

ANALYTICAL REPORT

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Rayonism, Red and Blue (Beach), 1911
Mikhail Larionov
Collection Museum Ludwig, Cologne, Inv. ML 1333

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Summary

A painting on canvas by Mikhail Larionov, *Rayonism, Red and Blue (Beach)*, belonging to the Museum Ludwig (reference: ML 1333), that has been dated to 1911 (it is signed 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 *Rayonism, Red and Blue (Beach)* (**Plate 1**), by the artist Mikhail Larionov (1881-1964), a work on canvas measuring 525 mm high by 680 mm wide, is now part of the collection of the Museum Ludwig, Cologne (Inv. ML 1333). It is inscribed 'M. Larionov' (lower right) but is undated (**Plate 10**). A date of 1911 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 work¹; consequently, fourteen well-provenanced paintings by the Russian artist couple held in the collection of the Museum Ludwig were thoroughly examined and analysed². 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 report³.

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 material⁴. 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**.

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.], Éditions du Centre Pompidou : 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; *Saucisson 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.K ML 1333 Conservation*, Franken, V. 'Report on the examination of the painting *Rayonism Red and Blue (Beach)* (1911) by Mikhail Larionov' (2017a) and *AAR0955.K ML 1333 Archives*, Franken, V. 'Report on the content of the Museum Ludwig archives, concerning the painting *Rayonism Red and Blue (Beach)* (1911) by Mikhail Larionov' (2017b).

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

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 datasets⁵. These are presented as follows:

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

Additionally, weave analysis (including thread counting) was conducted on the basis of the X-radiograph (**Plates 9.a-d**). Some exemplar images recorded as part of the surface microscopy and macrophotography are also reproduced here (**Plates 10-13**).

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 (with a double thread employed in the horizontal direction, a single thread in the vertical), which has not been lined, so that both the recto and the verso of the artwork could be studied. It is not, however, on its original stretcher, having been

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.

restretched onto a newer secondary support, which seems to be of the same size as the original. The painting is in relatively good condition. Two creases in the canvas may be noted: a large and a smaller vertical crease are present in the left half of the painting. These have caused minor damages in the form of loss and cracking of paint. The surface is unvarnished.

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 luminescence⁶ 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, as found here, 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 zinc white paint that dominates the right-hand side of the painting shows a bright yellow green tone. Equally, the exposed ground, left uncovered by the paint around the edges, exhibits a similar tone, which may be especially noted to the left, where there is a lesser predominance of white. The vertical crease to the left, that runs through the blue area is lightly visible, as the underlying ground has been exposed along the fine cracks. When viewed from the reverse, it is clear that the most serious of these cracks has affected the whole of the paint structure; a dark line resulting from penetration of material from the recto (thus perhaps oil from the paint film) indicates that the physical structure of the ground was ruptured along the crack. The ground, likewise containing zinc white, has a somewhat more yellow toned fluorescence than that of the paint.

Apart from the zinc white, no strong luminescence was otherwise noted from any of the original paints.

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.

B.3.ii Surface conformation

Examination of the surface structure of the painting was investigated by means of photography under oblique illumination, which provides a means of elucidating paint texture and object deformations. This served to reveal two kinds of textural features that are evident in this painting. The most visually dominant are the vertical creases in the left half of the painting. The underlying cause for this is unclear. However, it would seem that such creasing occurred when the paint was already dry.

Impasto arising from the brushwork is indicative of a fluid application of paint. However, perhaps the most notable surface features seem to be the presence of slubby threads and clumps of fibres, an aspect of the canvas texture.

The painting has been re-stretched; consequently, there are no significant features arising from defective mounting to the secondary support.

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 6**), the most striking features are not those of the visible image, but of an unfinished, underlying painting, which served as the basis for the present work. When turned 90 degrees clockwise (**Plate 7.a**), the upper body of a woman, whose head of a woman, whose face and neck have been painted, but whose shoulders and arms seem to have only been indicated by some loose, sketchy lines, becomes visible. Comparison with the image currently visible, and with the X-ray (**Plate 7**) reveals the large extent to which the form of this figure has been integrated into the current 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; Plates 7.c, 8**) reveals the underling image of a woman, but in greater detail. It may be suggested that given the relative density exhibited in her face in comparison with the brush strokes of white paint in the visible image, that her flesh is rendered very thickly as it appears so much more radio opaque than the thin strokes of zinc white paint of the visible image, thus, appearing as brighter and more distinct in the X-ray. The white strokes of the visible image that overlie the face of the unfinished portrait are barely visible in the X-ray.

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 9.a-d**).

The thread count of this work – painted on a plain weave canvas with a double thread employed in the horizontal direction, a single thread in the vertical (**Plate 11.a**) – was determined as 16.0 threads per centimetre in the horizontal direction (or, stated in other words, 8 double sets of threads) and 8.2 in the vertical. The well-distributed and even cusping distortion around the edges of the canvas (**Plate 9.a**) suggests that the painting retains its original format.

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 (**Table App.1.i and Plate 14**).

To this end, a series of 13 locations selected over a representative range of the painting were micro-sampled for identification of the pigments (**Table App.2.1**), with six micro-samples of paint taken for analysis of the binding media (**Tables App.2.2-2.5**). 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 15-19**). Finally, canvas threads were taken for fibre identification and radiocarbon dating (**App.2.v, Protocol 2.7 and App.2.vi, Protocol 2.8**).

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 (FTIR; **App.2.i-2.ii, Protocols 2.1-2.4**).

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) and Raman microscopy and some Fourier Transform Infrared Spectroscopy-Attenuated Total Reflectance (FTIR; **App.2.i-2.ii; Protocols 2.**).

Organic components were identified by Fourier Transform Infrared Spectroscopy-Attenuated Total Reflectance (FTIR **App.2.ii, Protocol 2.4**) and subsequently by Gas Chromatography-Mass Spectrometry (GCMS; **App.2.iii, Protocol 2.5**). Protein staining of cross-sections using SYPRO[®] Ruby was also conducted (**App.2.iv, Protocol 2.6, Plate 16**).

