

ANALYTICAL REPORT

[Ref.: AAR0229 / 26 May 2011]

Her Garden

Inscribed 'Walter Osborne .88'

A. Introduction

A painting on wooden panel (359 x 252 mm), *Her Garden* (right and **Plate 1**) was brought to Art Access & Research for analysis. It has been considered to be the work of the Irish painter Walter Osborne (1859-1903). The painting is inscribed 'WALTER OSBORNE .88' in the lower right corner, thus implying a date of 1888. In the past, issues have been raised concerning the authenticity of the inscription in the lower right corner, as it is clear that the painting was worked in two stages: the signature and some of the paint depicting flowers and grass in the lower right corner was added after the painting had been substantially finished. The practice of making adjustments to a painted work, and of signing a work at a slightly later or even a much later time in an artist's period of activity, are wholly commonplace occurrences, known from many examples from the history of art. It is equally true that additions and inscriptions may be added well after the death of an artist, for reasons both ethical (to label a piece with a suspected attribution) and unethical (for example, in order to increase the value of a painting by providing an attribution to a known, popular artist). Therefore, the issues of when and why an inscription was added must be addressed, in order to establish its authenticity. This report will consider these issues in terms of the available material evidence.



In 2008, this same painting was analysed by Nicholas Eastaugh¹ in order to establish its likely date of creation. The earlier report found that the materials used – specifically the pigments – are entirely consistent with the authorship and date implied by the inscription in the lower right corner of the painting: Walter Osborne, 1888. The focus of the 2008 report was a holistic evaluation of the painting, not a specific investigation of the signature, and as the material and visual examination did not produce any anomalous results, it was considered that the questions posed had been resolved. However, as the issue of the authenticity of the signature is of such importance to the acceptance of the painting as a genuine Osborne by certain experts, it was decided to examine this aspect in more detail, as a definitive discussion of the matter was clearly required. Thus, the present report will to

¹ Eastaugh, N. *The scientific examination of a painting bearing the inscription 'Walter Osborne'*. Ref. 018371.01 (Unpublished report), 23rd May, 2008.

build upon the findings obtained in 2008. Subsequently, the samples taken earlier were re-examined, and new material was taken from the painting prepared as cross-sections in order to study the physical superimposition of the paint layers.

The results of this report will show that the uppermost layers of paint in the lower right corner - encompassing the signature, added greenery upon which the signature rests and flowers - were added by the same painter responsible for the main body of the painting, quite soon after the first program of work. As they are stylistically consistent with Osborne's work of around 1888, and the materials are equally consistent with this dating, from a material standpoint, there would seem to be no reason to doubt *Her Garden* as a work of Osborne.

B. Results of earlier analytical work with additional analysis

The painting was initially examined visually to establish the range of colours to sample so as to determine the palette of pigments as fully as possible. It is painted on a wooden panel, which bears the label of a Dublin frame maker (**Plates 14 & 15**). While these were not the subject of a separate investigation, they presented no superficial anomalies. Visual examination of the recto of the painting under normal and ultraviolet (UV) light revealed no signs of any later interventions (reworking, repair or restoration). This process was repeated again in 2011; no obvious differences were found. In the first instance (2008) 10 samples were taken from the surface of the painting for analysis by scanning electron microscopy-energy dispersive X-ray spectrometry (SEM-EDX), polarised light microscopy (PLM) and UV/Visible/near-IR microspectrophotometry (**Table 1**, and **App. 2**). The samples were taken in the form of tiny fragments of paint from the surface, so as to represent the uppermost layers present. This is especially important to note in the instance of the paint samples taken from the lower right corner – in these, the material is representative of the upper paint layers, *not* the upper *and* lower paint layers. At that time, five samples were taken from the lower right corner, from, and around the inscription, while another five were taken from other locations on the painting which were from the 'first' phase of work. For this second phase of work, the samples were also examined anew with Raman microscopy (for the results, see **Table 2**, for analytical methodology, **App. 2**), a technique unavailable during the preparation of the 2008 report. The pigment mixtures identified in all cases were quite complex, consisting of 'primary' pigments: those responsible for the colour of the paint, as well as minor amount of other pigments, which we may refer to as 'secondary' materials.

The presence of the secondary materials may be accounted for by a variety of reasons, including the possibility that they were added intentionally by the artist, that they are additions to the paint added by the paint manufacturers to enhance colour or physical properties (such as speed of drying) or, that they are present in small quantities as a result of contamination (the artist not fully cleaning his brushes or palette). The presence of these components was suggested by elemental analysis (EDX) which is highly sensitive to the presence of extremely small amounts of materials. However, their presence was in practice very difficult or impossible to confirm through visual observation with the microscope (PLM), as they invariably are present in mixtures. Thus, to identify them visually is practically extremely difficult, as they are present in tiny quantities, as tiny particles in larger mixtures of similarly coloured particles. Equally, as minor components, they may be present in the samples taken for elemental analysis, but absent in the similar material prepared as a microscopy slide sample.

As ‘primary’ materials (pigments used in quantity) the following were identified:

- lead carbonate type white (‘lead white’);
- cobalt aluminium oxide (‘cobalt blue’);
- strontium chromate (‘chrome yellow’);
- cadmium sulfide (‘cadmium yellow’);
- chromium oxide hydrate (‘viridian’);
- various earth pigments including yellow, red and green varieties, most notably, a yellow variety rich in the mineral goethite;
- red ‘lake’ pigment (dyestuff and substrate not identified);
- bone coke (‘bone black’).

As ‘secondary’ materials (pigments present in smaller amounts)

- Cobalt zinc oxide (‘Rinmann’s green’)
- Possibly, (but not confirmed by PLM): ‘emerald green’ (copper acetate arsenite), indicated by the presence of copper and arsenic (noted with EDX), notably in sample 2, is normally associated with (‘emerald green’);
- Possibly, ‘cerulean blue’ (cobalt tin oxide) in sample 9.
- Possibly, ‘zinc white’ (zinc oxide), indicated by the presence of zinc in a number of samples (EDX), as well as suggested by the fluorescence (associated with this pigment) seen in many samples when observed with ultraviolet light.

C. Sampling and Analysis, 2011

Visual examination of the painting with magnification under conditions of visible, infrared and ultraviolet fluorescence revealed that the painting seems to have been worked up as a unified composition, after which the area of the lower right corner was modified. The paint in this area has a somewhat more granular appearance than the adjacent surfaces, as well as an increased transparency (**Plates 5, 11-13**).

