which you want to make solid blue, begin by laying in the mantle or drapery in fresco with sinoper and black...then, in secco, take some azurite...if the blue is good and deep in color, put into it a little size....Mix it up well...apply three or four coats....[36]

The blue background of the *Madonna and Child Enthroned with St. Ann*, in Matelica is built up in the same way as the background of *St. Michael*.[37] Following Cennini's advice to the letter, Lorenzo d'Alessandro used a dark preparatory layer in the drapery of the Madonna in the *Madonna del Monte*, which is also used as a processional standard to this day, carried every Easter Monday.[38]

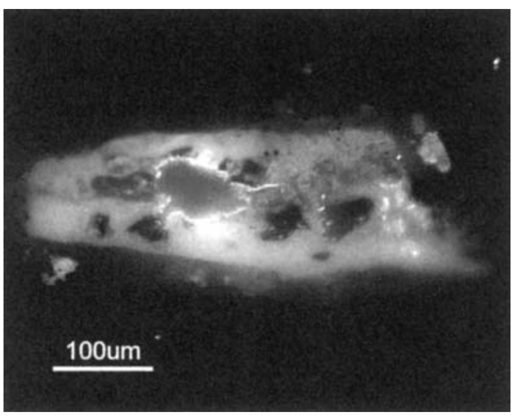

Fig. 10 Cross section taken from the background in The Crucifixion showing azurite and lead white mixed together. The top most layer is later overpaint. Museum Conservation Institute, Smithsonian Institution/The Walters Art Museum, Baltimore.

No black layer is present in the background of *The Crucifixion* because the effect of a solid field of blue was not intended. Instead, Lorenzo created a sky that modulates from darker blue at the top to a much lighter shade at the horizon by mixing azurite with increasing amounts of lead white (fig. 10). While this transition is obscured by overpaint in the Walters painting, Lorenzo d'Alessandro's original intentions are evident in the Brooklyn Museum's *Crucifixion*. The sky in the Brooklyn panel has a distinctive horizontal orientation from the direction of the brushstrokes. Similarly painted skies are found in the *Madonna and Child*, Palazzo Barberini, and in *The Nativity*, Pinacoteca Civica "P. Tacchi Venturi," Sanseverino.

Lorenzo d'Alessandro employs the decorative effects of both gold and silver leaf in his paintings in a variety of ways. In *The Crucifixion; St. Michael* deep red bole was laid as a base layer before the application of the metal leaf with water. Gold is present on the engaged frame (with the exception of the antependium), in the figures' halos, and in St. Michael's collar. Fine gold stripes in Christ's *perizoma*, dots in St. Michael's wings and in the yellow textile behind St. Michael were mordant gilt. Traces of silver leaf were confirmed with XRF in St. Michael's armor and sword which are now very oxidized and abraded exposing the bole underneath.

In the halos of the Crucifixion figures, a simple single punch delineates the outside boarders. Three or four incised concentric rings lie inside the punched boarder and each halo bears an inscription that stands out from a single punched gold ground. St. Michael's halo is simpler than the Crucifixion figures; his consists of four incised concentric rings on the edge of the halo, with incised rays radiating from his head. In some paintings of Lorenzo d'Alessandro the inscription is in *pastiglia*, lending a gentle three-dimensional effect to the halo like that of the

Madonna and Child with Angels, St. John the Baptist and St. Severinus, Pinacoteca Civica "P. Tacchi Venturi," Sanseverino, and the *Madonna and St. Ann*, Pinacoteca Vaticana. Lorenzo d'Alessandro also used *pastiglia* in fresco such as his frescoed chapel in Sarnano where the bishop saint has a raised gilded crozier, mantle border, and stamped rays in his halo. While *pastiglia* was somewhat anachronistic in larger Italian art-producing centers by this time, it was still in use in the provinces.

Glazing over metal leaf, at times combined with sgraffito, are other ways Lorenzo d'Alessandro modulates this precious surface. In his *Madonna and Child Adored by Saints Francis and Sebastian*, Galleria Nazionale d'Arte Antica, Palazzo Barberini, Rome, short strokes of a red glaze, most likely a lake, were laid over gold leaf to give luminosity and a sense of richness to the Virgin's dress. Silver leaf covered with translucent glazes became a sumptuous brocade fabric in the dress of the Madonna and sleeve of St. Sebastian in the Cleveland Museum of Art's *Madonna and Child Enthroned with Sts. Anthony Abbot, Sebastian, Mark, and Severinus*. Silver leaf appears to be also used for a brocade effect in the *Madonna and Child with Saints Peter Martyr and Vincent Ferrer*, Yale University Art Gallery.[39] The lavender paint laid over the metal leaf in the Madonna's dress was broken through with small dash marks in the highlighted areas exposing the metal leaf, now blackened, that must have made the dress sparkle. Silver leaf may also have been applied in the Serrapetrona polyptich for St. Peter's key and the sword of St. Michael. In St. Michael in the Walters' standard, a glaze, now gone, most likely was applied on top of the silver leaf to model the armor and sword. In addition, small commalike marks, incised by hand rather than punched, were made in St. Michael's collar, upper left arm, and skirt in imitation of chainmail.

There is no confirmation of varnish used by Lorenzo d'Alessandro, nor if he did use varnish, what type was chosen. Cennini does recommend varnishing standards to protect them from the rain when they are carried outdoors.[40] In the restoration of the *Madonna del Monte,* a protein layer was discovered between the original paint and the oily residues of a *beverone* applied to spruce up the painting. This protein layer is estimated to be an egg white varnish, and if not original, is certainly very old.[41]

4. CONDITION AND TREATMENT

When *The Crucifixion; St. Michael* entered the Walters collection, the painting was in a complex state of preservation, having undergone several alterations. Some of these alterations included changes to the composition and additions to the engaged frame. Fortunately, the Walters painting was spared from the most extreme alteration to which double-sided processional standards have been subjected to besides the removal of their engaged frames: the division of the panel into two halves to allow the two painted sides to be displayed next to each other on a gallery wall. This practice also gave rise to the dispersion of once integral double-sided processional standards among different collections, as in the case of the Getty Museum's "Coronation of the Virgin", whose other half, depicting St. Francis receiving the stigmata, is in the collection of a private foundation in Italy.[42]

The last major treatment of *The Crucifixion; St. Michael* was in 1946, when the painting was cleaned, inpainted with tempera, and varnished with mastic.[43] Although the panel has a slight warp and a few cracks from the restraint of the engaged frame, the standard is structurally stable. The painting's wooden support had been protected from environmental and insect damage by its encasement in gesso, paint, and gilding, but the standard was unexhibitable due to a discolored varnish and retouching that no longer matched the original. Furthermore, it was felt that restoration layers may have been covering original paint.

The flesh areas, confraternity figures, and architecture in the painting are in very good condition: the paint is not overly abraded and these elements have not been overpainted. The extent of the amount of overpaint did not become apparent until the varnish was being removed. The background of each side had been completely overpainted, and this layer had locally blanched, creating an even more unsightly surface. St. Michael's mantle, legs, boots, parts of the armor, the ground he stands on, and the robes of both St. John and the Virgin were all overpainted.[44] There were at least four kinds of restoration paint on *The Crucifixion; St. Michael* distinguished by different solubilities. As these kinds of objects were used regularly, they were periodically "freshened up" like icons and furniture. An example of this practice can be found in Gubbio, where a processional standard on linen recently attributed to Raphael is currently undergoing conservation treatment. Originally from the Confraternity of Corpus Christi, it depicts Christ carrying the Cross, and Sts. Ubaldo and Francesco. Here both sides were almost completely overpainted, possibly only fifty years after the painting was completed.[45]

Generally when overpaint is found, an instinct is summoned to remove it because it hides the hand of the artist, because it is not original. But when the overpaint is very old, does it acquire any historical value that it is deemed worth preserving at the expense of the artist? In the case of *The Crucifixion; St. Michael* it was decided in consultation with the curator[46] to remove as much of the overpaint as possible as it was clumsy, discolored, and not in keeping with Lorenzo d'Alessandro's precise style.

But most of the overpaint, including the blue backgrounds and St. Michael's mantle and legs, was insoluble in a wide array of cleaning materials. Cross-section analysis revealed two layers of overpaint on the blue backgrounds and a single layer of overpaint on the mantle. The presence of lead was confirmed in the most recent top layer of overpaint, and Fourier-transform infrared spectrometry (FTIR) suggests poppyseed oil or similar natural ester oil as a possible binder, which explains the insolubility of the overpaint.[47] The earlier overpaint was discovered to be smalt of a rather fine particle size and grayish in tone. Smalt was also applied in the recessed area of the acanthus leaves as part of the original decoration, but here the particles are very large, creating an ultramarine hue. The difference in particle size indicates that the two smalts were not from the same batch and had been painted in two different instances.

The cross sections of paint also show damaged original surfaces, more so in the background of St. Michael where the azurite particles are practically mixed in with the smalt overpaint. As much as we would have liked to uncover the original layers, there were several reasons for not removing some of the overpaint. One reason was that it was not possible to safely separate the overpaint from the original paint layers, as was true for the background of St. Michael. Another reason was the original paint was very damaged or completely missing, so there was little to gain from removing the overpaint. Some of the overpaint was not that offensive. Time was also a limiting factor in carrying out the treatment.

The treatment began by consolidating loose paint and gilding in the painting and in the antependium with sturgeon glue. Cleaning commenced with a mild enzymatic detergent that not only lifted surface dirt, but also solubilized the green-colored restorations on *The Crucifixion; St. Michael.* Then a weak solution of ammonium citrate was used on the antependium, which was free of restoration varnish, to remove significant amount of surface grime, revealing a brighter and clearer faux-carved design. The area was then cleared with a mild enzymatic detergent. Wax residues from a previous consolidation campaign were reduced or removed with Shellsol 71 or a Shellsol 71/xylene gel.


Fig. 11 During treatment of St. Michael: mechanical overpaint removal of white overpaint from pink mantle. The Walters Art Museum, Baltimore. 37.496.

The discolored mastic varnish was reduced with a 1:1 acetone/isopropanol mixture. More discolored retouchings were solubilized along with the varnish. Some small, localized older retouchings required an ethanol gel or acetone gel with a little benzyl alcohol to remove them.

The lead white overpaint on St. Michael's mantle could be safely removed by thinning very small areas first with a solution of ethanol and sodium hydroxide alternating with neutralizing swabs of mineral spirits. The rest was mechanically and painstakingly removed with a scalpel under the microscope, uncovering a beautifully modeled pink drapery (fig. 11). Grey overpaint on St. Michael's legs was not as tough probably due to less lead content in the paint, and was mechanically removed without chemical thinning. Some overpaint on the foreground around the devil was also mechanically removed revealing delicate shadowing. The overpaint on the blue backgrounds; on St. Michael's wings, armor and boots; and on the garments of the Virgin and St. John were left intact and integrated during the inpainting phase of the treatment.

The most compromised areas of the standard are the armor and the mantle lining of St. Michael. His arms and breastplate, which were covered in silver leaf, are overpainted. The chainmail of the saint's armor has traces of blackened, oxidized silver with much of the underlying red bole layer exposed. Silver does not necessarily degrade so severely in all of Lorenzo d'Alessando's paintings; in his Madonna and Child at the Cleveland Museum of Art, the silver leaf, protected by glazes, is well preserved. The overpaint on St. Michael's armor was left in place, and the bole was toned down with restoration colors to which a little mica pigment was added to knit together what remained of the armor.

The areas of green paint have suffered greatly in the Walters standard as it has discolored, been overpainted or disappeared altogether. Small islands of green paint found in and around the lining of St. Michael's mantle indicate what was once there. Traces of green paint (copper resinate over a natural malachite base) were also found beneath the overpaint of St. John's mantle. One can assume that the same technique was applied to St. Michael's mantle. A harsh cleaning in the past might have damaged the copper resinate layer, which is more soluble than other paint because it is composed mainly of organic binder. Overpaint on the few remaining green areas could not be removed without affecting the original, softer copper resinate layer. In Lorenzo d'Alessandro's other depictions of St. Michael, as in the upper tier of the Serrapetrona polyptich, and the panel in Matelica the lining of the saint's mantle is green. These were used as models in the reconstruction of the mantle in the Walters painting.

Only a small area of background overpaint at the top edge was removed mechanically from the St. Michael side. Small islands of yellow paint were visible through losses in the overpaint to the left and right of the top edge of the cloth of honor. These yellow islands transformed into a pole, perfectly preserved under two layers of overpaint, from which the cloth hangs, now anchoring the cloth in the background, defining and rationalizing the space in which St. Michael stands. Even the pole is anchored in place by white ties.[48]

After cleaning, an MS2A isolating varnish was applied to *The Crucifixion; St. Michael.* Old fills were reused when possible, and new fills were composed of a traditional gesso made with animal glue. Inpainting of the losses was carried out by toning the gesso with inks and then applying Charbonnel restoration colors to unify the image.

Unlike the Walters standard, the Brooklyn Museum's *Crucifixion; St. Dominic* panel is free of heavy, obscuring restoration, allowing us a unique opportunity to reconstruct the backgrounds of *The Crucifixion; St. Michael* that are covered by overpaint. In the Brooklyn *Crucifixion*, the sky, rather abraded, but intact overall, transitions from a dark blue at the top of the painting to almost white at the horizon. The background of St. Dominic, which is estimated to be azurite now darkened, is a solid, uniform color, a different type of background from *The Crucifixion*. The background of St. Michael was retouched a dark blue matching some exposed original azurite on the very edges of the painting.

The missing part of the cornice was replaced even though it is a later restoration to give a sense of completion to the object. The edges of the loss were first isolated with B-72. Then a mold of the intact cornice, isolated first with Winton retouching varnish, was taken with Po-Yo Putty, a two-component silicone rubber putty that cures in 30 minutes.[49] The cast of the cornice was made in place with Mohawk two part epoxy putty stick chosen for its easy-to-work-with consistency, and inpainted with Liquitex acrylic paint to imitate the surrounding gilding.

5. CONCLUSION

Because the Walters panel was not divided into two separate paintings and because it still retains its engaged frame, it is undoubtedly the best-preserved example of a processional standard on panel in the United States. The rectangular format is typical of the region in which d'Alessandro worked, but the survival of the engaged frame and antependium is unique among existing processional standards on panel. D'Alessandro not only created standards of typical format, but also ones that are not normally thought of as standards because of their large size and usual one-sided display. These are his *Madonna del Monte* and *St. Anthony of Padua*.

His painting technique is traditional and follows practice recorded by Cennino Cennini. By combining a variety of the prescribed methods d'Alessandro was able to achieve different effects on his painting, though these may not be so distinct or obvious now due to the unkind passage of time. Through careful study of his technique and the structure of the painting utilizing different analytical techniques, d'Alessandro's desired effects were understood.

Comparison with similar works in his oeuvre and those of his masters and contemporaries deepened the physical and iconographical understanding of the *Crucifixion; St. Michael.* It is only with this knowledge that a sensitive conservation treatment was devised so that the Walters' processional standard could once again be appreciated by a wider audience. (fig. 12, 13)

ACKNOWLEDGEMENTS

I am grateful to the Andrew W. Mellon Foundation for supporting the fellowship under which this research was carried out. In the multidisciplinary field of conservation, research is always the fruit of collaboration, so I thank everyone who contributed to this paper who are not mentioned elsewhere, but especially Eric Gordon, Head of Paintings Conservation at the Walters Art Museum, who suggested that I treat *The Crucifixion; St. Michael,* and encouraged me to bring my research to light; Gillian Cook, Karen French and Jennifer Giaccai of the Walters Art Museum; Michele De Felice of Macerata, who shared his research on Lorenzo d'Alessandro and assisted me in the Marches; Agnese Benedetti, mayor of Vallo di Nera; Giordana Benazzi, Soprintendenza per i Beni e le attività culturali di Umbria; Carolyn Tomkiewicz of the Brooklyn Museum of Art; Marcia Steele and Bruce Christman of the Cleveland Museum of Art; Mark Leonard of the J. Paul Getty Museum; Jia-sun Tsang and Harry Alden of the Smithsonian Center for Materials Research and Education; Richard Wolbers of Winterthur/University of Delaware Program in Art Conservation; Mark Aronson and Patricia Garland of the Yale University Art Gallery.

Fig. 12 Lorenzo d'Alessandro, "The Crucifixion", 1480-1490. Tempera, gold on panel. After treatment. The Walters Art Museum, Baltimore. 37.496.

Fig. 13 Lorenzo d'Alessandro, "St. Michael Archangel", 1480-1490. Tempera, gold on panel. After treatment. The Walters Art Museum, Baltimore. 37.496

NOTES

A version of this paper is published in *The Walters Art Museum Journal.*

ENDNOTES

[1] R. Paciaroni, *Lorenzo d'Alessandro detto il Severinate: Memorie e documenti* (Milan, 2001), 110.

[2] F. Zeri, *Italian Paintings in the Walters Art Gallery,* 2 vols. (Baltimore, 1976), 1:193.

[3] It was not unusual for important artists such as Luca Signorelli, Raphael, and Vasari to paint processional standards in all stages of their careers.

[4] Paciaroni, 43. Until recently it was thought Lorenzo d'Alessandro died in 1503, but documentary evidence published by Paciaroni in 1984 refutes this date.

[5] Zeri, *Italian Paintings,* 1:194.

[6] Paciaroni, *Lorenzo d'Alessandro,* 96, 110-11. The painting is now in the Museo Piersanti in the same city. This confraternity already owned a double-sided processional standard on panel attributed to the Maestro di San Verecondo depicting St. Francis and two flagellants kneeling at his feet. The Church of Sant'Angelo, where the confraternity was based, was destroyed in the 1955 to make room for the construction of a new convent of the Frati Minori.

[7] B. Wisch and D. C. Ahl, eds., *Confraternities and the Visual Arts in Renaissance Italy: Ritual, Spectacle, Image* (New York, 2000), 1-2.

[8] Schmidt, "Gli stendardi processionali," 561-63; Bury, "Documentary Evidence," 22.

[9] Gross examination of the wood panel and polarized light microscopy (PLM) of small samples by the author suggest *Populus spp* as a genus, commonly called poplar.

[10] In a technical study of fifteenth-century paintings from the Marches in the Pinacoteca di Brera, the species *Populus nigra* was identified in all of the paintings executed on panel with the exception of one painting by Pietro Alemanno (ca. 1430–1497 or 1498), in which *Tilia platiphyllos,* commonly known as limewood, was identified. A. Gallone Galassi, F. G. Albergoni, B. Basso, L. M. Recalcati, "Panneaux d'artistes des Marches du XVme siècle de la Pinacothèque de Brera: Etude des matériaux et des techniques," *ICOM Copenhagen* (1984), 84.1.15.

[11] Don Marione kindly allowed me to examine *The Crucifixion with Mary Magdalen/Madonna of Mercy* in the Chiesa di Croce, Caldarola, a town about 12 kilometers south of Sanseverino.

[12] Author's conversation with George Bisacca, Conservator of Paintings, the Metropolitan Museum of Art, New York. Ciro Castelli, a specialist in the structural conservation of panel paintings at the Opificio delle Pietre Dure, Florence, also believes the block to be original. Author's conversation, 5 April 2004.

[13] Bury, "Documentary Evidence," 20-21.

[14] Author's conversation with Matteo Ceriana, Soprintendenza per il Patrimonio storico artistico e demoetnoantropologico di Milano, 5 April 2004.

[15] *Madonna and Child; San Venanzio,* Pinacoteca e museo civici, Camerino.

[16] Zeri, *Italian Paintings,* 1:193.

[17] Author's conversation with Franco Sabatelli, frame scholar, 19 March 2004. Sabatelli dates the acanthus leaves to between 1550 and 1580; he also observed that the profile of the cornice would not have an overhang.

[18] Author's conversation with Marco Grassi, private paintings conservator, 19 March 2004.

[19] The metal was not magnetic.

[20] "Sant'Agata," *OPD* 8 (1996), 221. The sixteenth-century reframing and carrying pole is the work of Antonio legnaiolo.

[21] Keith Christiansen first hypothesized that the Getty painting was part of a processional standard. The other face, *St. Francis Receiving the Stigmata,* belongs to the Fondazione Magnani Rocca di Traversetolo, Parma. See Appendix 1. Keith Christiansen, "The *Coronation of the Virgin* by Gentile da Fabriano" *The J. Paul Getty Museum Journal* Vol. 6-7, 1978-1979, pp. 1-5. Andrea De Marchi, *Gentile da Fabriano: Un viaggio nella pittura italiana alla fine del gotico.* (Milan, 1992), 112 and note 4.

[22] "The fresco comes from the old oratory of the Church of S. Maria della Carità detta "la Scopa" della Confraternità dei Battuti o Flagellanti, who looked after and comforted prisoners sentenced to death in the hours before their execution." Author's translation of museum label.

[23] Bury, "Documentary Evidence", 25.

[24] Bury, "Documentary Evidence," 23-24.

[25] Bury, "Documentary Evidence," 26.

[26] Schmidt, "Gli stendardi processionali", 560.

[27] Physical evidence suggests that another panel painting by Lorenzo d'Alessandro in the Museo Piersanti, Matelica, may have been used as a processional standard but there is no documentation of such use. *St. Ann, the Virgin and Child and with Sts. Sebastian and Roch; Christ Deposed between Sts. Michael Archangel and Dominic* (in the lunette), 1480 - 90, has a monogram of Christ painted on a silver-gilt background on the panel's reverse, suggesting that the painting was intended to be seen from the back as well as the front. Its large dimensions, 244 x 213 cm (96 1/8 x 83 7/8 in.), however, would have made the panel difficult to carry in procession. De Felice, *Problemi di tecnica nella pittura su tavola di Lorenzo d'Alessandro*, unpublished thesis Università degli Studi di Macerata, Facoltà di Lettere e Filosofia, Corso di Laurea in Storia e Conservazione dei Beni Culturali, Anno Accademico 2002-2003, 73; 204. "Saint Ann" is from S. Michele Arcangelo, commonly called S. Angelo, Matelica, the presumed place of origin of the Walters painting.

[28] Carl Strehlke, unpublished manuscript in the curatorial files of the Brooklyn Museum of Art, 5/16/92, 2.

[29] *I pittori del Rinascimento a San Severino: Lorenzo d'Alessandro e Ludovico Urbani, Niccolò Alunno, Vittore Crivelli e il Pinturicchio. Catalogo a cura di Vittorio Sgarbi, Stefano Papetti.* (Milan, 2001), 202. Andrea de Marchi has listed numerous standards pertinent to the central Marches region.

[30] All SEM-EDS analysis in this study was carried out by Roland H. Cunningham, Senior Paintings Conservator/ Analytical Support Group, Smithsonian Center for Materials Research and Education (SCMRE).

[31] This was observed by the author.

[32] This was observed by the author.

[33] This was observed by Romeo Bigini, who recently restored the polyptich. Author's conversation with Michele de Felice 5 November 2003.

[34] FTIR analysis was carried out by Walter Hopwood, Organic Chemist, SCMRE. The results of the binder analysis in the original paint layers were inconclusive.

[35] This was observed by the author. *Madonna and Child with St. Anthony Abbot, St. Sebastian, St. Mark, and St. Severino*, 16.800. N. Coe Wixom, *The Cleveland Museum of Art. European Paintings Before 1500. Catalogue of Paintings: Part One.* (Cleveland, 1974), 86-88.

[36] Cennino d'Andrea Cennini, *Il libro dell'arte,* chapter 83: "To make a drapery, or a mantle for Our Lady, with azurite or ultramarine blue," in *The Craftsman's Handbook: The Italian "Il Libro dell'Arte,"* trans. Daniel V. Thompson, Jr. (New York, 1960), 54-55.

[37] De Felice, *Problemi di tecnica*, 211.

[38] De Felice, *Problemi di tecnica*, 175.

[39] The presence of silver has not been analytically confirmed.

[40] C. Villers, "Paintings on Canvas in Fourteenth Century Italy," *Zeitschrift für Kunstgeschichte*, 1995:3, 355-356; Cennini, *Il libro dell'Arte*, 104. In this translation the term "banner" is used, but in the Italian text there is reference to "stendardi" and "gonfaloni"; Cennino Cennini, *Il libro dell'arte. Commentato e annotato da Franco Brunello.* (Vicenza, 1982), 173-175.

[41] As described by Osvaldo Pieramici, who restored the painting in 1978, to Michele de Felice. De Felice, *Problemi di tecnica*, 177.

[42] There are numerous examples of processional standards on canvas that were separated to create two paintings; for example, Luca Signorelli's *Crucifixion* and *Pentecost*, Inv. 1990 D 60 and 61, which are displayed side by side in the Galleria Nazionale delle Marche, Urbino, was commissioned by Filippo Geroli and painted in the summer of 1494 for the Confraternita dello Spirito Santo di Urbino. The two canvases were separated in the eighteenth century. P. Dal Poggetto, *La Galleria Nazionale delle Marche e le altre Collezioni nel Palazzo Ducale di Urbino.* (Urbino and Rome, 2003), 175-176. A fuller discussion of processional standards on canvas is beyond the scope of this essay; see C. Villers, "Paintings on Canvas in Fourteenth Century Italy," 338-358.

[43] Treatment record, 37.496, conservation division of the Walters Art Museum.

[44] Roberto Bellucci suggested that the Walters standard might have been repainted for devotional purposes as early as the seventeenth century Author's conversation with Roberto Bellucci, paintings conservator, Opificio delle Pietre Dure, 5 April 2004.

[45] Author's conversation with Tiziana Monacelli, private paintings conservator, 13 May 2005. The overpaint is being mechanically removed with scalpels.

[46] Morten Steen Hansen, Assisant Curator of Renaissance and Baroque Art.

[47] Lead was identified through SEM, microchemical testing, and X-ray fluorescence spectometry (XRF). XRF was carried out by Jia-sun Tsang, Senior Paintings Conservator, SCMRE.

[48] These rods are not unusual in the paintings of d'Alessandro's contemporary Carlo Crivelli. For instance his *Madonna and Child*, 1470, San Diego Museum of Art, 1947:3; *St. Roch*, The Wallace Collection, London, P527.

[49] It is an economical alternative to dental silicone putties at under $30 a quart.

SOURCES OF MATERIALS

Po-Yo Putty 40
Smooth-On
2000 Saint John Street
Easton, PA 18042
(800) 762-0744
www.smooth-on.com

Mohawk Epoxy Putty Stick
Mohawk Finishing Products
Division of RPM Wood Finishes Group, Inc.
P.O. Box 22000
Hickory, NC 28603-0220
(800) 545-0047
www.mohawk-finishing.com

INSERT RECTANGLE HERE: *ART AND SCIENCE COMING TOGETHER TO DETERMINE THE UNIQUE CONSTRUCTION OF A PAINTING BY DAVID TENIERS THE YOUNGER*[1]

Noelle Ocon, Associate Conservator of Paintings

ABSTRACT - An intriguing discovery was made during the initial examination of David Teniers' The Armorer's Shop in the collection of the North Carolina Museum of Art (NCMA). The painting was constructed of three oak planks in an unusual configuration. The top half consists of a single horizontal plank. The bottom half consists of a horizontal plank, of which the left side was hollowed out and panel A inset. This painting has long been attributed to Teniers and is signed "D. Teniers" on the log upon which the armorer rests. More recent research, however, suggests that the bottom left section was painted first, perhaps by Jan Brueghel the Younger, and the rest of the composition was created around it. Because conventional microanalysis and traditional conservation examination methods did not resolve the chronology of the painting's construction, a new non-destructive sampling technique was employed, confocal x-ray fluorescence microscopy (CXRF). This innovative technique was developed with physicists at the Cornell University High Energy Synchrotron in conjunction with conservation scientists and graduate fellows at Winterthur Museum/ University of Delaware. CXRF directly reveals the heavy-element composition and location of buried paint layers by combining depth scans at a number of adjacent lateral positions and creating virtual cross-sections that provide paint layer positions, structures, thicknesses and pigment compositions. CXRF confirmed that the bottom left panel was painted first followed by the attachment of the L-shaped plank and completion of the composition.

In 1952, a gift of one million dollars was given by the state of North Carolina as seed money for what would soon become one of the cultural gems of the South, the North Carolina Museum of Art. With that money, the museum was able to purchase some wonderful paintings by the Dutch and Flemish masters, including paintings by Jan Steen, Joos de Momper, Peter Paul Rubens and Anthony van Dyck. Working with Dr. Dennis P. Weller, Chief Curator and Curator of Northern European Art, the conservation lab has made tremendous gains in the examination,

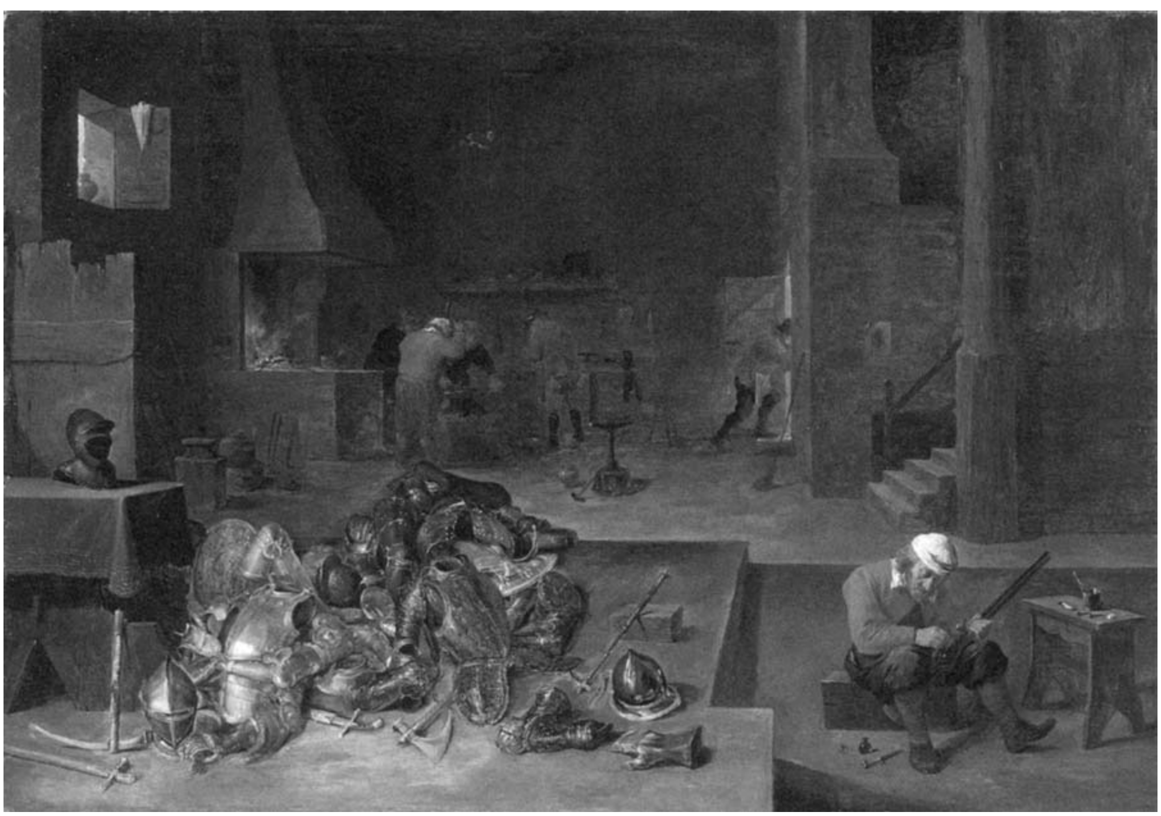

Fig. 1 David Teniers the Younger and Jan Brueghel the Younger, *The Armorer's Shop*, Oil on Panel, 56.5 x 80.7 centimeters, NCMA, 1640-1645.

Erica E. James, Painting Conservator, EEJ Painting Conservation, The Woodlands, Texas documentation and restoration of our collection for several exhibitions and for a systematic catalogue of the collection. In October of 2002, a recreation of a Flemish art room, called a kunstkamer, was constructed with the assistance of a Kress European "art in context" grant. With the installation of this wonderful room, we were able to showcase paintings, objects and decorative arts not previously exhibited. Among them was *The Armorer's Shop*, signed D Teniers, and certainly there had been no question of this attribution. Figure 1.