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 means⁷. 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.

C.2 Support

The canvas was identified as being based on linen (*Linum usitatissimum* L.) in both warp and weft directions (**App.2.v; Protocol 2.7**).

C.3 Radiocarbon dating

Radiocarbon dating was applied to fibres from the canvas support.

The radiocarbon date was determined as 106 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 1807-1928 at the 95.4% probability level, pre-dating the so-called ‘bomb-pulse’ period that begins in the mid-1950s.

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.4 Ground

The ground (Sample [9]) was found to be composed primarily of zinc oxide, combined with a minor amounts of calcium sulfate, calcium carbonate and an aluminosilicate. Although not confirmed by the FTIR (as the presence of calcium sulfate blocks the characteristic peaks in the spectrum for oil), it is likely to be bound in a drying oil. Protein detected in association with this layer by FTIR and a weak positive result for SYPRO[®] Ruby staining is probably related to a minor protein component in the ground layer (**Table App.2.iv, Plate 17**). However, further characterisation, such as to demonstrate the use of a mixed medium with casein, was not pursued⁸. Visual examination of the canvas does not reveal any obvious signs of application of a size layer prior to applying the white ground.

C.5 Underdrawing

Indistinct lines indicating the shoulders and arms of the underlying unfinished figure of a woman, which was painted over, were noted.

C.6 Paint layers: Pigments

The following pigments (**Tables App.2.1, App.2.2**) were identified:

- Zinc oxide ('zinc white')
- Mercury(II) sulfide ('vermillion' red)
- A red lake pigment on aluminium-based substrate
- Manganese phosphate ('Manganese violet')
- Ultramarine, synthetic, blue
- Earth pigments containing goethite, hematite and aluminosilicate clay minerals
- A carbon-based black as a bone coke ('bone' or 'ivory' black)

The following materials were noted to be present as 'secondary' materials (bulkers, extenders, brighteners, co-occurring materials) in the paint formulations used:

- Barium sulfate (along with the vermillion)
- Calcium sulfate, gypsum type (along with the ultramarine and with the zinc oxide)
- Calcium carbonate, calcite type (along with the zinc oxide)
- Alumina hydrate (as part of the red earth pigment containing hematite)

The composition of the three samples taken from the underlying painting - Samples [11, 12, 13] – were not found to contain any pigments not found in the visible composition.

⁸ If significant amounts of casein were present, then phosphorus would probably also have been detected by EDX, which was not the case.

C.7 Paint layers: Binding media

All paint samples analysed for binding medium using FTIR (**App.2.ii**) indicated the presence of a drying oil. Additional analysis of two samples by GCMS (**App.2.iii**) indicated that a brown paint (Sample [7]) contained poppy oil while a white (Sample [8]) contained linseed oil.

Additionally, staining of a cross-section of sample [14] with SYPRO[®] Ruby (**App.2.iv**) indicated that the blue paint probably contains some protein.

FTIR also indicated the presence of metal soaps, probably of 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.

In Sample [14] (**Plates 15-17**), a blue paint from lower edge of the painting, the white ground layer displays the characteristic green luminescence of zinc white under UV illumination. This is covered with a thick bright blue paint layer containing blue and white particles, and a few red particles. The darker blue paint above contains some larger red particles, and a streak of darker unmixed blue can be seen near the top of the layer. The different shades of blue do not appear as distinct separate layer, but are mingled throughout, particularly at the right-hand side of the sample, indicating wet-in-wet working.

Sample [15] (**Plates 18-19**), a brown lying over red taken from left edge, shows the luminescent white ground layer again. Over this lies a thick bright orange-red layer containing some larger red particles, which is swirled extensively into the dark brown layer above; again, the wet-in-wet working is very evident. A green layer with a distinct boundary (that is, not intermixed with the paint below) is also present at the top of the stratigraphy.

In both these samples, the paint lies directly over the white priming; there are no signs of the underlying painting confirming its unfinished nature.

D. Discussion of the findings

D.1 Support, ground and preparatory work

D.1.i The support

The painting has been executed on a plain-weave, linen canvas (**Plates 4, 5, 11, 12**), which features a double threading in the horizontal orientation and a single thread in the vertical (**Plate 11.a**), with thread counts of 16.0 threads per cm in the horizontal direction (with the double threading; therefore c. 8 sets of double threads) and 8.2 threads per cm in the vertical

direction (see **Plate 9**). Neither of the selvedge edges are preserved and the tacking margins show fraying at the cut edges of the canvas (**Plate 12.a**). The weave is of medium density, with only occasional, small interstices found between the threads.

The canvas is rather rough and coarse, suggesting it is not high quality (**Plates 3, 11.a, 11.b**). This is seen by the inclusion of many slubby and irregular threads (with a z-twist) in both directions of the weave, as well as numerous fragments of linen fibre husk (**Plate 11**), indicating that the plant fibres were not carefully cleaned before processing as threads. The type of material is more consistent with those produced for domestic or industrial use, rather than canvas produced specifically for fine art painting.

The canvas is unlined, so the verso is fully visible (**Plates 4, 5**). It is affixed to a later (non-original) stretcher by means of staples (**Plates 12.a**); the original tacking holes are characterised by the presence of circular, rust coloured impressions which suggest the former use of round headed tacks. In some areas, the tacking margins may be seen to extend roughly 2-2.5 cm over the edge of the stretcher (**Plate 12.a**). There is no indication that the size of the painting has been altered; the cusping resolved in the thread counting analysis (**Plate 9.a**) is even and regular and there is no sign of a change in turnover edge around the perimeter of the tacking margins. Thus, the stretcher appears to be of the same dimensions as the original version (525mm by 680mm).

There are a number of inscriptions and labels present on the verso of the painting (**Plates 4, 5**)⁹.