C.1 Cross-sections, visual examination

To investigate the relationship of this ‘adjusted’ area with the underlying paint film, it was decided to take samples to prepare as cross-sections, which allow for analysis of the layered build-up of a painting. To this end, two samples of material were taken, one from the area just above the ‘E’ in ‘WALTER’ (from which two cross-sections were prepared) and one from the deep green grass along the bottom edge of the panel (**App. 2, Table 2 and Plates 16-19**). Examination of these samples in all cases revealed an upper stratum of paint containing rather more medium than the lower layers. This can be clearly seen in the cross-sections, in photographic images made using ultraviolet illumination, which induced the fluorescence of certain materials. Here, the strong bluish fluorescence of the binding medium throws the pigment component of the paint into strong contrast. In comparison, the lower layers display only pockets of fluorescent medium, as a dense accumulation of pigment particles may be seen in these layers.

Most notably, there was no indication of any sort of intervening material between the lower and uppermost layers. Generally, if a layer is added much later, one often finds an intervening layer of

varnish, or, an accumulation of dirt or other air-borne particulate material. Here, no such material is to be seen. Instead, the layers are tightly and cleanly bound. Indeed, in the sample from the second location, Sample 13 (**Plates 18 and 19**) in the UV images, one can observe that the lower layers seem to have even been slightly solubilized by the medium rich upper layer of paint – there is some blending of the lower and upper material. This could not have happened unless the lower layer was still quite fresh; a well-dried paint film will not be affected by another layer applied over it.

C.2 Distribution of the pigments identified

As stated earlier, in the report undertaken in 2008, the question posed was to establish when the painting was likely to have been painted, based on the analysis of the pigments used. Consequently, the *distribution* of the pigments, their occurrence in the various samples taken, was not recorded. For this second round of analysis, the samples taken earlier were re-examined with the intent of establishing how the composition of the paint of the ‘first’ program compares to that of the lower right corner. With this goal in mind, the pigment samples were re-examined, in order to identify material conformity – whether or not the composition of the paints was similar, or dissimilar. While no notable points of dissimilarity in the types of pigments used were found, a number of significant observations were made regarding similar aspects. The primary pigment composition was extremely consistent across all samples, varying of course in respect to colour (**App. 2, Table 2**). However, the occurrence of one particular pigment was of high interest; almost all of the samples, from both the ‘first’ phase of the painting and from the lower right corner, contained a yellow-earth pigment, rich in the mineral goethite.

Earth pigments occur in a range of colours, and may be found in tones of yellow, orange, red, brown and green. Their colour is due to the presence of iron, in various forms, typically but not exclusively yellow goethite and red hematite. While iron compounds can be manufactured, and thus reasonably consistent in character, earths are naturally occurring, and thus show extreme variation: in the size and shape of particles, colour, amounts of non-coloured material occurring (clays, silicates, etc.). In this case, there is a notable consistency in the unusual particle morphology of the goethite in the yellow earth pigment found in both the paint of the ‘first’ program and in the lower right corner: the particle morphology (size and shape) and colour is extremely consistent in all of the samples. Such an extremely high level of consistency suggests the use of the same paint in both the main part of the painting as well as in the area of the signature.

C.3 Cross-sections, binding media analysis

It was also decided to examine the samples by FTIR microscopy and by Raman microscopy in order to establish whether the materials used in the above mentioned layers were essentially similar, or dissimilar to each other, apart from the varying concentrations of material used. The binding medium in the upper and lower paint layers of sample 13 were examined with FTIR microscopy and were found to produce identical spectra: both were oil based, with no obvious minor components.

D. Results of the imaging

The painting was imaged both with infrared and with ultraviolet fluorescence. The interpretations of these analyses are discussed below.

D.1 Infrared

New infrared images of the painting were made in 2011 (**Plate 2**). They clearly revealed the underdrawing of the painting, which indicates a substantial adjustment was made from sketch to final image, a typical aspect of the creative process, seen in many underdrawings². Unfortunately, no images of underdrawings by Osborne were available for consultation, but one may compare the style of line to the works in Osborne's sketchbooks (**Plate 3**).

Of primary importance to the question of authenticity of the signature, is the interpretation of this area in the infrared image. Reading an infrared image is not straightforward; the result is dependent on a number of factors. Two factors, in particular, are essential to interpreting the image in this case:

- a) the inherent contrast between the feature of interest (in this case the inscription) and the background on which it lies when recorded with infrared imaging;
- b) the relative visible/infrared transparency of any overlying layers.

These are the basic principles on which infrared reflectography for study of underdrawing functions. One should ideally have a highly infrared absorbent drawing material (usually of a dark colour), such as charcoal black (as found in the inscription here: **Table 2, Sample 5**), over a highly reflective substrate, such as a white ground (as found here, see cross-sections, **Plates 16-19**), the whole overlaid by a paint film which is relatively opaque to the unaided eye but which has higher transmission in the infrared (that is, it does not absorb the infrared wavelengths, and thus is transparent in the infrared image). Consequently the inscription is clearly visible from the infrared image. The image as seen with infrared is quite distinct from that seen with normal, visible light. Thus, one cannot draw conclusions regarding the relative visibility of parts of the inscription between the two techniques.

Careful study of the painting with magnification under normal, infrared and ultraviolet light found no evidence of any other inscription. 'WALTER OSBORNE .88' appears to be the only inscription present. The whole of the inscription is clearly visible under infrared lighting, although the '-88' is not visible under normal lighting conditions (**Plates 5 & 6**). It has been argued that the '-88' is not visible because someone had attempted to eradicate it. This, however, does not make sense. If it was abraded substantially, this would show, as there would not be enough material left to image clearly. Therefore, the '-88' is almost certainly still present, however, now covered by a layer of paint. This would correspond with the greyish green, visible only in the very lowermost right hand corner. Comparison of the infrared image with the visible light image shows many other features that image as dark shapes – in the foliage, for example. These are not visible in the visible light image. Equally, we may assume that these, like the signature, were worked in paint containing high amounts of infrared absorbing materials (such materials will absorb, not reflect, infrared, and thus

² As the authenticity of the painting has been, on occasion, called into question, it is useful to note that such loose sketches, and subsequent development of the image, are not typical of paintings made with deceptive intent.

will image as dark), and have been subsequently covered over with other layers of paint as the image was worked up.

D.2 Ultraviolet fluorescence

In the examination of 2008, the painting was photographed under ultraviolet light (**Plate 4**). Typically, this technique is used to aid in the determination of condition of a painting. The basic principle here is that natural resin varnishes commonly used in the past for paintings (dammar, and mastic) have a weak bluish-green fluorescence under UV; if overpaint is present over the varnish, it will show up clearly as a dark, non-fluorescent area. Equally, disturbance to the varnish, as when the varnish is partially removed, is likewise visible. In practice the interpretation is often a more complex process, one that is not straightforward. For example, if layers of retouching lie below a fluorescent varnish, they may or may not be visible, depending on how fluorescent the layer upon which they lie is (basically, a function of contrast) and the degree to which they do not react with UV. Equally, certain pigments have particular, distinct fluorescence colours. This may be seen on *Her Garden*, in the case of some of the red paint, which displays a very strong, orange pink colour, and also zinc oxides (zinc white), which often fluoresce in a blueish green tone. The ground, where it is exposed, appears quite bright in the UV image, suggesting a component of zinc white. This appears to be a significant contributory factor in the UV fluorescence appearance of the inscription in this painting, where the inscription (not fluorescent) is quite legible against the dull fluorescence of the underlying background.