David Teniers the Younger (1610-1690) was successful and renowned in his lifetime. He was active in Antwerp, a flourishing artistic center, alongside the prolific Brueghel family. In 1637, he married Anna Brueghel, daughter of Jan Brueghel the Elder, and half-sister of Brueghel the Younger. After the death of her father in 1625, Anna had become the ward of Rubens. With his marriage to Anna, Teniers became the guardian of two of her younger siblings, and also inherited many paintings and drawings by his father in law, Jan the Elder. As his style matured, he moved away from the biblical and mythological compositions of his father, David Teniers the Elder, and developed his passion for scenes of everyday life, including peasant, kermis and interior genre scene.[2] From 1651 to 1659, he was appointed court painter to the Spanish governor in Brussels, Archduke Leopold Wilhelm and to his successor, Don Juan of Austria. Teniers lived out the rest of his life as an active and well-respected artist.

The Armorer's Shop, oil on oak, depicts a seated armorer at the bottom right and a sumptuous pile of parade armor in the foreground. Figure 2. In the middle ground is a forge surrounded by workers above which hangs a dragon, a symbol for alchemy. Also of interest is that this armor can be identified and still exists today. The harness on the left, currently in Brussels has been identified as late Maximilian from the 16th Century – most likely the property of Emperor Charles V. The harness on the right in Vienna has been identified as belonging to Archduke Albert VII. Also, the helmet at the far right has been traced to Maximilian II who was holy roman emperor in the 16th century.[3]

Fig. 2 Detail, *The Armorer's Shop.*

The painting had the typical of a 17th century construction, oil paint on a glue and chalk ground on an oak panel - nothing seemed out of the ordinary. The difficulty arose, though, when trying to determine the construction of the panel because it had been glued to another piece of wood and then cradled.

In raking light, the grain pattern appeared continuous, but with a puzzling vertical ridge in the bottom center. Radiographic examination helped with identification of this ridge and join. Figure 3.

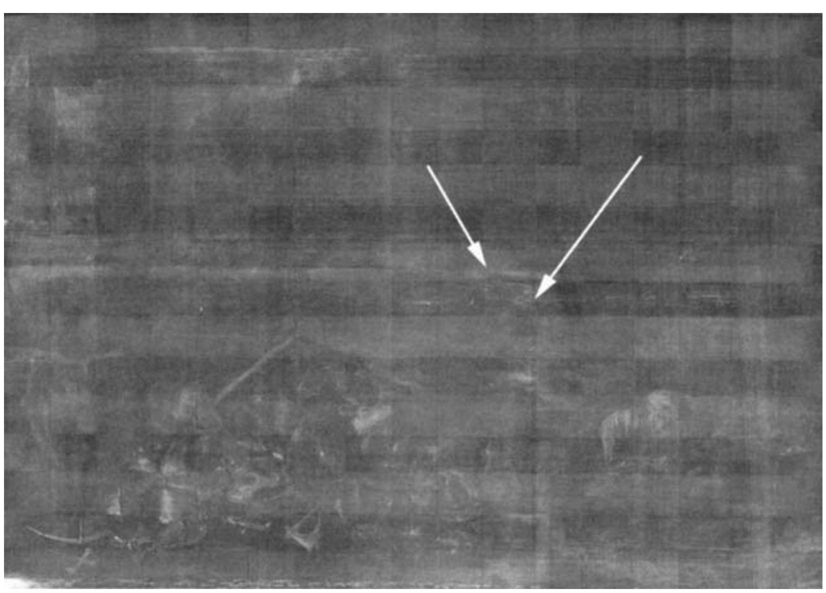

Fig. 3 X-Radiograph. Arrows show panel "insert".

There was a separate piece of wood (hereafter called part A) inserted into lower left corner upon which the armor was painted, and the armorer and forge was painted around it. Recent dendrochronological examination enabled the identification of the actual construction of the panel. Overall, there are two planks with a horizontal grain – as would be usual. Then the left half of part B was hollowed out and panel A was inserted into it - a very unusual circumstance. Figure 4.

The schematic as observed from the bottom edge better shows the construction and how panel "A" was set into panle "B". The panel support as shown in the diagram was added later as a restoration. Figure 5.

This construction is so finely wrought, that it could not be determined until recently after the sides were smoothed. Although this insert was unusual, the attribution was not questioned because its overall composition and execution would not be considered unusual for Teniers, fitting well into his 1640's work. The infrared reflectogram shows an amorphous contour – seemingly a layer of paint or filling material that originates to the left of the armor and extends over the vertical join into part A integrating the two. Figure 6. It seemed to suggest that the armor panel was painted first and then the armorer and forge scene was painted around it. But there was no indication that the two sections were by different artists. There is even a preparatory drawing of the group of workers also firmly attributed to Teniers.

While researching Teniers, though, other contemporaries were investigated especially his brother-in-law, Jan Brueghel the Younger. Depicted in Klaus Ertz's *Catalogue Raisonee* of the Younger Brueghel's work are several interesting paintings: the *Allegory of Discord* in Altenburg, Germany and the *Allegory of the Elements* in Lucerne Switzerland, both with very similar piles of armor.[4] Even more telling, though, was the *Allegory of Discord* at the Musée Calvet in

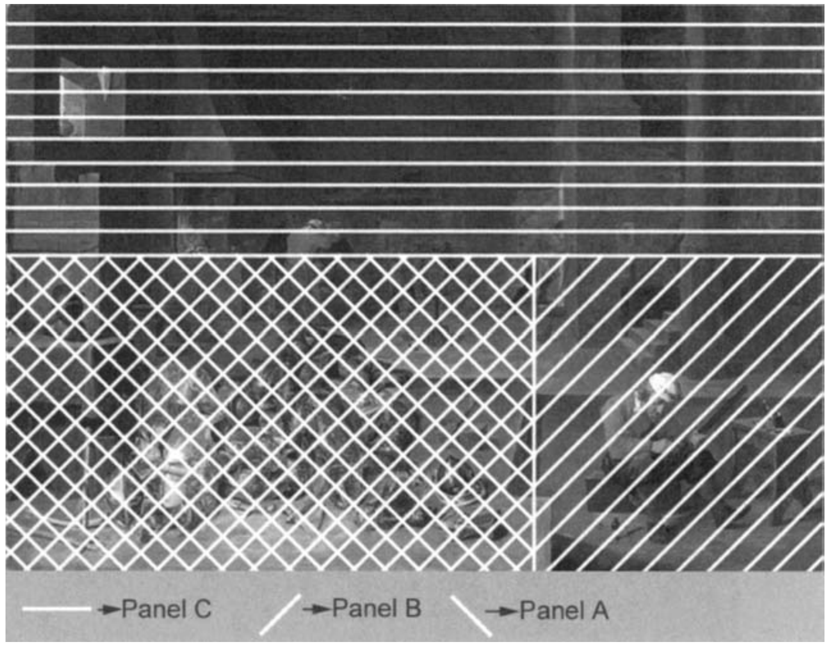

Fig. 4 Schematic showing the 3 oak panels.

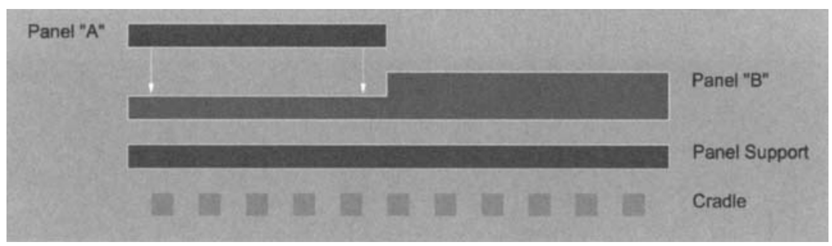

Fig. 5 Side view as observed from bottom edge.

Fig. 6 Infrared Reflectogram. Captured using FLIR SWIR-CAM with a PlSi detector and a 1.5-1.8 micron pass-through filter.

Fig. 7 Attributed to Jan Brueghel the Elder, *Allegory of Discord*, Oil on Panel, 53 x 89 centimeters, Musée Calvet, Avignon, France, circa 1647. (Recently reattributed to Brueghel the Younger and Hendrik van Balen and retitled Allegory of Touch, see endnote 5).

Fig. 8 Armor comparison. NCMA left, Musée Calvet right.

Avignon France.[5] Figure 7. After seeing the painting in Avignon, it can be said that the armor is virtually identical.[6] Figure 8. The style and technique are identical with the same use of the gray underpainting and the same application of highlights and shadows. An overlay determined that many of the items were of identical size, for example the helmets in the bottom left.

One difference is that the Musée Calvet painting shows a suit of armor displayed on a stand on the left side, whereas in the Raleigh painting, a helmet rests upon the table. Interestingly, X-radiography and infrared reflectography reveal that the helmet sitting on the table in *The Armorer's Shop* was part of a full suit of armor over which the table was later painted. Because this table is found in many of Teniers' compositions, it could be surmised that it was an integration technique.

To date, at least 5 paintings have been identified with this same pile of armor. Two are in private collections that have not been examined, and one is in an unknown location. After comparing the NCMA painting to the Musée Calvet *Allegory of Discord*, it was clear that the same artist painted both piles of armor, but could the NCMA armor been painted by Brueghel? Or the Musée Calvet armor painted by Teniers?

Based on both the appearance of the signature, the composition, the still-life elements and the depiction of the armorer, it would seem that an attribution to David Teniers of part B can be maintained. If David Teniers painted part B, then one must then try to assign an artist to part A: Teniers, Brueghel the Younger, or some other 17^{th} century Flemish artist.

Although there are many correlations between the NCMA armor pile and an attribution to Jan the Younger, there is another wrench into the works because Ertz identifies *Venus in the Forge of Vulcan* as by Jan the Elder and Hendrik van Balen, but with the same pile of armor.[7] This is even more intriguing because Jan the Elder would have had more opportunity than his son to examine and paint this specific armor as court painter for the Archduke in Brussels.

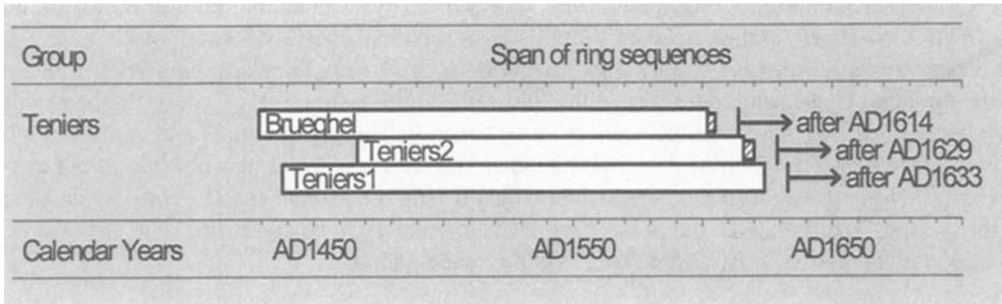

Fig. 9 Figure 9: Dendrochronology Data.

Another interesting aspect to this puzzle is the dendrochronology. Carol Griggs of the Aegean and Near Eastern Dendrochronology Lab at Cornell University, and Tomasz Wazny, from the Nicolaus Copernicus University in Poland, examined the painting this past winter. Although the fell dates the Teniers sections are 1629 and 1633, the earliest possible fell date for the armor panel was 1614. Figure 9. This date was calculated by adding the minimal number of 9 sapwood rings. So if you add between 2-8 years as transport/storage/cure time – it could mean that the armor panel was painted at the earliest 1616.[8] Could Jan the Elder have painted panel A? Furthermore, the painting in Avignon is attributed by that museum to Brueghel the Elder. However, in Ertz's catalogue raisonée, he attributes it to Brueghel the Younger.

During the recent retrospective exhibition on David Teniers in Karlsruhe, Germany, two wonderful guard room scenes, *The Guard Room with the Deliverance of Saint Peter* from the Metropolitan Museum of Art and the *Guardroom Interior* from the Art Institute of Chicago[9] were examined to compare and contrast with the NCMA painting. [10]There are certain visual clues that can be used to distinguish the difference between the NCMA armor versus armor with a firmer attribution to Teniers. This empirical evidence strongly suggests that the NCMA armor is not by Teniers. David Teniers depicted his highlights in a less descriptive way than Jan Brueghel the Younger. The contour and application of the highlight have a geometric quality and do not seem to define the shape and curve of the armor, an observation that can be extended into metallic objects in other paintings by him. The white paint is often a thick application that sits above the surface.

In comparison, Brueghel applied his highlights in a very thoughtful and well-planned manner, always accentuating the form as well as illustrating the metallic quality of the armor. Although Brueghel's paint is impastoed as well, the brushstrokes seem to integrate better into the overall composition instead of seeming like an afterthought. The highlights also seem to form gradually, going from dark to light and back to dark, smoothly accentuating the structure of the armor. This may seem to indicate that Teniers was the lesser artist, this does not seem to be the case, as the depictions of glassware in his paintings show a highly refined sense of shape and form.

So far, it was purely conjecture that the armor panel had been painted first. Two major questions remained: was the armor painted first, and if so, did Teniers paint it? Physical evidence would help determine if the two parts had been done at different times and by different artists.

Currently at the NCMA, scientific analysis capability consists of cross-sectional analysis and polarized light microscopy. Sampling the painting is extremely difficult due to the thin paint layer and the panel support. The near pristine surface limited sampling to existing damages along the edge of the painting, where 5 small samples were taken. Also, readings were inaccurate because of absorption of natural and synthetic resins, wax, and other impurities into the paint layers, especially in the existing voids where sampling occurred. However it could be assumed that the paint composition would be comparable between the two sections because the limited palette would be chemically similar in most aspects to two artists working in the same period and same city.

For technical analysis of the samples and for further research, the painting was examined in 2002 by James Martin at Orion Analytical Lab. Fourier Transform Infrared Spectroscopy (FTIR) on the cross-sections was performed in an attempt to identify differences in pigments and overall structure of the paint layer. As expected, results from the FTIR show that the palettes have similar chemical composition and do not support or refute that the painting was executed by two separate artists.

Could other scientific analyses determine more about two painting sections? Dr. Jennifer Mass and the other conservation scientists at Winterthur performed a wide variety of analyses including Fourier transform infrared spectroscopy (FTIR), polarized light microscopy (PLM), cross-sectional analysis, Raman spectroscopy, scanning electron microscopy/energy dispersive spectroscopy (SEM-EDS), and x-ray fluorescence (XRF). The table below summarizes the findings. These techniques were either performed non-destructively or done on the existing 5 samples taken back in 2001 or one additional sample taken last year. The imprimatura layer can be seen in the cross-section, but is easier to detect in the SEM data. SEM-EDS shows the presence of phosphorus, giving us confirmation of bone black. FTIR showed the reaction of lead white with a drying oil. Raman spectroscopy shows the presence of calcite in the ground. And with XRF the presence of lead-tin yellow can be confirmed. The tests verified that the painting has a paint construction consistent with 17th century panel painting.

Technique	Findings
Cross-Sectional Analysis	Degree of particle differentiation Presence of imprimatura Appearance of chalk/glue ground
Fourier Transform Infrared Spectroscopy (FTIR) Shows compounds	Lead White, Azurite in paint layer Calcium Carbonate in ground layer Drying oil as medium
Raman Spectroscopy Shows compounds	Calcium Carbonate in ground layer
Scanning Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS) Shows thickness of layers and distribution of elements within different pigment particles	Calcium and Phosphorus in blacks = presence of bone black Iron, Silicon and Aluminum = Iron Ocher Copper in imprimatura, perhaps azurite added as a drier
Conventional X-ray Fluorescence Shows elements	Calcium in ground layer Lead and Tin in yellow area = Lead-Tin Yellow Mercury in red areas = vermilion Blue in blue shell – copper-based blue such as azurite Flesh tones – lead, iron, copper, calcium, and manganese Browns – iron and manganese - umber

Perhaps the chronology of construction could be resolved without further destructive sampling. In early spring of 2005, William Brown, the chief conservator, was contacted by Christina Bisulca, then a 3rd year student at the University of Delaware. She was working with a team including Dr. Jennifer Mass, conservation scientist at Winterthur, Matt Cushman, then a 1st year student at Winterthur and Dr. Arthur Woll, a physicist at the Cornell High Energy Synchrotron Source, dubbed CHESS. They were developing a technique called confocal x-ray fluorescence, or CXRF using low kv x-rays formed by positrons in the particle accelerator.[11] First, the scientific explanation. CXRF could directly probe the heavy-element composition and location of buried paint layers by combining two x-ray optics focused on the same position in space. The first optic focuses the x-ray beam to a narrow cone that is incident on the sample, while the second collects fluorescence intensity from a small portion of this cone. Together the two optics define a small, 3D sampling volume. In other words, we could create a virtual cross-section of the paint layer.[12] Whereas conventional XRF provides data from all layers at once – giving an elemental spread from ground to paint, CXRF can separate out each discrete layer. Figure 10, 11.

Prior to the NCMA involvement, the technique had been purely experimental, using an 18th century copy of a 17[th] century painting. The visit in April of 2005 would be a proving ground for the technique, not only to help answer questions about *The Armorer's Shop*, but also to develop and fine tune CXRF.

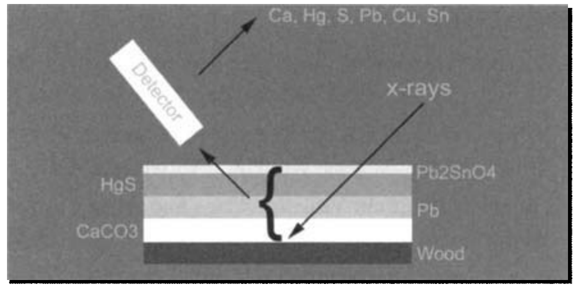

Fig. 10 Conventional X-Ray Fluorescence. Depicts how all elements are detected throughout the paint layer.

The painting was transported twice to CHESS for experimentation to see if CXRF could quantify the differences between the two sections of the painting. Obtaining virtual cross-sections could provide paint layer positions, structures, thicknesses, and pigment compositions. The process began by placing the painting on a specially-constructed motorized easel and then an x-ray beam was focused through a glass capillary and pointed at the sample sight. The data collected, the x-ray emission lines of each element, was imported into a statistical software program, MATLAB, revealing the elements in the sample as related to their depth in the paint layer.

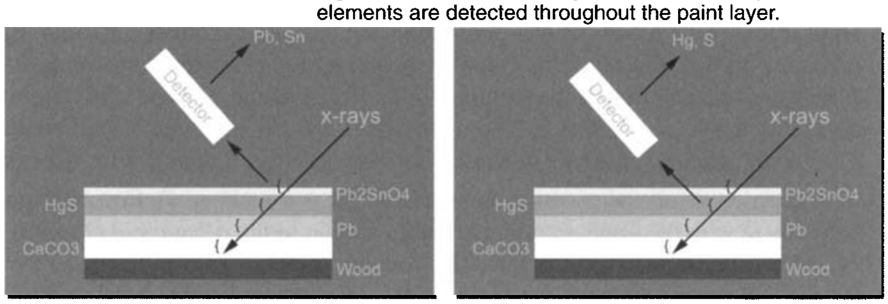

Fig. 11 Confocal X-Ray Fluorescence. Depicts how elements of each discrete layer of paint can be detected.

The data collected created a virtual cross-section that was created by CXRF of the interface between parts A and B. Figure 12 One can readily detect the paint layer from part A sloping down and then stopping abruptly at the vertical join. The paint used to integrate the two sections can then be seen coming across and covering the first layer. This finding is consistent with the hypothesis that the armor pile was painted first, and that *The Armorer's Shop* composition was conceived to make use of this earlier image. This demonstrates the utility of CXRF for nondestructive investigation of microstructural features that are critical to its interpretation – details that cannot be obtained by conventional means.

Based upon both the traditional and the innovative research employed so far, there is enough evidence to draw certain conclusions. First, the bottom left part was painted as a separate piece and the rest of the composition was created around it. And second, the attached part can be attributed to David Teniers the Younger. But beyond that, can it be concluded that the lower left section was painted by Jan Brueghel the Younger or by his father? Although initial opinions have pointed to Jan the Younger, the dendrochronology has cast slight doubt on that. Exploration will continue as more versions are identified and more Teniers paintings are examined. Dr. Dennis Weller, the chief curator and curator of northern European art has worked closely with this project, and in 2005, the attribution of *The Armorer's Shop* was changed to David Teniers the Younger and Jan Brueghel the Younger (?). While additional research and connoisseurship may change the current attribution, it will in no way lessen the intriguing nature of the painting.

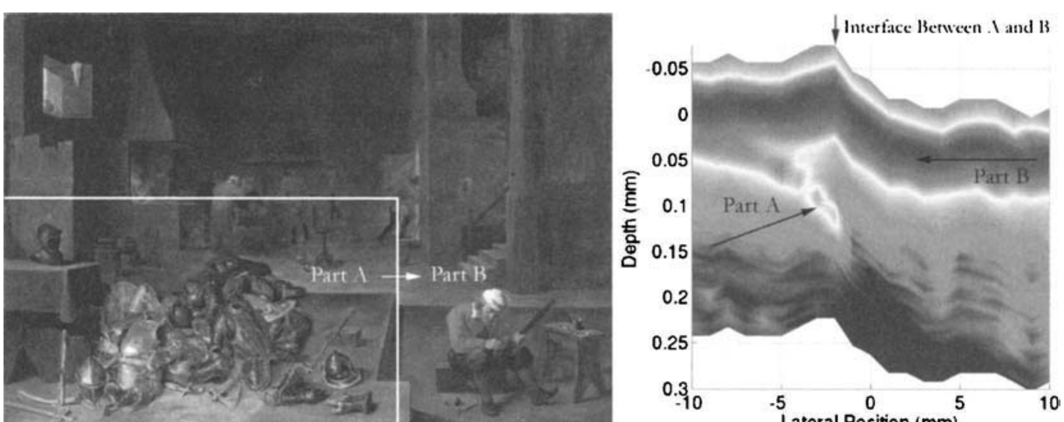

Fig. 12 Depth profile on left showing paint layer from "Brueghel" section sloping down (part A arrow) and stopping. Also shown is the "Teniers" paint on top (part B arrow).

ENDNOTES

[1] A shorter version of this paper was published in the Allentown Art Museum exhibition catalogue *Knights in Shining Armor: Myth and Reality 1450-1650.* Ida Sinkavic, ed. Bunker Hill Publishing. 2006.

[2] Klinge, Margret. *David Teniers the Younger: Paintings and Drawings.* Catalogue for the Exhibition. Koninklijk Museum Voor Schone Kunsten. Antwerp. 1991.

[3] Grancsay, Stephen Vincent. Arms and Armor in the Paintings by David Teniers the Younger. *The Journal of the Walters Art Gallery.* Volume IX. 1946. Pages 23-40.

[4] Ertz, Klaus. *Jan Breughel der Jüngere (1601-1678): Die Gemälde Mit Kritischem Œuvrekatalog.* Luca Verlag Freren. 1984.

[5] Until recently, the Musée Calvet in Avignon had the painting attributed to Jan Brueghel the Elder, although Ertz and other art historians had attributed the painting to Jan Brueghel the Younger. A new catalogue published in March of 2006 reatttibutes the painting to Jan Brueghel the Younger and Hendrik van Balen. The painting is also retitled *Allegory of Touch.* Please see Boyer, Sylvain and Franck Guillaume. *Les Maîtres du Nord. Peintures Flamandes, Hollandaises et Allemandes du Musée Calvet.* Catalogue for the exhibition. Mame. 2006.

[6] In his catalogue raisonée of Brueghel the Younger (see endnote 4), Ertz mentions several other paintings have been found with the same grouping of armor similar to the *Allegory of Discord* in Avignon. *Allegory of the Elements,* attributed to Jan Brueghel the Younger and Hendrik van Balen, Collection of Baron de Coppée, Brussels, Belgium, circa 1630. Catalog #204. *Allegory on Vanitas,* attributed to Jan Brueghel the Younger and a Flemish Master, Turin, circa 1650, Catalog #239 (which is based on catalog #238 in Brussels, and may also well depict this armor). This is based upon paintings illustrated in Ertz and it is highly possible that other paintings in the artist's œuvre exhibit the same grouping. Ertz remarks that Catalog # 230, another *Allegory of Discord* in Berlin, is similar to that of #228-29. Therefore, the grouping of armor may be similar as well.

[7] Ertz, Klaus. *Jan Brueghel der Ältere (1568-1625): Die Gemälde Mit Kritischem Œuvrekatalog.* DuMont Buchverlag. Köln. 1979.

[8] For more information concerning the interpretation of dendrochronology please see: Klein, Peter. Dendrochronological Analyses of Panel Paintings, pages 39-54. *The Structural Conservation of Panel Paintings*: Proceedings of a Symposium at the J. Paul Getty Museum, April 1995. The Getty Conservation Institute. Los Angeles, CA. 1998.

[9] Thanks to Frank Zuccari, Chief Conservator at the Art Institute of Chicago, for all the information he provided on the *Guardroom Interior.*

[10] Klinge, Margret and Dietmar Küdke. *David Teniers der Jungere (1610-1690). Alltage und Vergnügen in Flandern.* Catalogue for exhibition. Staatliche Kunsthalle Karlsruhe. Kehrer Verlag Heildelberg. 2005

[11] Arthur R. Woll, Ron Huang, Donald H. Bilderback, Sol Gruner, Ning Gao, Christina Bisulca, and Jennifer L. Mass, "Nondestructive Compositional Depth Profiling of Paintings by Confocal X-ray Fluorescence Microscopy," in Materials Issues in Art and Archaeology VII, eds. Pamela B. Vandiver, Jennifer L. Mass, and Alison Murray (Warrendale, Penns., 2005), 281–290. Also see Laszlo Vincze, Bart Vekemans, Frank E. Brenker, Gerald Falkenberg, Karen Rickers, Andrea Somogyi, Michael Kersten, and Freddy Adams, "Three-Demensional Trace Element Analysis by Confocal X-ray Microfluorescence Imaging," Analytical Chemistry 76 (2004), 6786–6791. Also see Birgit Kanngiesser, Wolfgang Malzer, and Ina Reiche, "A New 3D Micro X-ray Fluorescence Analysis Set-up—First Archaeometric Applications," Nuclear Instruments and Methods B 211 (2003), 259–264.

[12] For this technique see Arthur Woll, Science Meets Art: Confocal X-ray Fluorescence Microscopy at CHESS (www.chess.cornell.edu/pubs/csnm2005/ScienceArt.pdf).

ACKNOWLEDGEMENTS

This project would not have been possible without the Dr. Dennis P. Weller, Chief Curator and Curator of Northern European Art at the NCMA. Others instrumental in this research include my co-horts on this project: Dr. Arthur Woll, Dr. Jennifer Mass and Christina Bisulca, and the staff of the conservation department at the North Carolina Museum of Art including William Brown, Nancy Allred, David Beaudin, and Perry Hurt. I would like to extend my thanks to the staff at CHESS: Dr. Sol Grüner, Dr. Don Bilderback, Dr. Detlef Smilgies, Sterling Cornaby and Kathy Dedrick. Also thanks to Matt Cushman, FAIC, the Kress Foundation, the Mellon Foundation, Ida Sinkevic, Allentown Art Museum, Ruth Gleisberg, Staatliche-Lindenaumuseum in Altenburg, Germany, Jottany Pagenel, Musée Calvet, Avignon, France, Frank Zuccari, Art Institute of Chicago, Mark Leonard and Tiarna Doherty, J. Paul Getty Museum, Dr. Ken Sutherland, Philadelphia Museum of Art, James Martin, Orion Analytical Lab, Dr. Carol Griggs and Dr. Peter Kuniholm, Department for Aegean and Near Eastern Dendrochronology, Cornell University, and Dr. Tomasz Wazny, Nicolaus Copernicus University, Torun, Poland.

SEARCH FOR *THE NEW JERUSALEM*
GEORGE INNESS'S LOST MASTERPIECE

Eric Gordon, Head of Painting Conservation

ABSTRACT - In 1866, George Inness was given $10,000 by three gentlemen to paint a subject of his choice. The following year, he unveiled a series of three paintings inspired by John Bunyan's Pilgrim's Progress (1678). *The Valley of the Shadow of Death, The Vision of Faith,* and *The New Jerusalem* were exhibited to great acclaim and quickly withdrawn to private collections. *The New Jerusalem* was lent to an exhibition at Madison Square Garden in 1880 and considered lost when part of the building collapsed on the picture gallery. Recent scholarship has shown that the painting appears to have been salvaged and divided up by the artist who repaired and repainted details of the original, hiding religious references.

THE ACCIDENT

The first Madison Square Garden was built in 1879, at a time when New York's climate of corruption reached even into the city's building codes. The Garden contained dance halls, arenas, restaurants and an art gallery. A somewhat shoddy building was erected in the mid- 1870's and by the late 1870's the building passed into the hands of Commodore Vanderbilt. Vanderbilt began to repair and add onto the entertainment center. In 1879, an accident occurred when 8 boxes gave way, injuring many in the theatre.

In 1880, the New York lawyer Clark Bell lent one of his major George Inness landscapes, *The New Jerusalem* to an exhibition in the picture gallery in the Garden. On the night of April 21, 1880, a portion of the Garden's wall and tower suddenly collapsed. Newspapers reported the tragedy: three killed, dozens injured.[1]

Additionally, many paintings were lost, among them Bell's celebrated allegorical landscape by Inness. *The New Jerusalem* was one of the artist's most important works from the 1860's. As workers cleared away the rubble, it appeared the painting was forever lost.

THE VALLEY OF THE OLIVE TREES

George Inness remained a successful artist throughout his life. In fact, his body was laid out in state at the National Academy of Design at his death in 1894, one of only 3 artists to have received such an honor. By the turn of the century his canvases sold for record prices. In 1895, shortly after his death, one highly regarded landscape called *The Valley of the Olive Trees* was sold at auction from the Richard Halstead collection to William Laffan, who in turn sold it to Henry Walters that same year.

Upon seeing this painting at the sale, the French painter Benjamin Constant wrote in The New York Times, "If signed by Turner, Millet, or Corot it would be worth $10,000 and over. In my view it is equivalent to the best landscape ever painted by any great landscape painter. No warm and stormy day in June has ever been felt better nor expressed better." After praising the atmosphere and the richness of the green tones, he finished by stating that the painting "should be in the Metropolitan Museum of Art."[2]

In 1936, soon after the Walters Art Gallery opened, conservators decided to clean the canvas, but stumbled into the puzzle of Inness's complex painting technique. Inadvertently, important original paint was removed, revealing a damaged picture. The museum consigned the picture to storage.

GEORGE INNESS

George Inness (1825-1894) was born in Newburg, New York in 1825, the fifth of thirteen children. His father was a successful grocer who moved his family from New York City to a farm in upstate New York. From an early age, Inness showed an overriding interest in art. As a teenager, he apprenticed himself to an engraver for a month, his only formal training.

Inness was exposed to the Hudson River school paintings of Thomas Cole and Frederick Church and briefly followed in their footsteps, reproducing passages from nature, glorifying the beauty and majesty of America.

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600 North Charles Street, Baltimore, MD 21218

From early on though, he painted in a way that was not recognizable or categorical at the time. For example, he put trees in the middle of a composition, disturbing the traditional artistic balance of the overall design.
In 1851 Inness traveled to Europe where he studied the Old Masters and encountered the Barbizon school. Works by Corot, Millet, Rousseau and others opened up a new world to Inness. His goal shifted from replicating nature to representing the ideas and emotions that came to him in the presence of nature.

Upon his return, he opened a studio in New York City. But in 1850's America, the questions of Union and slavery deeply affected the sensitive artist. The Civil War was a catalyst for Inness that strengthened within him the notion that it was the artist's responsibility to improve civilization. He believed that in painting, one not only cultivated one's own spirituality but contributed to the spirituality of a society.

In 1861, Inness tried to enlist in the Union Army but the frail 36 year-old failed the physical. By 1863 New York City had become dangerously polarized, and in July, the city exploded in a deadly riot. Inness left New York for Eagleswood, a military academy in nearby Perth Amboy, New Jersey and found a new position that changed his life. Dedicated to utopian ideals, vigorous discussions of the day's issues, and a very comfortable lifestyle, Eagleswood was designed to graduate enlightened Union officers. Inness secured a job there teaching drawing and moved his family into a comfortable house and studio on the campus.