D.1.ii Priming

The canvas has been primed with a white ground layer, that appears to have been applied to the stretched canvas by hand, as it conforms to the painting surface but does not extend over the tacking margins (**Plates 10, 12.a**). Its application is thin and irregular (**Plates 12.b, 12.c**).

The ground (Sample [9]) was found to be composed primarily of zinc oxide, combined with a minor amounts of calcium sulfate, calcium carbonate and an aluminosilicate, bound with a drying oil. The source for the low-level protein component noted in the staining test undertaken is unclear; there is no obvious evidence for an application of a size layer before the white ground was applied.

In examining the preparation under magnification, it seems that the painter was not concerned to mask the coarse, rough surface of the canvas by applying a thick ground that might smooth out its imperfections. Rather, the thin application employed here allows the loose threads of the canvas and slubby bits to remain visible, producing a rather textured, sometimes 'furry' or 'felted' appearance (**Plates 12.b, 12.c**).

No evidence was noted of any attempt to mask the underlying painting with a single layer (that is, a second ground or priming) before the present composition was begun. The painter

⁹ These are described in more detail in V. Franken, *AAR0955.A 1333 Conservation Report* (2017).

simply began to work directly over the unfinished portrait, effacing its features and incorporating others as the work progressed.

D.1.iii Underdrawing

In the IR image taken of the painting (**Plate 6**) the form of a half-length portrait of a woman is revealed, whose facial features are more clearly resolved in the X-ray image (**Plates 7.a, 7.b**). In the IR image however, the extent of the figure is better resolved (**Plates 6, 7.a**); the body has been laid in with brushy, loose lines that delineate the contours of the sitter's shoulders and arms. These appear to have been rendered in brush in a thin, dilute paint. In contrast, there is no evidence for underdrawing of the visible image, which does, however, seem to incorporate forms from the underlying portrait into its structure.

D.2 Paint, pigments and binding media

D.2.i General observations

The condition of the painting is generally quite good, although there is minor loss and flaking. As noted above, although it is on a new stretcher, it retains its original dimensions.

Both the canvas and the ground might be seen in the context of an artist interested in working on a textured ground, and/or, an artist wanting to save money on supplies. The canvas – more likely a cloth made for domestic or industrial use, than an artists' canvas – and the hand-applied ground may both have been a cheap source of needed materials. There is no evidence for the application of the ground onto the tacking edges; it extends only to the edges of the image plane.

Further evidence that may attest to the artist in savings mode is found in the occasional occurrence of brush hairs in the paint; well-crafted brushes in good condition generally do not lose hairs, while poor quality, or older well used ones are prone to shed. Such inclusions are, however, not excessive, and do not form obvious visual feature. Finally, the reuse of an unfinished painting as a support for a new work fits this profile equally well.

The inclusion of slubby fibres and plant husks in the fabric surface (**Plates 3, 11**), features not at all masked by the thin ground (**Plates 12.b, 12.c**), all provide a textured, irregular surface on which to work. Given the use of wide brushes, evident brushstroke and little concern for smooth transitions and blending, this effect is well suited for the aesthetic of the painting.

The painting is executed in a very sure and spontaneous manner apparently without an underdrawing, suggesting that the shapes were roughly laid in as the artist progressed the composition. The prepared surface of the canvas is largely covered by the application of paint, which extends to and sometimes over the tacking margins, although small areas of ground as well as of the underlying painting (**Plate 13.b, 13.c**) are visible throughout the painting where forms abut. 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.

The paint surface is matt, the colours are bright and intense, the paint strongly opaque and used quite thickly as well as spread thinly in other passages. No use of transparent glazes was observed; the colours remain intense, though the surface aspect is quite matt. The painting does not show evidence of having been varnished, in keeping with the artist's preference for a brightly coloured, rough, matt finish.

To the left side of the painting, there are two vertical creases which have caused cracking to the paint (perhaps most clearly seen in raking light and in X-ray; **Plates 3, 8**); these may be the result of the painting having been removed from its stretcher and folded, after it has substantially dried. There is a report available which describes that artworks in Goncharova and Larionov's studio were deposited chaotically, after their deaths¹⁰. However, as the two artists are photographed with the artwork, stretched and framed, c. 1950, this specific scenario seems somewhat remote¹¹. More likely, the creases occurred at some earlier point in the painting's history.

D.2.ii Paint: pigment and binding medium

The palette used in this work is quite limited in scope, with more or less one pigment sufficing to render a specific colour, apart from (surprisingly, given this is a 'beach' scene) the reds, where three tones - vermilion, red lake and red earth - have been utilised. To extend the blue hues, small touches of manganese violet has been employed and the blue is mixed with white. Green has not been included in the palette. The binding medium in which the pigments are bound is oil based: both linseed and poppy were identified. In the staining tests undertaken with SYPRO[®] Ruby (**App.2.iv**), some use of a protein component in the paint layers was indicated. As this was not evidenced in the samples run with FTIR (**App.2.ii**), further testing would be required to be able to assess the extent of any use of oil and protein emulsion systems.

The cross-sections prepared confirm the observations made on the surface, and with the various forms of imaging: that the paint was worked freely and directly with considerable use of wet-in-wet application of paint (**Plates 15-19**). Mixing has taken place both on the palette, and on the brush, sometimes directly on the canvas. This direct application has led to

¹⁰ Chauvelin, J. 'Témoignages/ Encounters', *InCoRM Journal*, vol.1 Nos. 2-3 (2010) pp. 6-11, esp. pp. 8, 9. On their 'return to Paris in 1915, Goncharova and Larionov brought with them hundreds of works rolled up in their luggage in view to future exhibitions in Europe'. It is also known that after their deaths, Alexandra Tomilina-Larionova (Michal Larionov's widow) did not have the means to pay the rent for the studio on the rue Jacques Callot where the artists had lived and worked since the 1920s, and where many artworks were stored. Chauvelin describes the chaos of the studio, noting that paintings were stored both flat or rolled. 'Their works were piled and stacked, totally cluttering this studio – which, in fact, was quite large – with dozens of portfolios full of hundreds (if not thousands) of drawings, watercolours, gouaches, sketches. Oils on cardboard or canvases were lying either flat or were rolled up. [...] The warehousemen started taking the packets and boxes down and loading them into the trucks rather carelessly. [...] Two days later everything had been taken away and deposited randomly in the storage rooms at the two Paris warehouses, for which Tomilina was never able to pay. All these works disappeared from sight for the next thirty years. [...] A small number of works selected by Tomilina (only those by Michal) were taken from the studio to the third floor of the apartment on the rue Jacques Callot, which was already full to bursting.'

