Art Analysis & Research

ANALYTICAL REPORT

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Still Life with Coffee Pot, 1906 (?)
Mikhail Larionov
Collection Museum Ludwig, Cologne, Inv. ML 1486

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Summary

A painting on canvas by Mikhail Larionov, *Still Life with Coffee Pot*, belonging to the Museum Ludwig (reference: ML 1486), that has been dated to 1906 (it is inscribed with the initials 'M.L.', but not dated), was examined and analysed by Art Analysis & Research, Ltd. in cooperation with the Museum Ludwig, and funded through a grant from The Russian Avant Garde Research Project (RARP). This artwork formed a part of a group of fourteen well-provenanced paintings by the Russian artist couple Natalia Goncharova and Mikhail Larionov, held in the collection of the Museum Ludwig that comprised the focus of this work. The goal set for this research was to investigate these paintings in order to characterise similarities and differences, with the objectives of 1) providing detailed studies of the specific paintings, 2) obtaining wider information on the artists' methods, 3) defining a blueprint for promising methodologies to develop further on other works by these artists and with an aim of applying such information in support a *catalogue raisonné*, and 4) creating the foundation for applying similar methodologies and techniques to other artists of the genre. To this end, each of the paintings are described in individual reports (as here) accompanied by a summary report under separate cover. The results of the program of examination, material analysis and technical imaging will be set out herein.

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A. Introduction

The painting known as *Still Life with a Coffee Pot* (**Plate 1**), by the artist Mikhail Larionov (1881-1964), a work on canvas measuring 810 mm high by 450 mm wide, is now part of the collection of the Museum Ludwig, Cologne (Inv. ML 1486). It is inscribed 'M.L.' (upper left) but is undated (**Plate 11.a**). A date of c. 1906 has been proposed for its creation. It has been examined as part of a larger technical study of fourteen paintings by Natalia Goncharova and Larionov in the Museum Ludwig, as part of a project funded through a grant from the charity the Russian Avant Garde Research Project (RARP). The project goal has been to generate detailed technical profiles on authentic paintings by Goncharova and Larionov to expand the data available for art historical study and technical characterization of their work[1]; consequently, fourteen well-provenanced paintings by the Russian artist couple held in the collection of the Museum Ludwig were thoroughly examined and analysed[2]. The short-term goal of the project was to define a blueprint for promising routes of research to develop further on other works by these artists and with a long-term goal of contributing such information to support a technical *catalogue raisonné*; these recommendations are laid out in a summary report[3].

The information in this report therefore provides a detailed technical and material account of the painting. In addition, this is considered in light of the conservation history and provenance information relating to the painting, held by the Museum Ludwig; the supplementary reports produced by Verena Franken in the course of her work on the RARP project summarises this material[4]. Some of the information concerning examination of the painting has been included here, as relevant, as are a representative selection of the extensive documentation photographs she made.

The structure of this report is as follows. First, the primary findings of the visual examination and technical imaging will be described in **Section B**.

Materials analysis on micro-samples taken for pigment and binding medium identification and cross-sections is described in **Section C**.

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[1] There is limited specific information available. This includes: Rioux, J.-P.; Aitken, G.; Duval, A. 'Étude en laboratoire des peintures de Gontcharova et Larionov', pp. 220-223. In: *Nathalie Gontcharova, Michel Larionov* [exh. cat.], Paris (1995). Rioux, J.-P.; Aitken, G.; Duval, A. 'Matériaux et techniques des peintures de Nathalie S. Gontcharova et Michel F. Larionov du Musée national d'art moderne', *Techne* **8** (1998) 7-32. Gallone, A. 'Œuvres de Michel Larionov et Nathalie Gontcharova: Analyse de la Couleur', *Le dessin sous-jacent la technologie dans la peinture: Colloque XI 14-16 septembre 1995*, R. Van Schoute and H. Verougstraete (eds), Louvain-la-Neuve (1997) pp. 137-141, Pl. 74-76.

[2] These include: Natalia Goncharova: *Paysage de Tiraspol (Tiraspol Landscape)*, 1905, ML 01483; *Rusalka*, 1908, ML 1304; *Still Life with Tiger Skin*, 1908, ML 1305; *The Jewish Family*, 1912, ML 1369; *The Orange Seller*, 1916, ML 1484; *Portrait of Larionov*, 1913, ML 1319.
Mikhail Larionov, *Still Life with Coffee Pot*, c. 1906, ML 01486; *Still Life*, c. 1907/1912, ML 1487; *Still Life with a Crayfish (Nature morte à l'écrevisse*), c. 1907, ML 1331; *Portrait of a Man (Anton Beswal)*, c. 1910, ML 1306; *Rayonism, Red and Blue (Beach)*, 1911, ML 1333; *Saucission et maquereau rayonnists (Rayonistic Sausage and Mackerel)*, 1912, ML 1307; *Venus*, 1912, ML 1332; *Rayonistic Composition*, inscribed 1916, ML/Z 211/134.

[3] *Summary Report of the RARP Goncharova/Larionov Project, with the Museum Ludwig*, Art Analysis & Research Inc. (2017).

[4] See reports: *AAR0955.G ML 1486 Conservation*, Franken, V. 'Report on the examination of the painting *Still Life with Coffee Pot* by Mikhail Larionov' (2017a) and *AAR0955.G ML 1486 Archives*, Franken, V. 'Report on the content of the Museum Ludwig archives, concerning the painting *Still Life with Coffee Pot* by Mikhail Larionov' (2017b).

Inferences drawn regarding the painting on the basis of these investigations will be discussed in **Section D**.

The methodologies and protocols used in each case may be found described in the general **Protocols** supplement, appended to this series of reports.

B. Examination, imaging and analysis of the images

B.1 Methodology

The painting was initially examined visually under normal lighting conditions and with ultraviolet light (UV), then with a stereo binocular microscope.

A range of technical imaging techniques were also employed (**Appendix 3**), generating a variety of images and imaging datasets[5]. These are presented as follows:

- High-resolution visible colour (**Plates 1, 5**);
- UV luminescence (**Plates 2, 6**);
- Oblique illumination (**Plate 3**);
- 3D laser surface scanning (**Plate 4**);
- Short-wave infrared (SWIR), 1600-2500nm (**Plates 7**);
- X-radiography (**Plates 8, 9**).

Additionally, weave analysis (including thread counting) was conducted on the basis of the X-radiograph (**Plates 10.a-d**). Some exemplar images recorded as part of the surface microscopy and macrophotography are also reproduced here (**Plates 11-15**).

The imaging revealed a range of aspects regarding the use of materials, structure and technique of production of the painting that are complementary to the visual observations made. Consequently, specific observation will be made to each in this section regarding the interpretation of these specific forms of analysis, while a summary overview in the context of the painting technique is presented in **Section D**, below.

B.2 General observations

The painting is executed on a plain weave canvas, which has not been lined, so that both the recto and the verso of the artwork could be studied. The wooden strainer upon which the painting is stretched appears to be original; the visible painting was revealed to overlie an unfinished academic figure study. Thus, the canvas is ‘recycled’, although pending further stylistic evaluation, it is not

[5] Additionally, a visible-NIR multispectral dataset was collected to examine its suitability for study of paintings of Goncharova and Larionov. As it did not offer information significantly different or superior to that derived by the SWIR imaging, this has not been otherwise reproduced or further analysed here but is available for extramural studies in the future.

possible to say whether this is an early work by the artist, or, a canvas by a third party reused as a painting support. The work is in relatively good condition. The surface has not been varnished.

B.3 Imaging

Each form of imaging offers different types of insight into the various material aspects of the painting. The most relevant are introduced, in brief, here.

B.3.i Photography with ultraviolet illumination

Excitation by ultraviolet (UV) light can induce luminescence[6] in some materials, commonly seen as a weak re-emission of light in the visible region. Many natural varnishes have this property, emitting a characteristic weak greenish luminescence. While some pigments (notably zinc white and certain 'lake' pigments) are also active in this way, paints otherwise often do not luminesce. Because of the luminescence of varnishes, which are typically applied as a continuous coating across the surface of a painting, this can provide a means of determining if any disturbance has occurred, such as partial cleaning of the surface or addition of later restoration, where the changes show in contrast to the luminescent areas. Consequently, UV light is commonly used to reveal the presence of retouching. When paintings are not varnished, as is the case with the present work, differences between the colour of the luminescence of the different paints and any added retouching paints can also indicate later stages of intervention (none is visible here; **Protocol 3.2** and **Plate 2**).

In the UV image of this work, the white paint used in the visible image shows a dull pale bluish tone. Apart from the white, no strong luminescence was noted from any of the original paints. Although this material contains zinc white (which usually exhibits a more greenish or yellowing tone, as seen in the related painting *Still Life* [AAR0955.H / ML 1487]) it is in a mixture with lead white and barium sulfate, resulting in the distinctive luminescence seen here.

The verso of the painting, as viewed under UV illumination (**Plate 6**) throws the dark lines of the markings on the verso into higher contrast. A diagonal white (roughly) rectangular field with 'LARIONOW' written on it in dark blue, underlined, is seen to the top half of the canvas, above the support bar, while in the lower half, a sketch of a female figure and a head are found (also rendered in white with dark blue line; **Plate 5**). These white areas exhibit a greenish luminescence, as noted above, more similar to that seen on the related work, *Still Life* [AAR0955.H /ML 1487], than to the white areas of the recto of this painting. As the paint of the verso was not sampled, if further testing would be undertaken in the future, it would be interesting to see if the white of the verso is indeed different, or similar, to that on the recto.

[6] Commonly referred to as 'UV fluorescence', the word *luminescence* is used here as a broader term that may encompass not only fluorescence phenomena (prompt re-emission of light), but also phosphorescence (slow re-emission of light due to transition via forbidden quantum states). In both cases emission is typically at longer wavelengths than the excitation; here, the excitation is in the UV to blue part of the spectrum (hence 'UV'; in practice, so-called UV-A) and emission in the visible region.

As is visible in normal light, the canvas appears to be very pristine and clean. Haloes of brownish oil staining may be observed in the vicinity of the white paint, suggesting that it was quite medium rich. The sketched head is applied over a canvas stamp (**Plates 6, 11.b, 11.c**), which will be discussed in detail, below.

B.3.ii Surface conformation

Two techniques for examination of the surface structure of the painting were used: photography under oblique illumination and 3D laser scanning. While the former may be the more familiar of the two as a physical examination technique, both essentially provide a means of elucidating paint texture and object deformations, either by recording shadowing, or through direct measurement of surface height. Of the two, 3D laser scanning offers important advantages in terms of being more replicable in the future (to support longer-term conservation assessments for example) and as a numerical dataset that can be studied visually and algorithmically for diagnostic features of technique. Imaging of the painting using oblique illumination, as well as 3D laser surface scanning (see **Protocol 3.3**), served to reveal two kinds of textural features that are particularly evident in this painting.

The 3D imaging reveals that the surface texture present is mostly attributable to the visible image, *Still Life with Coffee Pot*, and to the stretching of the canvas, which shows deformations in the top right and lower left corners.