One of Inness's closest associates at Eagleswood was the painter William Page. A follower of the 18th century theologian Emmanuel Swedenborg, Page exposed the ever-searching Inness to a brand of Protestantism that blended science and spiritualism. Swedenborgianism in the middle of the 19th century in the United States represented first and foremost an opportunity to bring science together with the visionary experience. Swedenborgianism wed people's hunger for knowing more about the unknown with a scientific approach to nature.

Around this time Inness converted to Swedenborgianism and believed strongly in the tenet that the divine is manifest through nature. In his work, his paintings became less specific and illustrative of a scene, though they were always based on nature.

In 1865, Inness created a very important work. Ostensibly a view of the wheat fields of nearby Raritan, *Peace and Plenty* was in fact one of Inness's first attempts at allegorical painting. The rich and productive fields of grain seemed to represent a keenly longed-for era of reconciliation, harmony and prosperity following the war. The painting was greeted enthusiastically by the Eagleswood community.

THE COMMISSION

In the fall of 1866 three prominent New Yorkers, publisher Fletcher Harper, railroad executive Chauncey DePew, and lawyer Clark Bell came to Eagleswood to call on George Inness offering him $10,000 to subsidize a year's work. The subject matter was left up to Inness.

He turned his growing interest in Swedenborgianism into a theme for the commission and looked to the idea of pilgrimage. In 19th century America, the book *The Pilgrim's Progress* by the 17th century preacher John Bunyan, was enormously popular and influential. An elaborate allegory on the trials of Christian salvation, its story of journey and process were very compatible with Inness's understanding of Swedenborg.

It already was a popular theme for painters such as Thomas Cole and Frederick Church who painted their versions of the story in the 1840's. Coincidentally, as Inness planned his commission, a celebrated traveling panorama of *The Pilgrim's Progress* opened in New York. It featured dozens of scenes from the book painted on a nearly 9000 foot long canvas roll, 8 feet high, ingeniously engineered for high theatrical effect. The show drew over 200,000.[3]

Since *The Pilgrim's Progress* was an incredibly popular and widely read book at this time, Inness may have selected the subject matter for its broad appeal. However he also must have chosen the theme because of its content, as the story is one of spiritual enlightenment and the passage towards that goal.

Inness planned a series of three paintings that would be more than simple illustrations. He envisioned them as complex allegories on the theme of the journey to harmony and salvation. Undoubtedly this theme echoed his feelings towards America at the time following the devastation of the Civil War. *The Valley of the Shadow of Death* may have represented the war itself, *The Vision of Faith* illustrated his image of the future, and the *New Jerusalem*, depicted the desired harmony and peace in years to come.

Inness began painting the three pictures that together he entitled "The Triumph of the Cross" in late 1866. The first painting, *The Valley of the Shadow of Death,* now in the collection of Vassar College, shows the pilgrim Christian standing in a darkened valley at cliff's edge gazing toward a bright blue sky illuminated by a cross. According to accounts in George Inness Junior's biography of his father, the second and third paintings were lost, *The Vision of Faith* in the Chicago Fire of 1871 and *The New Jerusalem* also called *The Delectable City* in an accident at Madison Square Garden in 1880.[4]

We can understand how "The Triumph of the Cross" looked from contemporary accounts. In an 1867 review, *The New Jerusalem* was described as a landscape, filled with verdant meadows, lushly painted green trees, buildings in the far distance, illuminated by a glowing cross. In the foreground, the sick and lame traveled up the River of the Water of Life towards the Celestial City. And the celestial city is echoed in the skies. One critic described it as "a revelation of exquisite design and beauty of color." [5]

The Inness shows in New York were a critical success. Immediately afterward, the first and third paintings were shown in a Boston gallery. Later, the paintings appeared to enter the private collections of Depew, Harper and Bell. Bell, who owned *The New Jerusalem*, agreed to loan it out 13 years later to Madison Square Garden and most likely never saw it again.

Michael Quick, author of the forthcoming catalog raisonné, mentions that *The New Jerusalem* was a particular favorite. He said that individual critics might find quibbles with the other two paintings but they united in admiring *The New Jerusalem* which they considered to be very effective and emotionally fulfilling.[6]

RECENT SCHOLARSHIP

Dr. Quick came to the Walters in 1999 to examine the museum's Inness paintings for his catalog. He was very interested in the *The Valley of Olive Trees,* saying that aspects of it seemed like it was from 1867, as noted in the signature, but there were passages that seemed somewhat later. He mentioned that if I was ever thinking of treating the picture, he would be willing to assist me, as it undoubtedly was an important painting.

Three years later, I called up Michael to see if he would be able to offer insight into the restoration. In the interim he had come up with a theory. He was intrigued by the similarity of the Walters painting to written descriptions of *The New Jerusalem,* even though a key feature of the painting, a bright cross of light suspended in the heavens was missing. Also, of course, it was much smaller than *The Valley of the Shadow of Death.*

His years of research had led him to photos of two other Inness landscapes with similarities to the Walters's picture. One fragment, *Evening Landscape,* came from a college collection in Champagne-Urbana, Illinois. The other, *Visionary Landscape,* was discovered in an auction catalog and had entered a private collection. All three showed signs of being repaired and re-worked, and all three were signed G. Inness, two dated 1867.

Could Inness have salvaged *The New Jerusalem,* cut it up, and reworked the fragments? Inness was known to visit patron's homes and re-paint or revise pictures that had already been hung. He felt a painting was never finished. Accordingly, the Walters arranged for loans of the two canvases and began a campaign of scientific detective work.

Upon seeing the paintings together and comparing them to the written 1867 descriptions, it immediately became clear that they made up the majority of the lost *New Jerusalem.* It appeared that the damaged canvas must have been found in the Madison Square Garden wreckage and taken to the artist's studio. Inness then reworked passages, in the process de-sanctifying the city of Jerusalem by painting out specific references (such as domes) and making it appear more like a manor house in a bucolic landscape.

To prove this theory, all three paintings were scientifically examined under the polarizing microscope and with X-Rays, X-ray Fluorescence and FTIR (Fourier Transfer Infra-red).[7]

X-rays revealed that the canvas weaves of all three paintings were identical, down to the thread count per square inch and odd inconsistent placement of thick and thin threads. X-rays also clearly revealed evidence of damage such as randomly placed tears and holes.

Samples of green paint from the three landscapes revealed the same layer build-up as did the samples from the yellow sky in the two paintings with skies.

Under infra-red illumination the areas Inness had re-worked in the 1880's (an ochre/orange color in visible light) showed up distinctly. This painting technique was somewhat freer as well and the paint was applied with a wider brush.

Pigments and media were analyzed with X-ray Fluorescence and FTIR. Based upon their elemental content, similar colors of green and ochre from all three paintings were found to be comparable. The composition of the paints was so similar as to be considered a match.

TREATMENT

With the help of the other two fragments and cross-sectional analysis, I was able to restore the Walters badly damaged picture.

First I completed cleaning our picture by thinning the older, discolored varnish where it hadn't been entirely removed in earlier treatments. Discolored retouching added after Inness's restorations were removed under magnification.

Inness's distinctive painting technique, whereby he created unique colors and color combinations, could be understood more clearly by studying paint cross-sections. Transparent, semi-transparent, and sometimes opaque paint was applied thinly allowing the color below to impart an undertone or in some cases show through the top layers. The many layers were worked, rubbed away, occasionally varnished, and repainted numerous times. In this way, the artist felt that he could present the true appearance of nature, true in a spiritual as well as a physical sense.

Cross-sectional analysis provided the information necessary to devise a method to inpaint the losses in the Inness. When the individual layers of color in the paint sample were mixed together, the color did not resemble what appeared on the surface of the painting. Closer examination of the cross-sections revealed that the layers did not bleed into each other. With that in mind, I developed a system using three different paint mediums that would not bleed into each other when applied in succession. For example, in the yellow sky, I first built up a pink layer with inks. When that dried I applied a blue layer with acrylics; once that layer set I added yellow in a solvent-based system. By applying paints in different mediums, the layers did not blend into each other but intoned a color that could not be reproduced in an ordinary manner.

Additionally, with the continuity of design from the other fragments informing the design of the overall work, I could restore the overcleaned layers in the Walters damaged painting.

With the restoration complete, scholars could once again see this important painting from a pivotal series from Inness's career, a painting considered lost for over 125 years.

A MISSING PIECE

Dr. Quick mentioned in passing that he remembered seeing another small painting that could possibly be from *The New Jerusalem* in a gallery in New York City years ago. He had a photo of the painting, but apparently the gallery had closed and its owner had died. The painting, like *Evening Landscape,* had no horizon line, indicating its status as a fragment. The accompanying photograph is our only record of another possible piece of puzzle which most likely would fit in the bottom left corner of the painting.

APPENDUM

In December 2007, the private collector who owned *Visionary Landscape* donated the painting to the Walters.

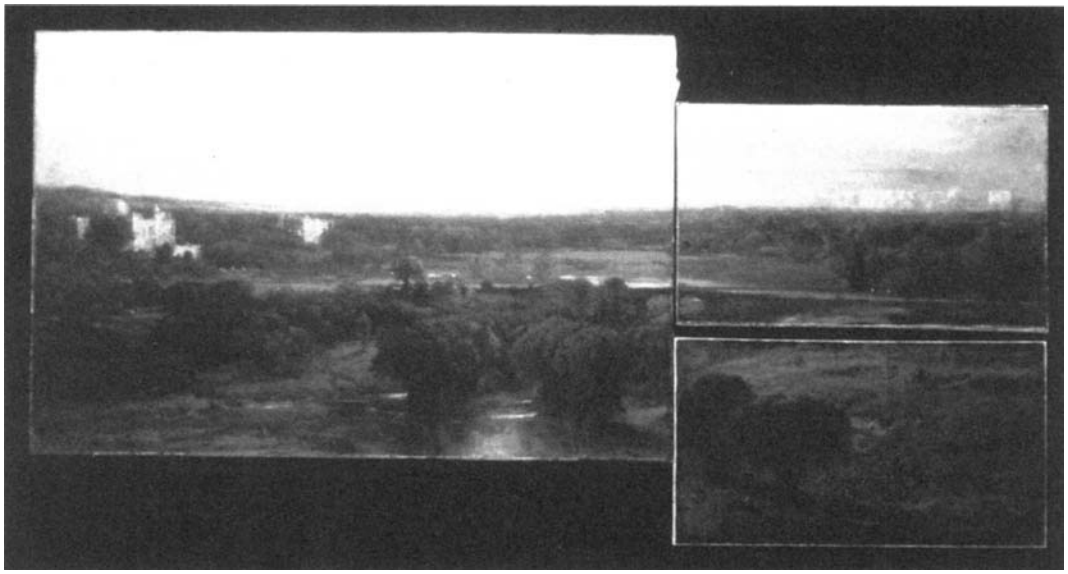

Fig. 1 Three fragments from The *New Jerusalem* (UL: *The Valley of the Olive Trees*, WAM, Baltimore, MD; UR: *Visionary Landscape*, private collection; LR: *Evening Landscape*, Krannert Art Museum, Champaign-Urbana IL)

Fig. 2 Possible missing fragment from *The New Jerusalem,* location unknown.

ENDNOTES

[1] The Evening Post, April 22, 1880, "The Morning News, A Shocking Calamity."

[2] The New York Times, January 5, 1895, "Inness Work Judged by an Artist."

[3] Kevin J. Avery, The Grand Moving Panorama of Pilgrim's Progress, Montclair Art Museum catalog, 1999, p. 17.

[4] George Inness, Junior, *Life, Art, and Letters of George Inness*, p. 68-69.

[5] The New York Evening Post, July 2, 1867, "Fine Arts."

[6] November 2002, taped conversation for documentary, "Search for the New Jersuslem."

[7] Miroscopic and Infra-red examination and X-Radiation were carried out at the Walters; X-Ray Fluorescence and FTIR were carried out by Jan Carlson at the scientific laboratories at the Winterthur, University of Delaware conservation program.

A BRONZINO WORKSHOP PORTRAIT OF ELEONORA DI TOLEDO

Rikke Foulke

ABSTRACT - A Bronzino workshop portrait in the collection of the North Carolina Museum of Art depicts Eleonora di Toledo around 1560 in a three-quarter length standing pose in a dark and limited palette. There are numerous versions of this portrait, with the most notable and frequently cited versions in collections in Berlin, Vienna, and Washington, D.C. Scholars have not yet reached a consensus on the authored prototype of this series. This study presents the findings collected by the survey of the infrared reflectograms and x-radiographs of these four variants. Technical studies were examined specifically to look for traces of the artist's hand in creating these portraits. The objective of this study is two-fold: firstly, a survey of the physical characteristic and underdrawings puts the quality of the North Carolina portrait of Eleonora in context with the other versions; secondly, the survey compares the techniques in the portraits with techniques identified in other Bronzino paintings and, from this comparison, identifies a practice and technique of making portrait copies. Findings from this study offer explanations of the unique, dark palette of the North Carolina composition.

THE PORTRAIT

The North Carolina Museum of Art acquired a Bronzino workshop *Portrait of a Medici Princess* in 1964 through a bequest from a private collector. (Figure 1) The princess is now recognized as Eleonora, a member of the powerful Aragón family and daughter of Don Pedro de Alvarez di Toledo, viceroy of Naples. She wed Cosimo I de Medici, Duke of Florence, in 1539 and is recognized as the Grand duchess of Florence and Siena. Eleonora gave birth to many children, including two daughters whose marriages to noble families fostered advantageous connections and two sons, Francesco and Ferdinando, who lived to reign as grand Dukes themselves, to establish a New Medici Dynasty. In this portrait the Grand duchess is shown in a knee-length standing pose. The provenance of the painting is not established with certainty and reaches only to the first half of the 19th century. Until 1839 it had been in collections of Lucien Bonaparte, Prince of Canino in Rome and/or possibly in a private collection in Bologna. Prior to acquisition by the museum in Raleigh from the private collection it was known to be in the Holford Collection until 1927. This work was last published in 1981 in Karla Langedijk's two-volume compilation *The Portraits of the Medici* and was identified as a copy after Bronzino with "whereabouts unknown", but it was presumed to be in a private American collection.[1] The origin, commission and authorship of the painting are presently unknown, but Andrea Emiliani in 1960 and Edi Baccheschi in 1973 believed it to be a Bronzino workshop copy of an unidentified original Bronzino, possibly the Berlin version of the portrait.[2]

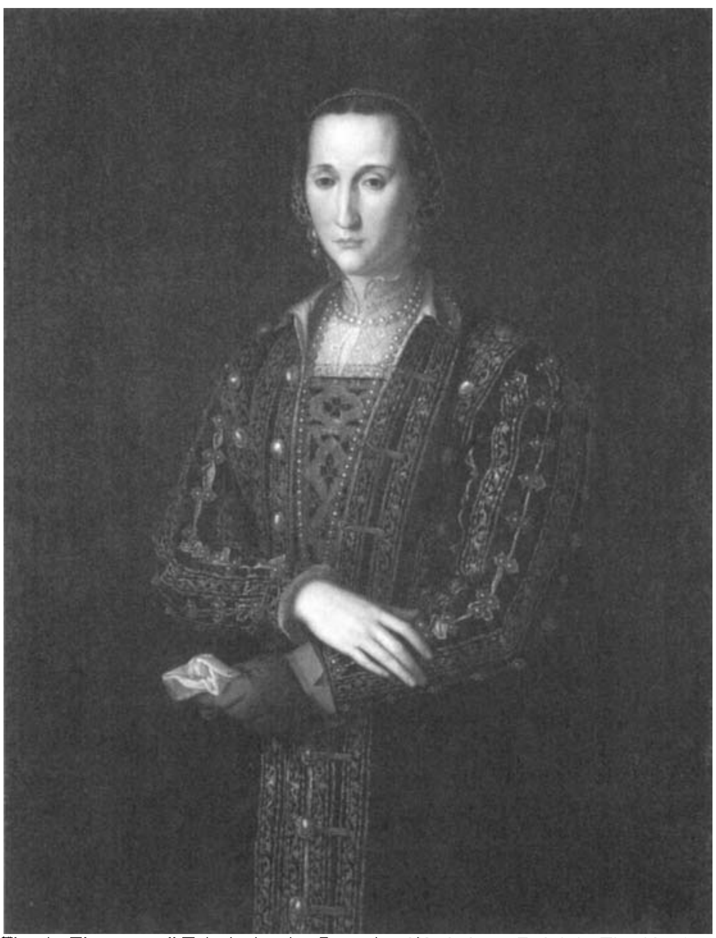
Fig. 1 *Eleonora di Toledo,* by the Bronzino Workshop, Raleigh, The North Carolina Museum of Art. Inv. No. 64.35.5

This essay briefly discusses the artist Agnolo Bronzino in the Medici court, the practice of making copies in the reign of the Medici, and introduces and compares the multiple versions of the late *Eleonora* portraits. Lastly, this study introduces the possibility that the technique of tracing was used in making the numerous images and this technique may contribute to the visual appearance of the painting.

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Eleonora's likeness was captured numerous times by Agnolo Bronzino throughout his long employment at the Medici court. The artist's most widely known portrait of the duchess hangs in the galleries of the Uffizi and depicts her at age twenty-three, in a white dress, with her son at her knee. Duke Cosimo I and the duchess commissioned many works from Bronzino, with portraits often sent as gifts to advertise and promote the duke and his realm, or were made for the duke's personal collection to commemorate significant dates or accomplishments. Some portraits were commissioned to hang in the *Guardaroba*, such as the *Eleonora with Don Giovanni as a Child* from 1545, identified by Giorgio Vasari in a 1560 inventory. Another original of Eleonora from 1561 was sent to Spain, and a copy was made to hang in the gallery of the *Guardaroba*.[3] The routine duplication of original portraits was even authorized by Duke Cosimo I. In one such account, the duke viewed the newly finished portrait of himself in armor and ordered it to be sent to the Holy Roman Emperor Charles V. When Bronzino then proposed to paint a second, more beautiful portrait the duke replied, "I don't want one more beautiful. I want it done exactly the way it is already."[4] This encouragement from the duke may have contributed to the twenty-five versions of the portrait of *Cosimo I in Armor*, the original dating to around 1545. It would also help explain the numerous copies of the portrait of *Eleonora with her Son* and the late portrait of Eleonora addressed in this study.

Unlike the earlier youthful portraits, Eleonora's face is gaunt and her expression is vacant in all known examples of this late portrayal. Her bearing shows the signs of tuberculosis of which she started showing symptoms as early as 1552. This portrait is unique in the starkly realistic portrayal of the duchess' weakened state of health prior to her death, along with two of her sons, Giovanni and Garzia, in Pisa in 1562 from malarial fever.

The portrait owned by North Carolina is one of ten versions, with the most notable and frequently cited versions in collections of the Gemäldegalerie in Berlin; the Kunsthistorisches Museum in Vienna, exhibited at Schloss Ambras in Innsbruck; and the National Gallery of Art in Washington, D.C. It is these more frequently cited works that were selected for closer examinations as comparisons for the Raleigh work. Scholars have not unanimously reached a consensus on which is the original prototype in the hand of Bronzino and date the original commission of this portrait anywhere from 1555 to 1562, the year of her death, and even later, possibly as a posthumous work. Scholars base their conclusions on the size of the portraits, the refinement of the hands or how the work relates to other portraits from the same period.[5] Additional versions of the portrait are found in collections in Dresden, believed to be lost since World War II; Poggio Imperiale, Florence; Museo Bardini, Florence; Ashmolean Museum, Oxford; a private collection in Fiesole; and the National Museum of Warsaw.[6]

The portraits capture a cool, detached and stately figure, a pictorial formula with which Bronzino found great success. The variations exhibit differences in dimensions, positions of hands, and details of costumes. Remarkably, the painting in the North Carolina collection is the only composition with a black dress and brown background; in all other versions the duchess wears a red costume against a red and curtained background. Combined with x-radiography and infrared reflectography, the examinations reveal the comprehensive differences in the lower layers and construction of paint not readily detected in the visible painted surface; whether there is a modification in the tilt of the head, slendering or correction of the fingers or shift in perspective, such adjustments show the artist's thinking process as he works towards the final composition in paint. Likewise, a workshop may use specific, identifiable and consistent practices to duplicate works that, through technical studies, become apparent and recognizable. Characteristics to support the makings of an original design would also present themselves.

AUTHORED PORTRAITS AND WORKS

A ubiquitous presence of Bronzino's revisions in allegories, frescos, religious scenes or court portraiture is familiar to modern curators and conservators and identifies the working method of the artist as self-critical and one continually in evolution. For example, infrared reflectogram details of the face of Mary Magdalene in Bronzino's *Lamentation* of 1545 at the Musée des Beaux Arts in Besançon, France were published in Cox-Rearick's *Chapel of Eleonora at Palazzo Vecchio* and show the adjustments in the positions of the eyes and mouth and tilt of the head. Our colleagues at the National Gallery of London, Carol Plazzotta and Larry Keith, looked more closely at earlier technical studies of Bronzino's *Allegory* of 1540 – 50 to demonstrate and discuss the artist's dramatic changes in figures and the relationships between them.[7] Robert Simon presented a line drawing of a composition dramatically different from the painted image of a *Portrait of Cosimo I de' Medici*.[8] Similarly, our colleagues Scott Heffley from the Nelson Atkins Museum found dramatic changes in *Portrait of a Young Man*;[9] and Beatrix Graf from the Gemäldegalerie in Berlin found a change in perspective of the *Portrait of Ugolino Martinelli*.[10] Furthermore, a contemporary critique in the form of a letter from historian Vincenzo Borghini to Giorgio Vasari in 1551 confirms the artist's reworkings seen in modern technical studies: Bronzino "made some significant retouchings, in fact, a total reworking of the composition," (Bronzino "*ha fatto un gran ritoccamento, anzi pur mutamento nelle sua tavole*").[11] Modern scholars found that, even after careful planning through sketches, the artist made significant changes in a composition; he finished areas to a very high degree, only to completely alter the position of the figure at a late stage. These changes identified as intrinsic to Bronzino's working method are examples of modifications sought after in the preparatory underdrawings of the Eleonora works. Nothing of this magnitude was discovered in the course of the examination of the *Eleonora di Toledo* series; the changes observed in these cases are on a smaller scale, and may suggest the role of the workshop or the conditions of the commission of the painting.

THE FOUR VARIANTS

The Gemäldegalerie in Berlin purchased the portrait *Eleonora von Toledo* in 1890 in Florence. The majority of historians single out the Berlin work as the one executed by Bronzino's hand.[12] This small portrait (Inv. No. 338b) measures 42 x 38 cm and depicts the head and half the length of the bust with the proper right hand resting on a parapet and holding a handkerchief. The object is preserved on its original, unmodified panel that consists of two vertically oriented planks of wood. Visual examination of the Berlin panel reveals a construction of multiple paint layers applied with short strokes. Technical examination reveals a clear and direct expression of the contours in the underdrawing. There is a lack of significant modifications in the composition and the lines consist of both dry and wet media of different weight and quality. Visible with the naked eye, but confirmed in both x-radiography and infrared reflectography, is the presence of substantial damage in the background behind the head.[13] Fine, featherweight lines in the hand show slight adjustments in the contours. No internal modeling is detected, nor is there evidence of pouncing or grid marks.

Notes from scholars in the curatorial files state that, in the x-radiograph, the neck appears to have initially been painted "naked", or unadorned, and the costume executed over the finished layer of flesh tones. The x-radiograph shows a difference in the building of paint layers and a difference in contrast between the lace and skin in the areas of neck and chest.[14] The speculation that the neck was initially painted naked is noteworthy due to a prevailing practice in the mid sixteenth century of making casts of from the faces of the figures upon their death to better imitate nature. Cennino Cennini described the technique of making casts from faces and whole figures at the end of the 14th century,[15] but in *I Ragionamenti e le Lettere*, Giorgio Vasari praised Andrea del Verrocchio for routinely using this technique to his advantage to effectively create the life-like appearance of sculptures throughout the Medici galleries.

> *". . . . ma molte più se ne fece quando fu trovato da Andrea del Verrocchio, scultore, il gittare il gesso da far presa, stemperato con l'acqua tiepida, e gittato in sul volto a' morti, che facendo spora quelli un cavo, e rigittando del medesimo gesso, ungendo prima la forma, o veci con terra fresca, in quell tanto che il cavo s'impressi, di relievo veniva la forma del viso, come so che Vostra Eccellenza sa, che avete visto formare di molte cose: la qual' comodiai e' stata cagione di render vive le persone morte nella effige loro."*[16]

In 1992 scholar Gabrielle Langdon proposed the possibility that these late *Eleonora* portraits were also based on studies from a death mask after which the portrait was "revivified" by capturing details of the sitter from and earlier portrait. Langdon found in a study of Pontormo's *Portrait of Maria Salviati* that, among other characteristics, the facial features of the elongated nose, hollowed and expressionless eyes, and sunken cheeks were the effects caused by the weight of the casting materials on the cadaver's face. Langdon's description, too, of the *Portrait of Maria Salviati*: "a remote gaze, monumental pose, and erect carriage make her a compelling but distance presence.... [The] features have been abstracted, idealized, and shorn of vivacity and reference to age," could suitably be applied to characterize the appearance of the duchess in the late portraits. These descriptive features and the unconvincing alignment of the head over the torso are consistent with posthumous portraits and would support a proposal of the series as posthumous works.[17] In this case, the Bronzino *Portrait of Eleonora with her Son Giovanni* from 1544 – 45 at the Uffizi in Florence would most likely serve as the earlier example to translate into a more life-like appearance in the posthumous work. Although speculative, if true, this hypothesis could support the Berlin painting as an original work and would date the series to no earlier than 1562, the year of Eleonora's death. Should the Berlin work be the original in this late depiction of the duchess, the condition captured here establishes the prototype for all others that follow. And the posthumous circumstance of making the work may contribute to the lack of significant changes.

The portrait *Eleonora di Toledo von Toscana*, in the collection of the Kunsthistorisches Museum (Inv. No. 1033) has slightly larger dimensions than the Berlin version, measuring 63 x 46.5 cm. With the same pose, that is, one with a curtained background and depicting the head and half the length of the bust with the proper right arm resting on a parapet and holding a handkerchief, it is generally considered to be a copy of the Berlin portrait. It has been identified either as workshop, or as a weak later version.[18] The features have been significantly idealized in this version and examination with x-radiography of the Kunsthistorisches Museum panel reveals a wooden support with an irregular and wavy grain, riddled with knots. A strong texture from a ground application is visible in the x-radiograph, and was likely to have been applied so thickly to smooth out the texture of the poor quality of the wood. The paint application has a direct manner of building up the image and no traces of revisions, or *pentimenti*, are present. The poor quality of the panel support would be a significant consideration in evaluating the quality of the portrait; the selection of a support riddled with so many knots and a grain characterized with such irregularity would hardly be appropriate material used by the court-appointed painter to capture a likeness of the duchess, and further substantiates the status of the portrait as a copy. Since the underdrawing was found to be congruous with the painted image, slightly visible in thinly painted passages, and neither grid- nor pouncing-marks were observed, an infrared image was not captured by the lab. The prominent underdrawing lines are found in the eyes, nose, mouth and contours of the face.

The *Eleonora di Toledo* in the National Gallery of Art in Washington (Samuel H. Kress Collection Inv. No. 1961.9.7), is larger in format, 86.4 x 65.1 cm, and depicts the duchess over half-length and sitting. She holds the handkerchief in a gloved proper left hand. Scholars are not of one consensus on the attribution, and credit it to Bronzino or as a workshop variant.[19] X-radiography shows that the portrait was executed on two vertically oriented pieces of poplar, now thinned and cradled. Application of the paint as shown in the x-radiograph is very loose in the background, and although the hand is defined with convincing volume, the treatment of the paint is stiff and linear, with features and contours rigidly placed. The underdrawing reveals the use of both wet and dry materials. Infrared reflectography reveals a sketch that captures far more details than any of the other works in the series.[20] Multiple lines indicate the circles and bone structure around the eyes, edges of the brows and nose, and contours of lips. In the hands, additional marks identify the placement of joints. No grid lines, pouncing marks, nor lines of internal shading are detected.

The North Carolina Museum of Art possesses the largest composition of *Eleonora di Toledo*, at 114.5 x 86.5 cm (Inv. No. 64.35.5), depicting the duchess nearly full length and standing. Like the Kress panel, Eleonora holds her handkerchief in a gloved proper left hand. Originally painted on panel, the gesso and paint layers were transferred to canvas prior to its acquisition by the Museum.[21] Scholars identified it as a workshop variant, probably copied after the Berlin work.[22] Despite the aggressive and invasive nature of earlier structural treatment, the underdrawing of the portrait was preserved between the gesso and paint layers. The infrared reflectogram shows the use of a variegated line. (Figure 2) Lines depict the face and figure in as few lines as possible, in both wet and dry media. In some areas, such as proper right side of face, under the chin, hand, and proper right arm the contour is doubled, but not congruous. Grid lines, pouncing marks and internal shadowing were not detected in infrared reflectography. The x-radiograph of the painting shows a direct and careful manner of building up the image and flesh tone; after execution of the underdrawing the background was painted first with a reserve left for the figure. Technical examinations of the Raleigh portrait reveal no evidence of major revisions from a creative process, but minor adjustments in details around the face and hands support that the work could be a product of the workshop. These technical findings confirm what scholars were already speculating – the likelihood that is it a product of the workshop.

Fig. 2 *Eleonora di Toledo,* Infrared Reflectogram, Raleigh, The North Carolina Museum of Art.

Fig. 3 *Eleonora di Toledo,* four underdrawings superimposed.

Although the compositions examined from the collections in Berlin, Vienna, Washington, and Raleigh exhibit a wide range of dimensions, the sizes of the faces seemed to change very little. To fill the fields in the backgrounds, extra length in the torso and width in the shoulders were expanded or abbreviated to different degrees. Since not all the compositions contained the whole figure, measurements were taken from each face to make an empirical comparison of the portraits. To determine the congruency of the underdrawings, the contours of the underdrawings were superimposed in Adobe Photoshop by aligning the measured elements and allowing the other facial features to fall into place. (Figure 3) Measurements were nearly identical, being only a millimeter or two off in any of the points, which are notable consistencies, given the range in dimensions of the objects. In the diagram, underdrawings from the different compositions are marked in different shades of grey and labeled in the key. Exact alignment begins to fail at the hairline, outer contours of mouth, pearls, and white collar. The differences do not stop with the small details; in a comparison beyond the facial features, the axis of the sitter and the face differ almost indiscernibly from one composition to the next, and the torso dimensions vary slightly in a stretching of the length or truncation of the torso, primarily due to the varying dimensions of the supports.

The authorization for Bronzino to paint exact replicas of portraits was documented, but unfortunately how Bronzino or his workshop carried out the task is not known. It would be safe to say from observed differences in character of the paintings and the underdrawings that more than one copyist profited from the Eleonora portraits; there were many active in the mid-sixteenth century capable of generating the additional works.[23] In fact, there was a 16th century practice of workshops employing craftsmen specializing only in the transferring of images and cartoons.[24] On the occasion that the artist would have to multiply the works, there were several means at his disposal to render multiple copies from an original work: pouncing, squared grids, and tracing.

THE COPYING TECHNIQUE

Although Bronzino was known to have worked from preparatory drawings, there are no known drawings for the portrait of *Eleonora* to confirm or invalidate the use of a cartoon.[25] Nor were marks from grids or pouncing observed in underdrawings from the variants. The lack of grid lines and pounce marks in the technical evaluations of authored portraits, as well as *Allegory* of the National Gallery London and Detroit's version of *Eleonora with Her Son*, support the familiarity of tracing of Bronzino and his workshop.[26] Among the different copying techniques, tracing may be the means of copying most difficult to detect in the preparatory layers of a painting. Tracing is a mechanical process that yields near perfect conformity of contour lines on a 1:1 scale. This advantage was recognized by humanist Raffaello Borghini in his discussion of tracings from 1584 with biographer and man of letters Francesco Saverio Baldinucci: "*così à punto che paiono qulle stesse*" ("in this way they seem the same").[27] Our understanding of the tracing process comes to us through a number of earlier manuscripts that include Cennino Cennini's *Il Libro dell'Arte*, which dates to the end of the fourteenth century; Vicente Carducho's treatise *Dialogos de la Pintura* of 1633; the manuscript *Modo da tener nel dipingere*, written by Gian Batista Volpato, from the end of the seventeenth century; and Antonio Palomino de Castro y Velasco's *El Museo pictórico y escala óptica* from the first quarter of the eighteenth century.[28]

The basic technique is as follows: the copyist initially prepares parchment by rubbing oil into it to make it transparent. The copyist either dusts the back of the paper with charcoal or brushes transparent oil glazes directly to the contours of the original painting. The copyist temporarily fixes the transparent paper to the work being copied and traces the contours with a pencil or bone stylus. By penciling the contours, the charcoal or paint adheres to the back of the paper where corresponding contact was made on the face. The copyist then presses the oiled paper onto to a newly prepared panel and, by rubbing or re-tracing the lines, transfers lines of the contours from the original.