In the present case the UV fluorescence results indicate a thin fluorescing varnish residing over the top of the inscription. The inscription itself is visible essentially because of a strong contrast in fluorescence between the inscription paint (low fluorescence) and the paint on which it lies (high fluorescence). This is a not uncommon occurrence among late nineteenth and twentieth century paintings where the primary paint layers can contain zinc white. The cross-sections prepared from the painting also confirmed the presence of a varnish at the uppermost layer (**Plates 16b & 17b**). (The section taken from the very edge of the panel – **Sample 13, Plates 18b and 19b** – does not show this phenomenon. However, this may be for the simple reason that the varnish is not preserved along the lowermost edge). They also reveal a number of other, interesting features.

The most noticeable is that the uppermost layers, corresponding to the ‘added’ paint upon which the signature lies, are more medium rich, as noted above. Essentially, they contain more binding medium than pigment, whereas the lowermost layers contain a higher concentration of pigment, with a smaller quantity of binding medium. The distribution of material with a strong, orange pink fluorescence may also be observed in both layers, although in reverse: the upper, medium-rich layer has a smaller portion of it, while the lower layers have a higher concentration. However, in both cases, the fluorescent material is present, simply again in different proportions. In the over-all UV image (**Plate 4**) it can be seen that this particular type of fluorescence is associated with areas that are red in colour, thus, most likely due to the use of a red lake pigment, a number of which are known to fluoresce strongly.

Further overall inspection of the overall UV fluorescence image provides no evidence for the argument that the light green paint in the lower right corner is a much later addition. The fluorescence is very consistent here, as in other areas of the painting, and there are no distinct boundary areas. Moreover, general visual examination of the painting, using high magnification,

equally revealed a surface that preserves a uniform crack pattern, no evidence of the upper paint layers passing over losses or cracks. In short, nothing indicative of a later addition to the painting.

E. Discussion of the analytical findings

The various analytical examinations revealed no features suggestive of the possibility that the upper, more transparent paint of the lower right corner was a substantially later addition. Instead, the material evidence would indicate that the lower right corner is most likely to have been painted very shortly after the 'first' program of work was finished. To recapitulate:

- Visual analysis of the painting by various means – with high magnification using both visible, ultraviolet and infrared illumination – reveals no evidence that would suggest that the paint in the lower right corner could have been added at a date substantially later than the painting itself.
- The pigments used over the whole of the painting correspond very well with the date of 1888 suggested in the inscription.
- The primary pigment composition was extremely consistent across all samples, to such an extent as to imply that at least one instance - the yellow earth – it is possible to state with a high degree of certainty that the same paint was used in both programs of painting, as such an extremely close correspondence of material is otherwise highly improbable.
- The binding medium used in both the lower, and upper layers of paint in the lower right corner is the same – it is simply present in greater quantity in the upper layer.
- The cross-sections prepared from samples taken from the lower right corner show an intimate contact with the lower layers. In one of the two areas sampled, there is evidence that the lowermost layers of paint were not fully dry when the upper layer was added.
- The visual difference in the upper and lower layers – transparency and 'granular' appearance – appears to be a simple result of a higher concentration of binding medium in the upper paint layer.

A few other observations are pertinent:

- The transparency of the paint in the lower right corner is not consistent. Two flowers in the lower right foreground were also added, and these are rendered in quite opaque paints. It would therefore seem that the use of a semi-transparent paint in the corner was a conscious choice, especially given that the pigments and binding media used are the same as those in the larger painting.
- The addition of a signature and date, slightly later than the virtual 'completion' of a work is a highly common painterly practice.
- The choice of a transparent paint would allow for better integration of tonality with the underlying paint, with which it needed to blend. However, when the painting was first 'fresh', it would have been substantially more glossy, thus, the addition would not have been visually distinguishable. However, over time, the painting settled, and the different compositions of the paint layers (medium rich over pigment rich) would have become (as they now are) more distinct.
- The signature is identical in style and execution (use of proportions of characters, date expressed in two numerals, slightly below the name, etc.) to a number of other works

executed in 1888 (such as *Potato Gathering*, **Plates 7 & 8**). Osborne changed the style of his signature over the course of his career; works executed slightly earlier and later are not rendered in the same manner (an example of 1884, **Plate 9**).

- The subject of the painting is recorded in Osborne's notebook, with sketches of other paintings made in 1888. It, like the others, varies in small details, but the basic composition is recognisably rendered, and the format is recorded.
- The date of '88', as seen in the infrared image (**Plates 6 & 10**), show that the second (rightmost) '8' is apparently abraded along its left edge. This corresponds with the edge of what appears to have been the rabbet of the frame. The date is not legible under normal lighting conditions.

E. Conclusion

Although it is ultimately impossible to reconstruct the exact sequence of events which led to the present condition of the painting, a certain amount of the details may be stated with certainty. From a material analysis, the painting is fully consistent with a dating of 1888. The paint of the lower right corner, including the signature, seems to have been done at about the same time, with the same materials, as the remainder of the painting. The inscription is fully stylistically consistent with other signatures of Osborne executed in and around 1888. The fact that the date of '88' is no longer visible is most likely explained by a very local addition of paint to the date (and indeed, here, in the lowermost right corner, the paint is of a slightly different tone). When the painting was framed, the rabbet would have obscured half of the date, as it has been placed so close to the rightmost edge of the panel. As this would have been unseemly for display (a single numeral '8' would have made no sense), or, perhaps for other reasons (such as the wish to exhibit the painting at a later date), the painter decided to cover the date with a very local application of paint.

To conclude, from a material standpoint, no reasonable doubt can be raised concerning the authenticity of the inscription and the painting upon which it lies, which were executed as a piece.

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APPENDICES

A.1 Sampling

A.1.i. Sampling: Sampling followed common methodologies for removal of material from paintings for analysis, with due care to take the minimum amount of sample necessary from relevant locations in a robust manner. Prior to sampling for analysis the painting was examined in detail visually, with the aid of low-power surface microscopy, and with UV fluorescence; infrared and X-ray images were also consulted. All samples were kept in the control of Art Access & Research.