B.3.iii Short-wave infrared (SWIR)

The interest in technologies capable of imaging artworks past the red end of the visible spectrum, in the 'near' ('NIR') or short-wave ('SWIR') infrared regions, has primarily developed out of the long-standing application to reflectography, exploiting the phenomenon of variable transparency of paint films at different wavelengths to enable visualisation of features lying beneath the surface. Imaging of underdrawing has been a major contribution to the study of authorship in paintings, permitting a fuller comprehension of artists' working practices and extending the evidence used in attribution questions. Practical experience (as well as theoretical consideration) has shown that deeper IR cameras can confer additional benefits in terms of penetration to underlying layers; consequently, a system capable of operating in the SWIR region was used here (see **Protocol 3.4**).

In the SWIR image taken (**Plate 7**), the most striking features are not those of the visible image, but of an unfinished, underlying painting, apparently a male nude study, which served as the basis for the present work. While most of this is rendered in brush, a (pencil? material not analysed) line that runs horizontally through the figure's thighs (in vertical direction, to the left of the centre in the orientation of the composition *Still Life with Coffee Pot*). It is not fully clear whether this line was made by the author of the underlying work, or during rendering *Still Life with Coffee Pot*.

The SWIR image (**Plate 7**) reveals that the figure occupies almost the entire height of the canvas, with feet at bottom, and head nearly touching on the top edge. The placement of the figure's arms is not legible. A dark shape behind the proper left leg of the figure is visible,

although it is not clear what it represents. Equally, dark areas in the foreground, around the feet, may resemble shadows. No linear underdrawing was visible.

Comparison with the image currently visible, and with the X-ray (**Plate 8**) reveals that the form of this figure has not been integrated into the current, visible composition.

B.3.iv X-radiography and weave analysis

X-radiography shows internal structures in paintings because the transmitted X-rays are blocked to different degrees by virtue of the inherent absorption and thickness variations of the constituent materials. For example, pigments based on lead (such as 'lead white') stop the passage of X-rays more effectively than materials based on organic compounds (such as carbon blacks or the binding medium of the paint), while a thicker application of a material will block more than a thinner one. This allows visualisation of sub-surface features, such as abandoned or altered earlier phases (*pentimenti*), use of techniques such as superimposed forms as opposed to forms left in reserve, characteristic brushwork and so forth.

As in the IR, the X-ray (**Protocol 3.6**; **Plate 8**) reveals the underling image of a figure study, but in different detail; here the figure images in darker tones, especially in the region of the lower body and legs, indicating that the background was worked up in more radio opaque layers, leaving the figure in reserve. The forms of the visible image are also legible.

Infilling of the interstices of the threads comprising the canvas support with the priming and paint also allows the canvas weave to be visualised in the X-ray. Even if a painting is lined, making direct access to the original canvas difficult or impossible, X-ray images can permit the primary weave structure to be examined in detail. A common characterisation of canvases (apart from weave type) cited in the study of paintings is the 'thread count', or number of threads per unit in warp and weft directions. Conventionally determined by hand-measuring a number of representative areas, this is now done by applying an image processing algorithm to the entire X-ray image, which has the benefit of providing both greatly enhanced determination of thread counts as well as density and thread orientation information across the whole painting (see **Protocol 3.7**; **Plates 10.a-.d**).

As no selvedge edge was present, warp and weft could not be unambiguously determined. The thread count of this work - painted on a plain weave canvas (**Plate 11.a**) - was determined as 19.4 threads per centimetre in the horizontal direction and 16.3 in the vertical. The irregular cusping distortion around the edges of the canvas (**Plate 10.a**), which is much stronger on the uppermost edge, though relatively even along the sides and bottom edges, is most likely due to the fact that the canvas is industrially prepared (i.e. not stretched on this strainer). This will be discussed further, in **Section D**.

C. Sampling and analysis

C.1 Introduction

Samples were taken of the support, ground preparation, paint and varnish layers of the work for analysis by different means in order to determine the range of materials (canvas, pigments, binders and coatings) used in the painting, the nature of the preparation layer and the sequence of layering employed in building up the painting.

To this end, a series of eight locations selected over a representative range of the painting were micro-sampled for identification of the pigments (**Tables App.1.i and App.2.i-.ii, Plate 16**), with three micro-samples of paint taken for analysis of the binding media (**Tables App.2.ii-2.iii**). Two further samples were taken for preparation as cross-sections to study the layering in the selected areas, with the aim of elucidating the development of the painting (**Plates 17-20**). Finally, canvas threads were taken for fibre identification (**App.2.iv**) and radiocarbon dating (**App.2.v**).

Micro-samples for analysis were taken from locations that were adjudged to be original (that is, were clearly contiguous with those below and adjacent to them, and not retouching or repair). Locations were also further selected to represent as wide a range of the colours – and therefore probably pigments and media – as possible. Thus, the materials identified and discussed below therefore represent, as far as can be determined, the full extent of the original palette used by the artist.

The micro-samples taken for pigment characterisation were subjected to systematic analysis by polarised light microscopy (PLM) combined with UV-visible-near infrared micro-spectrophotometry, scanning electron microscopy-energy dispersive X-ray spectrometry (SEM-EDX), Raman microscopy and some Fourier Transform Infrared Spectroscopy-Attenuated Total Reflectance (**App.2.i-.ii**).

Organic components were identified by FTIR (**App.2.ii**) and subsequently by Gas Chromatography-Mass Spectrometry (GCMS; **App.2.iii**).

All of the analytical techniques applied are standard methods within the field, capable of allowing the kinds of differentiation required for this type of work. Comparison was also made between samples from the painting and examples of similar pigments from a large collection of reference standards previously analysed by multiple means[7]. Certain differentiations cannot necessarily be made from this range of techniques, although for present purposes the level of discrimination is thought to be largely or wholly sufficient. All materials were generally identified through a combination of the techniques applied; however, certain key diagnostic features were specifically determined through one or other method.

[7] The pigment reference collection belongs to the Pigmentum Project (see: http://pigmentum.org) and runs to around 3500 samples of both historical and modern origin. Analysis of this collection includes PLM and SEM-EDX as well as other techniques such as X-ray diffraction and Raman microscopy. Access to this research collection is gratefully acknowledged. Reference to specific specimens in the text of this report is to the Pigmentum collection number [Pxxxx]. An organic binding media reference collection is also held by AA&R; samples in this set are cited as [AARxxx].

C.2 Support

The canvas was identified as being based on linen (*Linum usitatissimum* L.) (**App.2.iv**).

C.3 Radiocarbon dating

Radiocarbon dating was applied to fibres from the canvas support (**App.2.v**).

The radiocarbon date was determined as 88 years b.p. ±23 years. After calibration, this yielded a date distribution for which the most relevant period for the origin of the canvas lies 1810-1923 at the 95.4% probability level, pre-dating the so-called 'bomb-pulse' period that begins in the mid-1950s.

C.4 Ground

The upper layer of the ground (Sample [1]) was found to be composed principally of a mixture of lead carbonate hydroxide and lead(II) carbonate ('lead white'), with traces of clay minerals. A small amount of a carbon-based black, possibly as charcoal, was also present in the dispersed sample as well as in the cross-section of sample [10] (see below). It is bound in a drying oil (**App.2.ii**). Below this layer, a thin but discrete layer of a beige coloured, transparent material is visible in cross-section (**Plates 17-20**). This was found to consist of calcite (as identified in situ on both Samples [9 and 10] in cross-section); this was confirmed by FTIR analysis of the remains of ground on the sample submitted for radiocarbon dating, which was found to consist of calcite, with a minor component of calcium sulfate in the presence of a protein-based medium (not identified, but traditionally animal-skin glue) (**App.2.v**).

C.5 Underdrawing

No obvious signs of underdrawing were observed.

C.6 Paint layers: Pigments

The following **pigments** (**Tables App.2.i, App.2.ii**) were identified in the paint:

- Zinc oxide ('zinc white')
- Barium sulfate
- Possibly a barium sulfate-zinc sulfide 'lithopone' type pigment
- Lead carbonate hydroxide ('lead white')
- Lead(II) carbonate ('lead white')
- An aluminosilicate clay
- CI Pigment Blue 60
- Earth pigments of various hues (yellow, red and brown), some containing hematite
- A carbon-based black, probably a flame carbon

Barium sulfate, zinc oxide, and a lead carbonate type pigment were all directly identified in a sample of white paint. Additionally, it also seems probable that an excess of sulfur present for barium sulfate alone suggests that a 'lithopone' type pigment (a co-precipitate of barium sulfate and zinc sulfide) may be present.

Barium sulfate, often used as an extender pigment, was also identified as a minor component in most of the samples. Calcium sulfate, was found with hematite in the red and red-brown paint samples.

A number of samples, ranging from brown-yellow to red to dark-brown contain earth pigments. The presence of trace levels of manganese in some of these suggests that they fall into the category of siennas and umbers, for which manganese compounds are typical components.

CI Pigment Blue 60 (PB60) was identified in many of the samples. PB60 is an anthraquinone vat dye discovered in 1901 and launched commercially before 1910; it has been found in paintings as early as the 1920s. PB60 was first traded as *Indanthren X* and, at least since 1914, as *Indanthrenblau R*[8]. The suitability of indanthrene, as well as its many other blue substitution products, as artists' pigments was rated positively in the first decades of the 20th century: in 1910, Staeble described lakes of indanthrene as unusually lightfast in water colours and oil painting[9]. In 1915, Krais considered indanthrene blue and violet as applicable for artists' paints; nine years later it was suggested by the chemical companies BASF and Höchst for the same usage in the *Deutsches Farbenbuch*, and in 1925 the pigment was known to have been used in Mussinis´s '*Solidblau*' paint[10]. The earliest known instances of analysis of this pigment in use in artworks appear to be those in Kirchner´s *Sertigtal im Herbst* (1926) and his *Tanzschule*, parts of which are thought to be later re-working by the artist, presumably in the 1920s[11]. PB60 is also apparently infrequent in German paintings after World War II[12], but it has been detected in paint pots from the studio of Sam Francis (1923-1994)[13] and is today used by several manufacturers of commercial tube paints[14].

Although the ground layers of the underlying painting were sampled, the paint of the earlier work was not.

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[8] Schultz, G. *Farbstofftabellen*, 5. Auflage der im Handel befindlichen künstlichen organischen Farbstoffe von Gustav Schultz und Paul Julius, Berlin: Weidmannsche Buchhandlung (1914) p. 287.

[9] Staeble, R. *Die neueren Farbstoffe der Pigmentfarben-Industrie*, Berlin: Verlag von Julius Springer (1910) p. 126f.

[10] Schäning, A., Schreiner, M., Mäder, M. and Storch, U. 'Synthetische organische Pigmente in Künstlerfarben des frühen 20. Jahrhunderts: Möglichkeiten und Grenzen ihrer Identifizierung am Beispiel von zwei Gemälden um 1925 von My/Marianne Ullmann'. *Zeitschrift für Kunsttechnologie und Konservierung*, 1 (2007) pp. 87-110, esp. 90, 104, 105 (with further references).

[11] Stege, H., Richter, M., Steuer, C. 'Indanthrenblau, Helioechtrot and Pigmentscharlach – Identification of synthetic organic pigments in paintings of Ernst Ludwig Kirchner using Raman microscopy', *Aufbruch in die Farbe. Ernst Ludwig Kirchner und das Neue Malen am Beginn des 20. Jahrhunderts Kirchner, Zeitschrift für Kunsttechnologie und Konservierung*, **27** (2013) pp.30-42.