¹¹ See Franken (2017b) *op. cit.* p. 4, fig. 1.

quite thin passages where the canvas weave and lumpy texture of the ground remain fully visible, while in others where it is fully obliterated by a heavy build-up of impasto.

Three samples (Samples [11, 12, 13]), were taken from the underlying painting, and found to be composed of much the same pigments: zinc oxide, bone or ivory black, red lake, yellow earth pigments.

D.2.iii Materials analysis and implications for dating

A date of 1911 is proposed for the painting. The radiocarbon measurement of the canvas gave an origin for it between 1807-1928 at the 95.4% probability level, thus 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 entirely compatible with the stylistic date given to it.

The materials otherwise identified in the painting are likewise compatible with the supposed date of 1911 (although they were both available before, and continued in use after that time).

It seems likely that the unfinished, underlying painting whose forms are incorporated into this work is an abandoned canvas begun either by Goncharova or Larionov given the nature of the hand-applied, zinc white preparation, which is typical of both of their practice in the years before 1911¹². Other examples of Larionov's reuse of canvases are known; thus, this practice is not singular in his oeuvre¹³. The unfinished work appears to have been stored for some years before it was again utilised as the paint shows a considerable solidity. The specific composition of the paints of the three samples from the earlier work that were tested showed no variation from the materials used in the later composition. Equally, the findings generally agree well with the data collected in the study of 45 paintings by Goncharova and Larionov in the collection of the Musée national d'art moderne, Paris¹⁴.

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 materially consistent with the proposed date of 1911. It was worked over an abandoned, unfinished portrait of a woman, most likely by either Goncharova or Larionov, as the type of rather rough canvas (here a double thread in one direction) and hand-applied zinc white ground are consistent with their known practice.

¹² Rioux, Aitken and Duval (1998) *op. cit.* pp. 18, 19.

¹³ 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.

¹⁴ *Ibid.*



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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

#	Colour	Description	Location ¹⁵	Analysis
1		Red	365/160	PLM, SEM-EDX, Raman, FTIR
2		Orange	366/160	PLM, SEM-EDX, Raman
3		Purplish brown	335/198	PLM, SEM-EDX, Raman, FTIR
4		Purple	63/316	PLM, SEM-EDX, Raman
5		Mid blue	17/243	PLM, SEM-EDX, Raman
6		Dark blue	8/242	PLM, SEM-EDX, Raman, FTIR
7		Brown	21/365	PLM, SEM-EDX, Raman, FTIR, GC-MS
8		White	518/451	PLM, SEM-EDX, Raman, FTIR, GC-MS
9		White ground	682/382	PLM, SEM-EDX, Raman, FTIR
10		Black	685/238	PLM, SEM-EDX, Raman

¹⁵ The x/y coordinates in this column are given in millimetres from the left-hand and lower edges of the painting.

Table App.1.i. Samples taken for analysis

#	Colour	Description	Location ¹⁵	Analysis
11		Pink (underlying painting)	235/239	PLM, SEM-EDX, Raman
12		Yellow (underlying painting)	187/218	PLM, SEM-EDX, Raman
13		Yellowish grey (underlying painting)	123/204	PLM, SEM-EDX, Raman
14		Blue	356/0	CSA, SYPRO [®] Ruby Staining
15		Brown over red	1/171	CSA
16		Canvas	0/0	FTIR

App.1.ii Cross-sectional analysis

Results are shown in **App.5, Plates 14-18**.

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.2.6] Protein staining with Sypro Ruby[®]
- [P.2.7] Fibre Identification
- [P.2.8] Radiocarbon dating

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

#	Colour	SEM-EDX (elements)			Raman Microscopy (peaks, cm ⁻¹)	Identification
		Major	Minor	Trace		
1	Red	S, Hg	Ba	Al	988 (vw), 343 (m), 283 (w), 254 (vs), 143 (vw), 106 (vw)	Mercury sulfide [P0010] (main) ¹⁶ Barium sulfate (minor) ¹⁷
2	Orange	S	Mg, Al, Zn, Hg	Si, P, Ca, Ba	343 (w), 283 (vw), 253 (vs), 110 (vw)	Mercury sulfide [P0010] Red lake (dyestuff not identified) Zinc oxide
3	Purplish-brown	Fe	Al	Si, P, S, K, Ca, Ba, Hg	1302 (vw, br), 608 (vw), 495 (vw), 407 (w), 341 (vw), 290 (s), 251 (w), 224 (m)	Hematite (main) ¹⁸ Mercury sulfide (trace)
					1308 (vw, br), 609 (w), 494 (vw), 408 (m), 290 (vs), 243 (vw), 224 (s)	Hematite (main)
4	Purple	Al, P	Mn	Si, S, K, Ca, Fe, Cu, Zn, Ba	566 (vw), 255 (vw)	Manganese phosphate Mercury sulfide (trace) ¹⁹
5	Mid-blue	-	Na, S, Ca, Zn	Al, Si, Cl, K	1007 (vw), 547 (w), 436 (vw)	Ultramarine Calcium sulfate, gypsum type Zinc oxide
6	Dark blue	Si	Na, Al, S	Cl, K, Ca, Zn, Ba, Hg	581 (vw), 548 (m), 377 (vw, br), 257 (vw)	Ultramarine (main) Zinc oxide (trace)
7	Brown	-	Si, S, Ca, Fe	Mg, Al, P, K, Mn, Zn	1548 (vw, br), 1284 (vw, br), 1204 (vw), 396 (vw), 300 (vw), 247 (vw)	Goethite, as earth
8	White	Zn	S, Ca	Al, Si, Cl	1008 (vw), 437 (vw)	Zinc oxide (main) Calcium sulfate, gypsum type (minor)
9	White ground	Zn	-	Al, Si, S, Cl, Ca	437 (vw)	Zinc oxide An aluminosilicate (trace)
10	Black	P, Ca	-	Na, Mg, Al, Si, S, Cl	1576 (vw, br), 1302 (vw, br)	Carbon-based black (bone or ivory black)

¹⁶ Dry-process type.