It should be stressed at the outset of this discussion that great care was taken to establish that samples represented paint from the original layers of the painting and not from any later additions such as restoration. This process of differentiation is usually carried out by consideration of a number of pieces of evidence including (but not confined to) visual examination at up to around 50x magnification of the painting's surface along with consideration of other technical examination such as infrared and ultraviolet fluorescence. From this one is generally looking for characteristic features indicative of, for example³: continuity between canvas, ground and primary paint layers, including evidence of 'wet-in-wet' painting techniques; absence of discontinuities such as underlying varnish layers, cracks, damages and other lacunae that normally take time to occur; similarity of form of the pigments, without significant differences of morphology such as highly divergent particle sizes, or marked variation in mixtures used to achieve particular colours; a lack of any dissimilarity in terms of textural qualities such as might occur with the presence of different binding media across the painting.

Additionally, any areas where later interventions could have been present were avoided. For example, it is normal practice to take samples from locations such as edges of damages; these are however frequently where later restoration is found. Samples were therefore minimised in size but taken from suitable locations, such as colour rather than damage boundaries, where the reliability of sampling only original paint is maximised.

Table 1. Summary of samples

#	Sample Description	Location ⁴	Analysis ⁵					
			PLM	EDX	μ Spec	Raman	CSA	FTIR
1	Brown, granular, lower right corner	245/8	✓	✓	✓			
2	Brownish green	245/10	✓	✓				
3	Green thin, over ground	242/19	✓	✓				
4	Brown of inscription ('E')	239/20	✓	✓				
5	Brown of inscription ('S')	217/19	✓	✓				

³ These criteria have been essentially established for many years; more than 35 separate features used for making such decisions were laid out some 50 years ago in: Ruhemann, H., 'Criteria for Distinguishing Additions from Additional Paint', *Studies in Conservation* **3** #4 (1958) pp. 145-61. These still apply.

⁴ The coordinates for the sample locations registered here are given in millimetres, in the format of an X/Y access, X being the number of millimetres from the left side of the painting, Y being the number of millimetres up from the lowermost edge of the painting.

⁵ PLM = Polarised light microscopy; EDX = Scanning electron microscopy-energy dispersive X-ray spectrometry; μ Spec = UV/Visible/near-IR microspectrophotometry.

6	Green, thin over ground	126/61	✓	✓				
7	Olive green	15/249	✓	✓				
8	Dark green	18/184	✓	✓				
9	Brown	43/151	✓	✓				
10	Green, over ground	93/89	✓	✓				
11-1	Green grass, 'above 'E' of Walter	202/22				✓	✓	
11-2	As 1, above	202/22					✓	✓
11-3	Green grass, bottom edge	17/0					✓	✓

A.2 Analytical methods used

A.2.i. Polarised light microscopy (PLM): Sample fragments were dispersed in Cargille Meltmount^(C) of refractive index 1.66 and analytical methods developed by the present author and others were employed to aid identification⁶; additional comparisons were made to well-characterised reference material in the authors' collection. A Leica DMRX microscope with magnifications in the region of 100x to 1000x was used. PLM identification of the materials discussed was straightforward and was based on both observed morphology and comparison to reference samples. Also, PLM is not generally regarded as a technique necessarily providing definitive identification and therefore the analysis should be considered provisional unless or until confirmed by other methods, as here.

A.2.ii. UV/Visible/near-IR microspectrophotometry (μ Spec): A useful adjunct to PLM analysis, μ Spec allows the measurement of the absorption spectrum of individual pigment particles in dispersions, from the near-UV to the near-IR. In numerous cases the spectrum can significantly extend the confidence in PLM identifications, such as when discriminating indigo and Prussian blue, or detecting the absorption bands of cobalt-based compounds. Since it interfaces with the PLM, simultaneous analysis of particles by both techniques down to $\sim 1\mu\text{m}$ is readily possible.

Equipment used for this work was an Ocean Optics S2000/AN-10000 spectrometer connected via fibre-optic cable to a custom modification of the camera port of a Leica DMRX microscope. Analyses were principally carried out using 40x and 100x oil-immersion objective lenses, transmission measurements being referenced to blank background areas of the PLM dispersion slides. The Ocean Optics spectrometer has a nominal range of 350-850nm, but in practice this technique covers roughly 400-850nm due to absorption of optical components in the microscope.

A.2.iii. Scanning electron microscopy and energy dispersive X-ray spectrometry (SEM-EDX): The instrument used was a Hitachi TM-1000 scanning electron microscope, equipped with Oxford Instruments energy dispersive X-ray spectrometry system. Accelerator voltage was 15kV. Samples were mounted on conductive adhesive pads applied to stubs, coating being found unnecessary and further allowing other analysis to be applied, such as Raman microscopy.

⁶ Eastaugh, N.; Walsh, V.; Chaplin, T. and Siddall, R., *The Pigment Compendium*, Elsevier, Butterworth-Heinemann, Oxford (2004). All reference samples used in this analysis come from the collection of the Pigmentum Project (see: <http://pigmentum.org>).

A.2.iv. Raman microscopy: The instrument used for the Raman microscopy here was a Bruker Senterra Raman system equipped with two laser wavelengths, that used for this study being 785nm. The power setting was 10mW, 9-15cm⁻¹ spectral resolution with a 10x objective lens. In the chart below, the designation (tr) before a pigment indicates a trace amount.

Table 2. SEM-EDX and Raman results					
#	Description	EDX (elements)		Raman Microscopy (peaks, cm ⁻¹)	Identification
		Major	Minor		
1	Lower right: Brown, granular, lower right corner	Pb	Al, Si, Zn, Fe, Co, Cr, K, Mg, Mn	1052 (w)	Lead white Cobalt Aluminum Oxide ('Cobalt blue') Viridian Goethite-rich earth pigment (tr) Red lake
2	Lower right: Brownish green	Al, Pb	Zn, As, Si, K, Ca, Cr, Fe, Cu, Zn, Br	-	Lead carbonate type white Goethite-rich earth pigment
3	Lower right: Green, thin, over ground	Pb	Al, Si, Zn, Cd, Cr, Co, Fe	795 (vw), 347 (vw), 254 (w)	Lead carbonate type white Viridian Cobalt Aluminum Oxide ('Cobalt blue') Goethite-rich earth pigment
4	Lower right: Brown of inscription (‘E’)	Pb	Al, Si, Fe, Co, Zn, Pb, Si, Mg, Zn,	795 (vw), 344 (vw), 254 (w)	Lead carbonate type white (tr) Cobalt Aluminum Oxide ('Cobalt blue') Goethite-rich earth pigment
5	Brown of inscription (‘S’)	Pb, Cr	Si, Al, Cd, Co, Zn, Fe	1051 (w), 405 (w, br), 109 (m); 1597 (w, br), 1311 (w, br), 1051 (vw), 405 (vw, br)	Lead carbonate Viridian Carbon-based black Cobalt Aluminum Oxide ('Cobalt blue') Viridian Goethite-rich earth pigment
6	Green, thin over ground	Pb, Cr	Zn, Mg, Al, Si, P, Cl, P, Cd, K, Ca, Cr, Fe, Co, Cu	1055 (vw), 402 (vw, br)	Lead carbonate Viridian Cobalt Aluminum Oxide ('Cobalt blue')
7	Olive green	Pb, Fe	Zn, Al, Mg, Si, S, K, Cd, Ca, Cr	-	Lead carbonate type white Viridian Celadonite (green earth)
8	Dark green	Cr, Pb, Cd	Fe, Zn, Al, Si, Ca, Co	1583 (vw, br), 1286 (w, br)	Carbon-based black Viridian Cadmium yellow (tr) Goethite-rich earth
9	Brown	Pb	Zn, Al, Si, P, Cd, K, Ca, Cr, Sn, Fe, Co	-	Lead carbonate type white Red lake (tr) Goethite-rich earth pigment (tr) Chrome yellow (tr) Cobalt Aluminum Oxide ('Cobalt blue')
10	Green, over ground	Pb, Cd, Cr	Fe, Al, Si, Ca, Co	-	Viridian Cobalt Aluminum Oxide ('Cobalt blue') Chrome yellow (tr) Goethite-rich earth pigment