[12] Lutzenberger, K. *Künstlerfarben im Wandel – Synthetische organische Pigmente des 20. Jahrhunderts und Möglichkeiten ihrer zerstörungsarmen, analytischen Identifizierung*, Unpublished PhD thesis, Humboldt-Universität zu Berlin (2009).

[13] Bouchard, M., Rivenc, R., Menke, C. and Learner, T. 'Micro-FTIR and Micro-Raman study of paints used by Sam Francis'. *e-PreservationScience*, 6 (2009) pp. 27-37, esp. 30.

[14] Schäning, A. *Synthetische organische Farbmittel aus einer technologischen Materialsammlung des 19./20. Jahrhunderts: Identifizierung, Klassifizierung und ihre Verwendung sowie Akzeptanz in (Künstler)Farben Anfang des 20. Jahrhunderts*, Dissertation Akademie der bildenden Künste, Vienna (2010) p. 262.

C.7 Paint layers: Binding media

All paint samples analysed indicated the presence of a drying oil (**App.2.ii**). Two samples analysed additionally by GCMS indicated that it was either walnut oil or a mixture of poppy and linseed oils (**App.2.iii**).

FTIR also indicated the presence of metal soaps, probably of lead and zinc, assumed to be reaction products between pigments and binding medium.

C.8 Stratigraphy

The preparation of cross-sections allowed for examination of the overall stratigraphy and composition of the priming and paint layers. Two samples were studied in this way, a pale brownish-grey from the top edge of the painting and a pale brown-beige from the left-hand edge.

Sample [9], from the top edge, includes what appears to be a double layered ground, consisting of a protein (probably animal-skin glue) bound underlayer of calcite, over which a thick opaque layer of lead white has been applied. These layers have cracked, and over them, the material from the visible painting, *Still Life with Coffee Pot*, penetrates into the void. It is unclear whether there is a discrete, thin layer of medium and dark particles directly over the ground layer, or, if this is simply the boundary between old and new programs of work, with surface accumulation of dirt present in between. The thick brown-grey paint uppermost consists mainly of white pigment with some black and red particles.

Sample [10], from the left-hand edge, similarly shows a preparation structure with a double layer system. The white layer is seen to contain a few large, black particles. The orange-beige layer paint layer, uppermost, belonging to the visible painting (*Still Life with Coffee Pot*), consists of white with fine red and black particles, with some fine blue and green particles and a few larger red-brown particles.

D. Discussion of the findings

D.1 Support, ground and preparatory work

D.1.i The support

The painting has been executed on an open, plain-weave, linen canvas (**Plates 5, 12.a, 12.b**), with thread counts of 19.4 threads per cm in the horizontal direction and 16.3 threads per cm in the vertical direction (see **Plate 10.d**). Neither of the selvedge edges are preserved and the tacking margins show only minor fraying at the cut edges of the canvas (**Plate 13.a-c**). The weave is quite open (**Plate 12.a**), with distinct interstices between most of the threads.

The canvas is of a rather fine, uniform aspect, suggesting it is a purpose made artists' canvas. While some slubby and irregular threads may be noted, they are neither very numerous, nor much thicker than the other threads (**Plate 12.b**). Given the presence of a canvas stamp of a French colourman, Perrod (see below), the quality may be identified with what is known as the *étude* or *pouchadé* weights of canvas, which were inexpensive types of canvas made for sketching (as used here)[15].

The canvas is unlined, so the verso is fully visible (**Plates 5**). It is affixed to what may be its original strainer (with a horizontal central support bar) by means of what appear to be the original, round headed tacks (**Plate 13.a**). The strainer measures 810 x 450 x 20 mm; its members measure 39 mm in width and are fixed with three nails at each corner. The tacking margins generally extend over the edge of the strainer (**Plates 12.c, 13.a**).

A stamp on the verso of the prepared canvas gives the information of the colour merchant Perrod (**Plates 11.b, 11.c**); the visible (much is covered by the sketch of a head) and legible parts of the stamp, which reads as follows, are indicated in bold, below:

[COULEURS FINES & T]**OILES à** PEIND[RE/ TA]**BLEAUX**/ [F. PE]**RROD**/ [PARIS/ 51, Rue de la Rochefoucauld][16]

Perrod produced and sold artist's paint and canvas support between 1892 and 1904[17]. Implications for dating will be discussed below.

The presence of the canvas stamp raises other questions regarding the size of the canvas. In late 19th century Paris, canvases were often produced to standard sizes, although the shifts in format are not well documented. The dimensions here, however – 81 x 46 cm – do not match those of the standard formats noted slightly earlier (in the last 19th century). The narrowest width produced for a canvas of 81 cm in length was 56 cm, which corresponded to a 'marine' format[18]. The measure 46 cm was known to have been produced as a standard size support bar; it was simply not combined with the 81 cm length. On the other hand, the figure of the underlying painting is centred in the middle of the present format and the tacking edges (apart from the upper edge) exhibit unpainted priming, suggesting that the format is original. It is possible that, for figure studies, a tall thin support was used, stretched with an inexpensive study grade canvas, as is found here, which would have been a practical solution for such works. Thus, for the present, the configuration of this canvas will be accepted as the original, as the evidence, though not highly regular, does not strongly suggest otherwise.

[15] Callen, A. *The Art of Impressionism*, New Haven and London: Yale University Press (2000) pp. 31, 32, figures 45.-48.
[16] The full text may be found on the following website: *Guide Labreuche. Guide historique des fournisseurs de matériel pour artistes à Paris 1790-1960*, consulted 24 October (2017):
http://www.labreuche-fournisseurs-artistes-paris.fr/fournisseur/perrod
[17] *Ibid*. Labreuche website.
[18] Labreuche, P. *Paris, capitale de la toile à peindre XVIIIe-XIXe siècle*, CTHS-INHA: Paris (2011) pp. 298-303.

In addition to the Perrod stamp on the canvas, there are a number of inscriptions, stamps and labels present on the verso of the painting (both stretcher and canvas) that are less directly related to the original creation of the artwork (**Plates 5, 6**)[19].

D.1.ii Priming

The canvas has been primed with a white ground layer, that appears to have been applied industrially by a specialist supplier, as it is of a very even aspect and extends over the tacking margins to the cut canvas edges (**Plates 12.c, 13.a**).

Analysis of the ground indicated that it is composed of calcium carbonate (calcite; i.e. artificially manufactured chalk) and some calcium sulfate bound with protein. Although the binding medium was not specifically analysed to determine the nature of the protein, it assumed to be animal-skin glue, as was traditional practice for calcite ('chalk' type) grounds. Equally, it may be presumed that the canvas was first sized with a layer of pure glue, so help seal the interstices between the canvas threads (**Plate 11.a**), before the white priming was laid. As a thick layer of white – comprised of lead white and some clay minerals, bound in oil - appears above the calcite layer in both samples studied as cross-sections (Samples [9 and 10] **Plates 17-20**) and, because these two layers appear to have cracked simultaneously in Sample [9] (**Plate 19**), the lead white layer is presumed to be a second priming layer. As such, it was applied over the first calcite layer as an overall isolation layer in order to produce a less absorbent surface for painting in oil.

D.1.iii Underdrawing

The IR and X-ray images taken of the painting (**Plates 7, 8**) reveal the form of an unfinished, painted full length sketch of a nude man. In the X-ray image it appears that the figure was painted in reserve, as the background seems to be more radio opaque than the figure itself (**Plate 8**). A dark object behind the proper left foot of the figure shows dark in the IR, and light in the X-ray. However, it is unclear exactly what this represents. While the figure's contours are quite clear, there is no evidence for linear underdrawing of this figure, or of the *Still Life with Coffee Pot*, although drawn lines, apparently in pencil, are visible at the edges and tacking edges of the canvas (**Plate 12.c**). Apart from the imaging, the feet of the figure are visible in part through the transparent paint of the *Still Life with Coffee Pot*, at the bottom of the painting (**Plate 15**).

D.2 Paint, pigments and binding media

D.2.i General observations

The condition of the painting is generally very good. Although the paint layers exhibit some localised cracking (**Plate 14.b**), this has not led to loss of paint, and there is no observable retouching present. The canvas appears to be stretched in original configuration on its

[19] These are described in more detail in V. Franken, *AAR0955.G 1486 Conservation Report* (2017a).

original strainer; some slackness of the canvas may be observed in raking light, which reveals the tension lines of the somewhat slackened support (**Plate 3**).

The painting is executed in a very sure and spontaneous manner (single strokes of paint, often applied wet-in-wet, define form in many areas). While no trace of an underdrawing was noted, given the nature of the support, the presence of preliminary work would be difficult to discern; the shapes may have been sketched with paint in advance, or roughly laid in as the artist progressed the composition. The prepared surface of the canvas is largely but not wholly covered by the application of paint, which extends but rarely over the tacking margins allowing areas of ground to remain visible in some areas of the painting (**Plates 2, 13.a**) are visible throughout the painting at the turn over edges of the canvas (mostly to the right side). No evidence for complex layering was seen; areas are worked quite directly, with mixing both on the palette, and wet-in-wet directly on the canvas (**Plate 14.c**). Airborne dirt has accumulated on the surface (**Plate 14.b**) as well as staining around the edges of the canvas. The composition has not been varnished.

D.2.ii Paint: pigment and binding medium

The palette used in this work is quite limited in scope, encompassing white ('zinc white' primarily with additions of barium sulfate and lead white), black, blue and earth pigments in yellow, red and brown tones. It is worked in almost a warm 'monotone' effect of yellows and browns. The paint looks to have been applied in a very fluid state, and is very glossy (**Plates 13.c-14.c**).

In contrast to *Still Life with Coffee Pot*, the underlying figure study is based on a canvas prepared with a calcite ('chalk' – either synthetic or natural) preparation (presumably glue bound, though this was not specifically analysed), with a lead carbonate ('lead white') isolation layer applied above it. This would have 'sealed' the more absorbent calcite underlayer so that the oil binding media used in the paint layers was not absorbed excessively by the ground. The paint was applied freely; sometimes thinly (**Plates 14, 15**), sometimes in thicker applications. Brush hairs remain in the surface in several areas.

The colours of the underlying image are visible in some areas of the present composition, where upper layers have been laid quite thinly and which have become more transparent over the passage of time (**Plate 15**). In the more thickly painted upper portion of the *Still Life with Coffee Pot*, there are some passages of paint where depressions and impasto unrelated to the visible composition may be noted; it is assumed that these relate to the underlying work (**Plate 13.b**).

Analysis of the paint samples indicated that they are bound with drying oils; either walnut oil, or, a mixture of linseed and poppy oils (**App.2.iii**). The evident fluid handling of the paint, and the glossy surfaces suggest the use of a very medium rich paint (**Plates 13.c-14.c**). The white paint shows formation of surface air bubbles in some areas (**Plate 13.c**), though no evidence for the use of an emulsion system (gums or proteins) was noted in the analyses undertaken.