¹⁷ Probably as baryte.

¹⁸ Fine particle morphology may suggest a synthetic iron oxide.

¹⁹ Mercury was not identified in the SEM-EDX analysis.

#	Colour	SEM-EDX (elements)			Raman Microscopy (peaks, cm ⁻¹)	Identification
		Major	Minor	Trace		
11	Pink ²⁰ (under-lying painting)	Zn	Al	Si, P, S, Ca, Fe	1592 (w, br), 1312 (w, br)	Carbon-based black (bone or ivory black) (trace) Zinc oxide (main) Red lake on aluminium substrate (minor)
12	Yellow (under-lying painting)	Zn	Al, Si, Fe	P, S, Cl, K, Ca	1592 (w, br), 1307 (w, br), 550 (vw), 392 (vw), 299 (vw), 246 (vw), 145 (vw)	Goethite (minor) ²¹ Carbon-based black Zinc oxide (main) Aluminosilicate clay minerals (minor)
13	Yellowish grey (under-lying painting)	Fe	Al, Si, Ca	P, S, Cl, K, Ti, Zn	1594 (m, br), 1320 (m, br), 397 (vw)	Goethite (main) ²² Carbon-based black (bone or ivory black) Aluminosilicate clay minerals (minor)

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

#	Colour	FTIR (peaks, cm ⁻¹)	Identification
1	Red	3373 (vw, br), 2955 (vw, sh), 2916 (m), 2849 (m), 1732 (w), 1714 (vw), 1592 (vw), 1547 (m), 1528 (s), 1454 (m), 1408 (vw, sh), 1397 (w), 1318 (vw), 1170 (m), 1098 (vw, sh), 1059 (s), 981 (vw), 772 (vw), 743 (w), 720 (w), 633 (w), 604 (m)	Barium sulfate Oil ²³ Metal soap formation, zinc-based ²⁴ Metal soap formation
3	Purplish-brown	3344 (s, br), 2916 (w), 2852 (vw), 1732 (s), 1697 (vw), 1575 (m), 1456 (m), 1417 (vw), 1364 (vw, sh), 1070 (vs)	Alumina hydrate [P2128] ²⁵ Oil ²⁶ Metal soap formation

²⁰ Black pigments were observed.

²¹ As earth with aluminosilicates.

²² As earth with aluminosilicates. Similar to sample [12].

²³ The characteristic peak of oils 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.

²⁴ The peaks present in the sample spectrum matched the reference spectrum of zinc stearate, reference number AAR308. Zinc was not identified in the SEM-EDX analysis.

²⁵ Minor amounts of aluminium were identified in the SEM-EDX analysis.

²⁶ The characteristic peak of oil occurring at around 1160 cm⁻¹ was not observed in the spectrum however it is assumed that oil is present due to the formation of metal soaps.

Table App.2.ii Summary results from FTIR			
#	Colour	FTIR (peaks, cm⁻¹)	Identification
6	Dark blue	3377 (vw, br), 2953 (vw, sh), 2918 (w), 2851 (w), 1738 (w), 1718 (vw, sh), 1590 (w, sh) , 1541 (w), 1456 (w), 1417 (vw), 1400 (vw, sh), 1320 (vw), 1145 (vw, sh), 975 (vs), 799 (vw), 689 (m), 662 (m)	Ultramarine Oil ²⁷ Metal soap formation, zinc-based ²⁸ Metal soap formation
7	Brown	3214 (w, br), 2916 (s), 2849 (m), 1732 (m), 1713 (vw), 1634 (vw), 1591 (vw), 1530 (vs), 1454 (s), 1398 (m), 1354 (vw), 1319 (vw), 1283 (vw), 1242 (vw), 1166 (w, sh), 1098 (vw, sh), 1010 (s), 898 (vw), 888 (vw, sh), 795 (vw), 773 (vw), 744 (w), 721 (w), 667 (vw)	Goethite Oil Metal soap formation, zinc-based ²⁹ Possibly silicate-containing mineral
8	White	3523 (w), 3400 (w), 2920 (w), 2852 (vw), 1738 (w), 1682 (vw), 1620 (w), 1574 (vw) , 1557 (vw) , 1539 (m), 1454 (vw, sh), 1414 (w), 1363 (vw, sh), 1318 (vw), 1134 (vw, sh), 1111 (vs), 724 (vw), 667 (m)	Calcium sulfate, gypsum type Calcium carbonate ³⁰ Oil ³¹ Metal soap formation, zinc-based ³² Metal soap formation
9	White ground	3304 (vs, br), 2957 (vw), 2918 (w), 2849 (w), 1645 (vs), 1589 (vw), 1539 (s) , 1455 (w) , 1435 (vw), 1418 (vw), 1398 (w) , 1373 (vw, sh), 1319 (vw) , 1118 (vs), 1069 (m) , 1041 (vw, sh), 966 (vw), 874 (vw), 864 (vw)	Protein Metal soap formation, zinc-based ³³ Calcium sulfate type white Calcium carbonate, calcite type

²⁷ The characteristic peak of oil occurring at around 1160 cm⁻¹ was not observed in the spectrum due to the presence of ultramarine whose peaks were masking it; however, it is assumed that oil is present due to the formation of metal soaps.

²⁸ The peaks present in the sample spectrum matched the reference spectrum of zinc stearate, reference number AAR308. Zinc was identified in the SEM-EDX analysis.