Table 2. SEM-EDX and Raman results

#	Description	EDX (elements)		Raman Microscopy (peaks, cm^{-1})	Identification
		Major	Minor		
11	<i>Green grass, above 'E' of Walter</i>	-	-	-	Not analysed
12	<i>As 11-1, above</i>	-	-	-	Analyzed by Fourier transform infrared spectroscopy: oil found as a binding medium in all layers.
13	<i>Green grass, bottom edge.</i>	-	-	-	Analyzed by Fourier transform infrared spectroscopy: oil found as a binding medium in all layers.

A.2.v. Fourier transform infrared spectroscopy (FTIR) microscopy: The instrument used was a Bruker Vertex 70 infrared spectrometer equipped with a liquid nitrogen-cooled MCT (Mercury Cadmium Telluride) detector and a Hyperion 3000 microscope. Measurements were made with the microscope in reflectance mode. The spectra was collected over the range $4000\text{--}600\text{ cm}^{-1}$ using a collection time of 128 scans and a spectral resolution of 4 cm^{-1} .

A.3 Sampling

A.3.i. Sampling: Ultraviolet imaging: The painting was photographed illuminated with long-wave ultraviolet lamps, which produce light just beyond violet in the visible spectrum. The image was captured on a Canon 5D 12M-pixel camera equipped with a Canon EF 28mm f2.8 lens with a Kodak Wratten 2B filter. Ultraviolet (UV) light induces fluorescence in some materials, fluorescence being the effect that occurs when a material emits light during and shortly after exposure to excitation by another (external) light source, here, the ultraviolet. As a consequence of the underlying processes at work, transitions of electrons in molecules, the emitted light is invariably less energetic than the excitation light. Thus, for example, photoluminescence of old varnishes often involves excitation with (more energetic) UV-blue light for the emission of (less energetic and much weaker) greenish light. Ultraviolet imaging is particularly useful for identifying the presence of retouching. Aged natural-resin coatings, such as damar or mastic, fluoresce under ultraviolet light, and retouchings while later retouchings will not exhibit the same fluorescence (often appearing dark purple in tone), and are thus easily distinguished. However, if retouching lies under a varnish layer, it may not be perceptible by this means. Aged synthetic resin varnishes often fluoresce pale blue, and shellac may fluoresce in an orange tone while most recently applied varnishes will not fluoresce. The fluorescent components develop as a varnish ages and undergoes physical changes. Thus, the ultraviolet image must be interpreted through close comparison of the appearance of the painting under high magnification and normal lighting conditions.

A.3.ii. High-resolution imaging: Very high levels of image detail can be achieved by combining imaging systems such as infrared and ultraviolet cameras with the use of accurate positioning scanners. Through acquisition of an array of overlapping macroscopic images, combined with software capable of integrating and blending these images, large-scale mosaics can be created. Here, to acquire the image arrays needed the primary imaging camera is mounted onto a custom



designed and built multi-axis scanner (Isel, Germany) with proprietary software developed in-house. Final mosaic construction utilises a variety of commercial software packages that offer panoramic image stitching. For the purposes of this examination, the painting was photographed in this manner in IR and visible lighting conditions.

A.3 Plates



Plate 1. *Her Garden*, recto, normal lighting.



Plate 2. *Her Garden*, recto, digital infrared image.



a.



b.



c.

Plate 3. *Her Garden*, detail: a. infrared image; b. normal lighting; c. detail from Osborne's record sketchbook.



Plate 4. *Her Garden*, recto, ultraviolet fluorescence.

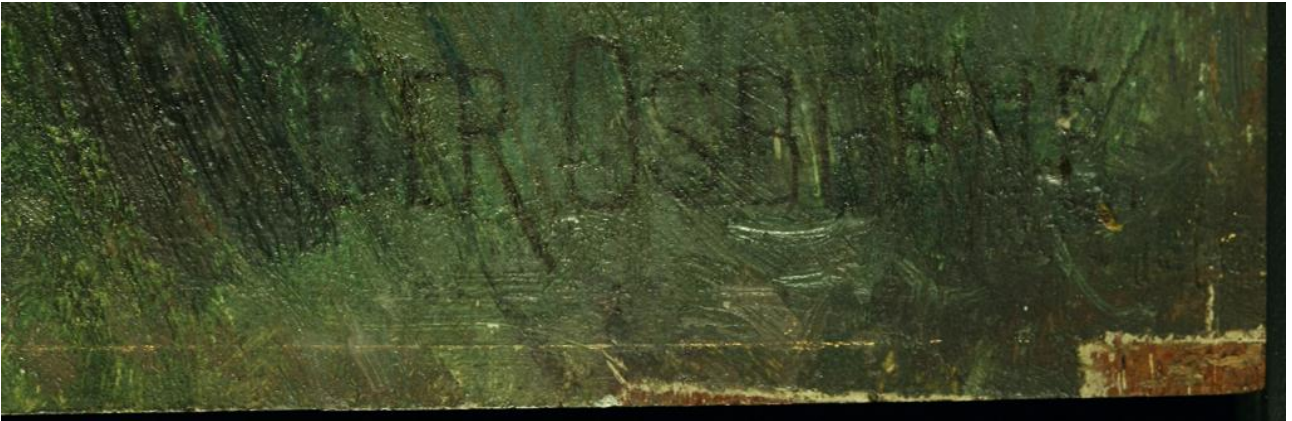


Plate 5. Detail, signature, normal lighting.