The cross-sections prepared show a very simple layer structure; a thick upper layer belonging to the visible painting, a double layered ground below (**Plates 15-19**). In the case of Sample [9], a crack had formed in the ground, which is penetrated by the paint of the overlying work. As a similar layer is absent in Sample [10], it seems likely that the thin brownish layer with black particles seen in Sample [9] is a discreet, thin application of medium rich paint, rather than an accumulation of surface dirt.

This cracking of the ground could not be confirmed in other areas, as examination under magnification revealed that the visible painting covers virtually all of the surface of the underlying composition.

D.2.iii Materials analysis and implications for dating

The provenance for this painting extends back only as far stated as ownership by the Gallery Schwarz, Milan (undetermined period); certain is that the work passed through the Gallery Gmurzynska into the collection of Peter and Irene Ludwig[20].

The radiocarbon measurement of the canvas gave an origin for it between 1810-1923 at the 95.4% probability level, though pre-dating the so-called 'bomb-pulse' period that begins in the mid-1950s. In addition to this a period of 3-5 years typically needs to be allowed for processing into canvas and use by the artist. This would be compatible with the stylistic date given to it. It should also be noted that as there is a figure study under the painting, the date of the canvas is more aligned with that of its first use, rather than the composition of *Still Life with Coffee Pot*.

Of the evidence found, the issue of a reused canvas and the presence of CI Pigment Blue 60 (PB60) in this painting raise the most significant issues regarding the dating of this work. Given that the canvas was used and subsequently the painting executed on it well dried (to the extent where brittle cracks had formed it seems unlikely that it could have been used at bare minimum less than 10 years after it was stretched. As Perrod was active from 1892-1904, it is possible that the canvas is made of linen harvested as early as c. 1890, thus providing a minimum *terminus post quem* for the visible composition of c. 1902 if the canvas was supplied and used as early as 1892, then allowed to dry and age. However, the finding of the pigment PB60 pushes this further forward.

The size of this painting is also quite unusual, in its format of 81 x 46 cm, is a non-standard Parisian canvas size (for a height of 81 cm, the smallest known width in standard canvas sizes was 54 cm; a *marine* format of 81 x 54 cm is known)[21]. Therefore, this work, along with the other painting in the Museum Ludwig collection [AAR0955.H / ML 1487], *Still Life*, likewise executed on a canvas that is a reused academic figure study, likewise stamped with the mark of an early 20th century supplier (here, Chabod, who was trading until 1905, a

[20] Franken (2017b).
[21] Labreuche (2011) *op. cit.* pp. 300-301.

similar time frame)[22] remain for now singular examples of this precise type of use of support in Larionov's oeuvre[23].

It should also be noted that the Perrod stamp found on the verso does not precisely match any of the known variants available to the researchers for comparison at the time of writing (such as **Plate 11.c**). Equally, the lettering does not look fully even and regular, but somewhat retouched (**Plate 11.b**). Further research into comparison examples to better date this impression, or to explore if it has been in some what modified.

Additional physical similarities shown between these paintings include: the use of similar colour palettes; the use of fluid, glossy paint; the use of the inscription format '[M.] LARIONOW', in a rectangle, on the verso of the painting and the initials 'M.L.' on the recto. Another two *Still Life* paintings of similar appearance and approximate dimensions, in the collection of the State Tretyakov Gallery, Moscow, seem related[24]. These are dated to around 1928. An additional piece that is similar in composition and style, though not in dimensions or support – it is a work on cardboard – provides further consideration[25]. This *Still Life, Fruits and Nude Study (Nature morte, fruits et étude de nu)*, is smaller format but is very like these other three in terms of style, palette (white and brown tones) and concept, and is likewise inscribed 'M.L.'.

An important question concerns the authorship of the unfinished, underlying painting; is it possible that it might have been an early work, in the Moscow academy, from either Goncharova or Larionov? Or, given the stamp of the Perrod, could it have been a work acquired cheaply by Larionov in Paris and reused as a support, essentially, 'recycled'? While other examples of Larionov's reuse of canvases are known, these all seem to involve unfinished works by either himself or by Goncharova. Equally, the formation of the final, visible image can be shown to have integrated, to some extent, the underlying forms of the first painting[26]. Here, the earlier work is simply used as a surface upon which to paint; if anything, the overlying painting obliterates it as thoroughly as possible, rather than working with the shapes of the form below. There is little of the underlying surface visible along the edges of the painting as the majority of the painting surface has been covered over. This attention to coverage of surface differs from other works by Larionov, where the underlying support is often left visible.

In terms of its material composition, although PB60 was technically available from its discovery in 1901 and launched commercially by 1910, it has not otherwise been found in

[22] See the report for AAR0955.H, *Still Life*, Museum Ludwig 1487.
[23] See note 24, below.
[24] See the Russian Edition of: State Tretyakov Gallery, *Catalogue of the Collection, Painting of the First Half of the 20th Century, Series Painting of the 18th to 20th Centuries*, Volume 6, Book Two, Letters K, L, State Tretyakov Gallery: Moscow (2017) p. 281, cats. 907, 909. These measure 48.2 x 81 cm and 81 x 45 cm respectively.
[25] Éditions du Centre Pompidou Paris, *Nathalie Gontcharova, Michel Larionov*, Imprimerie Le Govic: Saint-Herblain (1995) p. 149, Cat. 126.
[26] Other examples that may be cited include: *Boutique juive au marché de Tiraspol* (c. 1904), *Portrait de Tatline* (1913), both illustrated in Rioux, Aitken and Duval (1998) *op. cit*. pp. 23-31, and equally, *Rayonism, Red and Blue (Beach)*, Museum Ludwig 1333, in this current group of analysed works for the RARP project.

paintings before the 1920s, making this either an exceptionally early example of this material or requiring some revision of dating[27].

The materials otherwise identified in the painting would be compatible with the supposed date, although they also continued in use after that time (and would not preclude a revision of date if deemed necessary).

Other technical characteristics arising from the larger review of the works of Goncharova and Larionov may also contribute to a fuller understanding of the relative dating of this painting in the future.

E. Conclusions

The study of the painting revealed a work that is not materially consistent with a proposed date of creation for the *Still Life with Coffee Pot* in c. 1906; rather, a somewhat later dating is plausible, in the 1920s or 30s. It was worked over an abandoned, unfinished figure study, probably executed between 1900-c. 1906 (as the producer of the canvas, Perrod, ceased trading in 1904) though as this is a material study, we have refrained from speculating on the author of the work, pending specialist, stylistic analysis and fuller investigation of the canvas stamp. The canvas is industrially finished (not hand finished), with a double ground consisting of calcite and glue below, lead white in oil above, a combination not known to have been found in other works by Larionov or Goncharova. Equally, it is not of a size that is of standard measure for French works of the period. No visible measures were taken to efface the underlying study; simply, the paint of the visible composition was applied over it. The presence of the pigment PB60 suggests a dating rather later than has been suggested, after at least 1920, when this pigment was known to have been in use as a painters' material.

The work shares many similarities with [AAR0955.H / ML 1487], *Still Life*; further thoughts regarding their dating should most likely be considered simultaneously, ideally, as well with more information concerning the clearly similar (size, subject, style) Larionov paintings in the Tretyakov Gallery.

[27] PB60 was not noted in the study of Rioux, Aitken and Duval (1998) *op. cit*., though this cannot be taken to be significant, as the protocol used therein was not able to detect the presence of synthetic organic pigments. However, what is of significance is the fact that PB 60 has not been identified in any of the turn of the century French works or Russian paintings in the published literature.

Art Analysis & Research

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G. Appendices

Standard protocols used by AA&R in the preparation of this report for sampling, materials analysis and imaging are listed in each subsection below and detailed in the appendices to the global summary report.

App.1 Sampling and sample preparation

Protocols:

[P.1.1] Sampling
[P.1.2] Cross-sectional analysis

App.1.i Sampling

Table App.1.i Samples taken for analysis

#	*Colour*	*Description*	*Location*[28]	*Analysis*
1		Ground	452/50	PLM, SEM-EDX, Raman, FTIR
2		White	164/722	PLM, SEM-EDX, Raman, FTIR, GC-MS
3		Brown Yellow	37/430	PLM, SEM-EDX, Raman
4		Dark Brown	43/408	PLM, SEM-EDX, Raman
5		Red Brown	1/190	PLM, SEM-EDX, Raman
6		Dark Blue	10/416	PLM, SEM-EDX, Raman
7		Red	290/420	PLM, SEM-EDX, Raman
8		Black	420/530	PLM, SEM-EDX, Raman
9		Pale brownish grey	260/813	CSA
10		Pale brown beige	0/530	CSA

[28] The coordinates in this column are given in millimetres, the measurements taken from the left edge of the picture, and from the lower edge of the picture.

Table App.1.i Samples taken for analysis

#	*Colour*	*Description*	*Location*[28]	*Analysis*
11		Yellow Grey	3/134	FTIR, GC-MS
12		Canvas fibre	430/813	PLM, FTIR, C14

App.1.ii Cross-sectional analysis

Results are shown in **App.5**, **Plates 17-20.**

App.2 Materials analysis summary results

Protocols:

[P.2.1] Polarised light microscopy (PLM)
[P.2.2] Scanning electron microscopy-energy dispersive X-ray spectrometry (SEM-EDX)
[P.2.3] Raman microscopy
[P.2.4.1] Fourier Transform Infrared Spectroscopy-Attenuated Total Reflectance (FTIR-ATR)
[P.2.5] Gas Chromatography-Mass Spectrometry (GCMS)
[P.2.7] Fibre Identification
[P.2.8] Radiocarbon dating

App.2.i SEM-EDX, Raman microscopy and PLM analysis

Table App.2.i Analytical results SEM-EDX, Raman Microscopy and PLM

#	Colour	SEM-EDX (elements)			Raman Microscopy (peaks, cm^{-1})	Identification
		Major	Minor	Trace		
1	Ground	**Pb**	Al	*Si, Cl, Ca, Zn*	**1054 (w), 1050 (vw, sh),** 178 (vw), 149 (vw)	**Lead carbonate type white** Clay minerals (trace) Carbon-based black, possibly as charcoal
2	White	-	S, Zn, Ba, Pb	*Al, Si, Ca*	**1053 (vw), 1049 (vw), 988 (w), 461 (vw), 453 (vw)**	**Barium sulfate** **Lead carbonate type white** Zinc oxide/zinc sulfide[29]
3	Brown-yellow	-	Al, Si, S, Zn	*Mg, P, K, Ca, Fe, Ba, Pb*	**1086 (vw), 986 (vw)**	**Barium sulfate (trace)** **Calcium carbonate (trace)** Iron containing earth pigments Zinc oxide Aluminosilicate clay minerals
4	Dark brown	**S**	Ca, Fe	*Mg, Al, Si, K, Mn, Zn, Ba, Pb*	**1384 (vw), 1355 (vw), 1327 (vw), 1299 (vw), 1283 (vw), 1187 (vw), 1160 (vw), 803 (vw), 477 (vw), 213 (vw), 144 (vw)**	**CI Pigment Blue 60 [P1742]** Earth pigment Calcium sulfate Zinc oxide (trace)
5	Red-brown	**S**	Ca, Fe, Ba	*Mg, Al, Si, K, Mn, Zn, Pb*	**1383 (vw), 1355 (vw), 1327 (vw), 1300 (vw), 1284 (vw), 1185 (vw), 1157 (vw), 803 (vw), 477 (vw), 408 (vw), 291 (vw), 225 (vw), 212 (vw), 144 (vw)**	**Hematite, probably as earth** **CI Pigment Blue 60 [P1742]** Barium sulfate Calcium sulfate
6	Dark blue	**S**	Zn, Ba	*Mg, Al, Si, K, Ca, Fe, Pb*	**1382 (vw), 1354 (vw), 1326 (vw), 1300 (vw), 1283 (vw), 1182 (vw), 1158 (vw), 802 (vw), 477 (vw), 212 (vw), 145 (vw)**	**CI Pigment Blue 60 [P1742]** Barium sulfate Zinc oxide[30] Earth pigment
7	Red	**S**	Ca, Ba	*Mg, Al, Si, P, K, Fe, Zn*	**1007 (vw), 986 (vw), 611 (vw), 494 (vw), 409 (vw), 292 (w), 225 (vw)**	**Hematite, probably as earth** **Barium sulfate** **Calcium sulfate,**

[29] The analysis suggests that both zinc oxide and zinc sulfide may be present. UV luminescence under PLM indicated that zinc oxide was present, while the EDX analysis suggested that there is an excess of sulfur for there to be only barium sulfate. Additionally, the UV examination by PLM suggested that the proportion of luminescing zinc oxide was likely lower than might be expected if all the zinc was present as zinc oxide. The combination of barium sulfate and zinc sulfide as a coprecipitated pigment is commonly termed 'lithopone'.