²⁹ As note 28, above.

³⁰ Both lead carbonate type white and calcium carbonate show this peak. Other peaks which can be used to differentiate one from the other are absent. However, the SEM-EDX data did not identify any presence of lead but did identify calcium and therefore it is assumed that a form of calcium carbonate is present.

³¹ The characteristic peak of oils occurring at around 1160 cm⁻¹ was not observed in the spectrum due to the presence of calcium sulfate, gypsum type whose peaks were masking this characteristic peak of oil however it is assumed that oil is present due to the formation of metal soaps.

³² As note 28, above.

³³ As note 28, above.

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	
7	25.670	9.748 x 10 ⁸	29.613	2.213 x 10 ⁸	P/S = 4.40
8	25.670	1.629 x 10 ⁹	29.590	8.885 x 10 ⁸	P/S = 1.83

The P/S value of **Sample [7]**, brown paint, was 4.40, consistent with **poppy oil**.

The P/S value of **Sample [8]**, white paint, was 1.83, consistent with **linseed oil**.

App.2.iv SYPRO[®] Ruby protein staining

Table App.2.iv SYPRO [®] Ruby stain results for Sample [14] ³⁴ .				
Layer	EDX	FTIR	SYPRO [®] Ruby stain	Interpretation
Ground	Zn Al, Si, S, Cl, Ca	Protein	Pink staining of ground layer	Protein in ground layer
Paint	n.a.	Oil in red, purplish-brown, dark blue, brown, white	Pink staining of light and dark blue paint	Some protein in the paint layers

App.2.v Canvas fibre identification

Table App.2.v Canvas fibre identification, Sample [16]		
Sample	Observations under PLM	Interpretation
Vertical	Nodes across fibres, parallel extinction, s-twist. One or two slender fibres with similar appearance but lower birefringence	Bast fibre, probably linen (<i>Linum usitatissimum</i> L.)
Horizontal	Nodes across fibres, parallel extinction, s-twist. Areas of lower birefringence at broadened fibre ends	Bast fibre, probably linen (<i>Linum usitatissimum</i> L.)

App.2.vi Radiocarbon measurement

Radiocarbon dating is a method for determining age estimates of formerly living organic materials³⁵. Carbon has three naturally occurring isotopes, ¹²C, ¹³C and ¹⁴C. Both ¹²C and ¹³C are

³⁴ For the ground layer, EDX and FTIR data derives from separate analysis of another sample.

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 time³⁶.

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 sulfate (gypsum type), and possibly an oil, in addition to the cellulose of the fibre³⁷.

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.vi.i Radiocarbon measurement, Sample [16]

Sample-Nr.	Sample Code	Material	C14 age BP	$\pm 1\sigma$	F14C	$\pm 1\sigma$	δC13 ‰	$\pm 1\sigma$	mg C	C/N
ETH-77076	AAR0955.K.16	Textile fibre	106	23	0.9869	0.0028	-24.1	1	0.93	236.04

The radiocarbon date was determined as 106 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 1807-1928 at the 95.4% probability level, pre-dating the so-called ‘bomb-pulse’ period that begins in the mid-1950s.

³⁵ Based on from the websites of the NDT Resource Center, <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.

³⁶ For example, that used here is one known as IntCal13.

³⁷ Non-cellulosic materials are aimed to be removed by the sample pre-treatment process prior to the radiocarbon measurement.

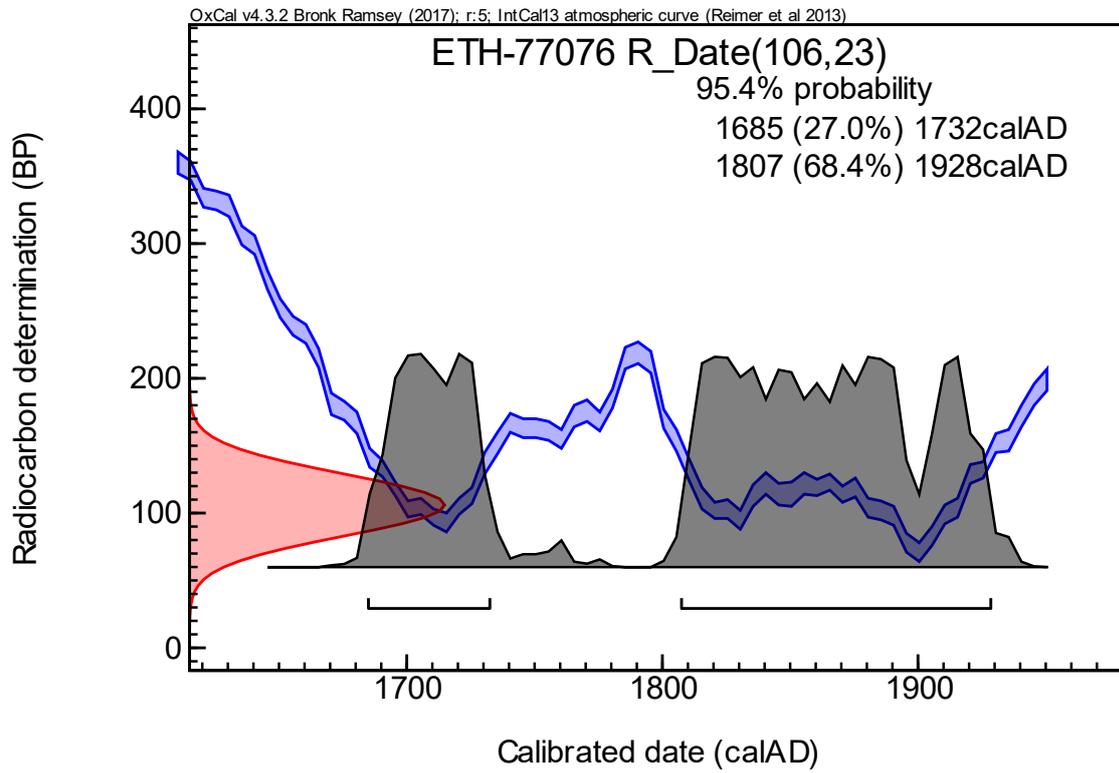


Figure App.2.vi.ii Radiocarbon determination.