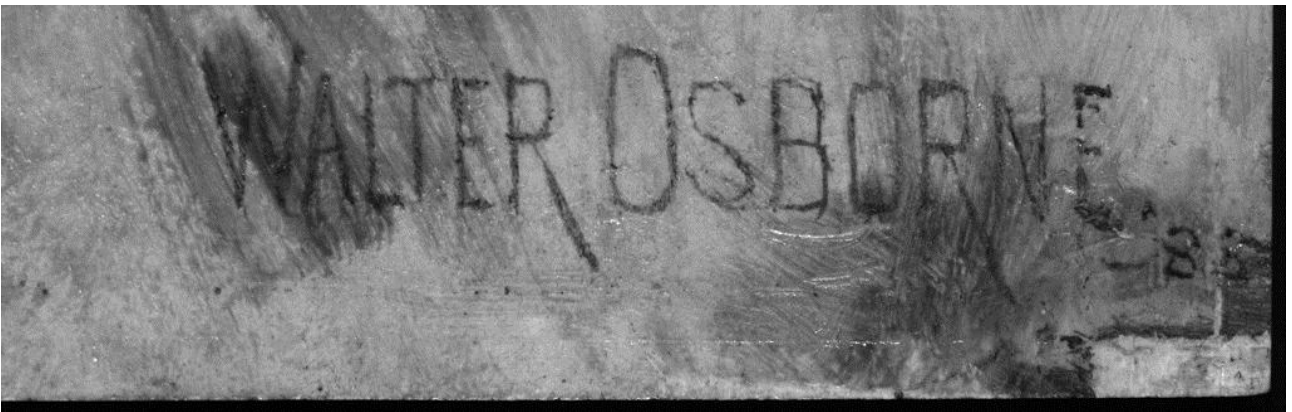


Plate 6. Detail, signature, digital infrared.



Plate 7. Above, detail of signature as Plate 8, lower left corner.



Plate 8. Walter Osborne, *Potato Gathering*, 1888.

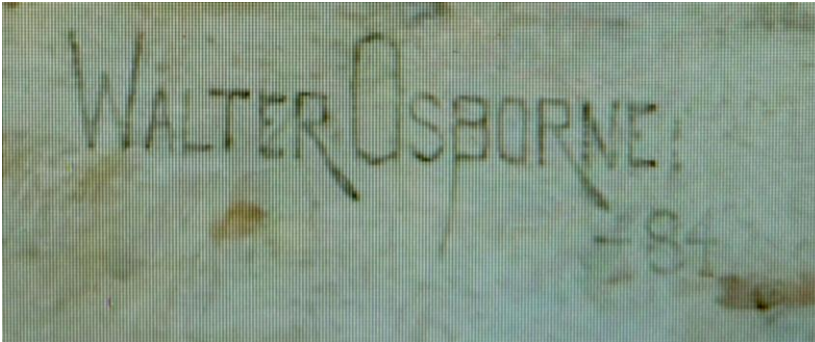


Plate 9. Detail of signature, Osborne painting *A Tale of the Sea*, 1884⁷.



Plate 10. Detail, date to the right of the signature, infrared image.

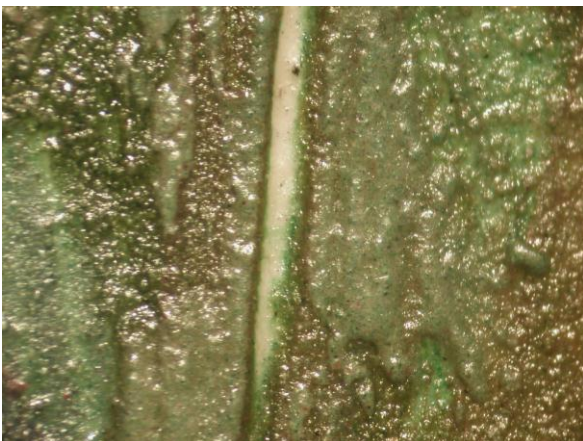


Plate 11. Detail, surface, lower right corner.

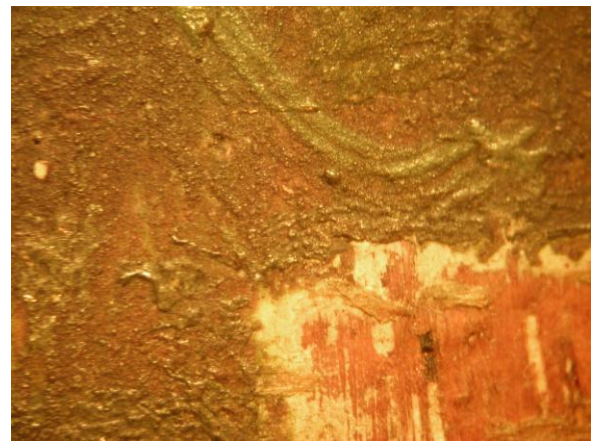


Plate 12. Detail, surface, lowermost right corner.

⁷ Image consulted online, May 2011.

http://www.sothebys.com/app/ecatalogue/ecat.do?dispatch=displayImageViewer&lot_id=159441521&SIZE=smaller