[30] As with sample [2], a lithopone type pigment may be present.

Table App.2.i Analytical results SEM-EDX, Raman Microscopy and PLM

#	Colour	SEM-EDX (elements)			Raman Microscopy (peaks, cm^{-1})	Identification
		Major	Minor	Trace		
						gypsum type
8	Black and dark blue	-	Al, S, Ca, Fe, Zn	*Na, Si, P, Cl, K, Mn, Cu, Ba, Pb*	**1621 (vw), 1384 (vw), 1353 (vw), 1328 (vw), 1301 (vw), 1286 (vw), 1156 (vw),** 476 (vw)	**CI Pigment Blue 60 [P1742]** Carbon-based black, probably as flame carbon Earth pigment Zinc oxide (trace)

App.2.ii Fourier Transform Infrared Spectroscopy-Attenuated Total Reflectance (FTIR-ATR)

Table App.2.ii Summary results from FTIR

#	Colour	FTIR (peaks, cm^{-1})	Identification
1	Ground	**3531 (vw), 3335 (vw, br), 2920 (vw), 2851 (vw), 1728 (w), 1715 (vw), 1622 (vw), 1539 (vw), 1373 (vs), 1301 (vw, sh), 1159 (vw), 1076 (vw), 1049 (w), 969 (vw, sh),** 876 (vw), **835 (m), 775 (w),** 691 (vw), **675 (s),** 628 (vw)	**Lead carbonate hydroxide [P0897]** **Lead(II) carbonate [P0896]**[31] **Oil** **Metal soap formation, presumably lead-based**
1a	Yellowish (glue?)	**3299 (m, br), 3081 (vw), 2920 (vw), 2850 (vw), 2509 (vw), 1794 (vw), 1715 (vw, sh), 1645 (s), 1520 (w), 1394 (vs), 1241 (vw, sh), 1152 (w), 1101 (vw), 1078 (vw), 1049 (vw), 1034 (m),** 970 (vw, sh), **871 (vs), 849 (vw), 839 (vw), 712 (m), 675 (w),** 670 (vw, sh), 627 (vw)	**Calcium carbonate, calcite type** **Lead carbonate type white**[32] **Protein** **Oil (traces, possibly from the paint)**
2	White	**3332 (vw, br), 2922 (w), 2852 (w), 1733 (m), 1716 (w), 1591 (w), 1557 (w), 1397 (s),** 1318 (vw, sh), **1171 (s), 1106 (w), 1061 (m), 982 (vw), 936 (vw), 837 (vw), 679 (w), 634 (m), 604 (s)**	**Barium sulfate** **Lead(II) carbonate** **Oil**[33] **Metal soap formation**

[31] The sample contains both lead carbonate hydroxide and lead II carbonate based on the additional peak at 835 cm^{-1}. This additional peak present at 835 cm^{-1} is absent in lead carbonate hydroxide but is present in lead II carbonate and it is on the basis of this peak that it is thought the lead II carbonate is present too. Some of the peaks that are assigned to lead carbonate hydroxide are also present in lead II carbonate.

[32] The very strong peak present at 1394 cm^{-1} is shared by both lead carbonate type white and calcium carbonate, calcite type.

[33] The characteristic peak of oil occurring at around 1160 cm^{-1} was not observed in the spectrum due to the presence of barium sulfate whose peaks were masking this characteristic peak of oil however it is assumed that oil is present due to the formation of metal soaps.

11	Yellow-grey	3359 (vw, br), 2954 (vw, sh), 2917 (s), 2849 (s), 1738 (m), 1716 (w), 1588 (w, sh), 1574 (vw), 1567 (vw), 1547 (m), 1537 (vw), 1531 (vs), 1455 (s), 1408 (vw), 1398 (w), 1379 (vw), 1354 (vw), 1317 (vw), 1168 (w), 1103 (vw, sh), 1066 (vw), 1031 (vw), 1008 (vw, sh), 983 (vw), 951 (vw, sh), 743 (w), 719 (w), 636 (vw), 607 (vw)	Barium sulfate Oil Metal soap formation, zinc-based[34] Metal soap formation Aluminosilicate clay minerals[?]

App.2.iii Gas Chromatography Mass Spectrometry (GCMS) Analysis

Table App.2.iii Summary results from GCMS

Sample #	Hexadecanoic acid, methyl ester ($C_{17}H_{34}O_2$)		Octadecanoic acid, methyl ester ($C_{19}H_{38}O_2$)		Ratio
	Retention time, mins	Peak area	Retention time, mins	Peak area	
2	25.678	1.020×10^9	29.605	3.854×10^8	P/S = 2.65
11	25.686	2.075×10^9	29.605	8.337×10^8	P/S = 2.49

The P/S value of **Sample [2]**, white paint, was 2.65, consistent with **walnut oil or a mixture of linseed and poppy oil.**[35]

The P/S value of **Sample [11]**, yellow-grey paint, was 2.49, consistent with **walnut oil or a mixture of linseed and poppy oil.**[36]

App.2.iv Fibre Identification of the Canvas

Table App.2.iv Canvas fibre identification

Sample	Observations under PLM	Interpretation
Vertical	Nodes across fibres, parallel extinction, s-twist A few structures with low birefringence. Lot of pigment particles. A few very narrow fibres, opposite twist?	Bast fibre, probably linen (*Linum usitatissimum* L.)
Horizontal	Nodes across fibres, parallel extinction, s-twist A very few structures with low birefringence	Bast fibre, probably linen (*Linum usitatissimum* L.)

App.2.v Radiocarbon measurement

Radiocarbon dating is a method for determining age estimates of formerly living organic materials[37]. Carbon has three naturally occurring isotopes, ^{12}C, ^{13}C and ^{14}C. Both ^{12}C and ^{13}C are

[34] The peaks present in the sample spectrum matched the reference spectrum of zinc stearate, reference number AAR308.
[35] Other possible matches would be with non-traditional oils such as safflower or soybean oil, though this seems highly unlikely given the dating of the painting.
[36] As above.
[37] Based on from the websites of the NDT Resource Center,

stable, but ^{14}C decays by very weak beta decay to nitrogen (^{14}N) with a half-life of approximately 5,730 years. While alive, organic materials continue to exchange carbon with the environment, such that they are in equilibrium. On death, the ^{14}C component begins to decay, such that over time the relative amount decreases. Measuring the level of ^{14}C remaining in the material then allows for a date to be estimated. This must be additionally calibrated against natural historical variation in relative ^{14}C levels in the environment, for which there are accepted standard curves expressing the changes over time[38].

Prior to radiocarbon measurement, fibre identification was undertaken and the canvas sample was pre-tested using FTIR to ascertain the presence of any contaminating material that could influence the outcome. As noted elsewhere, the fibre was identified as a bast type, probably linen (*Linum usitatissimum* L.). FTIR indicated the presence of calcium carbonate (calcite type), calcium sulfate (gypsum type), a proteinaceous material, and possibly an oil, in addition to the cellulose of the fibre[39].

The canvas sample was then submitted to the Laboratory of Ion Beam Physics, ETHZ at the Swiss Federal Institute of Technology (*Eidgenössische Technische Hochschule Zürich*) for radiocarbon dating (see **Protocol 2.7**).

Table App.2.v.i Radiocarbon measurement

Sample-Nr.	Sample Code	Material	C14 age BP	±1σ	F14C	±1σ	δC13 ‰	±1σ	mg C	C/N
ETH-77072	AAR0955.G.12	textile	88	23	0.9892	0.0028	-24.5	1	0.98	227.81

The radiocarbon date was determined as 88 years b.p. ±23 years. After calibration, this yielded a date distribution for which the most relevant period for the origin of the canvas lies 1810-1923 at the 95.4% probability level, pre-dating the so-called 'bomb-pulse' period that begins in the mid-1950s.

http://www.ndt-ed.org/EducationResources/CommunityCollege/Radiography/Physics/carbondating.htm and the website of the Oxford Radiocarbon webinfo site: http://c14.arch.ox.ac.uk/embed.php?File=webinfo.html, both consulted on 3 February 2013.

[38] For example, that used here is one known as IntCal13.

[39] Non-cellulosic materials are aimed to be removed by the sample pre-treatment process prior to the radiocarbon measurement.