App.3 Imaging methods

Protocols:

- [P.3.1] Photography with visible light
- [P.3.2] Photography with ultraviolet illumination
- [P.3.4] SWIR infrared imaging (IR)
- [P.3.6] X-radiography
- [P.3.7] Thread counting and weave analysis

App.4 Plates

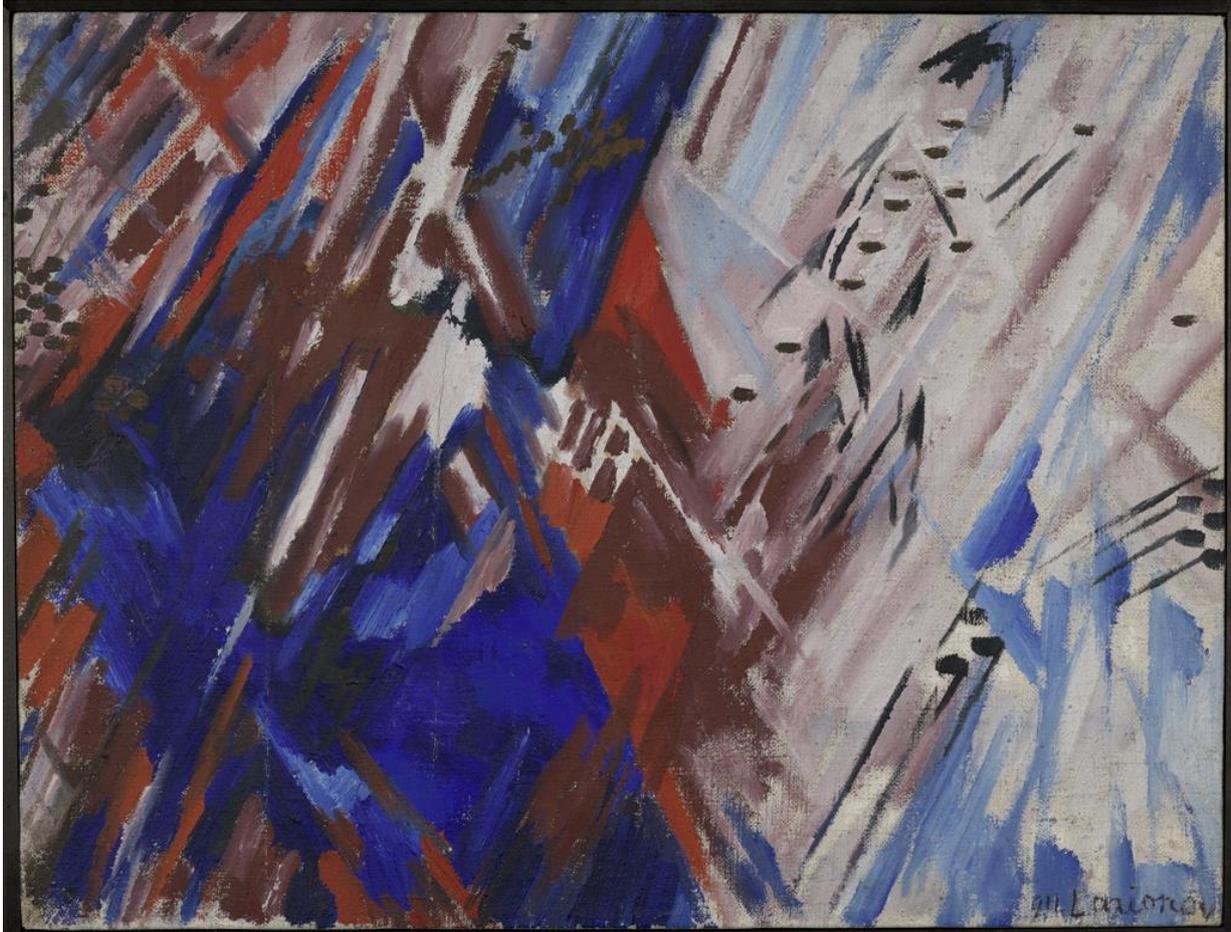


Plate 1. Michel Larionov, *Rayonism, Red and Blue (Beach)*, 1911, collection Museum Ludwig:
Inv. Nr. ML 1333. **Recto, visible light.**

Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050875_08, www.kulturelles-erbe-koeln.de/documents/obj/05020022



Plate 2. Michel Larionov, *Rayonism, Red and Blue (Beach)*, 1911, collection Museum Ludwig: Inv. Nr. ML 1333. **Recto, UV light.**

Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050875_06, www.kulturelles-erbe-koeln.de/documents/obj/05020022



Plate 3. Michel Larionov, *Rayonism, Red and Blue (Beach)*, 1911, collection Museum Ludwig:
Inv. Nr. ML 1333. **Recto, raking light.**

Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050875_04, www.kulturelles-erbe-koeln.de/documents/obj/05020022



Plate 4. Michel Larionov, *Rayonism, Red and Blue (Beach)*, 1911, collection Museum Ludwig: Inv. Nr. ML 1333. **Verso, visible light.**

Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050875_02, www.kulturelles-erbe-koeln.de/documents/obj/05020022