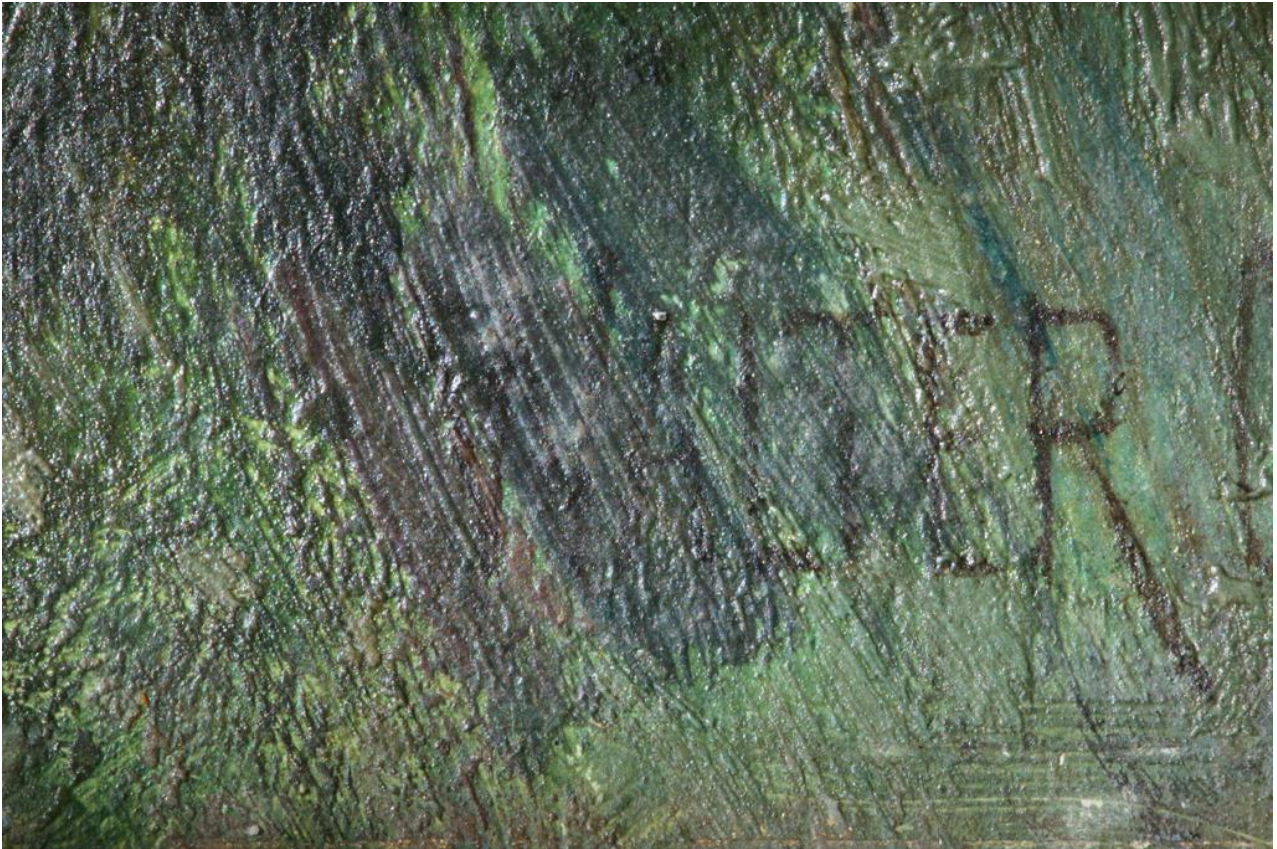


Plate 13. Detail, signature, surface texture.

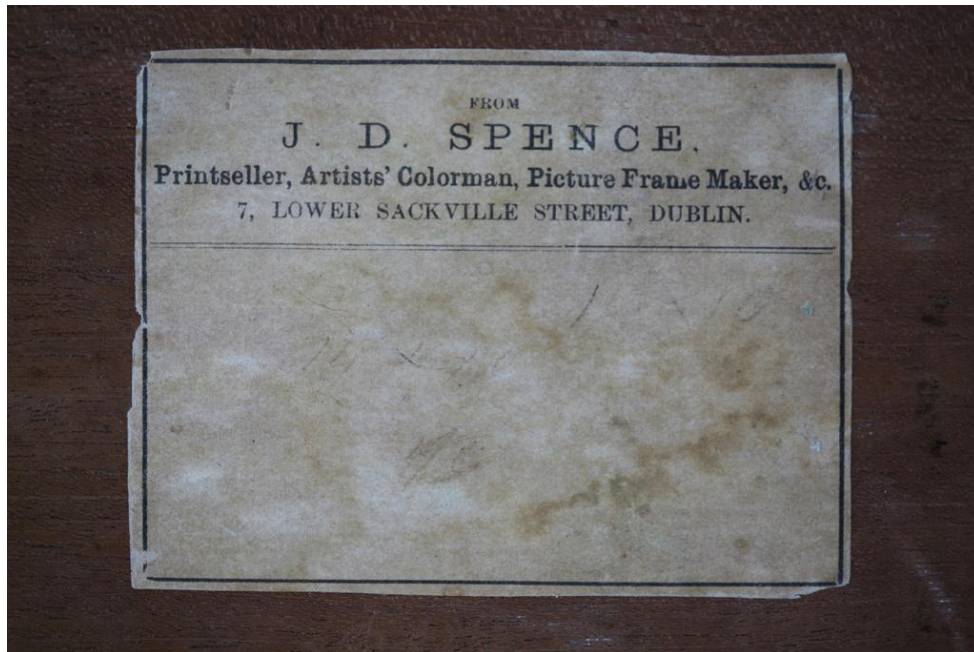


Plate 14. Detail, verso, label.

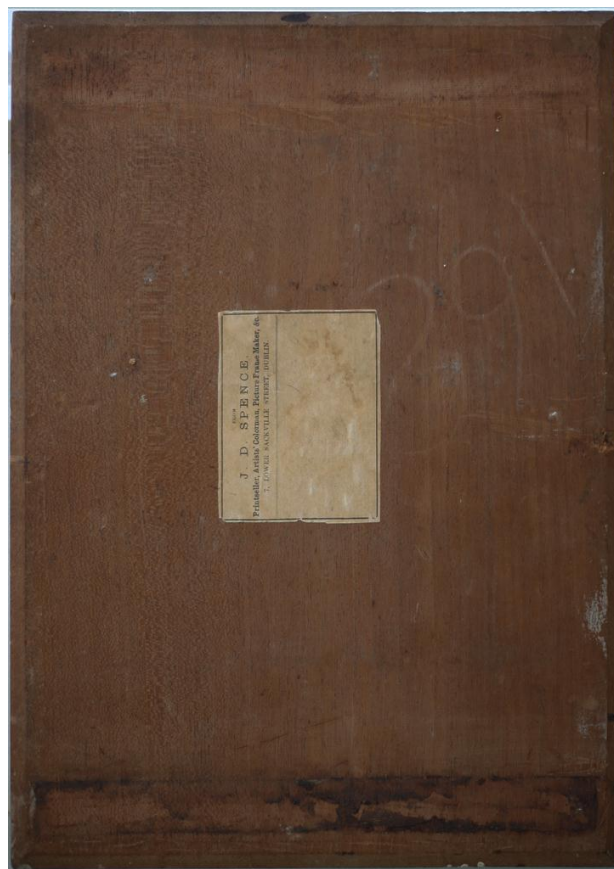


Plate 15. Verso.

CROSS-SECTIONS⁸

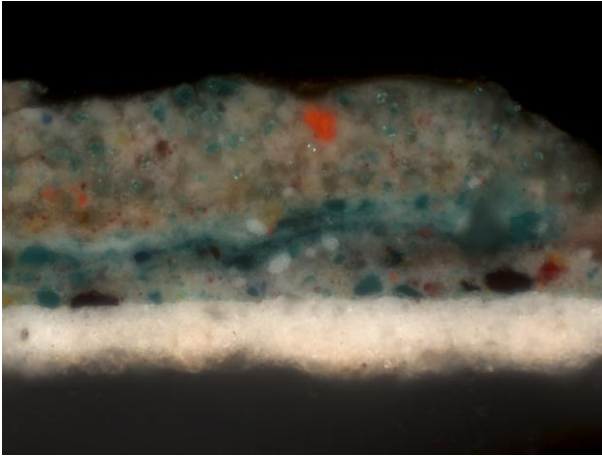


Plate 16a. Sample 11, normal light.