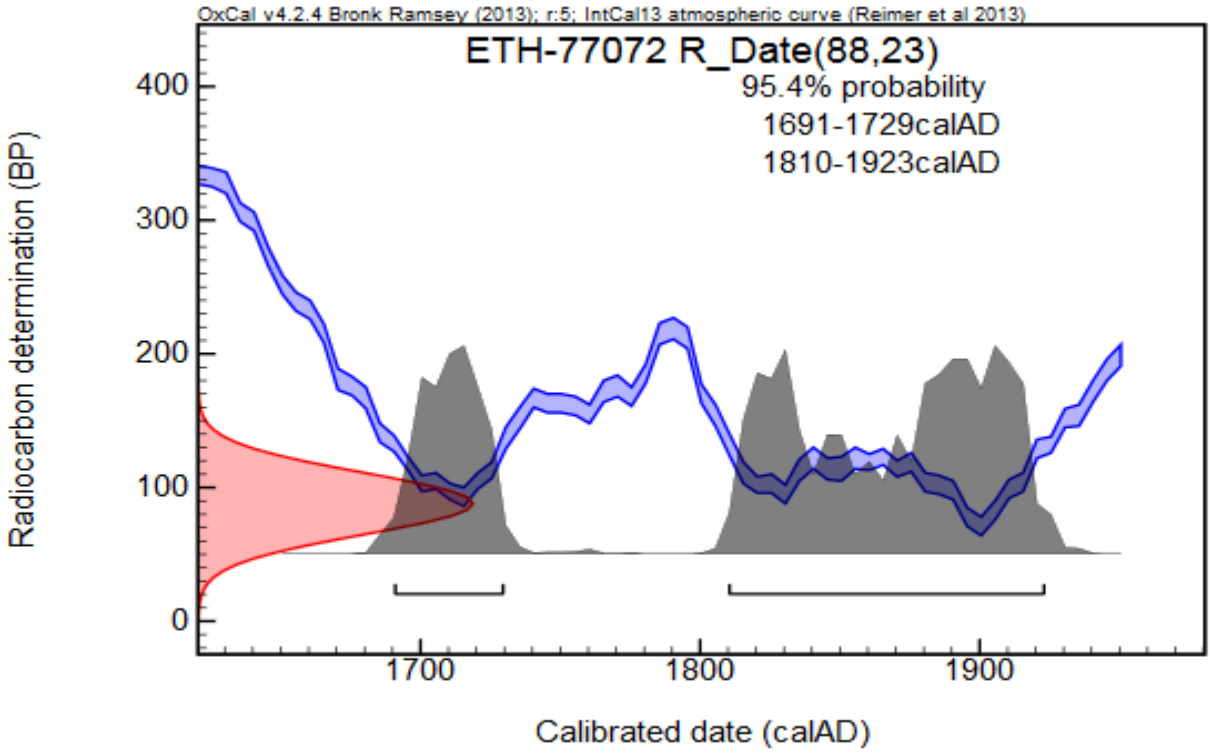


Figure App.2.v.ii Radiocarbon determination.

App.3 Imaging methods

Protocols:

App.4 Plates

Plate 1. Mikhail Larionov, *Still Life with Coffee Pot*, c. 1906(?), collection Museum Ludwig: Inv. Nr. ML 1486.

Recto, visible light. Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050877_08, www.kulturelles-erbe-koeln.de/documents/obj/05021028.

Plate 2. Mikhail Larionov, *Still Life with Coffee Pot*, c. 1906, collection Museum Ludwig: Inv. Nr. ML 1486. **Verso, UV light.**

Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050877_07, www.kulturelles-erbe-koeln.de/documents/obj/05021028

Plate 3. Mikhail Larionov, *Still Life with Coffee Pot*, c. 1906, collection Museum Ludwig: Inv. Nr. ML 1486. **Recto, oblique illumination.**

Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050877_04, www.kulturelles-erbe-koeln.de/documents/obj/05021028

Plate 4. Mikhail Larionov, *Still Life with Coffee Pot*, c. 1906, collection Museum Ludwig: Inv. Nr. ML 1486. **Recto, 3D laser scan**.

Plate 5. Mikhail Larionov, *Still Life with Coffee Pot*, c. 1906, collection Museum Ludwig: Inv. Nr. ML 1486. **Verso, visible light.**

Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050877_02, www.kulturelles-erbe-koeln.de/documents/obj/05021028

Plate 6. Mikhail Larionov, *Still Life with Coffee Pot*, c. 1906, collection Museum Ludwig: Inv. Nr. ML 1486. **Verso, UV light.**

Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050877_07, www.kulturelles-erbe-koeln.de/documents/obj/05021028

Plate 7. Mikhail Larionov, *Still Life with Coffee Pot*, c. 1906, collection Museum Ludwig: Inv. Nr. ML 1486. **Recto, SWIR image**.

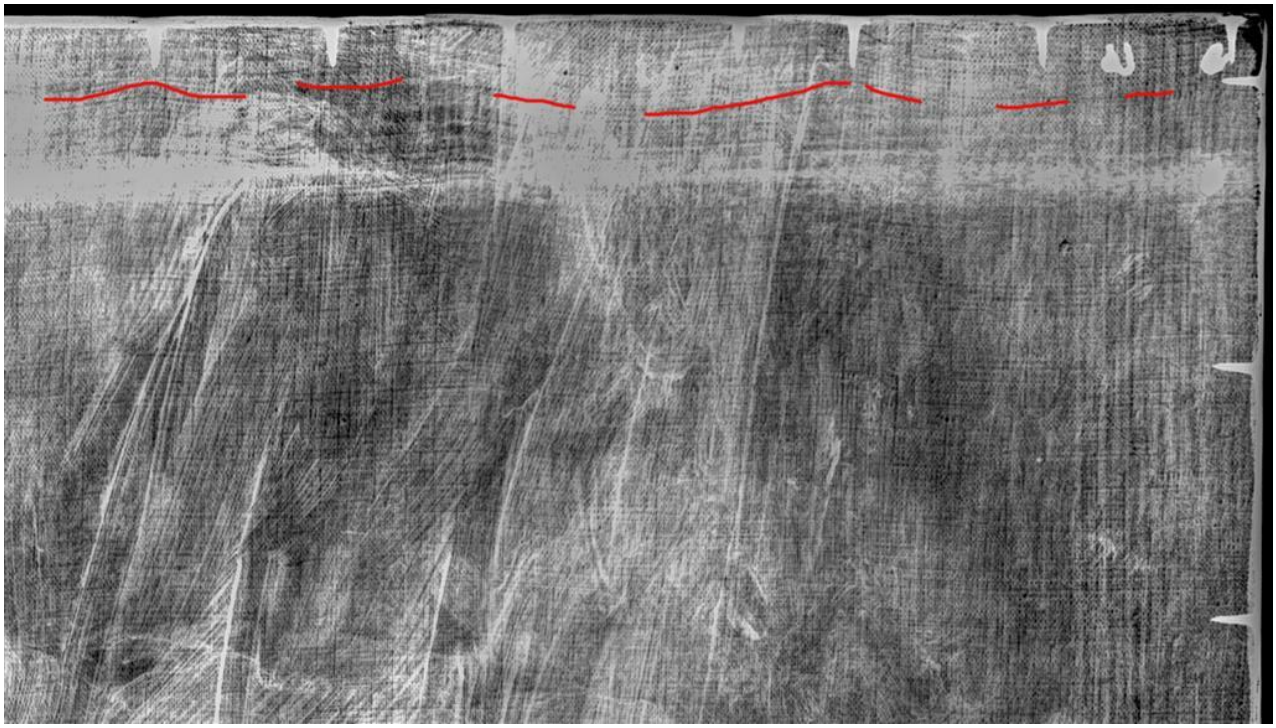
The motif below the visible painting, a nude study, may be seen. (Note: the image shows diagonal banding that is intrinsic to the SWIR image, not to the painting).

Plate 8. Mikhail Larionov, *Still Life with Coffee Pot*, c. 1906, collection Museum Ludwig: Inv. Nr. ML 1486. **X-ray image**.

The motif below the visible painting, a nude study, may be seen.

Plate 9.a The X-ray image (right) before digital compensation for the stretcher bars.

Plate 9.b Detail of the upper right corner of the X-ray image (below), showing cusping of the canvas.



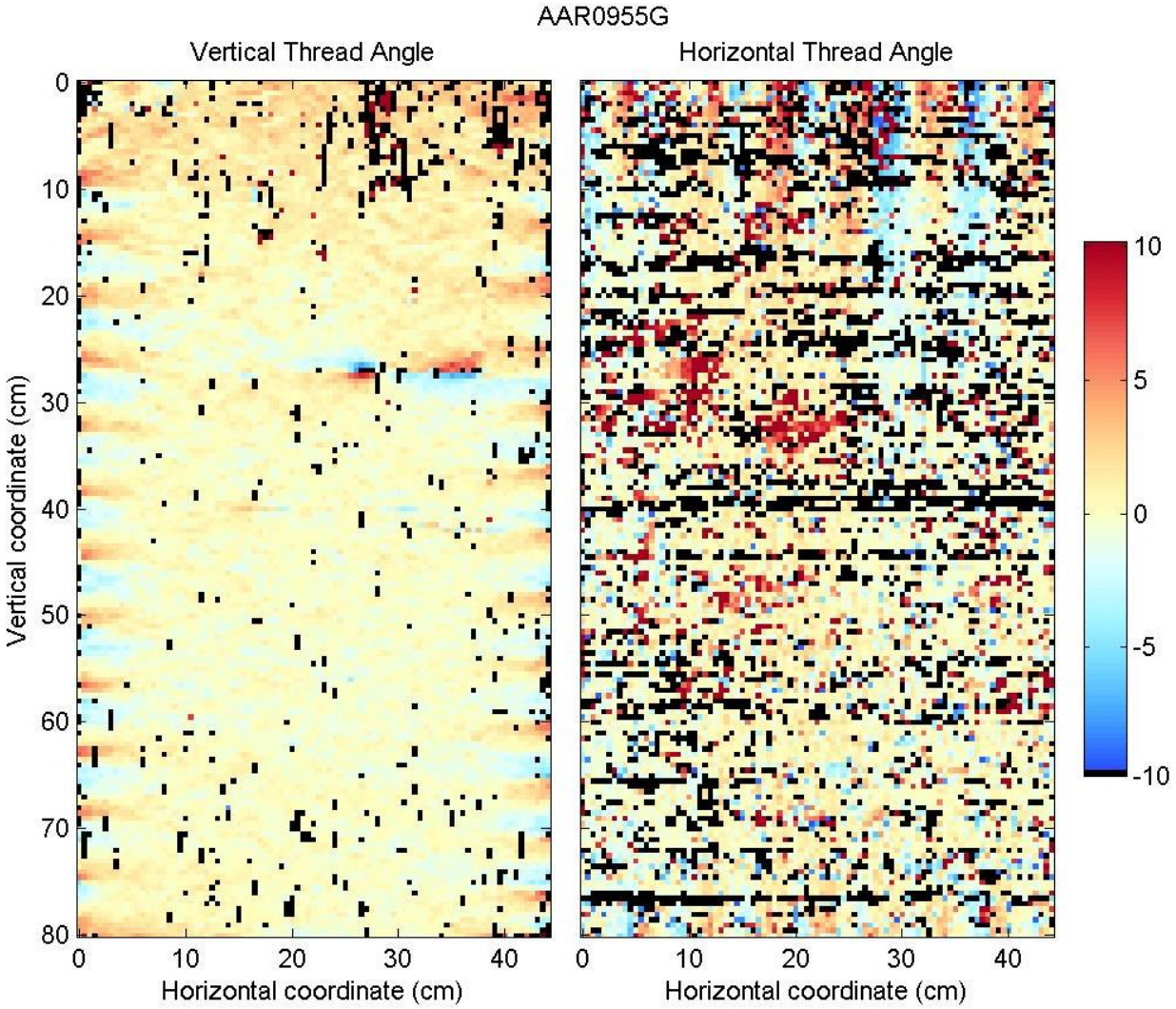


Plate 10.a Maps showing variation in canvas thread angle.