Tracing was recognized early on as a process that resulted in serious damage to the original painting. After the pigment and oils were applied to the original, the residue left behind had to be cleared with cloth or solvents. Some cleaning measures may have been carried out on works completed only a short time prior. There would also be mechanical damage from repeated pressure to the contours, especially when a work was replicated multiple times. For example, according to 17th century accounts, the "spoiled and blackened" ("*guasto et anerito*") surface of Titian's *Martyrdom of Saint Peter* arose from tracing. Gian Batista Volopato, a critic of the practice, argued that the "sacrilegious blockheads" ("*sacrilegi e sgratiati*") who made such practices of tracing "should have their hands cut off for spoiling such gems". Volpato advised, too, that proper respect should be given to beautiful pictures and the practice should be forbidden. Coincidentally, this Titian painting is now lost, but at the time of Volpato it had been sent to Paris to be cleaned.[29]

The material evidence of the underdrawings also points towards the technique of tracing. Neither pouncing and nor grids were present in any of the paintings. The use of different media, that is, dry and fluid materials in the underdrawings along the contours may result from a transfer process. That is, after the initial tracing, contour lines may have some skipping or weakness, and are reinforced in a different medium.

THE DARK PALETTE

The Raleigh work is the only portrait examined in the series with a brown and black palette resulting in a portrait with remarkably little contrast between the figure and the background. From samples taken from the costume and background of this version traces of faded red lake were found, which confirm that the appearance of the portrait we observe today is not representative of the original palette. Furthermore, cross-sections sampled from the North Carolina portrait confirm minute traces of an opaque red layer, still visible in discrete areas along the edges. The pigments were identified as vermilion and a red lake by polarized light microscopy. Of course, coupling the identification with additional analytical methods would be worthwhile. In addition to the fading of the red lake, materials and solvents -- used to apply an oiled paper and pigments, and later used to remove residue -- may have contributed to the damaged condition of paint and glazes that toned the background. As a result of personal experience with the painting and the examination of the different versions of this late portrayal of Eleonora, it is believed that fading and these unfortunate practices explain the appearance of the portrait today.

CONCLUSIONS

The Eleonora portraits, united by costume, poses, and identical sizes of the faces, allowed an empirical comparison by superimposing the underdrawings. Naturally there are weaknesses in a comparison of the portraits by underdrawing alone, and this study does not venture to be definitive. Secure records of provenance of each portrait and stylistic comparisons of the painted surfaces contribute to the arguments. Although not conclusive, results from technical examinations of the Berlin portrait support the likelihood that it was the prototype from which other late Eleonora portraits were made. The discovery of minor refinements in contours of the hands and application of multiple layers of paint supported a steady working process. It would be possible too, that a tracing from a cartoon could have also been used in the making of this prototype. Technique observed in the x-radiograph linked the portrait to contemporary practices of the making of portraits from death masks and Vasari's *I Ragionamenti e le Lettere* attributed the success of the portraits in the Medici galleries to the technique. Moreover, Robert Simon, a scholar who carried out the extensive research on the numerous versions of *Cosimo I in Armor* concluded that a larger composition, depicting the figure full length or sitting, is less likely than a bust-length work to be the original in a series of copies, supporting further the prototype status of the Berlin work.[30] Connoisseurship studies by scholars already favored the Berlin work as the strongest portrayal of the duchess. The technical examinations do not conclude that Bronzino painted the Berlin work, but the Gemäldegalerie portrait is a strong enough contender to be considered, if not the hand of Bronzino, at least a product of the Bronzino workshop. Should the Berlin *Eleonora* portrait be the original, it was commissioned at a time in Bronzino's career when his most gifted pupil, Alessandro Allori (1535 – 1607) was already established in the master's studio. So similar in technique, and so closely the master and pupil worked, it is often too difficult to distinguish the hand of each artist in any given painting, as could be the case of the Eleonora portrait in question.

These findings generally concurred with the opinions of the historians and this research aimed to contribute to the discussion of the series. The character of the underdrawing and the material evidence support the likelihood that the North Carolina portrait is a sixteenth-century portrait from the workshop of Bronzino. Technical examinations reveal minor revisions in the face, head, hands and arm that confirm the participation of a critical eye in the completion of the portrait. It is possible that the Raleigh work was used as a template from which other works were based, but it is not yet clear which works were based on the Raleigh variation. Though transferred and damaged and having lost its original palette, and though it is not a portrait in the hand of the Florentine Master, the attention given to placing the painting in the context with the other portraits is an introduction to the series and the reader has a better appreciation for the role of Bronzino and his workshop and the use of other 16^{th} century workshop practices in the making of the Medici court portraits.

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13 Infrared images were captured by traditional infrared-sensitive black and white film and, in this case by Christophe Schmidt with a Hamamatsu camera, most sensitive in the range of 0.9 – 1.4 µm region.

14 Langdon, G. and Dr. Schleier, E. 1993. The correspondence is between Gabrielle Langdon, art historian at the University of Western Ontario, Canada, and curator of Sixteenth and Seventeenth Century Italian Art, Dr. Erich Schleier. The original comment arises from the curator's observation of the infrared reflectogram, but in this recent survey the x-radiograph appeared to support the curator's comments regarding the "naked neck". The x-radiograph confirms a distinctive difference in handling of the paint in the areas of the neck and top of the chest. However, the notion that the neck was initially painted unadorned is speculative. The difference in appearance of the paint layers could also be explained by the quantity of x-ray opaque materials, such as lead white, added into the mixtures of paint in the face. Lace in the area of the neck is depicted in shadow and therefore has lower content of white added to the mixture, but more white is used to delineate the lace at the top of the chest.

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16 Vasari, G. *I Ragionamenti e le Lettere: la descrizione del l'apparato per le nozze del Principe Francesco de' Medici.* 1878. Sansoni. (VIII) Florence: 87 - 88.

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18 McComb 1928, as a weak copy; Baccheschi 1973, as a weak copy.

19 Langedijk 1981, as Bronzino workshop; Berenson, B. 1957. *Italian Painters of the Renaissance. Florentine School*, I, as Bronzino; Emiliani 1960, as Bronzino; Costamagna 1988, as Bronzino.

20 Notes from conservation files and personal analysis of infrared reflectogram. The Conservation Department of the National Gallery of Art in Washington was using an infrared digital Mitsubishi M600 camera with a platinum-silicide detector, configured to 1.2 – 2.5 µm region.

21 It is important to mention the material history of the portrait in the North Carolina collection due to the extensive damage to its surface. The sale catalogue of the Holford Collection from 1927 identifies the media in the portrait of *Eleonora* as oil on panel. In an undocumented restoration that probably took place in the second quarter of the twentieth century, the gesso and paint layers were transferred to canvas. Remnant traces of wood splinters found along the edges were identified as poplar in conservation records.

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25 Numerous examples of Bronzino's oeuvre show squared grids superimposed over preparatory drawings, including studies for pictorial presentation for the Chapel of Eleonora at the Palazzo Vecchio and portrait drawings. Preparatory sketches with grids include the black chalk drawing of the *Portrait of the Head of Dante*, Munich, Graphische Sammlung, later executed in paint in *Allegorical Portrait of Dante*, National Gallery of Art, Washington, D.C.; a *modello* for the *Annunciate Virgin* in the Chapel of Eleonora, which shows a squared grid carefully drawn over the figure to enlarge it for the scale of the fresco; and the black chalk study of *A Young Man with a Lute*, Chatsworth, Duke of Devonshire Collection.

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EUGÈNE LEROY'S PAINTINGS: SOFT MATTER AND GRAVITY. THE SINGULARITY OF SOFT WORKS.

Grazia Nicosia, Conservator of Paintings, Director of LECRA

ABSTRACT-The intent of the article is to introduce the notion of soft matter as a state of pictorial material in contemporary art by a concrete study of the works of Eugène Leroy. His paint layer only polymerizes on the surface. The dual state of the painted material is solid and soft. Softness is characterized by a lack of cohesion in matter and a low mechanical resistance to stress. The soft matter modifies the essence of the work, allowing us to discern alterations with the introduction of gravity as a constitutive element of the work.

1. THE EUGÈNE LEROY'S WORK

Eugene Leroy (1910-2000) is a contemporary French painter who painted with linseed oil on canvas. Chronically dissatisfied with his work, he would tirelessly restart the composition completed the day before. Some of his paintings have been worked on for over twenty years. He strove to capture the luminescence of colour, and desired that the colored paste itself becomes a source of light[1]. This tireless quest led him to build his works through a succession of coloured layers.

The more the years advanced, the more the matter was heaped upon the canvas. During the Eighties he abandoned the palette and sometimes even the brush to use the colour directly from the tube[2]. These works then became completely singular. The layer, painted without a drying agent, is composed of heaps of pure juxtaposed colours. It sometimes exceeds 1.6 inch in thickness and exudes a strong odour of linseed. *G*[3], an oil on canvas mounted on a stretcher of 76 x 51.6 inches painted in 1995, weigh approximately 200 pounds. Only the surface layer polymerizes in contact with oxygen thus creating a quasi gas-tight layer which hinders the solidification of the deep layers. A solid "crust" eventually floats on viscoplastic matter. The painted layer is thus composed of two states of matter: soft and solid. This material composition gives a particular rheological behaviour to the work. Although the artist never desired this state, he was completely conscious of it and used it as a way of creating. He sometimes pierced the crust several years later, to blend a new colour with that of the original work[4].

Fig. 1 Eugène Leroy, detail, *G*, 1995, oil on canvas, 193 x 131cm, Collection du Fonds national d'art contemporain, ministère de la culture et de la communication, Paris. The state of the painted material is thus in a biphase, solid and soft, and develops a mobile behaviour. That is a solid layer floats on the soft matter.

How do we grasp these folds of matter that are linked to time and gravity? We must understand the correlation which is established between the displacement of matter and time in his work.

2. THE FOURTH STATE OF THE MATTER: THE SOFTNESS

Before the nineties, the soft matter was perceived as an intermediary state between the liquid and the solid. It then became the Fourth State of Matter. It is characterized by mechanical characteristics both physical and optical. The research of Pierre-Gilles de Gennes on this subject is awarded the Nobel Prize of physics in 1991[5]. Pierre-Gilles de Gennes likes to define soft matter as clay that a sculptor can mold with

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Fig. 2 Eugène Leroy, detail, *G*, 1995, oil on canvas, 193 x 131cm, Collection du Fonds national d'art contemporain, ministère de la culture et de la communication, Paris.
The folding of the painted material

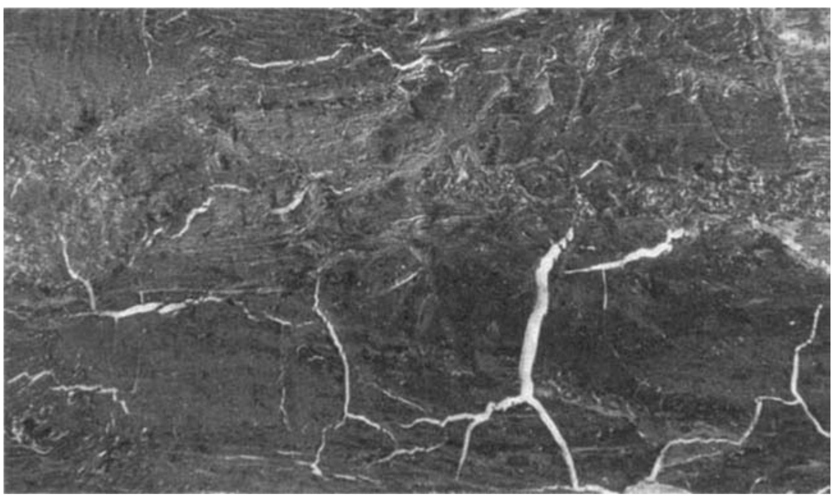

Fig. 3 Eugène Leroy, detail, *Chaîne d'aveugles,* 1960, oil on hardboard, 52,5 x 65 cm, La Piscine, Musée d'Art et d'Industrie, Roubaix
The drying cracks

Fig. 4 Eugène Leroy, detail, *Pour Maxime,* 1987–1990, oil on canvas, 162 x 130 cm, Collection du Fonds national d'art contemporain, ministère de la culture et de la communication, Paris.
The sliding of the painted material

a very weak force[6]. The soft matter is, among other traits, characterized by a chronic lack of cohesion which causes a low mechanical resistance to the constraint.

3. THE MORPHOLOGICAL MODIFICATIONS OF THE SOFT WORKS

The deficiency of the intermolecular bonds of the soft matter combined with a distinct type of internal stress generates specific modifications to the texture of the painted layer. Like drying wrinkles, the drying cracks represent the gravitational flows of the matter.

The analogy which we make between the drying wrinkles and the ageing skin wrinkles is completely founded. In the present case, the dimensions of the coloured film increase during the process of polymerization, so that the differential of this dimensional ratio causes a lateral compression of the upper layer and generates an undulation of the upper stratum which is turned perpendicularly to the compressive force.

The drying cracks correspond to a structural break of the matter that generates a dividing up of the solid stratum and a lateral displacement of the coloured layer on the soft matter. The lack of cohesion of the deep layers does not offer any resistance to this contraction; the surface film, thus parcelled out, literally slips on the underlying layers which are still liquid.

The gravitational flow corresponds to a gradual displacement of the matter; this causes an undulation of the pictorial layer which turns perpendicularly to the force of gravity.

The heart of the pictorial layer still remains soft; it presents little resistance to the sheer stress caused by the matter's weight. This deformation generates a gradual sliding of the matter that is proportional to its mass and to time.

4. THE SINGULARITY OF SOFT WORKS.

The soft matter creates a soft work which evolves independently from the painter's brush stroke. The foldings caused by the gravitational flow of the deep layers of the matter change the texture of surface and directly modify its aspect.

Cesare Brandi sees in the patina the "testimony of passed time"[7], perceived like "the sedimentation of time on the work"[8], dependent on the double historicity of the object. The process of gravitational flow of the matter of soft works, here, can be compared to the concept of patina in traditional painting.

The soft matter has the potential to displace due to its weight and the passage of time. The more time passes, the more the phenomenon of folding is pronounced and the more the work is "wrinkled". They are kinetic works whose matter flows out according to time. The foldings of matter thus express a temporal rhythm, which is associated with the concept of displacement and with that of time.

5. THE CONSERVATION OF THE SOFT WORKS

The conservator acts on the object to reduce the effects of time. His intervention, however, must respect the nature of the work, which resides in its "softness". Gravity being proportional to the mass, the position of storage of work is one determining element of the manifestation of the phenomenon. To store in reserve this type of works to horizontal, with a back protection, modifies the orientation of the forces. The mass subjected to gravity is then proportional only to the thickness of the matter and not to the totality's height of the painting. The phenomenon of creep is thus undervalued.

Moreover, the flow is directly proportional to the viscosity. Given the same constraint, the more the liquid is viscous the more the flow is slowed down. The higher the viscosity, the stronger the intermolecular interactions. This increases its resistance to gravity's sheer force the viscosity of the pictorial matter of a work is not directly controllable. It depends, however, on the temperature: we know that its rise decreases it. To slow down the flow, it is thus necessary to lower the temperature in conserving these works to increase the viscosity of the pictorial matter.

6. CONCLUSION

The morphological modifications posterior to the creation inevitably do not correspond to deterioration. This chronic lack of cohesion creates a considerable brittleness of the painted matter that morphologically changes with the least stress. Certain aesthetic modifications are intrinsic to its essence and correspond to a natural evolution of work. The soft matter makes the work autonomous, moving and living.

The gravity's force creates a flow of matter. The materials are moving. Thus we find ourselves in front of actual kinetic works which integrate gravity as a constitutive material. This study makes it possible to define a technique and a deontology specific to the treatments of soft works by considering measures of preservation which respect their material entity.

Fig. 5 Eugène Leroy, detail, *Pour Maxime*, 1987–1990, oil on canvas, 162 x 130 cm, Collection du Fonds national d'art contemporain, ministère de la culture et de la communication, Paris.

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TRANSLATION

Jennifer Leveau

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[8] *Ibidem*, p.50

THE ORGANIZED CHAOS OF JEAN DUBUFFET: INVESTIGATING HIS TECHNIQUES AND MATERIALS

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At the time of the publication, the author was the William R. Leisher Fellow in Modern and Contemporary Paintings Conservation at the National Gallery of Art, Washington, DC

The French artist Jean Dubuffet explored a wide array of artistic forms during a career spanning over 4 decades. In the early 1940's, Dubuffet combined the use of artist materials and non-traditional materials to create a variety of complex surfaces and textures.

A study was devised in which fourteen paintings by Dubuffet produced between 1943 and 1950 in the collection of the National Gallery of Art of Washington (NGA) were examined to determine if some of the paintings had been inappropriately varnished after leaving the artist's studio. Technical and scientific analysis combined with information from the artists' journals provided a better understanding of the working methods and materials used by Jean Dubuffet. This information was crucial in establishing appropriate treatment protocols.

INTRODUCTION

Over the course of an artistic career of more than forty years, Jean Dubuffet expressed his creativity through a wide array of artistic forms. Considered by some as controversial, the opinionated artist developed an anti-establishment philosophy early in his career. Questioning the prevailing notions of aesthetics and the necessity of reproducing reality, Dubuffet celebrated the ordinary and targeted the common man as his audience rather than the esthete. At the end of his life in 1985, Dubuffet had created more than 10,000 works. Over 400 exhibits have so far celebrated the immense contribution by this artist. The Dubuffet Foundation in Paris, founded in 1974 by Dubuffet himself, manages his estate and remains an active exhibition and research center. The encounter with a painting by Jean Dubuffet often results in feelings of pleasure or displeasure, but never indifference.

The year 1942 marks Dubuffet's third and final attempt to start an artistic career. In a war torn Europe, the artist's paintings offered no hope, no utopist salvation, and no romantic interlude. By 1945 Dubuffet set forth the concept of "Art Brut" (Raw Art) used to describe art conceived outside the influence of the institutionalized culture. This art form found resonance in the use of non-traditional artist materials and techniques to create a new and unique visual language. But within the great degree of liberty he allotted himself, Dubuffet was a disciplined, systematic and dedicated artist who feverishly worked to develop a form of art that was and remains unique.

The paintings produced during the 40's are the first result of the artist's newly found modes of expression. Dubuffet liberally used artist materials such as oil paints and resins along with non-traditional materials. No material was rejected in the creation of his rugged and complex surfaces. Charcoal, sand, and tar were sometimes mixed with traditional paint or thrown onto the surface of the painting, creating a variety of textures and surface finishes. Inspired by simple things that surrounded him such as grass, roads, or graffiti on walls, Dubuffet's impression of them resounded in his works. He scoured and kneaded the thick layers of paint to create figures and objects in their simplest demeanor.

The material components used to create his paintings became as important as the created image. The surface quality produced by the artist is therefore an essential factor in the appreciation and understanding of the artist's work.

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PRELIMINARY SURVEY

Fifteen Dubuffet paintings, produced between 1940 and 1950, reside in the collection of the National Gallery of Art. This project was initiated because it was suspected that several works had been altered prior to their arrival at the Gallery. The application of varnish appeared to inappropriately saturate the surfaces of several of the paintings, possibly compromising the original appearance. Although art historical research of Dubuffet's works is widely available, information on his technique, use of materials, and the intended appearance of his paintings remains scarce. This technical study provided an entry point to a greater understanding of Dubuffet's use of materials, and was essential to the development of treatment protocols for the conservation of the paintings. It was hoped that the removal of these coatings would allow the works to regain an aspect closer to the original state intended by the artist.

Paintings included in the research

Twelve of the fifteen paintings were selected as a representative core and were classified into three categories for the purposes of this project:

<u>1) Original Surface - Requiring No Treatment</u>

This category includes paintings that are thought to have retained their original surfaces and have not been altered by previous conservation treatments. They were used as a reference to compare surface quality, materials and technique.

Fig. 1 *Gesturer* (1945)

Fig. 2 *Big Mouth Terracotta* (1946)

Fig. 3 *Bertele as a Blossoming Bouquet-Side-Show Portrait* (1947)

<u>2) Altered Surface - After Restoration/Treatment</u>

This category includes paintings that were previously treated (by the NGA or other entities). These were used as reference material to compare surface quality, materials and technique of works after treatment.

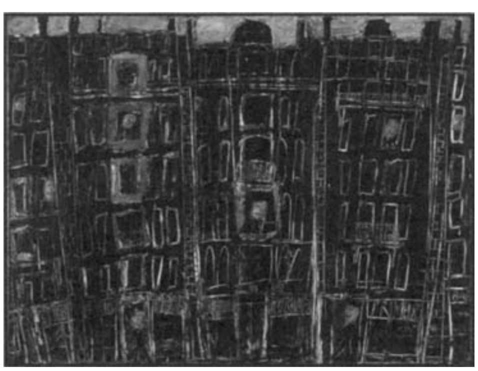

Fig. 4 *Building Facades* (1946)

Fig. 5 *Limbour Prepared as a Chicken Dropping* (1946)

Fig. 6 They Hold Council (1947)

Fig. 7 *Marbleized Body of a Lady* (1950)

3) Possibly Altered Surface - Requiring Treatment

This category included paintings that might have been altered by previous treatments (lining, varnishing, retouching, etc.), which may have compromised the visual balance of the paintings. These paintings were examined and compared to paintings in the previous two categories. Treatment was proposed when necessary.

Fig. 8 *Darner of socks* (1945)

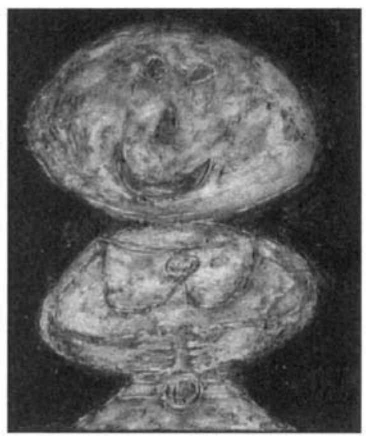

Fig. 9 *Crescent Mouth* (1946

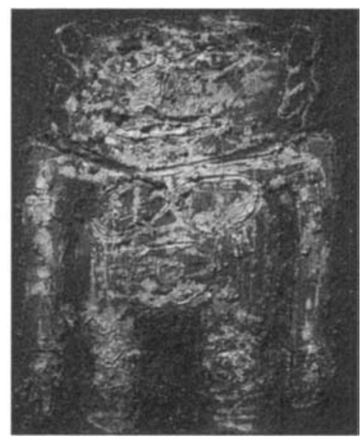

Fig. 10 *Lady with a Pompon* (1946)

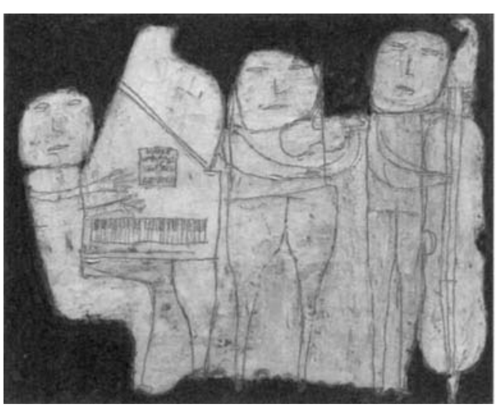

Fig. 11 *Little Musical Number for Edith* (1946)

Fig. 12 *Two Figures in a Landscape* (1949)

EXPERIMENTAL DESIGN

This project was divided into four stages of research and treatment. The first stage was an initial examination of the paintings during which the construction methods, materials and identification of previous treatment could be assessed. The second stage involved technical and scientific analysis to allow a better understanding of the artist's technique and use of materials, as well as the identification of coatings thought to have been applied during and after the creation of the works.

Techniques employed to date:

- UV-induced autofluorescence for visual characterization of coatings and materials such as varnishes, repairs and retouching.
- Infrared reflectography to characterize preparatory drawing and material density.
- X-radiography for visual identification of construction technique of the image and identification of materials.
- Optical microscopy of paint cross-sections, thin sections, and dispersed pigment samples in reflected, transmitted and ultra-violet light to analyze layering of materials, media and pigments.
- Fourier Transform Infra-Red (FTIR), used as a preliminary means of analysis to help categorize pigments, extenders, media and orient further analysis; pyrolysis-gas chromatography/ mass spectroscopy, used to further identify organic media.

The third stage involved the compilation of data gathered from the artist's log books. These books, dated as early as 1946, were written by Dubuffet and contained detailed information on his techniques and materials and commentaries on his experimentations. The information collected in these books was compared to the data obtained from the technical and scientific examinations.

In the fourth and final stage, the information gathered from the previous areas of research was compiled and protocols developed for those works that required treatment.

Comparison of Selected Paintings

Construction

The paintings included in this study were constructed in a similar fashion and incorporate many of the following elements:

- Use of a lead white base ground applied commercially or by the artist on a linen canvas mounted on a stretcher or a Masonite-type panel secured on a strainer.
- Application of a thin, smooth layer of white paint applied over the initial ground layer.
- Application of a thick layer of off-white paint with a spatula, creating impasto of varying heights.[1]
- Addition of sand, pebbles and/or charcoal on or within the paint layers.
- Use of small multicolored strokes of paint or general uniform toning of the entire surface.
- Building the composition (by adding a figure or object) with an additional application of off-white paint and/or scratching out the elements in the composition with a variety of tools (spatula, finger, etc.).
- Sporadic addition of sand, pebbles, pieces of glass and thread to modify the surface finish and define certain elements in the composition.
- Painting and glazing of the surface with oil and/or varnish-based pigmented glazes with the possible addition of driers.

Following the initial application of the thicker off-white paint, all of these aspects presented themselves in varying degrees depending on the picture. The surface was given a general tone or covered by multicolored paint strokes. Sand, pebbles and charcoal were applied or thrown onto the surface and sometimes partially incorporated within the paint layer. The contours of elements in the composition would sometimes be determined by the positioning of pebbles in the paint matrix. The blunt tools would rip through the wet or partially dried paint layers and in some cases expose the strata of the paint down to the commercial preparation layer. The final effects on the surface were often achieved by successive applications of oil glazes (ranging from pure to highly tinted), splashes of turpentine to partially dissolve the glazes, and rubbing of the surface with rags.[2]

ARTIST LOG BOOKS

Information gathered from the artist's log books corroborates these observations. Dubuffet mentions the use of commercially prepared canvas as well as solid supports.[3] The thin and thick layers of white and off-white paints are identified respectively as "Rollpeinture" and "Rollplastique".[4]

The materials mentioned in the books that were used for the top layers consisted of:

- Commercial artist oil paints.
- Dry pigments mixed with oil and turpentine.
- Home-made emulsions made from oil paint and water.
- Commercial emulsions by Lageze et Croze mixed with dry pigments.[5]
- Dried or semi-dried oil paint scrapings from the artist's paint palette.
- Commercial household paints such as Duco, Ripolin, Arte and Artista.
- Other materials such as lime, cement, asphalt, bitumen, driers, varnish, oil, pigments, sand and pebbles.

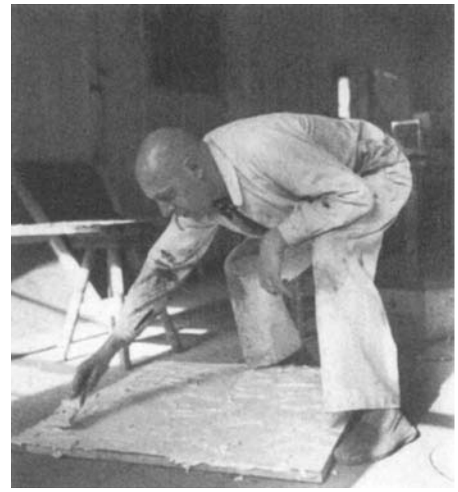

Fig. 13 Example of Dubuffet applying the thick white paint layers. (New York, 1952)

Dubuffet also gives a description of his use of glazes, variably composed of oil, varnish, driers, and pigments, followed by drizzling turpentine on the surface to create different effects. The contours of certain elements within the paintings (such as eyes or buttons) were sometimes reinforced with thin painted lines or with pebbles, broken glass or thread. Curiously, the application of a varnish as a protective coating is not mentioned in the log books covering this period. Glue is however mentioned as a consolident to maintain certain elements such as sand or pebbles that might not be well adhered to the surface of the painting.

The only painting which does not follow the above sequences is the work entitled *Two Figures in a Landscape.* [6] This painting is part of a series done in 1949 with the theme of "Figures in a Landscape". The structure and materials of these paintings involved the use of burlap canvas prepared with a colored casein or oil ground, on which the design was painted with oil or casein paint.

FURTHER INVESTIGATION

Non-destructive investigation techniques were used as a first step in obtaining a better understanding of Dubuffet's construction processes and the state of preservation of the paintings.

The UV-induced autofluorescence revealed very complex surfaces. The three paintings included in the first group representing the "Original Surface - Requiring No Treatment" (*Gesturer, Big Mouth Terracotta, Bertele as a Blossoming Bouquet-Side Show Portrait*) showed no sign of surface coatings. The painting *Bertele as a Blossoming Bouquet-Side Show Portrait*) did show minimal signs of inpainting on the periphery of the painting.[7]

The second group of paintings representing the "Altered Surface - After Restoration/Treatment" (*Facades d'immeubles, Limbour as a Chicken Dropping, They Hold Council, Marbleized Body of a Lady*) showed signs of filling, retouching and gloss adjustment following the removal of a varnish as well as remounting in some cases.

In the third group of paintings representing "Possibly Altered Surface - Requiring Treatment" (*Darner of Socks, Crescent Mouth, Lady with a Pompon, Little Musical Number for Edith, Two Figures in a Landscape*), only *Little Musical Number for Edith* showed signs of a thin synthetic varnish. No obvious signs of coatings or intervention were clearly identified in the other paintings.

The UV examination allowed a more precise mapping of the different media used in the construction of the design, something that was not always apparent with basic examination. It revealed the intricate network of different types of paints, glazes, varnishes and pigments, mixed together in varying degrees and dissolved by the solvents that Dubuffet would throw on the surface. The arrangement of these materials was very different from one painting to the next, sometimes seeming to reinforce the presence of a certain motifs in the composition, while at other times appearing to be arbitrarily applied onto the surface. Their presence varies from barely perceptible, to thick and very glossy.

Infra-red reflectographs revealed the absence of underdrawings, indicating that the compositions were made with rapid, precise and free-flowing gestures with virtually no changes.[8] X-radiography exposed in more detail the application technique of the initial thick layers as well as an indication of their thickness.[9] An underpainting was also discovered under the painting *Building Facades* which will be discussed in the last section of this paper.

Further analysis was required in order to confirm assessments made with the technical examination. Samples examined with Fourier-Transform Infra-Red Spectroscopy (FTIR) combined with pyrolysis gas chromatography-mass spectroscopy (pyGC-MS) [10] allowed preliminary identification of the paint media, the glazes and the glossy coatings. The main components were identified as drying oil and natural resin varnish. Pine resin was also been found in very small quantities in some samples.[11] A wide range of pigments were found including notable quantities of charcoal, sulfate and carbonate-based pigments, as well as silica (largely due to the presence of sand in the paint layers).

This investigation method also confirmed the presence of a synthetic varnish on *Little Musical Number for Edith*[12] and unexpectedly on *Lady with a Pompon*. The later coating was not easily perceptible with the naked eye and could not be clearly identified with UV examination. The evenness and thinness of the layer might indicate a spray application.

Polarized Light Microscopy revealed the layering method of paint, pure pigments, sand, and glazes. No specific order was predominant in the application of the paint except for the presence of the thick off-white paint layer and the thin white paint layer applied over the ground. The manipulation of the paint by the artist resulted in a complex mixing of the layers, with the stratigraphy varying greatly from one location to another. Surprisingly, the cohesion of the layers shows no serious weaknesses.