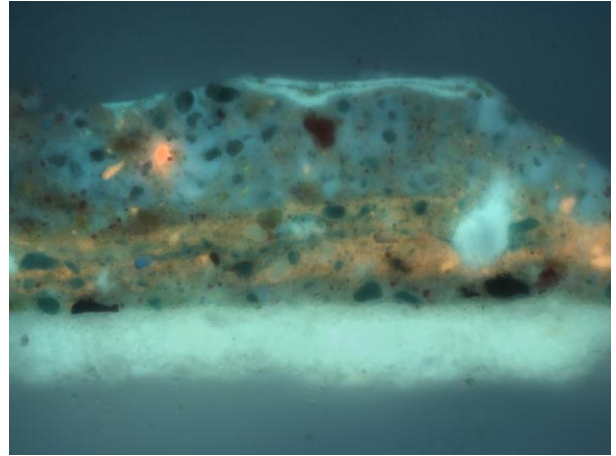


Plate 16b. Sample 11, UV light.

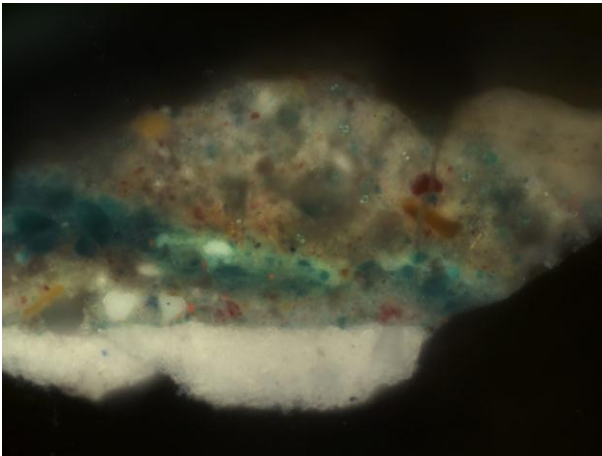


Plate 17a. Sample 12, normal light.

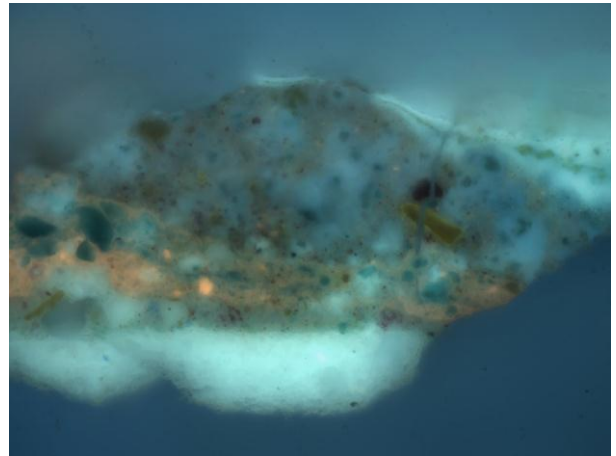


Plate 17b. Sample 12, UV light.

⁸ All images of samples prepared as cross-sections illustrated were photographed with a x40 objective. In the images as printed the full height of each image corresponds to c. 266 μm .

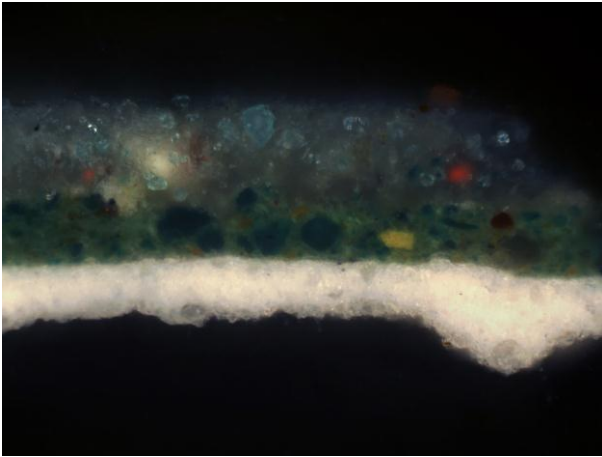


Plate 18a. Sample 13, normal light.

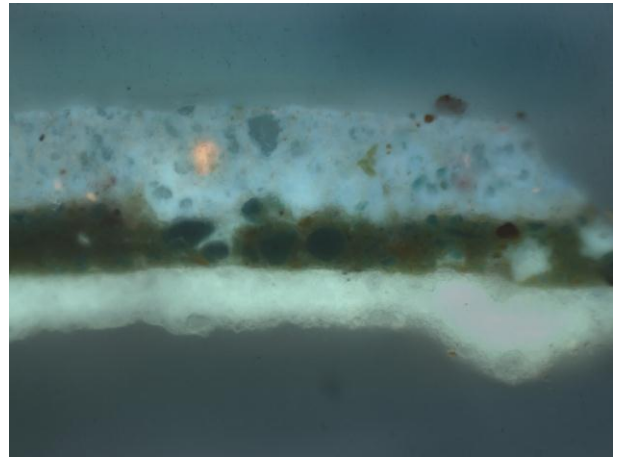


Plate 18b. Sample 13, UV light.

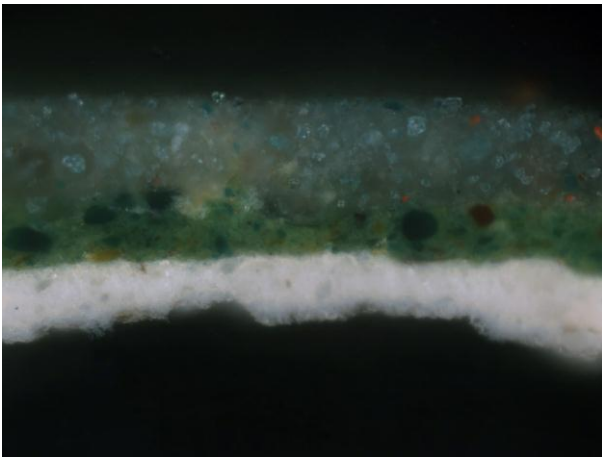


Plate 19a. Sample 13 (different view to 18), normal light.

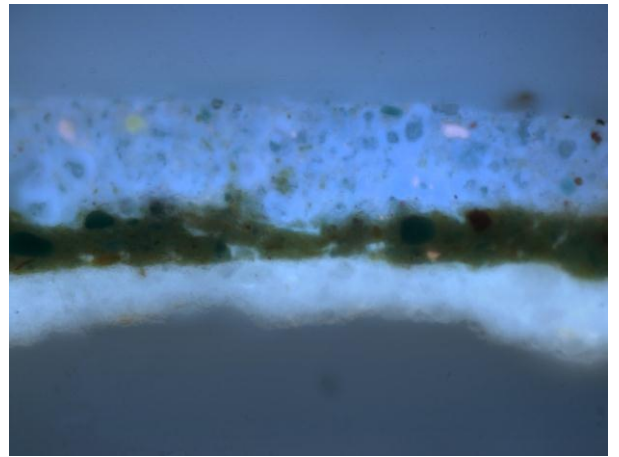


Plate 19b. Sample 13, UV light.