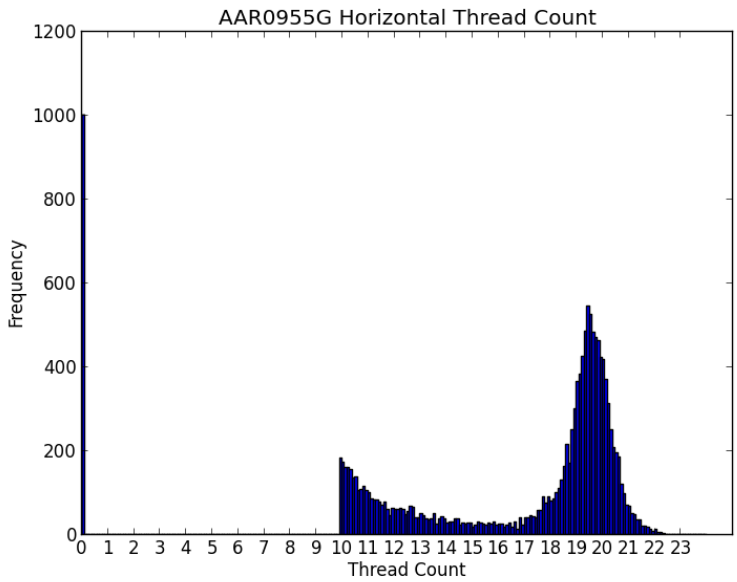


Plate 10.b Histogram of horizontal thread count readings.

Showing variation in thread count per centimetre.

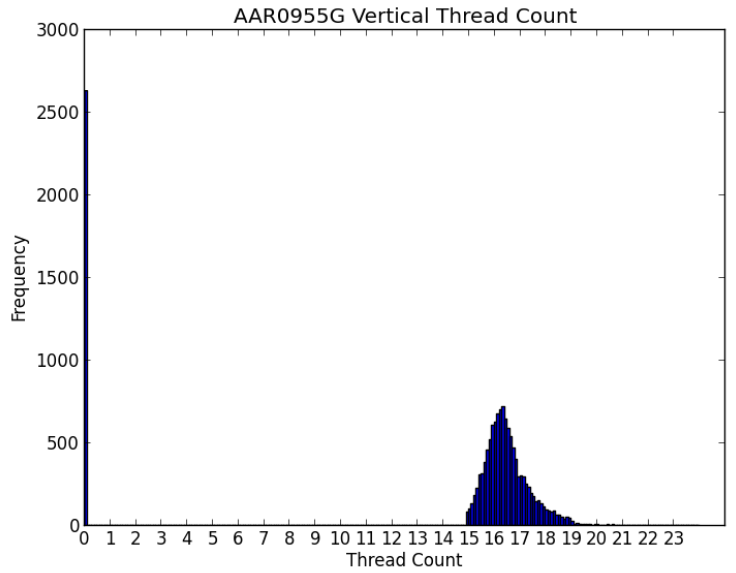


Plate 10.c Histogram of vertical thread count readings.

Showing variation in thread count per centimetre.

Plate 10.d Table of thread count data (threads per centimetre)

	Mean	Estimated thread count (mode)
Horizontal	19.61	19.4
Vertical	16.52	16.3

Plate 11.a Detail (above) of the recto, upper left corner, showing the inscription, 'M.L.'.

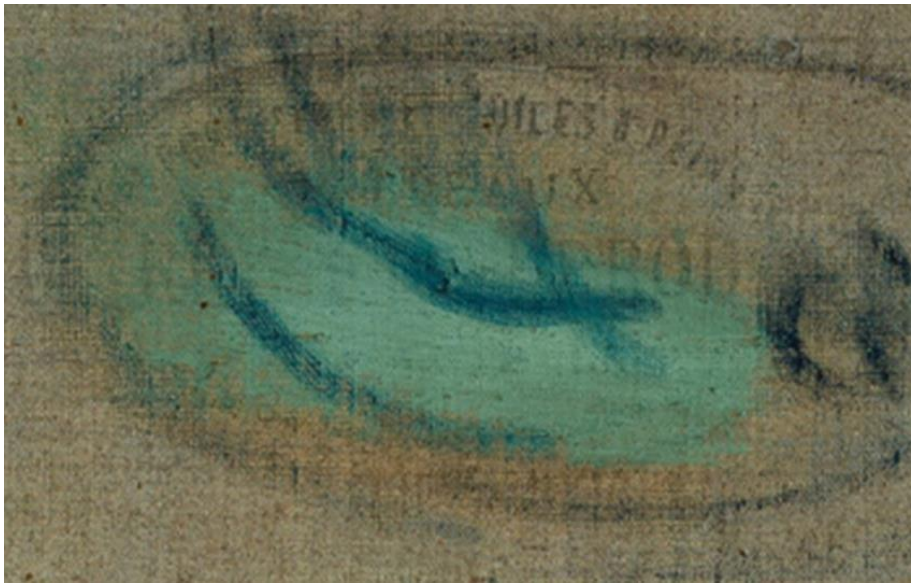


Plate 11.b Detail of the verso, showing the canvas stamp of Perrod in UV illumination.

Compared with the Perrod stamp below (Plate 11.c), this impression looks as if it was hand lettered or touched up – there are many spacing irregularities.

Plate 11.c Detail of a Perrod stamp, c. 1899.

Illustrated online: http://www.labreuche-fournisseurs-artistes-paris.fr/fournisseur/perrod "COULEURS FINES & TOILES A PEINDRE / TABLEAUX / F. PERROD / PARIS / 51, Rue de la Rochefoucauld" (photo Rémi Weber 2015).

Plate 12.a Detail of canvas, verso.

The canvas is a thin, plain weave comprised of a bast type fibre, probably linen. The priming and shiny layer of size, may be seen in the interstices between the threads.

Plate 12.b Detail of canvas, verso.

A number of slubby, irregular threads may be seen.

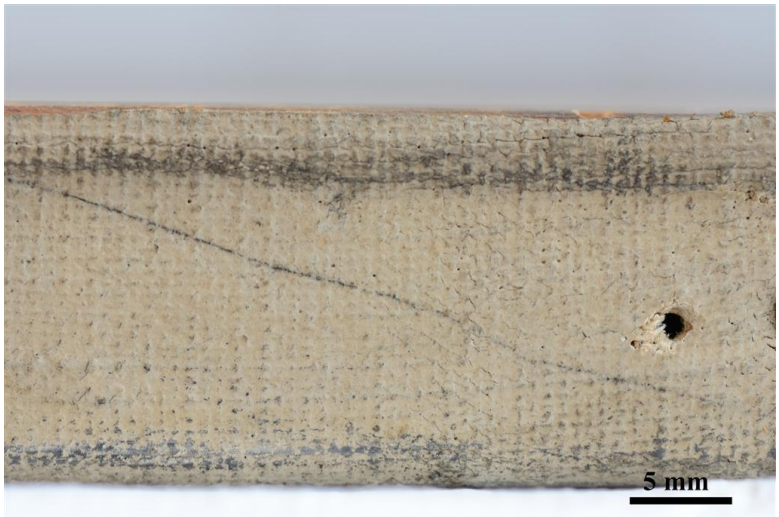


Plate 12.c Detail of canvas, bottom tacking margin.

The application of the thin, white ground to the cut edge is visible, as is a (pencil?) line running across it.

Plate 13.a Detail of taking margin with tacks, left edge.

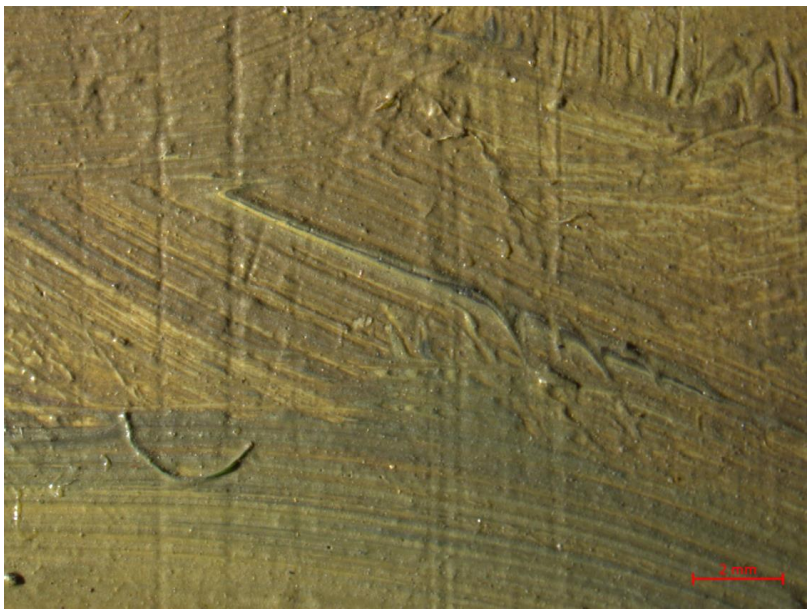


Plate 13.b Detail, right lower area of the table, incident light.

There are a few groove-like depressions in vertical direction and raised forms, which might refer to the underlying composition.

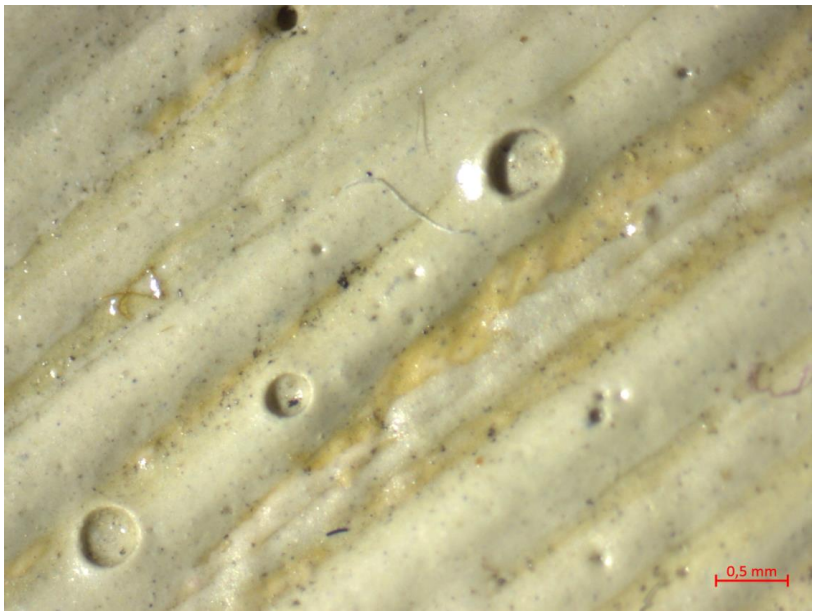


Plate 13.c Detail white paint, upper left of painting.

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Plate 14.a Detail of paint surface, recto.

The surface may be seen to exhibit small, localised cracks.

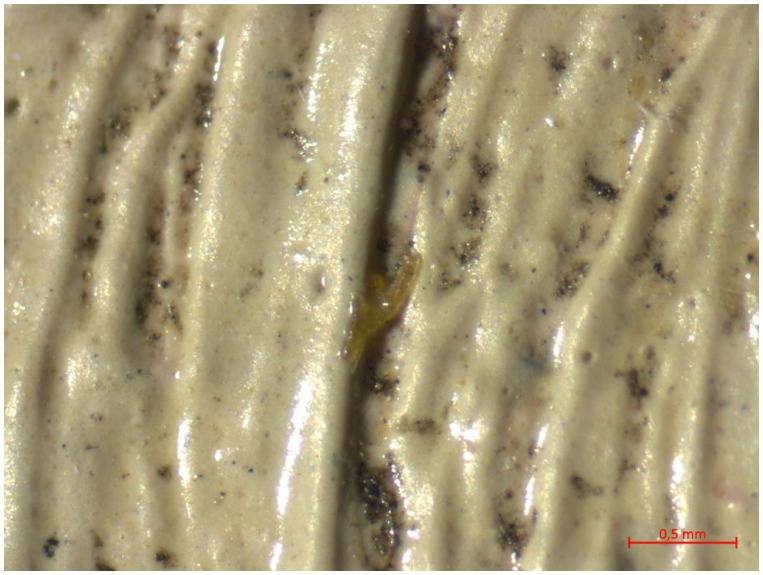


Plate 14.b Detail of paint surface, recto.