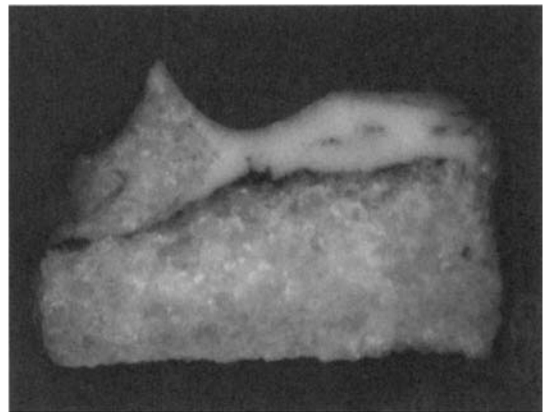

Fig. 14 Typical cross-section of the structure of the paint matrix of most of the Dubuffet paintings. The arrows indicate the presence of the thick off-white base layer visible at three levels of the paint matrix following the manipulation by the artist.

ADDITIONAL FINDINGS

The years 1943-1944 were considered to be a turning point in Dubuffet's career. Work produced prior to that year was considered by Dubuffet as part of his "Prehistoric Period". These paintings differ from the later paintings by their more traditional use of materials and representational qualities. Two paintings of that period were summarily examined as complementary to the paintings of this research. Dissimilar to the works dating from 1944 and later, no additives such as sand, pebbles, fibers, etc, were found in the paint matrix of the "Prehistoric Period" works.
The presence of underdrawing was also noted.

Infrared reflectography of the painting *Green Landscape* (1944) revealed the presence of three different compositions. Elements from the initial composition include a cow lying down in the center, topped by a house and a figure in a window, and the repositioning of trees and the cyclist in the top right corner.

Fig. 15 Green Landscape (1944)

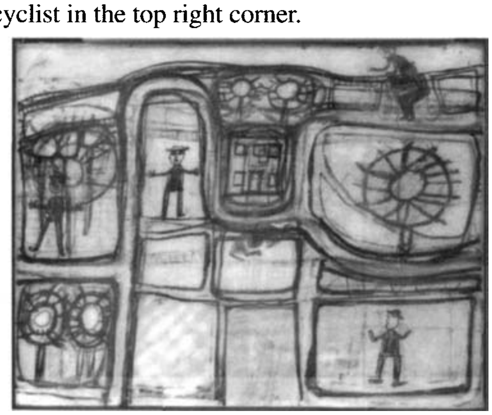

Fig. 16 Green Landscape (1944), IRR

Another interesting discovery was that of a painting possibly dating from the early 1930's found painted under *Building Facades* (1946). X-radiography revealed the coarse and rapid application of a thick layer of paint into which the contours of four figures were incised.

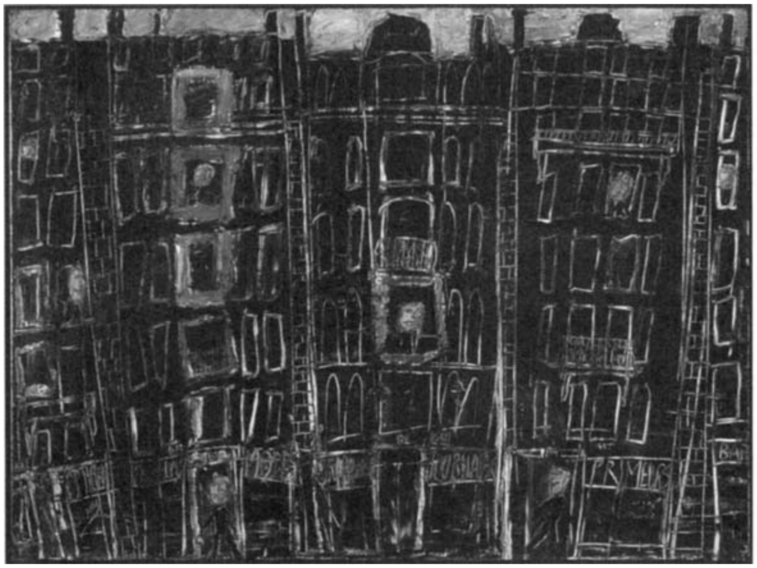

Fig. 17 Building Facades, Normal illumination (1946)

Fig. 18 Building Facades , X-Radiography showing the contours of four female figures (1946)

The four female standing figures are similar to paintings made by Dubuffet in the 1930's during his "Prehistoric Period".[13] To date, the related paintings are all thought to be destroyed.[14] It remains unclear why this specific painting was never catalogued at the same time as the others, but perhaps the answer lies in the fact that the painting may never have been completed. The large format of the canvas could certainly explain its safekeeping for later reuse, but the format of many of the "destroyed" paintings was also large and one can only wonder if the others are not also waiting to be discovered under later compositions.

CONCLUSION

Technical and scientific analysis has allowed the identification of the major components and a better understanding of the structure and materials of the paint layers in Dubuffet's work during the period of 1943 to 1950. It was possible to determine that the presence of large amounts of oil and natural-resin based glazes (what is a "natural based glaze") as well as important concentrations of pure pigments between the layers and on the surface, features that created a wide range of solubility (sensitivity to solvents?). In addition, the components added to the paint layers and the paint handling technique also increased the solubility levels and restricted the use of traditional cleaning methods. Finally, the variable surface texture, the diverse composition of the paint layers, and the challenges of sampling necessitated a constant reassessment of the cleaning methods.

Confirming the original suspicion that instigated this study, non-original synthetic varnish was identified on two paintings from the third category of "Possibly Altered/ Requiring Treatment" (*Little Musical Number for Edith* and *Lady with a Pompon*). The sensitivity of the paint layers as well as the relatively smooth surface of the *Little Musical Number for Edith* necessitated the removal of the synthetic varnish with an aromatic solvent based solution applied through Japanese paper.[15] The treatment revealed subtle variations in tone and gloss level which had been altered by the glossy synthetic varnish. *Lady with a Pompon* remains untreated to date. The complex layer structure which includes large areas of sensitive natural resin varnish and oil-based glazes, combined with highly textured surface does not allow any intervention on the surface.

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ENDNOTES

1 The thickness of this material ranged from very thin layers to approximately 1" in thickness.

2 Clusters of fibers were often found on the surface. They were covered with oil and natural resin varnish, and possibly came from the rags used by Dubuffet to remove excess glazes or solvents.

3 The solid supports were arbitrarily painted on either the smooth or the rough side. Small gouges were sometimes made on the surface to act as anchor sites in which the thick layer of paint could key in. Most of the canvas supports were commercially prepared with a lead white base ground.

4 Dubuffet, J. 1946. *Cahiers d'atelier* , unpublished material, Foundation Dubuffet, Paris, France.

5 Research is still ongoing to identify the exact components of this material.

6 This painting was part of a series of works done in 1949, under the theme of *Figures in a Landscape*. The materials and technique used for this series were very similar and consisted in the use of a burlap canvas, mounted by the artist on a stretcher, prepared with a colored casein or oil ground, on which the design was painted.

7 Filling and inpainting were visible on the periphery of the painting. It was noted during examination that the painting had been at one time taken off from its stretcher to allow the insertion of a panel of massonite between the canvas and the stretcher. The very thick layer of paint and the size of the painting, increased the weight of the painting. An important network of cracking on the surface of the painting might indicate that the canvas was at one time sagging under the weight of the material, and might explain the addition of the massonite as supplemental support. The inpainting was done with tinted wax. Wax might also have been used to secure the canvas to the massonite.

8 "X-Radiography was carried out with equipment consisting of a Eureka Emerald 125 MT tube, a Continental 0-110 kV control panel, and a Duocon M collumator. Kodak X-OMAT x-ray film was used. The x-radiograph composites were prepared with scanning and Adobe Photoshop® soft ware.

9 Infrared reflectography was carried out with a digital system consisting of a Mitsubishi M600 PtSi camera fitted with a 512 x 512 pixel, platinum silicide focalplane array and a Nikon F/1.2 Silicon Lens with AR Coating, a Macintosh Quadra computer, a Perceptics Pixelbuffer NuBus video frame grabber card, a Macintosh Power Mac computer, a Scion PCI video frame grabber card AG-5, Systems Analytics' IP-Lab Spectrum software and Adobe Photoshop software.

10 Infra red reflectography was obtained with a Nicolet Nexus 670 bench, equipped with a Continuum microscope. The extracts were spotted on a single window of a Diamond Cell (Spectratech). Solid paint samples were compressed between the two windows of the Diamond Cell. Two hundred scans were collected at $4cm^{-1}$ resolution. The Pyrolisis analyses were performed on Perkin Elmer Autosystem gas chromatograph. A 30 meter RTX-1 methyl silicone capillary column was used (film thickness 0.25 micron, column diameter 0.32 mm). The injector temperature was 300 degrees C, and the column pressure was 8 psi. The FID detector was maintained at 325 degrees C. The initial column temperature was 50 degrees C (for 0.5 minutes), and the oven was temperature programmed to 100 degrees C at 25 degrees C/minute, then at 6 degrees C/minute to 280 degrees C. The column temperature was held at 280 degrees C for 5 minutes.

11 The role of this component in the oil paint is still being investigated. At the time of publication, scientific analysis was still ongoing. Supplemental testing was necessary to provide a clearer understanding of the role of this compound.

12 The varnish was determined to be a poly(n-butyl methacrylate).

13 Loreau, Max, 1993 (revised edition of 1966).*Catalogue des travaux de Jean Dubuffet – Marionnettes de la ville et de la campagne*, Paris,Minuit; J.-J Pauvert.(1st edition)

14 Personal communication with Florence Quènue , Fondation Dubuffet, Paris.

15 This technique was used to minimize direct contact with the surface. A solution of xylene/isooctane (1:3) was rolled with a swab on the paper. The capillary action was sufficient to pick-up the layer of synthetic varnish without disrupting the surface.

IMAGING TOF-SIMS AND NANOSIMS STUDIES OF BARITE-CELESTITE PARTICLES IN GROUNDS FROM PAINTINGS BY VAN GOGH

Beatrice Marino, Jaap J. Boon , Ella Hendriks, François Horréard, François Hillion

ABSTRACT – Late in the 19th century, Van Gogh like many painters would buy ready-made artists' materials. For matters of dating and authenticity, it is interesting to distinguish the different formulations and production batches, and to identify the nature and the source of the materials used. This information is useful also to point to different manufacturers, and is of relevance for studies of other impressionists besides Van Gogh.

One of the materials used as paint extender is barium sulphate. In its natural source, barite, barium can be replaced by strontium in a continuous solid solution series from barite ($BaSO_4$) to celestite ($SrSO_4$). In the process of making artificial barium sulphate most of the impurities are eliminated. Therefore, strontium can be used as an indication of natural barium sulphate in paints, and is potentially an interesting feature for discriminating different sources of the natural mineral.

Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) and NanoSIMS are surface sensitive instruments that combine mass-spectrometric analysis with spatial resolution to give information on both the inorganic and organic fractions of a sample. In this paper we show their efficacy in the characterisation of the ground paint and in particular of barite-celestite in a painting by Van Gogh, *Plaster Figure of a Female Torso* (F216j, dated mid. June 1886).

The barite-celestite particles have overlapping TOF-SIMS maps for sulphur, barium and strontium. NanoSIMS images show that larger particles (about 20 μm across) consist of separate phases of barite and celestite, while the smaller particles (few microns size) consist of a single phase, probably as a result of the grinding of the mineral. Isotopic ratios of strontium were also obtained in an attempt to trace the origin of the mineral.

1. INTRODUCTION

Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS) is a powerful instrument that allows the investigation of both the inorganic and the organic fractions in a sample, and simultaneously combines high spatial and mass resolution. TOF-SIMS has been used in a variety of applications in surface analysis of materials such as polymers and semiconductors [Vickerman et al. 2001]. SIMS also proved extremely useful and efficient in the examination of the layer structure of paintings in paint cross-sections [Keune et al. 2005]. Its mapping capabilities allow investigating the nature and the distribution of paint materials within individual paint layers, with a lateral resolution that is approximately 1 μm, depending on the image size. The advantage of SIMS over other imaging analytical instruments, such as SEM-EDX and imaging FTIR, is that it can analyze both the inorganic and organic components of the paint, providing information on the nature of both the pigment and the binding medium. An important benefit of static SIMS probing the upper atomic layers of the surface is that no structural damage is visible. As paint cross-sections are single exemplars and available in limited supply, the advantages mentioned above make SIMS particularly useful for their study.

A new generation of ion microprobes is the CAMECA NanoSIMS 50, whose design ensures higher sensitivity combined with higher lateral and mass resolution [Hillion et al. 1993, Hillion et al. 1995, Schuhmacher and Hillion 1995, Schuhmacher et al. 1999]. This instrument finds various applications in biology [Grignon et al. 1999], material science [Bou et al. 1992], geochemistry and paleoceanography [Meibom et al. 2004]. The high sensitivity and mass resolution also allow precise isotopic ratio measurement [Stern et al. 2005]. Ferreira et al. [2005] used NanoSIMS in a multi-technique chemical microscopic study of the ground and preparatory layers in a paint cross-section from *Descent from the Cross*, a 15th-century painting by Rogier van der Weyden.

In this paper we explore and compare the capabilities of TOF-SIMS and NanoSIMS in the analysis of paint materials in a cross-section taken from a painting of Van Gogh's Paris period *Plaster Figure of a Female Torso*

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(F216j[1], dated mid. June 1886). Apart from a general survey, special attention will be given to barium sulphate ($BaSO_4$). Barium sulphate is used as extender in paints to reduce the production costs, as well as to improve the handling properties of the paint. Natural barium sulphate is preferred for cheaper paint preparations such as ground paints [Carlyle 2001]. In the natural source of barium sulphate, barite, barium can be replaced by strontium in a continuous solid solution series from barite to celestite ($SrSO_4$) [Deer 1967]. In the process of making artificial barium sulphate a very pure product is obtained and most of the impurities are eliminated [Feller 1986]. Therefore, strontium can be used as an indicator of natural barium sulphate in paints. In addition, it is potentially an interesting feature for discriminating different sources of the natural mineral [Marino et al. 2005]. Like many other natural crystals, barite-celestite exhibits compositional oscillatory zoning, which consists of a more or less regular alternation of barium- and strontium-rich layers [L'Heureux and Katsev 2006]. Studies on barites and barite-celestite solid solutions ($(Ba,Sr)SO_4$-H_2O) indicate that a correlation exists between the structural and physico-chemical characteristics of barite and its depositional environment [Bréhéret and Brumsack 2000, Castorina et al. 1999, Paytan et al. 2002, Sánchez-Pastor et al. 2006]. The improved feature discrimination by NanoSIMS should allow an investigation of the distribution of barium and strontium in barite particles, and the characterization of their finer structural and sub-structural details.

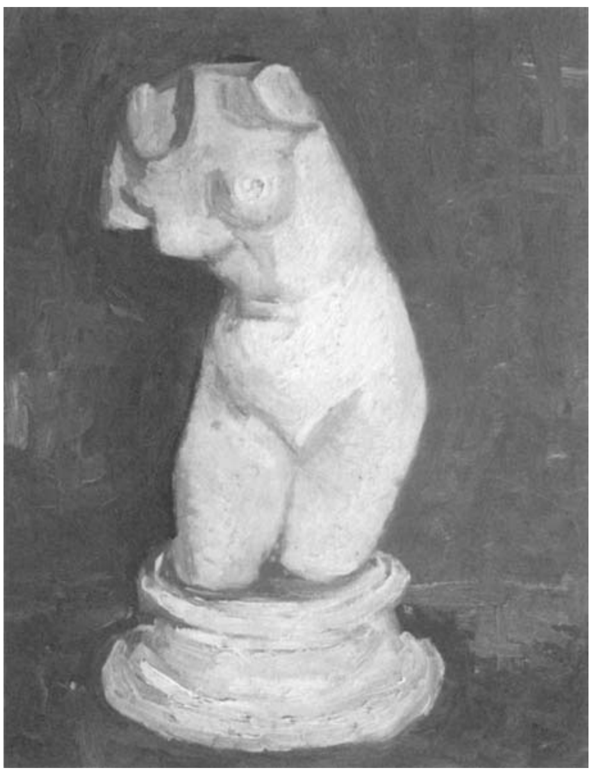

Fig. 1 *Plaster Figure of a Female Torso* (F216j, mid. June 1886; Van Gogh Museum, Vincent van Gogh Foundation, Amsterdam).

2. MATERIALS

2.1 SAMPLE

The painting is made on cardboard, *carton* in French sources, pre-primed with a pale-gray ground of smooth (*à lisse*) surface texture. A picture of the painting is represented in Figure 1. An original trade sticker surviving on the back of the *carton* informs us that the support was purchased from the shop of Pignel-Dupont, established at the number 17 rue Lepic in Paris, just down the street from the apartment of Vincent's brother, where Vincent moved in June 1886. The sample was taken from along the bottom edge of the painting, where paper tape has been removed. The sample was embedded in polyester resin and polished with Micromesh paper to expose the paint at the surface and to achieve a flat surface.

2.2 ANALYTICAL TECHNIQUES

Light Microscopy

Light microscopic images of the paint cross-section were acquired with a Nikon DX1200 24-bit color digital still camera (Nikon Instech Co., Ldt., Japan) mounted on a Leica DMRX microscope (Leica, Wetzlar, Germany). Images were obtained under illumination provided by a 100 W tungsten-halogen lamp in visible light, and by an Osram HBO 50W lamp and a Leica filter D (excitation 360-420 nm, emission > 460 nm) in UV light. Images under visible light were acquired in reflection mode in dark field.

TOF-SIMS

The static SIMS experiments were performed on a Physical Electronics (Eden Prairie, MN) TRIFT-II TOF-SIMS. Before acquisition with SIMS, the paint cross-section was carefully polished with increasing grades of Micromesh paper (up to 12000 grade), in order to avoid peak broadening in the mass spectra due to height differences of the sample surface, and to reduce effects of surface morphology on the ion yields. The sample surface was scanned with a 15 keV primary ion beam from an In^{115} liquid metal ion tip. The pulsed beam was non-bunched with a pulse width of 20 ns, a current of 600 pA and a spot size of ~120 nm. The primary ion beam was rastered over a 100 μm x 100 μm area, and the secondary ion signal was collected in an array of 256 x 256 points, each point collecting a full mass spectrum. Measurements were made both in positive and negative mode. In order to prevent charge accumulation on the insulating surface of the sample, the sample surface was charge compensated by means of an electron beam pulsed in between the primary ion beam pulses. To prevent large variations in the extraction field over the sample surface, a non-magnetic stainless-steel plate with a 1 mm-thick slit was placed on top of the sample. The paint cross-section was rinsed in hexane to reduce contaminations of polydimethilsiloxanes.

TOF-SIMS data were obtained under conditions of a sliding scale of mass resolutions ($m/\Delta M$ from 600 to 1500 over a mass range from 12 to 2000). The spectra are represented as nominal mass plots. Mass spectra were visualized at smaller mass ranges around elements or fragments of interest. Corresponding mass peaks were then carefully manually selected, also in order to minimize overlapping with organic fragments in positive spectra, and the resulting distribution maps plotted as images. Distribution maps aid in the identification of the materials present in the sample, and are most valuable when this is achieved through the comparison of multiple SIMS maps, and with a light-microscopic image of the analyzed area, or with images obtained by means of other instruments.

After TOF-SIMS analysis the sample was gold-coated and examined with NanoSIMS.

NanoSIMS

Dynamic NanoSIMS measurements were performed with a CAMECA NanoSIMS 50. The CAMECA NanoSIMS 50 is a double focusing mass spectrometer that allows simultaneous collection of multiple masses by a system of five parallel detectors (or seven with the NS50L). The coaxial objective and extraction lens permit a very short working distance. This ensures low aberration coefficients for a high lateral resolution, and a quasi-full collection of the secondary ions, requisite for high transmission. All measurements are done at high mass resolution (without any slit or aperture in the spectrometer, $M/\Delta M$ = 2500). The NanoSIMS 50 is designed to work in dynamic SIMS mode. In contrast to TOF systems, its parallel detection mode allows continuous sputtering and therefore considerably higher secondary ion yields and shorter acquisition times.

The instrument is equipped with two reactive ion sources. Cs^+ primary ions are employed to detect negative secondary ions (ultimate resolution better than 50 nm). O^- primary ions are used to detect positive secondary ions (ultimate resolution better than 200 nm). Beam size, beam current, and number of pixels were chosen to optimize lateral resolution and acquisition time. The Cs^+ primary ion beam was operated at 16 keV, 6.4 or 2.8 pA current, and 150 or 100 nm spot size, and the O^- primary ion beam at 16 keV, 34, 13.9, 14.3, or 14.7 pA current, and 500 or 300 nm spot size. The images were acquired as 256 x 256 pixel images at scales varying between 25 and 100 μm, with a resulting effective resolution of 400, 150 and 100 nm for negative secondary ions images, and of 500 and 300 nm for positive ion images. The sample was gold coated (30 nm). This was sufficient to avoid any charging so no electron charge compensation was needed.

Backscattered electron images of the cross-section were taken after NanoSIMS analysis.

SEM-BSE

Scanning electron microscopy (SEM) analysis was performed on a XL30 SFEG high-vacuum electron microscope (FEI, Eindhoven, The Netherlands) with EDX system (spot analysis and elemental mapping facilities) from EDAX (Tilburg, The Netherlands). Backscattered electron (BSE) images of the cross-section were taken at 20 kV acceleration voltage at 5 and 6 mm eucentric working distance and spot size of 3 that correspond to a beam diameter of 2.2 nm with current density of ~ 130 pA.

3. CASE STUDY

Results of technical investigations by SEM-EDX and microchemical analysis made on the sample under investigation in a previous work by Hendriks and Geldof [2005] revealed that the ground paint consists of lead white, little barium sulphate, gypsum, and few particles of carbon black and earth pigments. This composition is in agreement with the typical composition of commercial 19th-century ground paints [Bomford et al. 1991, Callen 2000, Carlyle 2001]. This information was considered as a guide in the examination and interpretation of SIMS data.

3.1 SAMPLE DESCRIPTION AND ANALYSIS BY LIGHT MICROSCOPY

Light-microscopic images of the cross-section under visible and UV light are shown in Figure 2. The sample contains a thin light blue paint layer (layer 2, up to 10 µm thick), the ground layer (layer 1, 20-25 µm thick), and fibers from the support. The bluish paint contains also orange and red particles. The ground layer includes transparent particles and a few black, red and ochreous particles. Several blue-fluorescing spots appear in the light blue layer under UV light.

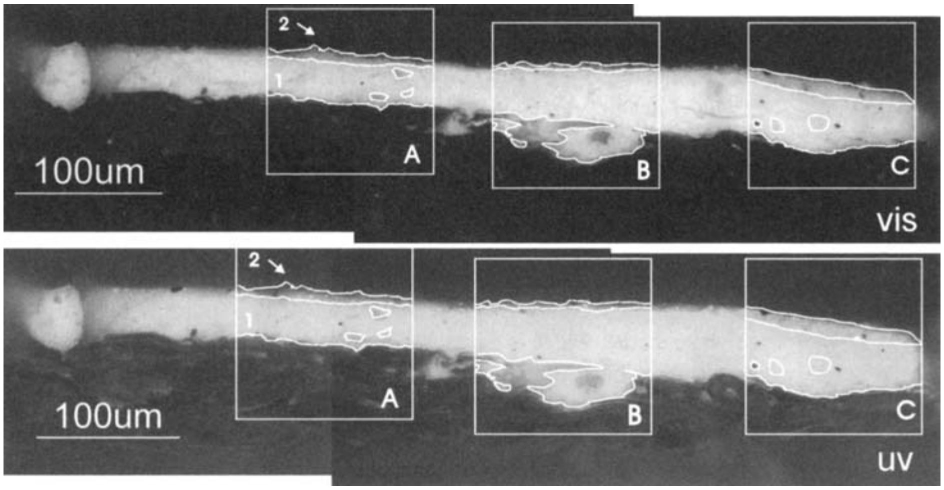

Fig. 2 Paint cross-section F216j/1, light-microscopic images under visible (top) and UV light (bottom). The rectangular outlines in the light-microscopic images (A, B, C) indicate the areas mapped with TOF-SIMS.

3.2 SPECTRAL SIMS INFORMATION

The paint cross-section has been analyzed in three areas (indicated in the light-microscopic image with letters from A to C). Two TOF-SIMS spectra, acquired in both positive and negative ion mode, and corresponding to the entire probed area, are shown in Figure 3. Characteristic mass peaks of these paint samples are those of lead (*m/z* 208), calcium (*m/z* 40), barium (*m/z* 138), strontium (*m/z* 88), iron (*m/z* 56), aluminum (*m/z* 27), and potassium (*m/z* 39) in positive mode, sulphur (*m/z* 32),

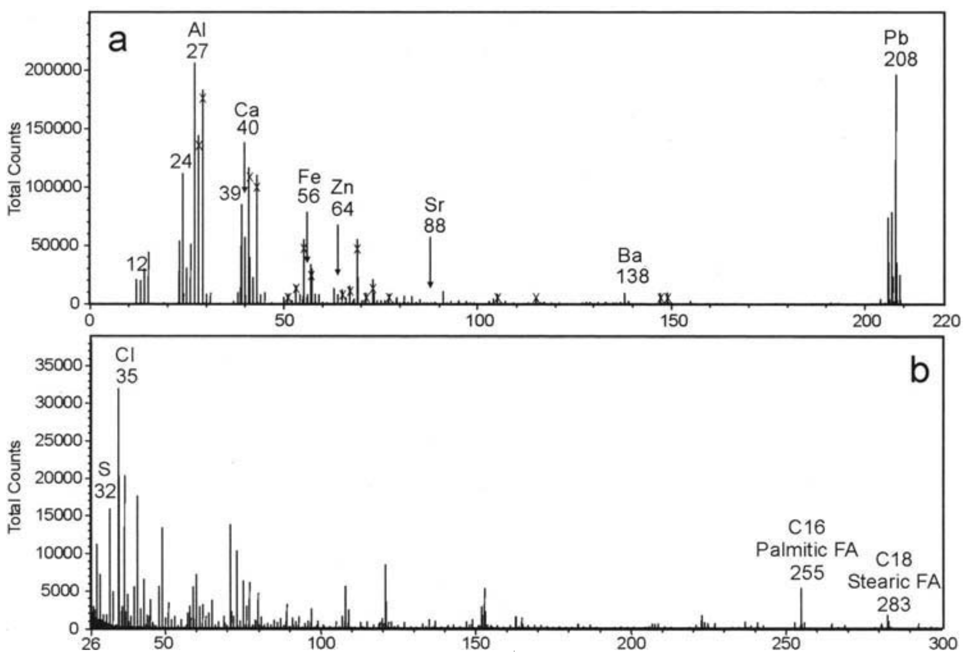

Fig. 3 TOF-SIMS spectra in positive (a) and negative (b) ion mode of the paint cross-section under investigation (X = polydimethylsiloxane, polyester, and phtalate contaminations; the peak at m/z 115 is produced by indium ions used to probe the sample surfaces).

chlorine (m/z 35), and deprotonated $[M - H]^-$ palmitic (m/z 255) and stearic (m/z 283) acids in negative mode. The blue paint layer is characterized by lead and zinc (m/z 64). The distribution maps (Figures 4-6) characterize the paints as follows.

Barite in the ground paint

Detection of barium and sulphur reveal the presence of barium sulphate ($BaSO_4$) in the ground paint layer (layer 1). Barium sulphate is used as extender in paints to reduce the production costs, as well as to improve the handling properties of the paint. Under the light microscope in visible light, barium sulphate in oil paint appears transparent, because of its similar refractive index.

The clear co-occurrence of barium and strontium is an indication of the natural origin of barium sulphate. In fact, the natural source of barium sulphate, barite, which is the most common barium mineral, is generally pure $BaSO_4$, however barium can be replaced by strontium in a continuous solid solution series from barites to celestite ($SrSO_4$). Barites of this series with a preponderance of barium are called strontiobarites [Deer 1967]. We also observe in the distribution maps that the relative intensity distributions of these two elements vary over the different particles. In the process of making artificial barium sulphate a very pure product is obtained and most of the impurities are eliminated [Feller 1986]. Therefore, strontium can be used as an indicator of natural barium sulphate in paints; in addition, it is potentially an interesting feature discriminating between different sources of the natural mineral [Marino et al. 2005].

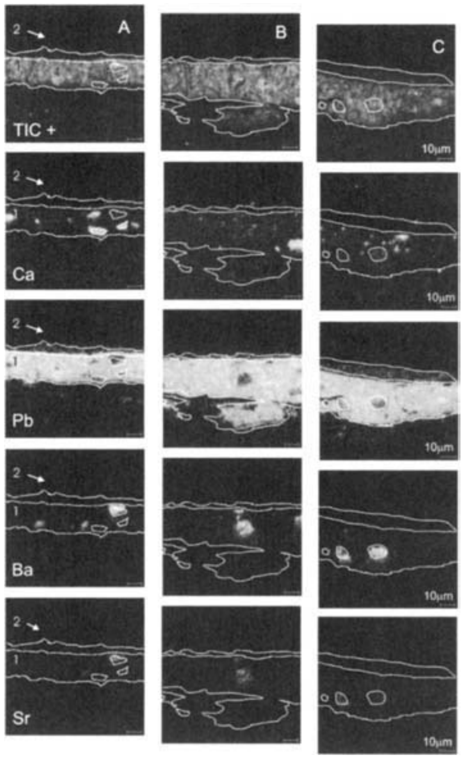

Fig. 4 Paint cross-section F216j/1, TOF-SIMS total ion current image and distribution maps of characteristic elements in positive mode.

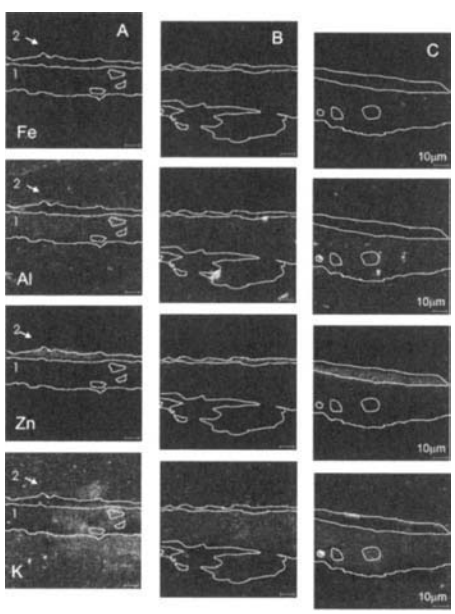

Fig. 5 Paint cross-section F216j/1, TOF-SIMS distribution maps of characteristic elements in positive mode.

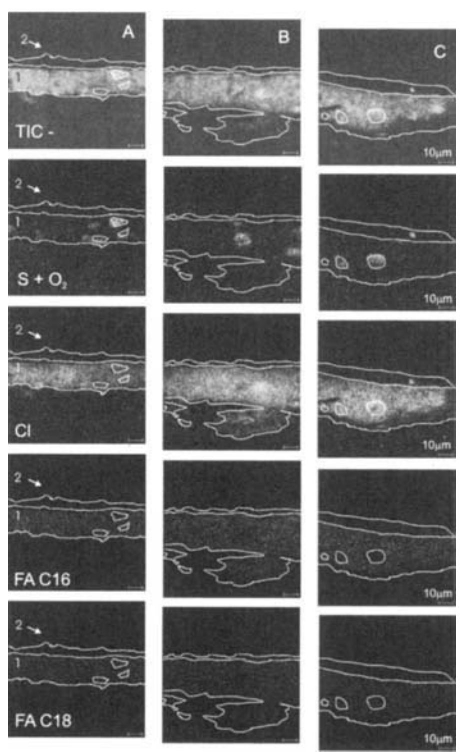

Fig. 6 Paint cross-section F216j/1, TOF-SIMS total ion current image and distribution maps of characteristic elements in negative mode.

Other materials in the ground paint

The distribution maps reveal that the ground paint consists of massive amounts of fine-grained lead white, mixed with particles of varying sizes of calcium carbonate and gypsum, and of barium sulphate, which was discussed above.

Lead white (leadhydroxycarbonate, $2PbCO_3 \cdot Pb(OH)_2$) is the main white component of the ground paint and can be identified from the map of lead. Chlorine is associated with lead as chloride, as is evident from the very high correlation between their distributions [Keune and Boon 2004}. The source of chlorine and its form in the paint is unknown.

Calcium is found in calcium carbonate ($CaCO_3$) and gypsum (calcium sulphate, $CaSO_4$), the co-occurrence of sulphur with calcium being indicative of gypsum. Calcium carbonate as well as finely ground gypsum are commonly mixed with lead white as cheap adulterants in oil ground paint preparations. [Carlyle 2001, Gettens and Stout 1966]. Some spots in the maps of aluminum, silicon, potassium and iron are indicative of clay, silica, and iron oxides and hydroxides. The literature informs us that these materials are commonly included in the ground paint as extenders and impart a tint to the ground [Callen 2000]. However, in recent work Marino [2006] suggests that alternatively, cheaper, impure materials might have been used in the making of cheap grounds, and that the tint is imparted by the presence of impurities rather than by addition of separate materials. In fact, clay, silica and iron oxides could also point to a marl as a calcium carbonate source. Marls are very common forms of limestone in Tertiary rocks of the Paris Basin area, which is a likely source of the calcium carbonate used in the ground paint under study [Marino 2006].

The oil binding medium is characterized by the peaks of deprotonated $[M - H]^-$ palmitic (C16: m/z 255) and stearic acids (C18: m/z 283) in negative mode spectra. The relative amount of palmitic over stearic fatty acid (called P/S ratio) characterizes oils used as binding medium as follows: P/S < 2 linseed oil, P/S > 2.5 walnut or poppy oil, P/S > 5 poppy oil [Keune 2005, Mills and White 1987, Schilling and Khaijan 1996], assuming that oil mixtures were not used. The distributions of fatty acids in the paint cross-section closely resemble the distribution of lead. It has been already observed by [Keune 2005] that pseudo molecular ions from fatty acids have a relatively higher yield near the lead white particles, a fact suggesting assistance of lead in the secondary ion formation or higher relative concentration of fatty acids on the surface of lead white. The values of the P/S ratio in this case are inconclusive with respect to the type of oil used as binding medium (respectively 2.4, 2.4, and 2.3 in areas A, B, and C).

Materials in the upper paint layer

The blue paint layer (layer 2) is characterized by the presence of lead white, in lower amounts than in the ground paint, and of zinc white (the source of the fluorescence), with no evidence in SIMS data of colored materials. Zinc white (zinc oxide, ZnO_2) was commonly used in tube-paint formulations as a lightening agent to adjust the color in artists' paints [Bomford et al. 1991].

According to the earlier microchemical analysis, performed by treatment with 4M NaOH, the blue paint layer loses its color, indicating that Prussian blue is the source of the blue color [Berrie 1986, Plesters 1955/56]. Prussian blue can be identified with SIMS through the characteristic negative ion clusters of ferrocyanide [van der Berg and Heeren 1998]. Unfortunately, static SIMS analysis on this sample did not give any evidence of either ferrocyanides in negative spectra, nor of iron in positive spectra. However, Prussian blue is a pigment of very deep blue color, and is usually ground very finely and used mixed with white pigment (e.g. lead white or zinc white). It is therefore likely that, even if Prussian blue is present, the particle size of the pigment is so small and its concentration so low that they are well below the detection limit of the instrument.

A 'hot' spot in the map of sulphur can be correlated to a red particle in the light-microscopic image, suggesting the presence of vermilion (mercuric sulphide, HgS). Mercury was not detected because of its poor ionization with TOF-SIMS. Other red particles remain undetected; the presence of other types of red pigment can therefore not be excluded.

Minute amounts of the same aluminum-containing materials found in the ground paint were found in the upper paint layer as well.

Texture analysis from SIMS maps

The maps of lead, calcium and barium, show that the ground layer (layer 1) has a very fine and homogeneous texture of mostly fine (sub)-micron particles and some larger particles (1-10 μm) of calcium carbonate, gypsum, barium sulphate

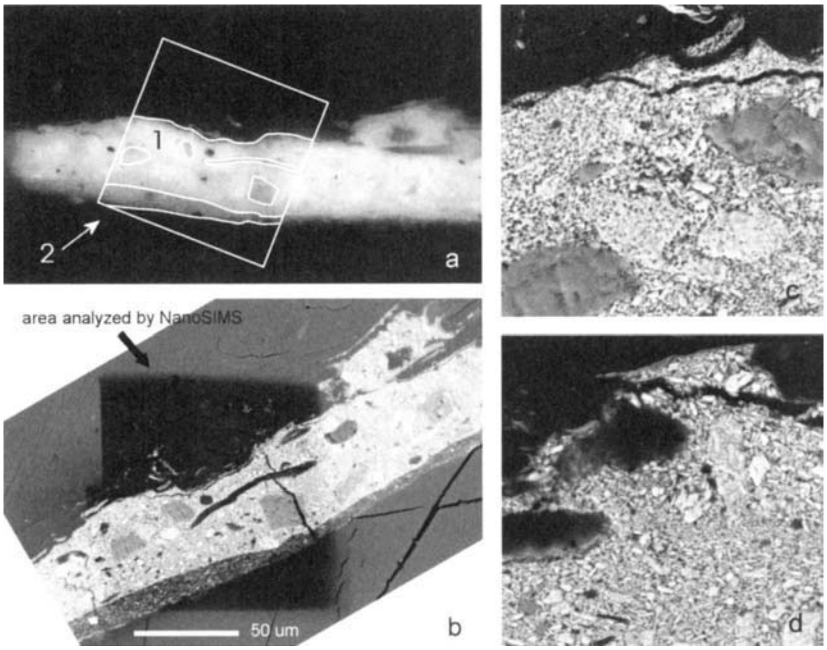

Fig. 7 Light-microscopic (a) and SEM-BSE (b) images showing the area analyzed by NanoSIMS. Two BSE images acquired at higher magnification (in two different areas) show the damage caused by the sputtering process (c) compared to the undamaged surface, exposed after repolishing of the paint cross-section (d). In these images the ground layer is on top to match the orientation of the NanoSIMS images.

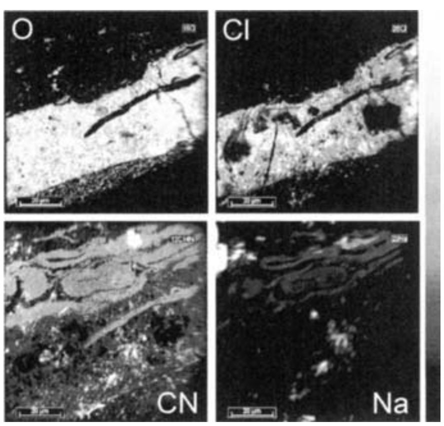

Fig. 8 NanoSIMS maps of oxygen, chlorine, nitrogen (detected as CN^- where carbon is also present), and sodium. The ground paint layer and the cardboard fibers are highlighted respectively in the maps of oxygen and chlorine, and in those of nitrogen and sodium. Oxygen is associated to lead white, calcium carbonate, gypsum, and barite. Chlorine is a marker for the lead white present in the ground paint. Nitrogen and is indicative of protein residual in the fibers or of glue that might have been used in the manufacturing of the cardboard. Sodium can be naturally present in the fibers or might have been introduced during the manufacturing process for softening the pulp.

and lead white. Barium sulphate particles lie in the range up to 10-15 μm with preponderance of the larger ones. Lead white and zinc white give the blue upper paint layer (layer 2) a very fine and homogeneous texture in the (sub)-micron size range.

3.3 INTERPRETATION OF NANOSIMS DATA

The mass information obtained by NanoSIMS is distinct from that obtained by static SIMS. The ion dosage and energy in each analyzed spot are higher and only small fragments and elements can be detected by this method.

Distribution maps of carbon (*m/z* 12), oxygen (*m/z* 16), nitrogen (detected as CN^-, *m/z* 26), sulphur (*m/z* 32), chlorine (*m/z* 35) as negative secondary ions, and sodium (*m/z* 23), calcium (*m/z* 40), strontium (*m/z* 88), barium (*m/z* 138) as positive secondary ions were acquired. Chlorine was used instead of lead as a marker of lead white, to which it is associated. Because of the parallel positioning of the detectors, the choice of chlorine allowed the acquisition of element maps over a smaller mass range and consequently at higher mass resolution.

The area analyzed by NanoSIMS is outlined in the light-microscopic image illustrated in Figure 7a. A SEM-BSE micrograph of the sample surface after sputtering off of the gold layer and NanoSIMS analysis is shown in Figure 7b. The exposed analyzed area appears as a darker rectangular region. A close-up view of the region shows the damage caused by the sputtering process (Figure 7c). The BSE detection was set up in order to optimize atomic number contrast; because of differences in atomic numbers and therefore of backscattered electrons yields, lead, barium and calcium appear respectively in white, gray and black. The elemental distribution maps obtained by NanoSIMS are depicted in Figures 8-11. These maps allow the identification of paint materials as discussed in the previous section for TOF-SIMS analysis. In addition, in contrast with static SIMS, NanoSIMS provides better

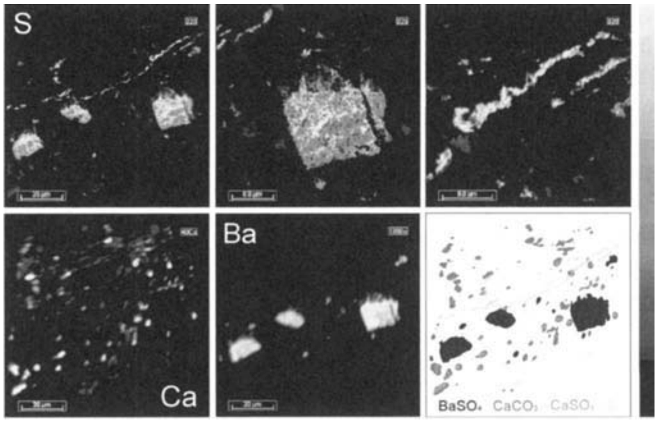

Fig. 9 Images of sulphur indicate gypsum and barite particles (where there is co-occurrence with calcium and barium). The overlay of sulphur, barium and calcium represented in the bottom right corner represents particles of barite (in black), calcium carbonate (in dark gray), and gypsum (in medium gray). The thin line of sulphur (in light gray in the overlay) lies in the contact zone of the ground paint layer with the cardboard (compare BSE image of Figure 7). Sulphur was likely absorbed by the cardboard from the atmosphere and had subsequently reacted with lead in the ground paint to form lead sulphate.

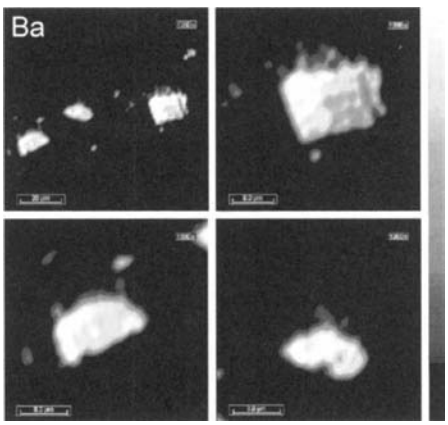

Fig. 10 Barium and strontium (Figure 11) exhibit heterogeneous distributions with differences in relative concentrations between- and within-particles.

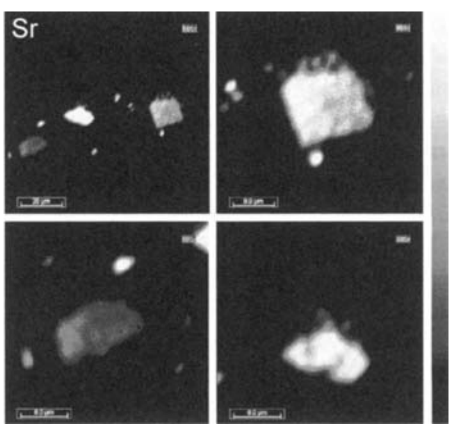

Fig. 11 Barium (Figure 10) and strontium exhibit heterogeneous distributions with differences in relative concentrations between- and within-particles.

resolution, and a higher sensitivity due to the dynamic regime. As it will be illustrated later in the text, NanoSIMS also allows to performing quantitative isotopic characterization.

Distribution maps of oxygen, chlorine, CN^-, and sodium are depicted in Figure 8. Oxygen is present in association with lead white, calcium carbonate, gypsum, barite, and with the binding medium. The chlorine map follows the distribution of lead white in the ground paint.

The cardboard fibers are clearly visible in the CN^- and sodium maps. The advantage of NanoSIMS compared to static SIMS is a better sensitivity to nitrogen detected in the form of CN^-, which is a reaction product of the sputtering process when both nitrogen and carbon are present in the analyzed spots. The nitrogen component associated to the fibers can be indicative of protein residues in the plant cell walls, of an attempt to glue the fibers together in the manufacturing of the cardboard [Bower 2002], or of application of a water-based size prior to the ground. CN^- seems to be abundant also in the paint layers, most likely as ammonia or nitrate impurity in lead white (this fragment is also observed in lead white oil paint reconstructions when NanoSIMS is performed, unpublished test results).

Sodium is another feature, possibly naturally present in the fibers or introduced during the manufacturing process of the cardboard, or as residues of sodium hydroxide or sodium chlorate in the preparation the cardboard pulp. In the latter case, chlorine is not observed in the cardboard as it reacts away in the bleaching process.

The sulphur maps in Figure 9 show particles of barium sulphate (in combination with barium) and gypsum (in combination with calcium). The higher sensitivity of NanoSIMS compared to static SIMS to sulphur improves the discrimination between calcium carbonate and gypsum. The sulphur map also exhibits a thin line along the contact zone between the priming layer and the cardboard. The sulphur and chlorine maps show that sulphur and lead overlap along this line. It can be observed also in the SEM-BSE image that the line lies along the edge of the lead paint (appearing in white because of the high electron backscattering).

Sulphur might have been absorbed as sulphide or sulphur oxide by the cardboard from the atmosphere before application of the ground paint, and could have reacted subsequently with lead white to form lead sulphate. In the bottom right of Figure 9 an overlay of the maps of sulphur, calcium and barium shows the distribution of calcium carbonate, gypsum, barium sulphate, and the thin line of sulphur.

Compared to static SIMS, NanoSIMS shows better sensitivity also to strontium. Combined with its high resolution, it was possible to characterize finer structural and sub-structural details of barite particles and to measure differences in relative concentrations. Specifically, barium and strontium show uneven distributions, with between- and within-particle differences in relative concentrations (Figures 10-11). Barite-celestite ($(Ba,Sr)SO_4$-H_2O) solid solutions exhibit a relationship between crystal size, morphology and composition [Sánchez-Pastor et al. 2006]. The (uncalibrated) ion yields ratio of strontium to barium, measured at different spots in two particles, fluctuates between 0.7% and 3% in one particle and between 0.4% and 0.61% in the other. Although not observed here, the oscillatory zoning characteristic of barite-celestite does not make the relative concentration of strontium-to-barium useful for tracing the different sources of the mineral.

Instead, the $^{86}Sr/^{87}Sr$ isotope ratio seems to be a more promising tool for this purpose. Strontium and sulphur isotope ratios are considered useful tools for distinguishing between barites of different origins and ages [Bréhéret and Brumsack 2000, Castorina et al. 1999]. In the field of authentication and origin assignment, isotopic characterization has already been successfully tested for lead in lead white paints [Fortunato et al. 2005]. The capability of NanoSIMS for isotopic characterization of barite was also tested by measuring the strontium $^{86}Sr/^{87}Sr$ isotope ratio in one particle. The obtained value of 0.718 falls within the range considered characteristic of non-marine barites as indicated for example by Castorina et al. [1999]. Paytan et al. [2002] suggest to combine strontium and sulphur isotopic analyses with a crystal-morphology characterization to provide a reliable indicator of the depositional environment of a given barite.

4. CONCLUSIONS

With static SIMS we were able to investigate the material composition and the textural characteristics of the paint layers in painting cross-sections. TOF-SIMS allowed analysis of both the pigment and the binding medium content of the paints, providing information on their spatial distribution within the paint layers. The combination of these characteristics enables us to identify and differentiate the different materials in the paint layers, and at the same time to examine the texture of the particulate materials individually.

In the painting under investigation we were able to detect and identify all the major components of the ground paints, lead white, calcium carbonate, gypsum, and barium sulphate. Barium sulphate is in its natural form, as it was found in association with strontium. TOF-SIMS data also show different grades of coarseness for the paint. For elements of higher detection efficiency, yields reflected the morphology of individual particles, provided that these are sufficiently large compared to the instrumental lateral resolution at the analytical conditions used.

The results of the explorative investigation presented in this paper shows the potential of NanoSIMS for the analysis of paint cross-sections. Compared to TOF-SIMS, NanoSIMS exhibits higher sensitivity and a higher lateral and mass resolution, which can be achieved simultaneously. In the case study considered, the improved features provided additional information that could not be obtained by TOF-SIMS. These include the enhanced detection of fine sub-structural details within barite particles and of other fine structures in the paint cross-section, of key trace elements and of organic markers. This work demonstrated that NanoSIMS can be used to measure differences in relative concentrations of strontium to barium, to examine the distribution of barium and strontium within and between barite particles, and to perform isotope analysis of strontium in barites. Strontium and sulphur isotopic ratios seem promising tools for to distinct different sources of barite used in paints. More extensive work on barite in paints involving the development/consultation of a database of barites from different locations is required. The analytical potential presented by NanoSIMS for the characterization of barites shows that this instrument can assist in the distinction of different sources of the barite in paints.

5. ACKNOWLEDGEMENTS

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ENDNOTE

[1]The F-number of the painting refers to its identifying number in the Van Gogh's oeuvre catalogue by De la Faille [1970].

A DESCRIPTION OF 19TH CENTURY AMERICAN GILDED PICTURE FRAMES AND AN OUTLINE OF THEIR MODERN USE AND CONSERVATION

Hugh Glover, Conservator of Furniture and Wood Objects

ABSTRACT – American 19th century gilded picture frame history is described from a conservation perspective. Subjects addressed include: original and datable frames; characterization of the frames; their wear, care, and use; and their restoration.

After an introduction (Section 1), Section 2 outlines the physical evidence found on frames and stretchers that help determine whether frames are original to the artwork within. Section 3 describes frame nomenclature, construction, materials, ornament, and decoration. It centers on recognizing the progression of 19th century American frame forms and technology that help in assessing the date of a frame. Section 4 addresses general preservation, handling, and preparation of frames for exhibition with glazing and microclimate set-ups. Section 5 is a brief description of restoration methods now used, together with some of their limitations.

1. INTRODUCTION

Picture frames are a component of most art collections and they are subject to wear and tear in their functional role surrounding paintings. Damage to frames occurs during exhibition, storage, and travel, and it is caused by handling, hanging processes, adverse environments, neglect, and irreversible restorations. Picture frames are maintained by a variety of preservation specialist and their preservation interests have only rarely been addressed.

An original or appropriate frame is a contextual surround that can enhance and inform the exhibition of a painting. Criteria for judging a frame's historical appropriateness, however, is woefully scarce. A starting point for understanding the technical and stylistic development of 19th century American frames can be the examination of datable frames of the period. Datable frames, particularly those that have remained united with their paintings, provide valuable information about contemporaneous taste and technique.

Because of the clear parallels between the techniques and styles of picture frames with those of gilded mirror frames, furniture, and decorative architectural elements, the 19th century literature of gilding and decoration can provide insights into the chronology of picture frame development. There are several known workshop manuals of the period describing decorating techniques, and further examples no doubt remain to be discovered.

Rare and important forays into frame research have been undertaken by Adair (1983), Smeaton (1988), Kaufman and Wilner (1995), Gill (1996, 2003), and Wilner (2000), etc. These and the small number of exhibitions and symposia devoted to picture frames have brought an increased level of connoisseurship and scholarship to the subject. By bringing together existing frame and gilding scholarship with a comprehensive examination of dateable period frames, we can begin to construct an accurate history of 19th century American frames. Understanding the characteristics of period frames will enable us to select frames that are historically and aesthetically appropriate for the painting they surround.

Finally, the conservation of picture frames provides a valuable opportunity to examine and analyze them closely to identify original forms, techniques, and materials. Gilding conservators have been developing more reversible and less intrusive restoration methods for the last twenty years, and conservation generally continues to fine tune our preservation efforts.

2. ORIGINAL AND DATABLE FRAMES

Original 19th century American frame/painting combinations survive in quantity, particularly in more static collections and on portraits. This is less true of imported European examples that have changed hands more frequently. Although there are American painting/frame combinations that can be quickly determined as original, others take more time to assess. Some frames remain questionable, and the remainder is easily determined as not original. Recognizing the history and appropriateness of the pair is likely to influence decisions made for the preservation of the frame.

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Some original combinations can be identified through surviving documentation, particularly photographs, but more often they will be identified by the physical evidence on the painting, stretcher, and frame. Examples of this evidence include:

- Corresponding period style and materials between frame and framee. Many datable components and marks on painting supports have been described by Katlan (1992).
- Shared wood coloring and markings on the frame and stretcher back resulting from oxidation, pollution, spills, and handling. Gravity influences the deposition of grime and upper parts will be darker, and coloring may have been influenced by dust covers and backing boards.
- Shared nail impressions and datable nails from fitting the painting, which can also indicate if and how many times the painting has been out of the frame. The dating of nails has been addressed by Edwards and Wells (1994) and Moyer (2002). The evidence available on the frame back may have been altered or lost by repetitive holes from fasteners, replacement stretchers, and other restorations.
- Changes to a frame's rail length or rebate size imply a different painting has been installed, although small increments of rebate widening can be explained by a keyed out, altered, or replaced stretcher. The occasional use of antique frames in the late 19th century may have resulted in their adaptation to fit a new painting.

3. CHARACTERIZATION OF 19th CENTURY AMERICAN FRAMES

This section is generally organized according to the sequence of frame construction and the chronology of techniques and material use.

3.1 NOMENCLATURE

Rectangular frames have top, bottom, and side rails, and the sides can be referred to as proper left and proper right for clarity. The rails have shaped profiles between a sight edge and back edge, and a rebate (or rabbet) behind the sight edge to house the painting. The terms front molding and top molding refer to the same feature, the most forward molding when the frame is hanging or the topmost molding when it is face up on a table (the term top molding is used here). The knoll, a more English term, describes the rounded summit of that molding. The top molding is usually located closer to the frame's outer edge, and when it is closer to the painting the frame is termed a reverse profile, or bolection.

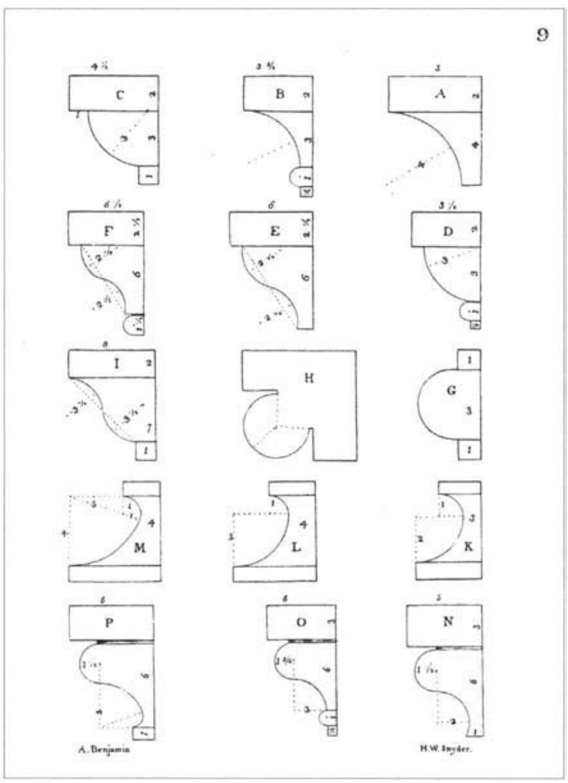

Fig. 1 Plate 9 from Benjamine, A [1827]. *The American Builder's Companion.* "A, cavetto, or hollow; B, cavetto and astragal; C, ovolo and fillet; D, ovolo and astragal; E, cymareversa, or ogee; F, cymareversa and bead; G, astragal; H, bead; I, cimarecta; K, L, and M, are scoties of different projections and curves; N, O, P, are quirk ogees."

Forms for moldings derive from Greek and Roman architecture. Recurring frame moldings include the fillet (small flat), fascia (large flat), cavetto (concave quarter-circle), scotia (non-circular concave), cong (combined flat and concave), ovolo (convex quarter-circle), torus (large convex half-circle), astragal (small version of torus), cyma recta (concave to convex, sometimes called an ogee), cyma-reversa (convex to concave, an ogee). Examples of molding profiles are reproduced in many descriptions of traditional architecture, e.g. Benjamine [1827] (fig. 1). Later and more general terminology also applies, such as ogee, cove, scoop, hollow, flat, etc.

The inside descent from the knoll is the frame's main profile and popular forms went from cove to ogee in the first half-century, and to convex in the last quarter of the century. The outside decent from the knoll went from plain flat (perpendicular to the wall), bevel, a small hollow within the flat, and a full scotia, all in the first quarter-century. An outside scotia with an ornamented back edge molding was popular during much of the remaining century. The silhouette outline of frames included straight, swept sided (rococo), and oval forms (neoclassical) in the first half-century, and then mostly straight sided in the second half-century.

Corners, centers, and sub-centers refer to enriched ornament at those sites, and piercing describes openings through the decoration. A mat is the liner that modifies the frame's opening to elliptical or round, and a liner is the removable inner section of sight edge. A slip is an insert at the sight edge, and usually a later addition.

The styles of frames are described using a combination of old and new architectural and decorative art terms. Some frame styles are named by association with a painter, e.g., Thomas Sully, Thomas Cole, James Whistler, Childe Hassam, etc. More style terms and forms originated in Europe, for which European frame history resources are useful, e.g., Grimm (1981); Mitchell and Roberts (1996, 1996); Newbery et al (1990); Simon (1996); VanThiel and deBruyn Kops (1995).

The design and scale of ornament on frames evolved throughout the century in line with prevailing taste in architecture and the decorative arts. The majority of American frame ornament was derived from European and classical standards, while other sources included indigenous vegetation and flora (1845-65), the exotic from the Mid-East and Asia (1850-90), Native American (after 1880), and industrial inspired patterns (after 1880). Terminology for ornament is outlined in various sources including, Lewis and Darley (1986), Meyer [1957], and Stafford and Ware (1975).

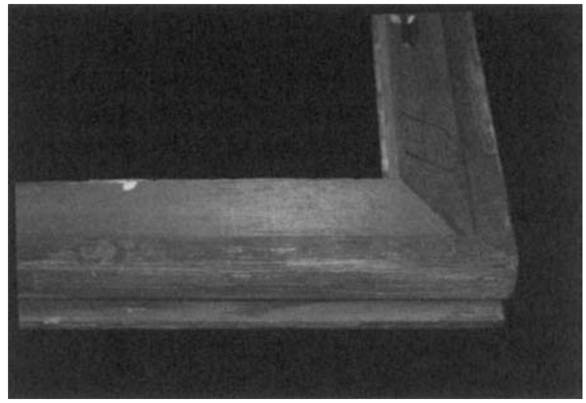

Fig 2. Back view of a sloped main profile edge glued to a painted perpendicular outer edge, a popular form in the second quarter of the century.

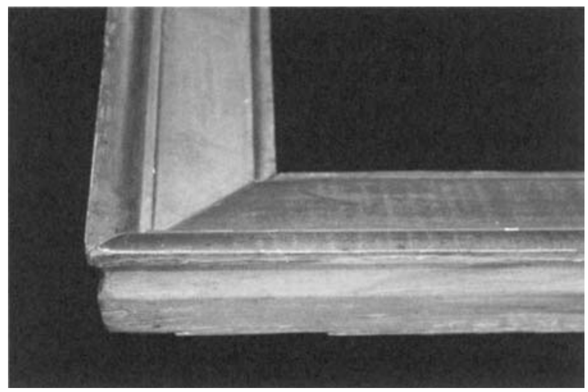

Fig. 3 Front view of fig. 2. The frame is water gilded and has an ovolo top molding, beveled main profile, cavetto sight edge, and a hollow in the yellow painted perpendicular back edge.

3.2 WOOD SUBSTRATE

The substrate of most 19th century American frames is a relatively knot-free softwood, predominately white pine. In the last quarter-century various plain hardwoods (generally diffuse porous) were also used, and after 1860 the figurative markings of ring-porous hardwoods (e.g., oak, chestnut) were occasionally used decoratively beneath oil gilding without gesso.

3.3 SHAPED MOLDINGS

Early frame profiles were small and prepared by hand with planes, and wider rails after 1820 still involved hand planes. Successful machines for molding and shaping wood were developed in America in 1848 by C. B. Rogers & Co. and J. A. Fry & Co. (Englund 1978). The large, wide, and clean profiles from about 1840 suggest that machine shaping may have already been in use before the mid-century patent dates of these machines. Machine developments continued with cast iron frames introduced around 1850, the first vertical spindle molding machine patented by Andrew Gear (US) in 1853, and inside or center feed molders appearing in the 1860's. Demand for architectural moldings exceeded demand for picture frames and would have spurred these machine developments.

3.4 RAIL CONSTRUCTION

Early narrow frame rails were single pieces of wood. As they widened they were formed from two glued pieces, with a slope for the main profile glued to a perpendicular top molding/outer edge (fig. 2, 3). Popular profiles on the slope included the bevel (Thomas Sully style), cove (Grecian), and ogee, often with an integral sight edge of an astragal and cavetto. Varnished cross-veneer and faux painted veneer versions were also popular.

Frame rail developments in the second quarter included two-section rails, square (boxed) recessed backs with supporting glue blocks, and lengthwise glued laminations for deeper rails. In the second half-century three and four concentric section rails achieved greater widths, while rail laminations, box recessed backs, and supporting glue blocks all remained common. The concentric sections of multiple section rails were gilded before assembly, seated in rebates, and fastened with angled nails in the back (fig. 4). Most reform styles (aesthetic movement, arts and crafts, etc.) after 1865 reverted to simple single rail arrangements.

Fig. 4 Back view of a four section frame with a box section recess in the main outer profile, and supporting glue blocks.

3.5 CORNER JOINERY

Many early-century frames relied on half-lapped corner joinery in a back frame, with applied mitered front moldings. A few joiner-made examples relied on mortise and tenons in a back frame. Most frames, however, had simple mitered corners secured with glue and cut nails (fig. 5), with the nails in one direction that alternated around the corners (nails in both directions implies that nails have been added). Rails were assembled before the gesso and gilding were applied, and overlaid corner ornaments could contribute to the joinery. Tapered dovetail splines across the mitered corners were popular in Europe but uncommon in the United States. Late-century joinery methods included internal wood splines in grooves along the length of the miter, and the distinctive Newcombe-Macklin joint of thin plywood inserts over the back (fig. 6). Frames as large as doorways were generally assembled with lapped, mortised, and mitered joinery and held with draw bolts and trapped nuts.

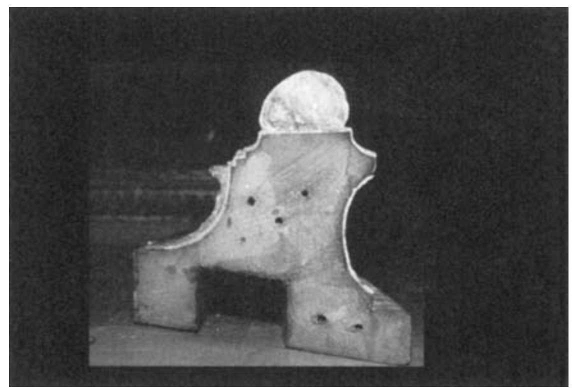

Fig. 5 An opened miter corner of an outer profile with a box section back recess and laminated four-part construction.

Oval frames, popular in the second quarter, were mostly formed from a four-piece lap-joined or splined back frame and front laminations that bridged the seams, before being turned on an elliptical lathe[1]. Gilded wood mats and liners with rounded corners were mitered and fitted with wood corner inserts that were sometimes lapped or splined.