Some areas exhibit a build-up of particulate black matter, as seen here.

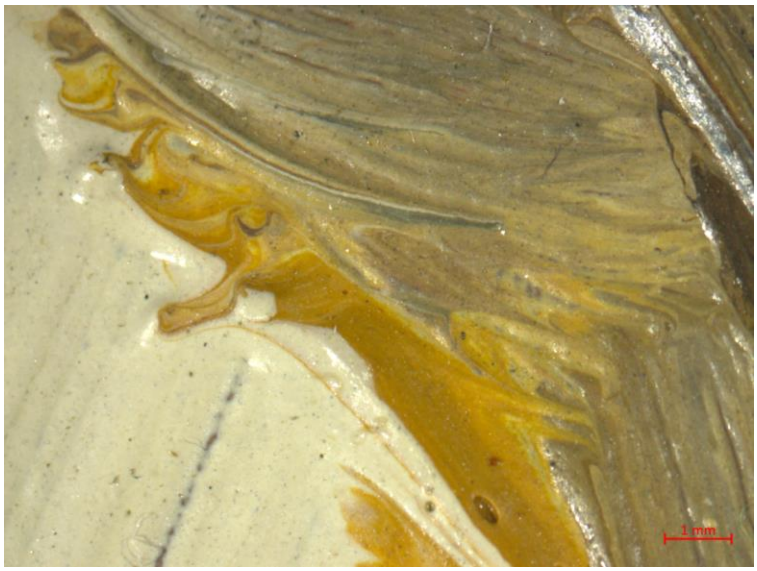


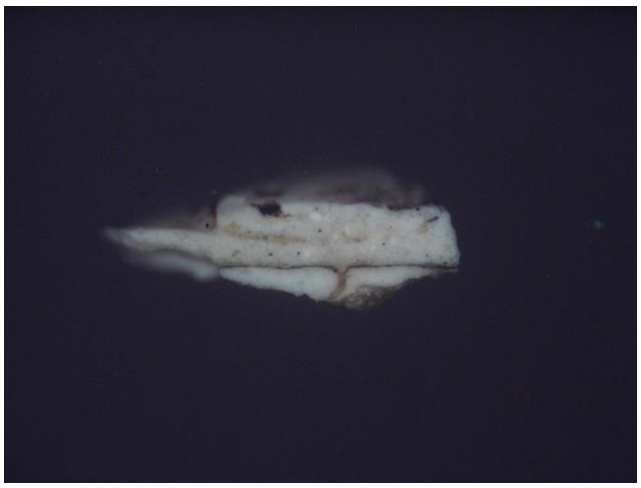
Plate 14.c Detail of paint surface, coffee pot, recto.

Fine bubbles in the paint layer may be seen.

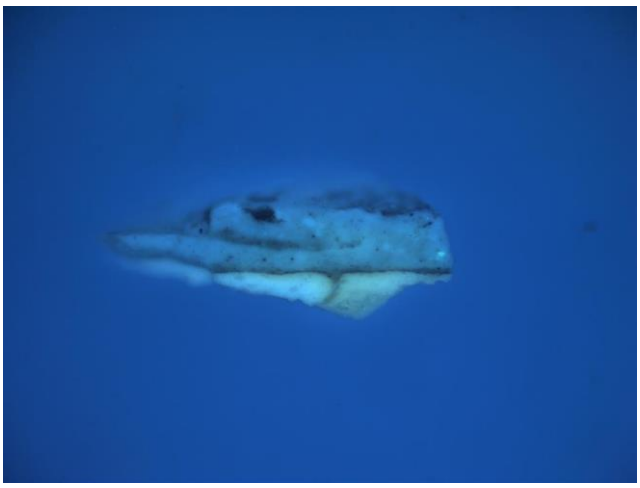
Plate 15. Detail of the foot of the nude in the figure study below the visible painting. Bottom edge in the orientation of *Still Life with Coffee Pot*, right of centre.

Plate 16. Image showing approximate location of samples taken for materials analysis.

App.5 Cross-sections[40]



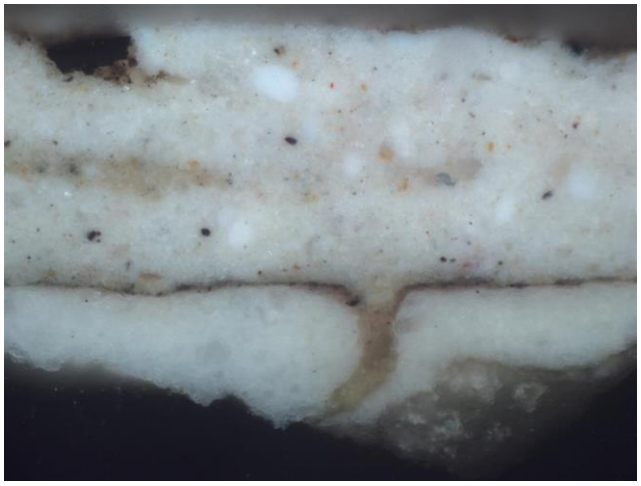
a.



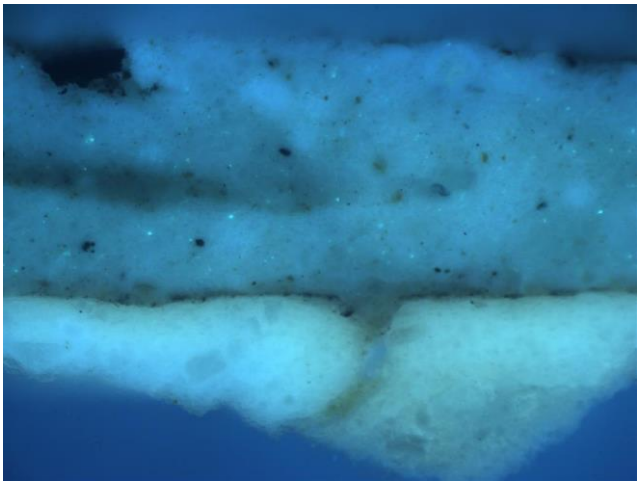
b.

Plate 17. Cross section, Sample [9].

Image ~1mm high. Pale brownish grey from top edge. The sample exhibits a double layered priming – below, a thin, transparent layer of calcite, over which lies a thick, opaque layer of white (primarily lead white). The ground has cracked, and the paint of the overlying layers (from *Still Life with Coffee Pot*) may be seen to penetrate the crack. It is unclear as to whether the thin, dark brown boundary (with many small dark particles) is a separate later, or whether it represents an accumulation of surface dirt. Uppermost is a thick layer that is pale brown-grey in tone.



a.

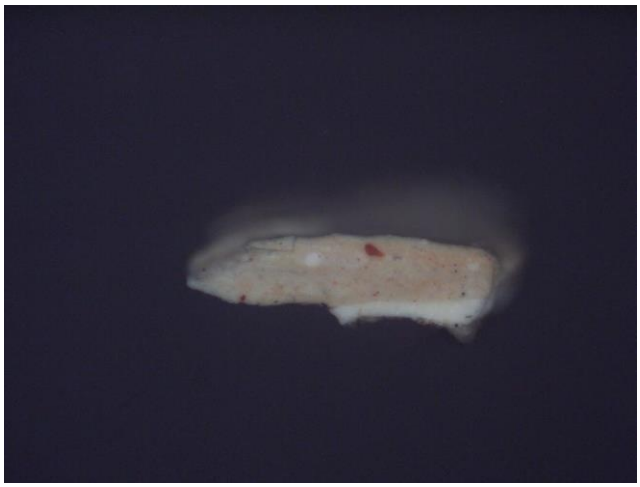


b.

Plate 18. Cross section, Sample [9].

Image ~260µm high. Pale brownish grey from top edge, sample shown at higher magnification. Fine red, orange and black particles can be seen in the brownish grey layer.

[40] Photographed under visible light, left (**a.**), and with ultraviolet illumination, right (**b.**).

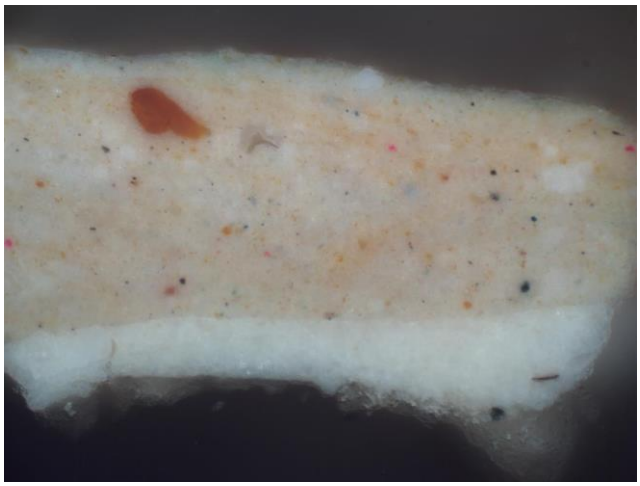


a.

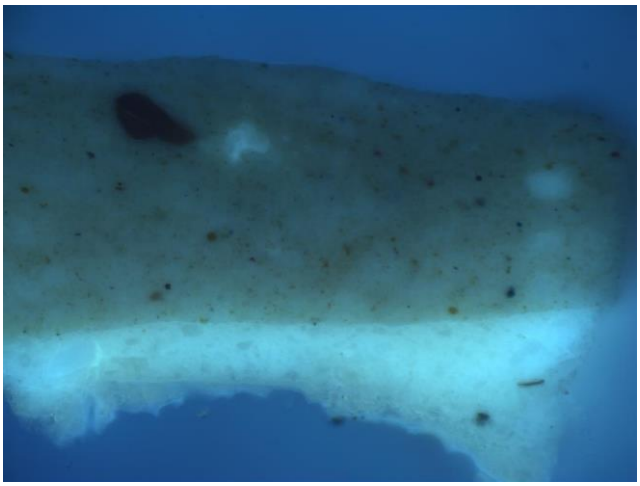
b.

Plate 19. Cross section, Sample [10].

Image ~1mm high. Pale brown beige from left edge. As in Sample [9], a lower layer of translucent brownish ground, comprised of calcite, is visible lowermost, followed by a thick white layer. The thick pale orange layer, uppermost, beige layer consists of white with fine red and black particles, with some fine blue and green particles and a few larger red-brown particles.



a.



b.

Plate 20. Cross section, Sample [10].

Image ~260µm high. Pale orange brown layer from left edge, sample shown at higher magnification, showing the colours of the particle mixture more clearly.