3.6 CARVED ORNAMENT

Ornament on early Federal frames was generally carved in the wood as small cross-cut sight edge decoration. Carved and gilded lengths of round rope twist ornament nailed into cove profiles were also popular. After about 1815 most ornament was molded. The use of low-relief carving was revived in late-century reform styles for foliage ornament and gouge textured surfaces, many of which were likely to have been first prepared on shaping machinery.

3.7 COMPO ORNAMENT

Compo (composition) was the popular material for molded ornament beginning about 1815 and its history and technology have been described by Thornton (1985) and Wetherall (1991). Compo ornament was much faster to produce than carved wood and it was also more stable as a substrate for gilding, since wood in the American climate is prone to movement. Compo was pressed into rigid molds of reverse carved wood, molded sulfur, or resin. Pressed compo ornament continues to be available today, and the dough-like material is easily prepared (Thornton 1985).

Fig. 6 The distinctive Newcombe-Macklin corner joint of thin plywood inserted in the back of the miter.

The form, placement and detail of compo ornament evolved in fashion during the century in conjunction with developing rail forms and gilded effects. Early compo was more globular, and later examples became finely detailed. Logical early placement was to cover the corner joinery, visually strengthening the joints, and then the next vacant space, the centers, were filled after about 1820, and by 1830 the ornaments had spread to almost connect. By 1840 continuous compo top moldings were popular, and scrolled foliage and strap-work could entirely fill the main profile (a style associated with Thomas Cole). Popular top molding forms at the mid-century included the rustic twig, with ivy at the corners, followed by laurel-and-berry or reeding with corner bindings. In the third quarter diaper patterns filled the cove, and more geometric designs followed. In the last quarter detailed foliate compo was applied as distinct bands, separated by plain fillets, flats, and hollows (Barbizon style).

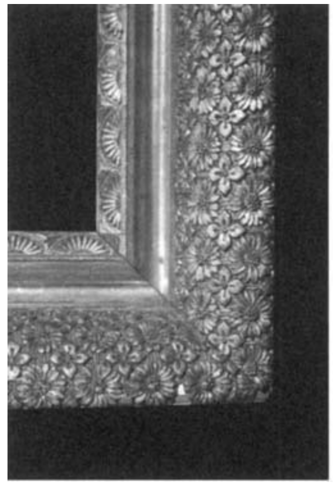

Fig. 7 Discontinuous design at the miter of late-century machine pressed ornament.

Fig. 8 Oil gilded tulle net as textural decoration. Sections of compo are missing and reveal the net beneath.

The compo was applied to assembled and gessoed rails and it could be bent to conform to the rail shape and curvature. It was secured with hide glue or its own tackiness after steaming, and larger pieces were held with nails/sprigs. Undercutting was only achieved by raising parts from the substrate or backing it with putty fills. Compo is characterized by its pale brown raw umber-like color, its thickness varying from 1/16" to 1", the absence of undercutting, and the development of proportional shrinkage cracks on drying.

The dried compo was prepared with a thin gesso or clay (Gilders Manual 1876, 12), or gilded directly using oil gilding for the larger part and water gilding on bole for forward features.

Mechanized processes in the later century used rollers and dyes to produce compo ornamented rail lengths (Hünkel 1991), as many ornaments on frames have been made since. Examples can be distinguished by their thin compo cross-section, mitered corner cuts through the compo and gesso, and discontinuous ornament designs at the miter [fig. 7). Sometimes these features are hidden beneath compo corner overlays.

3.8 TULLE NET

Tulle net as textural decoration was popular in the second quarter-century (fig. 8). Strips of machine woven tulle lace were applied with glue to the gessoed frame rails (before the compo), a technique that was used in Munich in the 1840's (Hünkel 1991). The textured surface is reminiscent of 18th century European cross-hatching cut in gesso. The weave pattern in the lace is generally a plain square 2 to 3 mm wide, but more complex and decorative weaves developed on the theme. Bolder cross-hatched effects at the end of the century were cast directly in the surface of compo or plaster.

3.9 SAND TEXTURE

Sand textured surfaces were popular after about 1840. Fine sand was applied to oil size to produce a contrasting texture and reflection. Stenciled rustic patterns of rocks (repeated patches) initially filled the main cove (fig. 9), which were later relegated to smaller moldings. More stylized wave and foliate sand patterns were used in the third quarter (fig 10). A plain narrow band of sand texture positioned towards the sight edge was eventually popular, as it had been in 18th century European frames. Softer grit textured effects were also used in the mid-century, and on later revival styles.

Fig. 9 Stenciled rustic patterns of rocks (repeated patches) initially filled the main cove after about 1840.

Fig. 10 Stylized wave and foliate sand patterns were used in the third quarter.

3.10 PLASTER ORNAMENT

Cast plaster ornament was popular after about 1870, corresponding to the development of wax and gelatin mold techniques (Millar 1897). These reusable molds were flexible and allowed for new undercut forms, and presumably still cheaper and faster production. Glue is often absent under the plaster, as are corner seams, suggesting that the plaster could be added simultaneously in a single pour onto all four gessoed rails.

Plaster ornament is characterized by its white interior, full length forms, and its greater weight and bulk, usually more than an inch thick due to its inherent weakness. Internal wire armatures were sometimes incorporated for support. Common plaster placement was as a convex half-round top molding (torus), while smaller moldings on the same frame continued to be of denser compo. Early plaster ornament is bulky and less modeled, and may be oil gilded only, while later examples have dramatic undercut foliage, leaf turnovers, and lively surface effects of oil gilding against burnished and matt water gilding (fig 11).

As with compo, it was not essential to prepare plaster with gesso, although sealant coatings of oil or glue size were recommended (Gilder's Manual 1876, 27). Similarly, its surface was generally oil gilded with forward features water gilded and burnished. Some late century examples were also gilded with brass leaf and powders.

Fig. 11 Lively late-century plaster ornament on a top molding (the corner leaf turnover is missing), and a small inside band of compo bead-and-reel.

3.11 GESSO

Gesso is the animal glue bound white preparation for wood, filled with inert white pigment, most commonly calcium carbonate (chalk). Some late century reform style frames have red pigmented gesso to influence the color of the final gilding, or to reduce color contrast when the gesso is chipped. New gesso was smoothed and shaped with rushes, fish skin, damp cloth, shaped pumice stone forms, or other abrasives. By the third quarter manufacturers were supplying framers with whitened up (gessoed) stock moldings prepared with templates (Gilder's Manual 1876, 11), although the regularity of earlier surfaces suggests already well developed production methods.

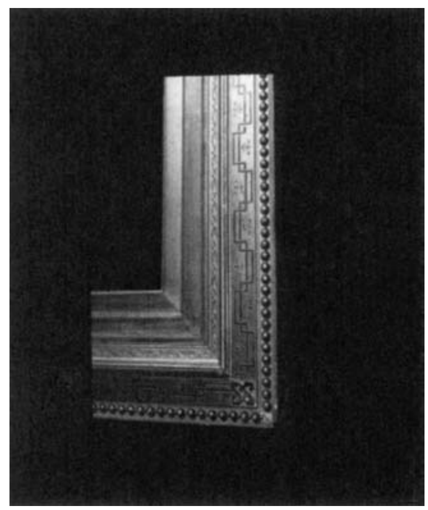

Fig 12 Incised, gilded, and selectively burnished flat bands were popular on high style frames during the 1860's to 1880's (the main outer profile has been removed).

3.12 GESSO RECUTTING

Gesso re-cutting is rare on American frames since the primary gesso was used on unadorned surfaces, and detail in ornament was derived from a mold. An exception is the gesso cut fluted cove that was popular as a main profile in the third quarter. Flat bands of incised, gilded, and selectively burnished, or punched gesso were popular on high style frames from 1860 to 1885 (fig 12). Incised patterns of white within a dark pigmented gesso surface (not gilded) were popular with Eastlake styles.

3.13 BOLE

Bole is colored clay mixed with glue size and a small fat component applied as the preparation for water gilding (The Painter, Gilder, and Varnishes' Companion 1883, 78). Different bole colors were popular throughout the century, beginning with shades of mauve, grays after about 1830, and later red colors. Red oil paint was used to prepare for some late century oil gilding. Some modern reproductions of early century styles are inaccurately prepared with red bole.

3.14 WATER AND OIL GILDING

The term *gilding* is used here in the broad sense to describe all applied metallic finishes on frames and some of these finishes do not include gold.

Nineteenth-century use of water and oil gilding was an integral part of the frame's decorative development. Water gilding alone dominated until about 1820, and then faster oil gilding was introduced for the compo parts.

Popular second-quarter plain molding frames that had no compo were typically profiled with an ovolo top molding, a main cove or bevel, and a small fillet or torus before a cavetto sight edge. They were water gilded on mauve bole and burnished along the top molding and the fillet/torus close to the sight edge. A similar contemporaneous profile decorated with compo corners/centers would be oil gilded only on the compo, and water gilded between the ornaments. An exception is found on some of the earliest compo that may be only water gilded.

The proportion of oil to water gilding on frames increased with the introduction of more compo, but water gilding continued to be the choice for the plain matte or burnished surfaces between the compo/plaster bands, and for burnished highlights on forward features of the compo/plaster. Plain small moldings between the bands of ornament, such as fillet, torus, and hollow, were usually burnished water gilding, and flats were usually matte water gilding. In all cases of combined oil and water gilding it was practical to complete the water gilding before the oil gilding since the brushed oil size could be neatly lapped onto the edges of the water gilding.

The solid gilded and matte effect common on flat liners popular after 1840, wide bevels and flats popular in the last quarter, and other plain surfaces, was achieved with double water gilding and matting size (Gilder's Manual 1876, 17; Savory 1875, 67). Burnished sight edges next to a painting were rare but they were used for works on paper that were spaced away from the gilding with a paper mat (Gilder's Manual 1876, 16). Oil gilding alone was unlikely to have been used for an entire frame until the last two decades of the century.

3.15 OIL SIZE

Recipes for 19th century oil size included resin mixtures and aged linseed oil, colored with red or yellow resins and pigments (The Painter, Gilder, and Varnishes' Companion 1883, 65, 78). A visual assessment of the period's oil size suggests that most was lightly colored yellow, if colored at all. Chrome yellow colors were used occasionally by mid-century, and brighter red pigmentation was used in the late-century.

3.16 COLORING YELLOW

Coloring yellow, a distemper prepared with yellow pigment in glue size, was used during the first half of the century to economically color the outside plain wood profile, usually a flat, bevel, or scotia, and it was used to prepare recesses for water and oil gilding (The Painter, Gilder, and Varnishes' Companion 1883, 79; Gilder's Manual 1876, 12).

3.17 GOLD LEAF

Gold is alloyed today with copper for red shades, and silver for lemon/green shades. More shades of gold leaf are probably available today than were available for most of the 19th century. The color of most 19th century gold leaf visually corresponds to the present day red colors of about 23½ K, although the color of old gilding is now altered with grime, oxidized coatings, and handling. A preference for a redder color is indicated in a letter from Thomas Cole to Asher B. Durand in 1837, where he specifies: "...the best gold not the pale"[2]. Domestic gold beaters were also producing cooler shades of gold (Fennimore 1991, 140). Lemon/green shades were popular for reform styles, and are specified in James Whistler's correspondence of the 1870's (MacDonald et al 2003). A late-century example of lemon/green gold on such a frame examined by x-ray fluorescence spectroscopy (XRF) revealed a high zinc component, rather than silver.

True gold powder (shell gold) is described in most gilding manuals (e.g., The Painter, Gilder, and Varnishes' Companion 1883, 74) but its use for gilding frames was likely limited.

3.18 NON-GOLD GILDING

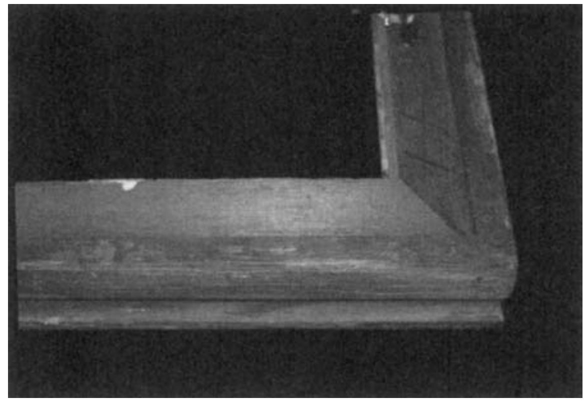

Fig 13. Mecca gilding of faded yellow varnish on silver leaf on an outside ovolo, with oxidized silver where the varnish is thin or broken.

The terms "mecca gilding" (origin uncertain) and "changing varnish" refer to resin or pigment colored varnish glazes (The Painter, Gilder, and Varnishes' Companion 1883, 64). The technique of coating burnished silver leaf with yellow varnish to imitate gold was popular before the mid-century and in the last quarter. Stenciled matte patterns on the varnish were occasionally used to represent fluting, etc. Examples of mecca gilding are visually recognized by the faded yellow varnish coating, and oxidized silver where the varnish is thin or broken (fig. 13).

Brass leaf gilding became popular in the last quarter-century, generally applied using the oil gilding technique and always protected from oxidation with a varnish coating. Brass leaf gilding was initially used on secondary surfaces (e.g., outside coves) but by the end of the century it could be used overall or in combination with mecca gilding and Roman gilding with bronze powders. Brass leaf is visually recognized by its varnish coating, sometimes a wrinkled appearance due to its thickness, large leaf size of more than 5-inches (gold leaf is 3 3/8-inch square), and general or localized darkening due to oxidation.

Mass production of bronze powder and its preparation as paint in a de-acified varnish was developed in mid 19th century London by Sir Henry Bessemer in answer to costly German imports (Bessemer 1905). Bronze powder gilding is found on American frames after about 1880 and the technique has been termed Roman gilding since at least 1909 (Ford and Mimmack 1909, 42). Methods varied from applying the powder as paint in a glue or varnish medium, to dusting the powder onto oil size (The Painter, Gilder, and Varnishes' Companion 1883, 120), and various varnish coatings were applied for protection from oxidation (Ford and Mimmack 1909, 43, 58). Examples can incorporate a modest burnish within the bronze, and brighter burnished highlights of water gilding on bole. Roman gilding is visually recognized by its dull and oxidized color, UV fluorescence of coatings, and broken particles under magnification. The tin-based gold powder, aurum mosaicum (The Painter, Gilder, and Varnishes' Companion 1883, 75), probably had little application on gilded picture frames.

3.19 TONE AND VARNISH COATINGS

Gilded surfaces, except burnished parts, were brush coated with a thin size layer to matt and even the finish, adding contrast to the bright burnished passages. Coatings varied from plain glue size (The Painter, Gilder, and Varnishes' Companion 1883, 110-111), glue size or water colored with resin/dye/pigments, termed ormolu (Gilder's Manual 1876, 10; Savory 1875) or vermeil (The Painter, Gilder, and Varnishes' Companion 1883, 80), or the later use of thinned shellac (Ford and Mimmack 1909, 59). Thick and glossy varnish was not applied on gold leaf as it would interfere with the gold color and reflection, but thick and evenly applied varnish was a necessary barrier for non-gold gilding to prevent tarnishing.

The gilding on some reform style frames of the late century was mildly abraded and toned with colored varnish to better compliment the painting. The gilding of mainstream frames was intended to be clean, bright, and only subtly toned. The practice of using stronger pigment, stain, and dye-toned coatings purposefully pooled within design recesses to mimic collected grime (antiquing) may have seen occasional use in the late-century, bur it has been more common since the 20th century for effects and reproductions. Equally, intentional abrasion of gilding for the ageing effect (distressing) was uncommon until the 20th century.

4. FRAME WEAR, CARE, AND USE

4.1 ENVIRONMENT

Gilded wood objects are ultra sensitive to environmental conditions and they are probably more sensitive than most paintings. In adverse climates gilded wood experiences detachment and loss of gilding/ornament, while an accumulation of grime leads to surface darkening and cleaning campaigns that may well cause damage.

The protected bright gilding that survives on shadow-boxed frames of the second half-century illustrates how more exposed gilding has now been altered by grime, abrasion, and staining from moisture and grease during handling.

4.2 HANDLING

All gilded objects should be handled with non-marring gloves to avoid abrasions and staining, and even paper towels or cotton cloth will suffice. In practice, however, gilded frames are still handled with bare hands as the frame is considered a safe means of handling the artwork. Other handling precautions include using soft support pads, not lifting empty frames by the thin sight edge, and avoiding contact with loose parts. Ziploc-type bags labeled with marker pens are useful for saving detached parts.

4.3 DUSTING

Occasional dusting of frames with a clean soft brush and vacuum is recommended to remove the dust that eventually becomes grime and attracts moisture. Light-weight dust covers can help in dustier storage areas (e.g. clear 0.35 mil (9 µm) polyethylene). Over-zealous dusting results in progressive abrasion that removes the gold (< 1 thick) and reveals the bole and gesso preparation layers. Varying degrees of this condition are very common, especially on the shelf of the bottom rail. Aqueous cleaning results in the removal of water gilding and toned coatings which is another common condition.

4.4 HANGING HARDWARE

The early 19th century hanging device was a ring and screw combination located singly or as a pair in the top rail. Simpler early devices included wire, leather, and sheet metal loops, located in the top rail. Some rural portraits were not originally framed and had the loop device attached to the top stretcher bar. Paired screw eyelets located in the side rails were popular after about 1825, and heavier frames could have custom hardware.

Modern practice is to fit steel D-rings for hanging, Oz-clips for some crating, and mending plates for securing the artwork, attached with pan-head sheet-metal screws (countersunk screws for Oz-clips). Secure fittings reduce the incidence of repeated screw holes, but events can lead to new holes in the frame and stretcher backs, and care is necessary to avoid excessive holes or obscuring historic evidence. A direct-reading caliper is useful for optimizing the length of screws added to a frame. Redundant early hardware can be preserved on the frame, or stored separately if necessary.

A heavy-duty hanging scale was used to crudely measure the failure point of a common D-ring with a stand-up wire loop (item U711, United Manufacturers Supplies Inc.). The wire loop failed by unwinding from its strap at around 520 lbs, despite the strap being fixed with only small screws in softwood (No. 8 x 1 in. screws in sugar pine). With safety margins that include an allowance for one hanger to temporarily hold the whole weight, perhaps 150 lbs is a reasonable maximum loading for a pair of these D-rings. Most framed paintings weigh less than 150 lbs, even when they are fitted with laminated safety glass. A record of the weight of heavier objects can be useful, as would further load tests of hanging devices. Old braided steel wire corrodes and becomes brittle and should be replaced with a stainless type. A single wall fixture combined with a connecting wire on the back of the frame is less secure than two wall fixtures, one for each D-ring. Failures within the hanging arrangement can be disastrous.

4.5 LABELS

Frame makers can be identified from the occasional inscriptions found on the frame back. These can be printed paper glued on the wood, pencil inscriptions, and late-century marks applied by carving, ink stamp, and engraved metal coupons. A selection of late century marks are illustrated by Smeaton (1988), and many New York and Boston makers have been recorded by Katlan (1987). Other frame back inscriptions record dimensions, style, owner, and hanging location, etc.

Ideally, owner records should include copies of maker's labels/marks since they are fragile and subject to loss. Surviving labels can be protected in place with an overlay of 5 mil (0.127 mm) Mylar attached with double coated tape (3M 415) on an isolation layer (B72), and detached labels can be encapsulated in Mylar envelopes.

Exhibition labels have traditionally been placed on frame and stretcher backs. A less intrusive and longer lasting location is on the painting's backboard encapsulated in Mylar, and/or placed in the owner's records.

Modern inventory marks are applied between soluble varnish coatings to a discreet part of the frame, usually an outside corner and/or the back. Troublesome old inventory labels include gummed paper on water gilding, and pressure adhesive labels or masking tape on oil gilding.

Gilding that has been covered with a title plate is usually better preserved than adjacent surfaces and indicates an earlier condition. The silhouette revealed when plates are removed may need to be masked with pigments. The introduction of new title plates will eventually result in the same irregular coloring to the gilding.

4.6 REBATE MODIFICATIONS

Frame rebates are sometimes modified to improve the fit of a painting. When an aperture is too large to neatly and safely house a painting the sight size can be reduced by fitting flat or L-section wood slips (or a liner) within the rebate. Mitering the ends of the slips is often sufficient to hold them in place, rather than adding fasteners or adhesive. L-section slips can double-serve by also centering the painting. Whether to only paint the reveal of the new slip, include a cavetto profile, or gesso and gild the reveal with oil or water gilding, depends on the frame's existing gilding quality and the extent of the reveal. Linen covered liners were popular in the second half of the 20th century and they can be original to a 20th century frame, but they are a later addition to a 19th century frame and were added to modify the sight size.

A keyed out stretcher or a larger painting can require the widening of the rebate. Wood may need to be removed with a sharp chisel or router, although this obviously involves the loss of original material and detail.

Strips of polyester felt tape with an adhesive backing (e.g. Decco tape) are now generally fitted to rebates to cushion the edges of the painting. Attachment of the felt is improved by first dusting the rebate with a brush, and/or coating it with thin varnish (e.g., B72, shellac).

4.7 GLAZING

Glazing is added to frames for the protection of artwork, generally for specific exhibitions and travel. Modern glazing materials are light-weight thermoplastics (acrylic or polycarbonate) or heavier-weight laminated glass, and most have proprietary coatings to reduce UV light and reflection. A glossary of glazing terms and a comparison of glazing materials are available as technical leaflets on WACC's website[3]. Glazing is fitted in the rebate (or in front of a liner) and is backed with dark colored and felted wood or acrylic spacers. The increased protrusion of the painting in the back can be enclosed within an added build-up (*see* 4.9).

4.8 MICROCLIMATES

Sealed microclimate enclosures are used to stabalize environmental influences during exhibition and travel. The history, development, and design of various enclosures have been described in recent literature: e.g., Kamba (1993); Richard (1995); Wadum (1995); Sozzani (1997); Phibbs (2002). The painting is enclosed behind glazing within the frame (or travel frame), or larger enclosures such as vitrines can also include the frame.

Sozzani demonstrates that the moisture content of wood within the enclosure (i.e. stretcher, panel, cradling, interior frame and build-up, etc.) helps control RH during temperature variations, and a silica gel component can be a hindrance. The method described uses gaskets fitted between the glazing and rebate, and between the back of frame or build-up and an aluminum sheet backing, plus additional seals as needed.

Phibbs describes a simple method that uses a single piece of Marvelseal covering the object's back and sealed to the front edges of the glazing with double coated adhesive tape. Phibbs also describes a more labor intensive method that involves two pieces of Marvelseal per edge, bonded to the front and back edge of the glazing with hot melt adhesive, and folded and heat sealed over the painting's backboard.

Factors influencing the choice of microclimate method include size, weight, shape of the packaged artwork, rebate size of the frame, the exhibition environment and duration, and individual preferences. A small data logger enclosed within the envelope can give an after-event assessment of temperature and RH.

4.9 BUILD-UP

A build-up is an addition on the frame back that extends the rebate's depth to improve the housing of protruding artwork. A build-up is usually made from four pieces of straight grained and light-weight wood (e.g. sugar pine, tulip poplar), ½ - 1 ½ in. deep, and attached to the frame back with a minimum number of woodscrews. Joining the corners of the build-up with splines or lap joints adds useful support to the frame's own corner joinery, and beveling and painting the outside perimeter reduces visibility. A build-up for an oval or round frame can be prepared from birch plywood cut to a circle with band saw and jig saw. Reasons for adding a build-up include protecting the back of protruding artwork, as a component of glazing and microclimate set-ups, and as a support for failing frame joinery. Build-ups do push the hanging object away from the wall, but they also hold hardware and can provide an insulating air space behind.

5. RESTORATION

Frame restoration/conservation treatments address structural and surface security, the housing accommodation, and the restoration of appearance. The condition of gilding on frames is rarely perfect and it reveals its history of use as a patina. A complete restoration to its original bright condition is generally impractical and often undesirable.

The extent and location of restoration interventions to a frame are generally weighted toward achieving a successful presentation of the painting, and less visible frame damage may be left untreated. Quick restoration methods using different materials are often applied when they are reversible and reasonably durable, such as inpainting gesso losses, or filling dimensional losses with wax.

Reversible gilding techniques have been in development since the 1980's, initially published by Herbert and Small (1991) and Thornton (1991), and their development continues for the preservation of all historic gilding. The following is a brief description of gilded frame restoration methods for common situations.

5.1 LOOSE STRUCTURE

Loose frame corners can compromise the structure and lead to loss of local decoration. The condition of the joinery is assessed by gently manipulating an empty frame on a table. The original 45° angle of most miter joints has been reduced by wood shrinkage and regluing with hide glue is not generally effective. One method of supporting loose frame corners involves adding birch plywood L-plates, or a full build-up to the back, secured with hide glue and/or woodscrews. Flat metal L-plates fitted with screws are less practical since the joint usually remains flexible. Half lapped corner joints can be re-glued with hide glue, or supported with plywood L-plates.

Glue failure in laminations within a rail sometimes lead to gesso losses along the seams. The laminations can be glued with hide glue after isolating the gilding with temporary varnish, or they can be secured with woodscrews from the back. Gesso loss can also be caused by wood shrinkage against the long grain of glue blocks on the back, and the blocks may need to be shortened before the damage is restored.

5.2 LOOSE DECORATION

Breaks or splits within wood parts are generally secured with hide glue, and connections with gaps or end-grain can be secured with carvable epoxy between isolation layers of B72 (Ellis and Heginbotham 2002). Loose compo ornament is effectively and reversibly secured with B72/acetone adhesive (Koob 1985), as are small sections of plaster. Adhesives to consider for larger sections of loose plaster include hide glue, PVA emulsion, and polyvinyl butyral.

Loose gesso on wood is a common condition where wood movement is greatest, such as edges of outside angles and convex forms. Loose gesso can be successfully secured with gelatin or rabbit skin glue size (about 4%), applied with a small brush without contacting the gilded surface.

Micro-flaking in the top surface of oil and water gilding layers also occurs. In water gilding it is rare and probably results from ineffective sizing of the gesso or excess glue in a coating on the gold leaf. Micro-flaking in oil gilding is more common particularly at the base of compo ornaments and in the interstices of tulle net, resulting from insufficient sealant, excesses of glue and oil size (fig. 14), or contraction of over-coatings. Careful handling of these surfaces may be the most practical means of their preservation.

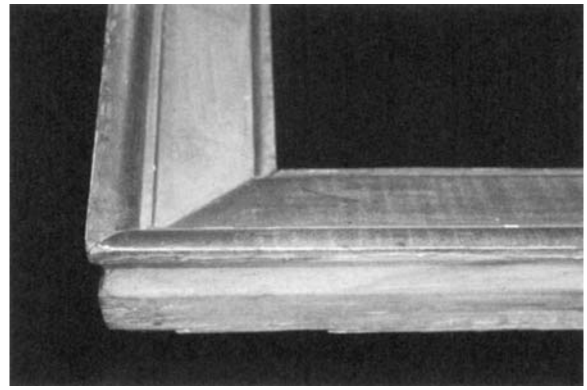

Fig. 14. Micro-flaking in oil gilding at the base of compo ornaments resulting from insufficient sealant or an excess of glue or oil size.

5.3 INPAINTING

Small losses of gesso and gilding are masked by inpainting with stable and soluble pigment systems that can incorporate mica pigments (e.g. acrylic emulsions, MSA and PVA colors, watercolors, etc.). Coloring all the revealed white on a frame facilitates monitoring new losses, and can be useful before events when frames are frequently handled and their conditions are inspected and reported.

5.4 GESSO FILLS

Gesso losses on frames are common and their restoration can be prioritized to address those that are most prominent in the hanging position. Fills within bright or flat surfaces are more demanding to execute than fills within ornament or darker toned gilding. Several methods for filling the losses in gilding have been described by Thornton (1991).

Polymer binders prepared with inert fillers (calcium carbonate, calcium sulfate, kaolin, microballoons, cellulose powders, etc.) are used for reversible fills. Sheldon (1996) has described the use of Aquazol (poly(2-ethyl-2-oxazoline), Thornton (1991) describes the use of B72, and polyvinyl alcohol has been used by Herbert and Small (1991) and Thornton (1991). Acrylic resin (previously cellulose ether) is used in Kolner brand burnishing clay. The use of regular protein gesso is also popular due to its reliability and performance, and Salimnejad (2002) has demonstrated that a protein bound gesso prepared with zinc oxide (35%), bismuth oxide (10%), and calcium carbonate (55%) provides an x-ray dense material. The drying of polymer gessoes tends to result in strata within the fill's thickness, something that is not apparent in regular protein gesso that sets initially by gelling.

Gesso putties for deeper fills and proprietary spackle compounds like Modostuc (calcium carbonate, small amounts of barium sulfate, a polyvinyl acetate copolymer binder) can be quick to use, and wax for small fills can be quicker still. Recipes for fills are designed for the size and location of the loss, reversibility, less density than original material, working properties, and the gilding layers that will be applied.

5.5 ORNAMENT FILLS

The reproduction of ornament losses by molding and casting is common restoration practice, and small losses can be reproduced by direct modeling of a fill material. For molding and casting extant ornament is used as the pattern for producing flexible molds. Quick setting dental putty (vinyl polysiloxane impression material) probably reduces the risk of silicone oil contamination, and RTV silicone rubber poured within dammed boundaries is useful for larger molds. In both cases the original surface is coated with a temporary isolation coating (B72, B67, petroleum jelly, wax, etc.). Extant ornament patterns do not always survive and it may not be possible to fill the loss accurately. In these cases similar frames can provide a pattern, and sometimes fills can be creatively modeled based on adjacent patterns. Historically appropriate new compo from a modern supplier may also be considered. Images of damaged repeat ornaments can be overlaid in Photoshop to help visualize the parts that do not survive.

Options for the casting material include new compo or plaster, or thermosetting polymers such as polyester, polyurethane, or epoxy resin. At the Williamstown Art Conservation Center (WACC) we generally use a low-viscosity epoxy resin (West System) bulked with microballoons, or a proprietary bulked epoxy resin (Woodcast). Steps that aid the casting process and reduce air pockets include pre-painting the mold with a base color, and warming the mold and the pre-catalyzed casting material under a heat lamp. The back and edges of the cured casting are reduced with files and abrasives until it fits the lacunae. Parts that fit well are secured with B72/acetone adhesive, and parts that that have only a small contact with the substrate are secured with small spots of carveable epoxy on a B72 isolation layer. Wax, gesso, or spackle type fills may be necessary to complete the edges of the new fill before the gilding is applied.

Carved wood fills for American frames are rarely necessary since the medium is less common, and late century carving is generally in low-relief and more robust. Options for fills in carvings include new wood, carvable epoxy, wax, or casting methods. Fill selection considers the type and size of the loss.

5.6 IN-GILDING

New fills are gilded and colored to match adjacent surfaces. Dull and toned gilded effects can be quickly achieved by inpainting with pigments that include mica or shell gold. Brighter effects require gilding with a corresponding shade of leaf applied on a matching base color and surface quality. The selection of leaf shade is aided by temporarily fixing small pieces of each option onto the extant gilding with B72.

A gilding method for attaching new leaf is selected for its gilded effect and reversibility. Sawicki (2002) has compared the performance of non-traditional mordants and concludes with the successful application of Plextol B-500 (an aqueous emulsion of ethylacrylate/methyl methacrylate copolymer) for reproducing matte gilded effects (and it can be manipulated to produce shinier effects). Others have described the use of acrylic resins, acrylic emulsions, Aquazol, polyvinyl alcohol, and wax (Thornton 1991; Moyer and Hanlon 1996; Sheldon 1996). In some circumstances traditional oil and water gilding methods can be reversible, and garlic juice (Cennini [1960], 97) and glare could perhaps also be considered. Reversible gilding systems are also used to apply new leaf onto original bole where old leaf has been abraded. Newly leafed passages are then toned with abrasion if necessary, followed by colored coatings.

5.7 CLEANING

An undisturbed distribution of moderate grime on gilding is perceived as a desirable and historic patina. Naturally acquired grime concentrates on upward facing surfaces although some frames have been inverted to show the cleaner underside. Cleaning the gilded surface is considered when the grime is excessive relative to the painting and exhibition environment. Factors that complicate cleaning treatments include solubility of gilding and toning layers, the risk of abrasion, embedded grime, loose gesso and ornament, cleaning system residues, and the need for an even result on an often topographically irregular surface.

An initial cleaning involves dusting with soft brushes and a vacuum; the next level involves safe solvent wipes (e.g. petroleum benzine on cotton), and finally tailored aqueous and solvent systems can be used to reduce grime further.

5.8 PREVIOUS TREATMENTS

Common previous treatments to frames include the introduction of different adhesives, crude fills, bronze overpaint, and over-cleaning. Other examples include frame size changes, and over-gilding with leaf. Only the all-too-common bronze overpaint will be briefly discussed here.

Partial or complete bronze overpaint was applied generously to gilded frames in the 20th century. Its removal usually reveals a superior gilded surface and this implies the motive for its application was usually to hide grime rather than other damage. Bronze overpaint is visually recognized by its even and dull brown oxidized color, and its untidy application. Bronze powder pigment was prepared in many different varnish-like mediums and solubility of the aged paint varies considerably.

Its safe removal depends on the difference in solubility between the overpaint and the underlying layers which often include both water and oil gilding. It is generally easier to remove the overpaint from water gilding where non-aqueous solvent systems can be used more safely, than from solvent sensitive oil gilding. Some bronze paints are soluble in aromatic hydrocarbons (e.g. petroleum benzine, xylene), but others require tailored cleaning systems that can include more polar solvents, chelating agents, and surfactants.

6. CONCLUSIONS

There are many American frame/painting combinations surviving in collections which provide a standard against which less well matched combinations can be compared, and they can enable more accurate pairings and reproductions. Original, historic, or otherwise appropriate frames deserve identification and publication, as well as the particular care that conservation can provide.

ACKNOWLEDGEMENTS

The author is grateful to the many WACC staff members and interns who have shared an interest in the history and conservation of picture frames, with particular gratitude to Michael Heslip.

NOTES

[1]Pictured at the website of The Old Schwamb Mill: www.oldschwambmill.org

[2]Thomas Cole to Asher B. Durand, November 2, 1837. Asher B. Durand Papers, New York Public Library, microfilm Archives of American Art). As noted by Annette Blaugrund.

[3]WACC's website: www.williamstownart.org

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SOURCES OF MATERIALS

Compo:

Decorators Supply Corp. 3610 S. Morgan St. Chicago, Ilinois 60609	J. P. Weaver & Co. 941 Air Way Glendale, California 91201-3001

Decco felt:
Testfabrics, Inc.
PO Box 26
West Pittston, Pennsylvania 18643

Direct reading caliper:
Veritas Tools, Inc.
1090 Morrison Dr.
Ottawa, Canada. K2H 1C2

D-rings (item U711) and hanging hardware:
United Manufacturers Supplies, Inc.
80 Gordon Drive
Syosset, New York 11791

Low viscocity epoxy resin:
West System, Inc.
102 Patterson Ave.
PO Box 665
Bay City, Michigan 48707-0665

Microballoons:
Conservation Support Systems
924 West Pedregosa St.
Santa Barbara, California 93101

Pre-bulked epoxy resin; Woodcast:
Abatron, Inc.
5501 95th Ave.
Kenosha, Wisconsin 53144

Rite-Dent vinyl polysiloxane impression material putty:
International Dental Supply
8205 West 20th Ave.
Miami, Florida 33014

RTV silicone rubber encapsulant:
Dow Corning 3110, catalyst #1:
Museum Services Corp.
385 Bridgepoint Drive
South St. Paul, Minnesota 55075-2466

LEAD SOAP EFFLORESCENCE IN A 19TH C PAINTING: APPEARANCE, NATURE AND SOURCES OF MATERIALS

Katrien Keune, Kathrin Kirsch and Jaap Boon

INTRODUCTION

Painting defects related to lead soaps formation are nowadays frequently recognised in lead-containing paintings and can seriously affect their stability and appearance. Lead soaps show up in several ways in paintings: below the surface in the paint as dispersed metal soap, in the form of aggregates or protruding soap masses, and on the surface as crusts. They can not only cause paint deformation, paint loss and pitting, but also lead to efflorescence and changes in transparency and colour.

The Dutch oil painting on canvas *Portrait of P.J. Teding van Berkhout* by Sigibert Chrétien Bosch-Reitz (1891, locally varnished) shows a whitish efflorescence on the surface of the painting (Figure 1). The efflorescence is clearly present in the lower and left part of the painting. It manifests itself differently in the various paint areas, but is not related to a particular paint colors. As the painting has never been restored and always kept in a private collection under known environmental conditions, this painting is a suitable case study to investigate the source and forms of expression of the efflorescence.

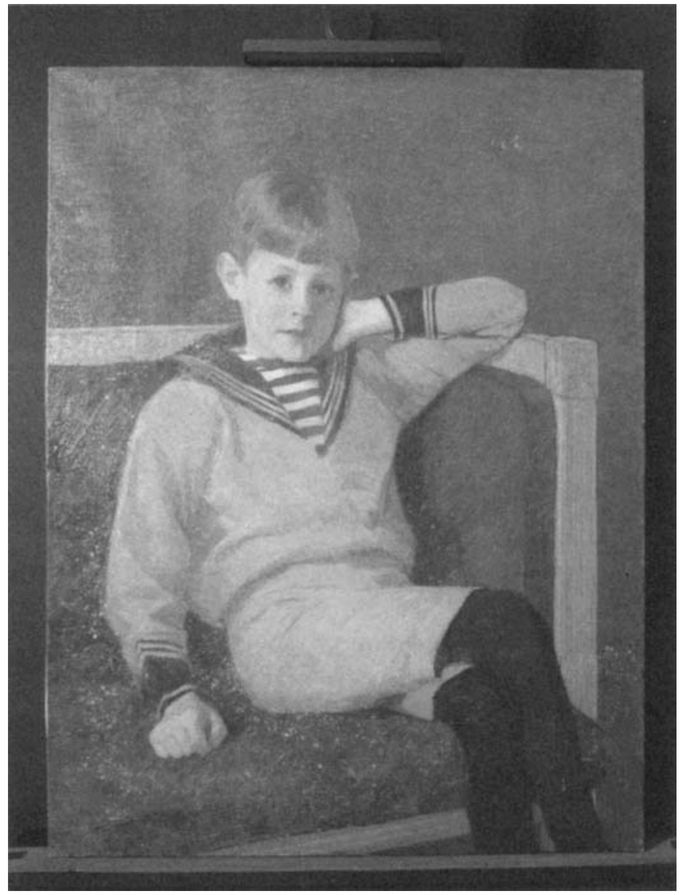

Fig. 1 *Portrait of P.J. Teding van Berkhout* by Sigibert Chrétien Bosch-Reitz (1891) (oil, canvas, locally varnished).

The painting was examined on a macroscopic level as well as on a microscopic level. The macroscopic studies reveal the nature of the efflorescent crusts while microscopic studies with advanced imaging techniques lead to a better insight into the characteristic features of the efflorescence and the sources of the materials that form the crystals. The work presented here is work in progress.

EXPERIMENTAL

The paint cross-section was embedded in Technovit® 2000LC (Heraeus Kulzer, Germany). Both paint cross-sections were dry polished with Micro-mesh® polishing cloths (final step 12 000 mesh) (Scientific Instruments Services Inc., Minnesota).

The instrumental settings and conditions of light microscopy, imaging-FTIR, SEM/EDX and SIMS can be found elsewhere [1].

Katrien Keune (1), Kathrin Kirsch (2) and Jaap Boon (1)
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(2) Restauratieatelier Amsterdam, Asterweg 17 A13, 1031 HL, Amsterdam, The Netherlands

RESULTS

Macroscopic studies

The efflorescence appears in different manifestations on the surface of the painting. It is distributed for example as fine round rod-shaped crystals in the valleys of the brush stroke (Figure 2a) or as patches of densely packed crystals (Figure 2b). In general, the fine and homogenously distributed crystals are found in the black/dark paint, whereas patches of densely packed crystals are observed in the green areas. An obvious relationship between the paint composition and the appearance of efflorescence on the paint surface does not seem to exist.

Microscopic studies

A series of 14 paint cross-sections derived from different areas of the painting were investigated in detail. Their paint build-up was found to vary significantly. We have selected one example that illustrates the process of efflorescence. The sample is taken from a crystal rich area in the green background on the right side of the painting. The paint sample is build-up consists of six layers (Figure 3). On top of the layered system whitish, semi-transparent crystals are present, which fluoresce under UV illumination (layer 7 in Figure 3). Chemical analyses are performed with imaging-FTIR, SEM/EDX and SIMS to characterize the semi-transparent crystals and paint composition spatial-resolved.

Fig. 2a Macroscopic images of the dark stocking showing fine round rod-shaped crystals in the valleys of the brush stroke.

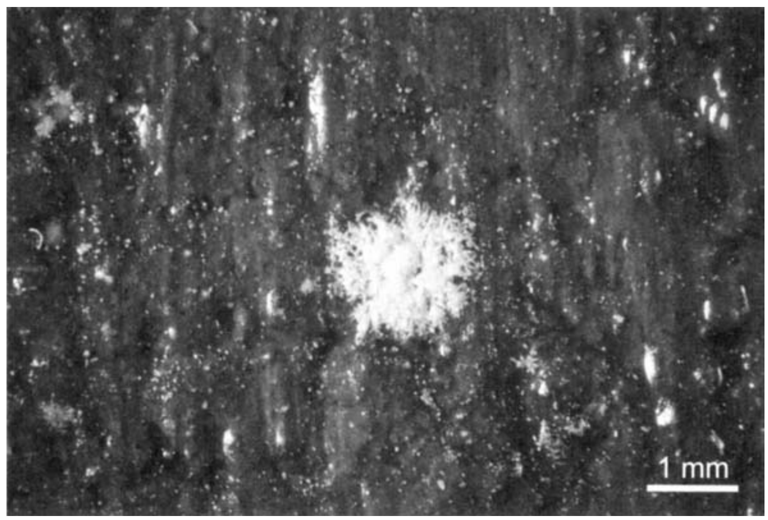


Fig. 2b Macroscopic images of the green background (lower right side) showing a patch of densely packed crystals.

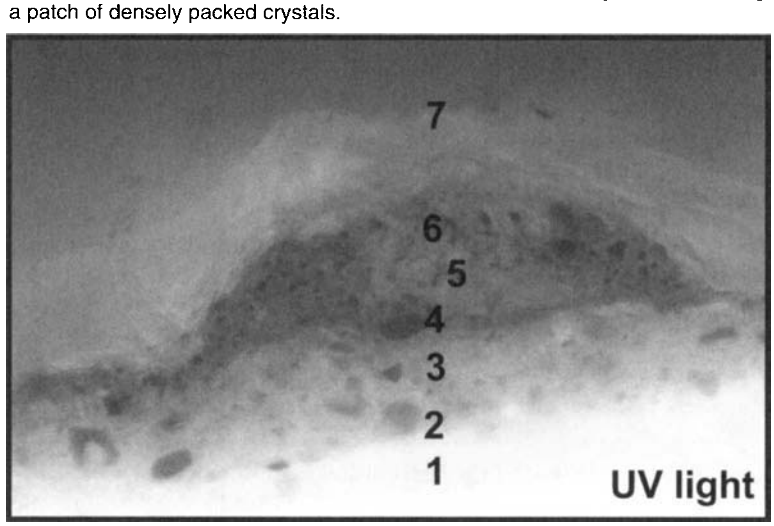


Fig. 3 Part of the paint cross-section under UV illumination consisting of six paint layers with a whitish, semi-transparent crystal layer on top (7).

Imaging-FTIR reveals the embedding medium at 1722 cm^{-1} outlining the paint cross-section (Figure 4a), the carbonates at 1400 cm^{-1} are representative for intact lead white (Figure 4b), while lead carboxylates at 1507 cm^{-1} are representative for dispersed lead soaps in the paint matrix (Figure 4d). These lead carboxylates and the carbonates are located in the lead white-containing ground (layer 1 in Figure 4d). The crystals in layer 7 show a strong band at 1536 cm^{-1} (Figure 4c). The wave number is relatively high for lead carboxylate, but the transmission FTIR spectrum of the crystals confirms the presences of the strong lead carboxylate band (Figure 4e). The lead carboxylate band expected at 1510 cm^{-1} is shifted to higher wavelength and the CH vibrations are weaker. We propose that the lead soaps at the surface are modified by different counter anions and are in a semi-mineralized crystal form.

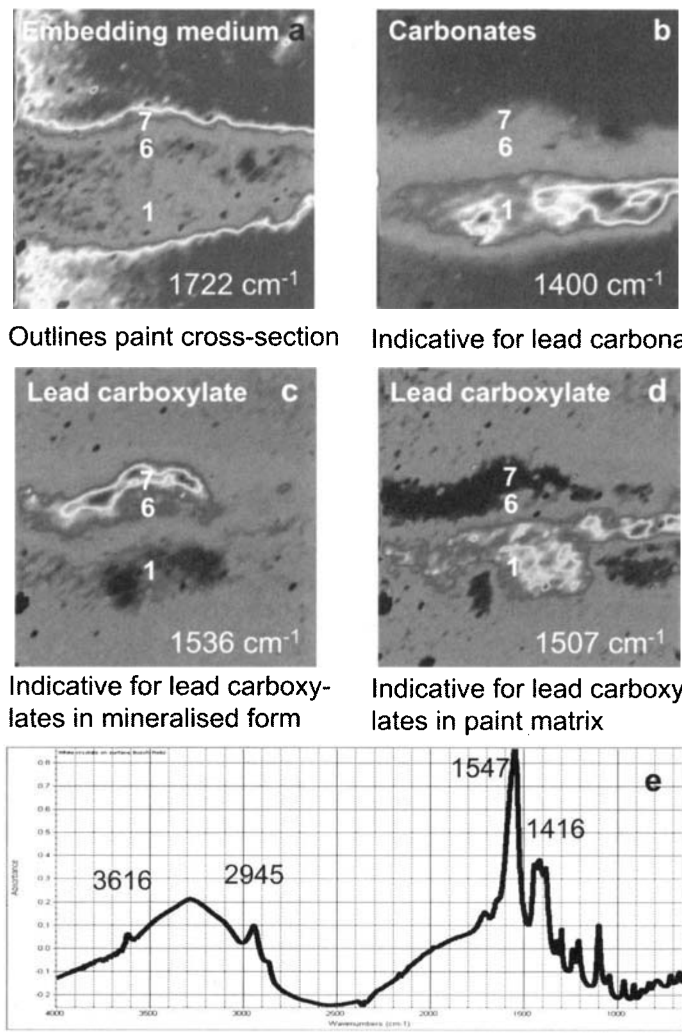
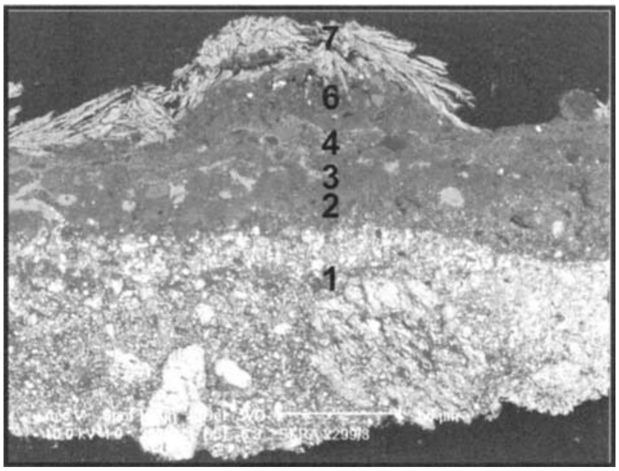
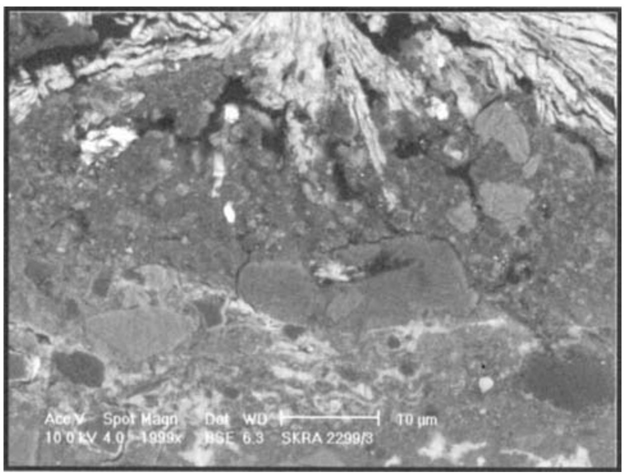


Fig. 4 FTIR-image of the embedding medium at 1722 cm^{-1} (a), carbonates at 1400 cm^{-1} (b), lead carboxylate at 1536 cm^{-1} (c) and 1507 cm^{-1} (d) and a FTIR transmission spectrum of the white surface crystals (e).

The layer structure and morphology of the layers and crystals are visualized in the backscatter image (Figure 5a and b). The crystals are integrated with the porous top paint layer and light grey areas are observed in layer 3, 4, and 5 (Figure 5b). The elemental maps show that the crystals and the light grey areas in layer 3, 4 and 5 are lead rich (Figure 5e). The lead probably derives from the lower ground layer since the upper paint layers are lead poor. The lead rich areas in the layers 3, 4 and 5 are an indication for a lead gradient in the paint system.
Parts of the organic as well as the inorganic components of the paint are revealed with SIMS. SIMS detected oil-



5a



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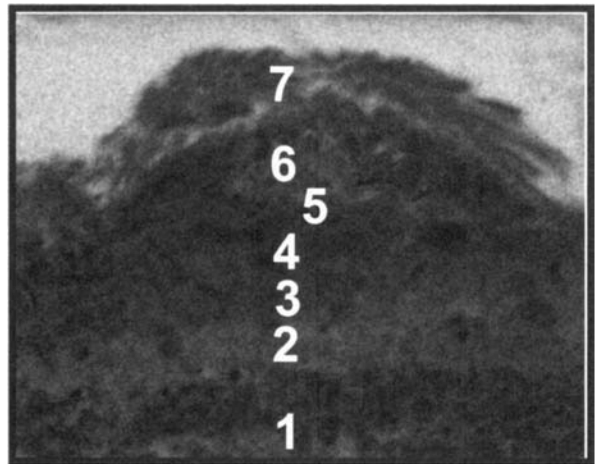

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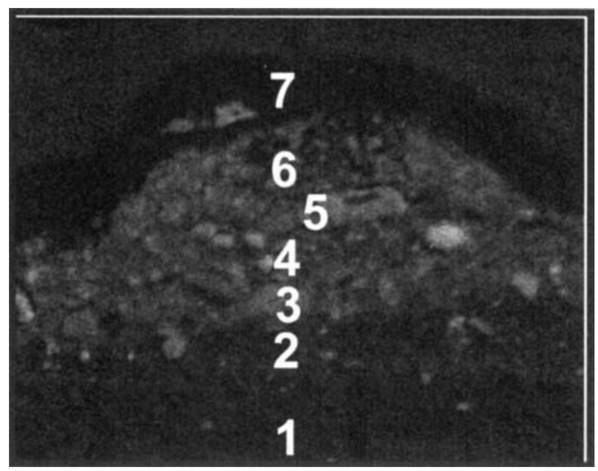
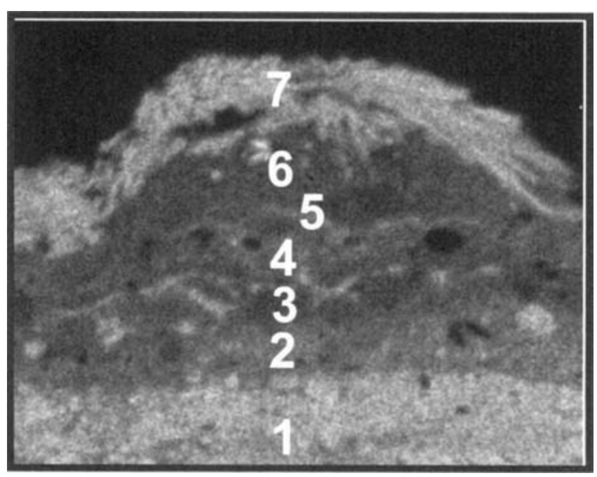


5d



5e

Fig. 5 Backscatter electron image of the paint cross-section (a) with a detail at high magnification (b), elemental distribution maps of carbon (c), oxygen (d) and lead (e).

derived fatty acids and lead soaps in the ground layer, but not in the crystals (Figure 6a-c). Direct Temperature resolved Mass Spectrometry of the crystalline material shows lead, sulphate, carbonates and a small amount of palmitic and stearic acid (spectrum not shown).

DISCUSSION AND CONCLUSION

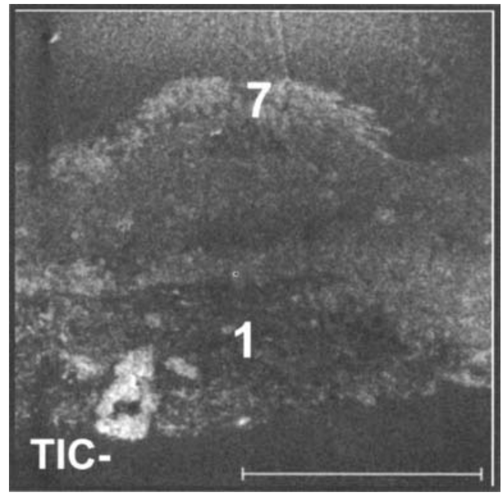
The macroscopic study shows different manifestations of the white crystals on the surface which depend on the paint composition. As the chemical characterization of only one paint cross-section is presented in this poster, a direct correlation between the macroscopic and microscopic studies is not expected here. The microscopic studies with the various analytical techniques show that a thick layer of crystals is positioned on top and appears to be integrated with the upper paint layer. The crystals contain mainly lead and imaging FTIR shows that the lead carboxylates are present in a mineralized form. Imaging FTIR and SIMS show the presence of lead soaps in the ground layer.
We postulate that the lead-containing white crystals are originating from lead soaps that migrate from lower paint layers to the surface. There they react with the atmosphere to form mineralized phases.

ACKNOWLEDGEMENTS

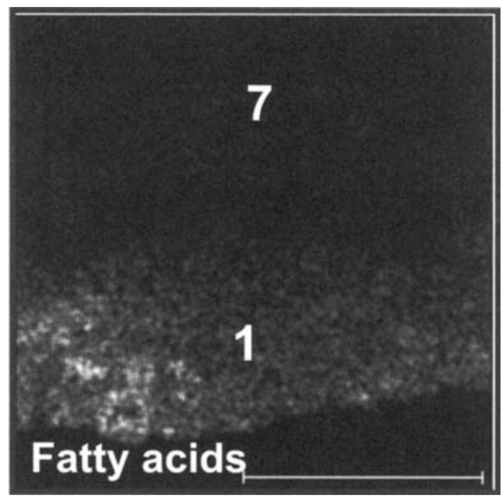
The authors are very grateful to Jkhr. mr. G.C. Six, Laren, The Netherlands for making the painting by Bosch-Reitz available for research. This research is supported by the De Mayerne program for paintings research of NWO (Netherlands Organization for Scientific Research, The Hague, NL) and the FOM research program nr. 49 on Biomolecular Mass Spectrometric Imaging at AMOLF, which is supported by FOM (Fundamental Research on Matter, Utrecht, NL), a subsidiary of NWO.

REFERENCE

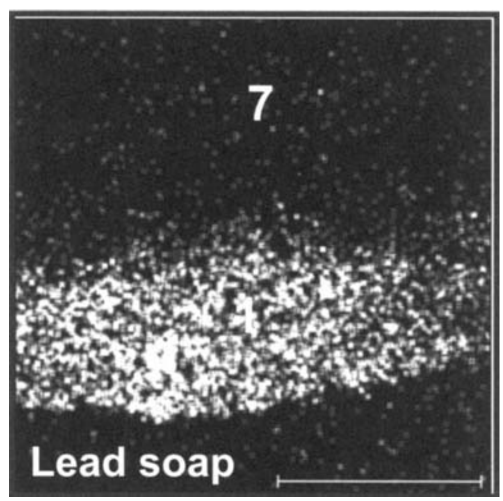
[1] K. Keune and J.J. Boon, *Imaging secondary ion mass spectrometry of a paint cross-section taken from an early Netherlandish painting by Rogier van der Weyden,* Analytical Chemistry, 76, 2004, p. 1374-1385.



6a



6b



6c

Fig. 6 SIMS images: total ion counts image (negative ions) (a), deprotonated palmitic acid (- ions; *m/z* 255) (b), lead soaps (lead palmitic acid salt) (+ ions; *m/z* 461-463) (c).

STUDIO TIPS

ABOUT TESTFABRICS

Testfabrics, Inc. (a sponsor of the PSG lunch) is a supplier to conservation, museums and exhibition specialists who need consistent high-quality textiles and fiber-based goods. Paintings conservators may know Testfabrics as a source for such special products as extra wide fabrics suitable to line paintings. Many are unfamiliar with the other items useful to conservation they carry, and the services they provide.

Testfabrics is principally a supplier for the textile testing industry: This is why they maintain the stock of undyed and unbleached "clean" fabrics that conservators demand. Over the past 25 years, Testfabrics has developed a sideline business to support the needs of the conservation, museum and design communities.

Testfabrics is interested in helping conservators find and obtain the (fiber-based) materials needed for their work. They are often asked to source and stock items of interest to conservators for which there is a high minimum order: When there is interest in a product they may purchase the larger quantity and permit conservators to order on an as-needed basis. Conservators have turned to Testfabrics to source and supply such materials as Skala polyester threads, Création Baumann textiles, natural cotton and polyester tapes, and several styles of battings and felts. Testfabrics also offers custom dyeing and printing, cutting and slitting services, basic and contract sewing assembly, Oddy test laboratory services and washing services.

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A TIP FOR REMOVING CORRODED TACKS FROM STRETCHERS

Tacks are frequently found to be intractable from stretchers. This occurs because the metal corrosion products become interlaced with the wood's structure. In order to release the tack from its surroundings with the minimum amount of stress to the entire structure the conservator requires only a generic soldering iron and an optional Stanley Bostitch staple remover. The staple remover cited has a thin, rounded metal tip with a concave profile housed in a sturdy plastic handle. The removal technique is as follows: allow the soldering iron to achieve its maximum heat, place the tip against the expose tack head for 10 to 30 seconds, remove the tip and allow the tack to cool. Using pliers or the above-mentioned staple remover, gently wiggle and remove the tack. If the tack remains firmly attach repeat the process extending the contact time of the iron to the tack. The heat from the iron should expanded the metal tack and the subsequent cooling and contraction break its bond to the corrosion.

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PACK AND GO:
TRAVELING WITH CONSERVATION SUPPLIES

Barbara Heller, Chief Conservator

Fig. 1

I've found that Revlon™ nail polish bottles are great to use for adhesives or small amounts of solvents. Years ago Louis Pomerantz suggested using nail polish bottles since they closed tightly and tended not to leak. I purchase natural (clear) polish because there's no color to deal with and the polish residue is easily removed with acetone. The incorporated brush is resistant to the cadre of solvents used to dissolve adhesives. I've used the same bottles for portable B-72 and PVOH for decades. In addition to the benefit of never needing to clean the brush, it never hardens and is always ready for use. Due to its design, the Revlon cap can be turned upside down on a table and won't tip over (*Figure 1*). The adhesive remains on the brush or inside the cap without spilling or dripping. Transporting these bottles in Ziploc bags to protect from accidental spillage has always been good practice. Please note that the new airline restrictions allow passengers to hand carry travel-size containers (3.4 ounces/100 ml or less) of liquids, gels or aerosols in one, quart-size, clear plastic re-sealable bag. However, it may be better to check this.

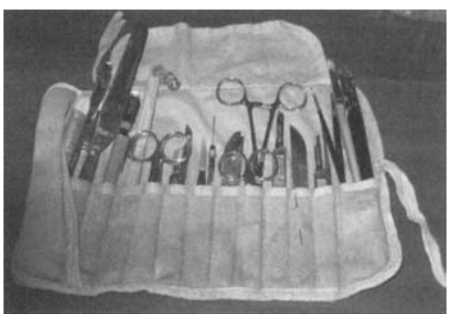

Fig. 2

To carry small tools, I use a cloth roll-up pouch that was made for dissection instruments (*Figure 2*). It protects and keeps the tools organized. Similar pouches with dissecting tools are sold by medical supply companies for biology, medicine and nursing students. Most kits come with scalpel blade holders, forceps, tweezers, scissors and the like. D.R. Instruments sells an 11-piece Botany Kit with a vinyl zippered care for under $24, 1-888-599-3442, see http://www.drinstruments.com. Narang Medical Supply sells a 9-piece Student Dissecting Kit with a surgical pouch for $30 including shipping, see http://www.narang.com/. Indigo Instruments sells a Deluxe Anatomy Set for $32 but its canvas roll-up tool/instrument bag can also be purchased separately for under $10, 1-877-746-4764, see http://www.indigo.com/. My original roll-up pouch came from the U.K. and is still available from Med-Tel UK Ltd., 64 Harley Street, London, W1G 7HB. I have successfully taken a few tools with me on airplanes, but always inside checked luggage. Depending upon type and quantity, you should declare that you are carrying tools.

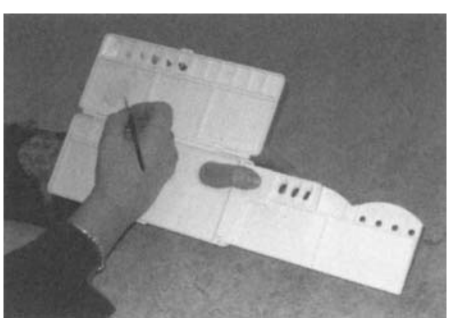

Fig. 3

While browsing an art supply store in Kyoto, Japan about 10 years ago, I came upon a compact, light weight plastic painting palette. Made of solvent resistant white plastic, it has three fold-out sections, slots for brushes and an easy grip thumbhole (*Figure 3*). Metal palettes are much heavier and usually have only two fold-out sections for mixing colors, while porcelain, ceramic and most plastic palettes have limited compartments and do not fold. The manufacturer, Tuboyone in Osaka, does not have a website so I was not able to confirm if the same product is still available. A colleague will look for a source the next time she visits her family in Japan, as she too is interested in purchasing this handy light weight palette.

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INTERNATIONAL NETWORK FOR THE CONSERVATION OF CONTEMPORARY ART - NORTH AMERICA (INCCA-NA)

Announcing the Launch of the International Network for the Conservation of Contemporary Art - North America (INCCA-NA)

INCCA-NA is the North American chapter of INCCA (The International Network for the Conservation of Contemporary Art). INCCA is a network organization, comprised of professionals in the field, with the mission to disseminate information and knowledge through a Database for Artists' Archive. This database is a unique tool that is created by members, allowing them to access unpublished research by other members and contribute new knowledge (good practice and tools) essential for the proper conservation of modern and contemporary art. The website also provides information about projects, events (workshops and seminars), links and literature relating to this topic.

Issues with Contemporary Art

Today's works of art are becoming increasingly complex in the structure and variety of media used, presenting challenges to the institutions and individuals who collect and safeguard works of art. Few adequate solutions are available to slow down the degradation of modern and contemporary materials, and the issues of long-term preservation can be particularly difficult to resolve when the artist's intensions, techniques, and materials are unknown. These challenges have opened a whole new era in art conservation that merits increased attention and study as these works age.

One of the main aims of INCCA is to collect information from artists or their representatives that can be used by the conservation community in addressing such challenges. INCCA members participate in the network by delivering content (meta-data records, project information and other news) to the network's webmaster, located at the ICN in Amsterdam. Members also collaborate on research projects that result in the creation of new tools and good practice to be used by the field.

Launch of INCCA-NA

INCCA's membership has heretofore been limited to European participants. Responding to a perceived need to import INCCA to North America, an advisory committee of 25 individuals was formed at a preliminary meeting of interested professionals in 2003. A feasibility committee was formed in 2004. During 2005, this group completed a feasibility study for developing INCCA in North America. Currently INCCA-NA has representation in Canada, Mexico, and the US.

Submitted by the Steering Committee for INCCA-NA: Karen te Brake - Baldock, Elizabeth Burke, Richard Gagnier, Derek Pullen, Gwynne Ryan, Denise Rosenzweig Will Shank, Tatja Scholte, and Glenn Wharton.

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