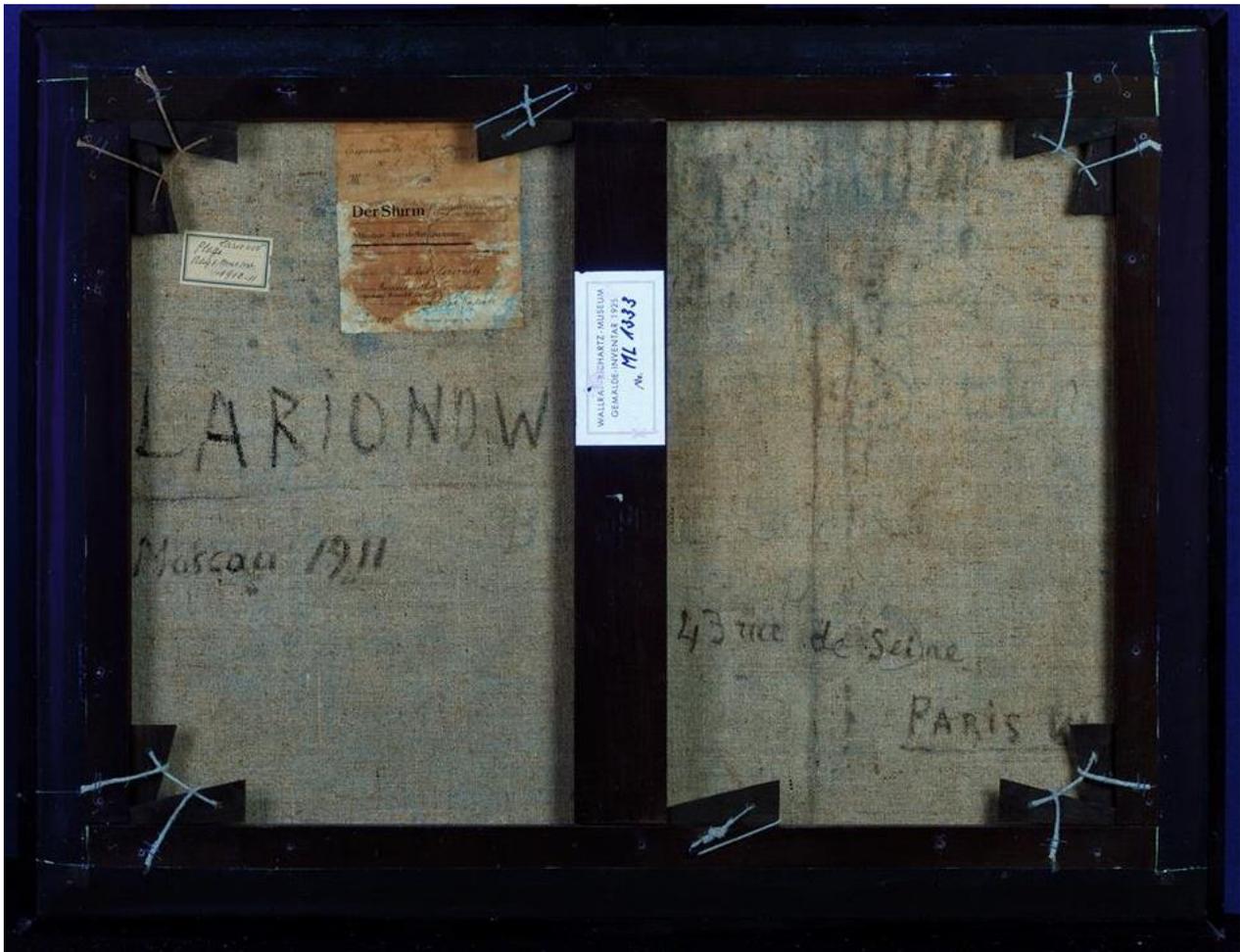


Plate 5. Michel Larionov, *Rayonism, Red and Blue (Beach)*, 1911, collection Museum Ludwig:
Inv. Nr. ML 1333. **Verso, UV light.**

Rheinisches Bildarchiv Köln, Patrick Schwarz, rba_d050875_07, www.kulturelles-erbe-koeln.de/documents/obj/05020022



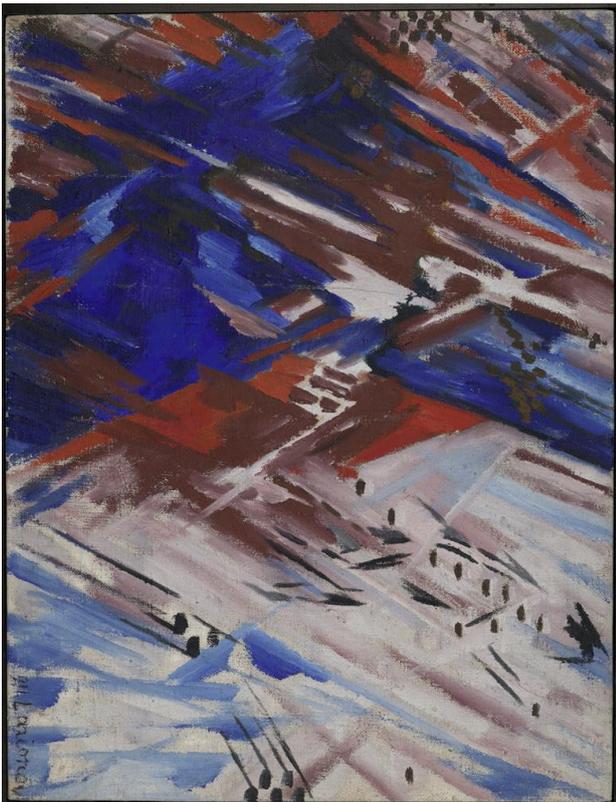
Plate 6. Michel Larionov, *Rayonism, Red and Blue (Beach)*, 1911, collection Museum Ludwig: Inv. Nr. ML 1333. **Recto, SWIR image.**



a.



b.



c.

Plate 7. Michel Larionov, *Rayonism, Red and Blue (Beach)*, 1911, collection Museum Ludwig: Inv. Nr. ML 1333, rotated 90 degrees clockwise.

Left, **a.**) SWIR image (as Plate 6); right, **b.**) X-ray image (as Plate 8) and **c.**) visible light.



Plate 8. Michel Larionov, Rayonism, Red and Blue (Beach), 1911, collection Museum Ludwig: Inv. Nr. ML 1333. **X-ray image.**

Plate 8.b The X-ray image before digital compensation for the stretcher bars.



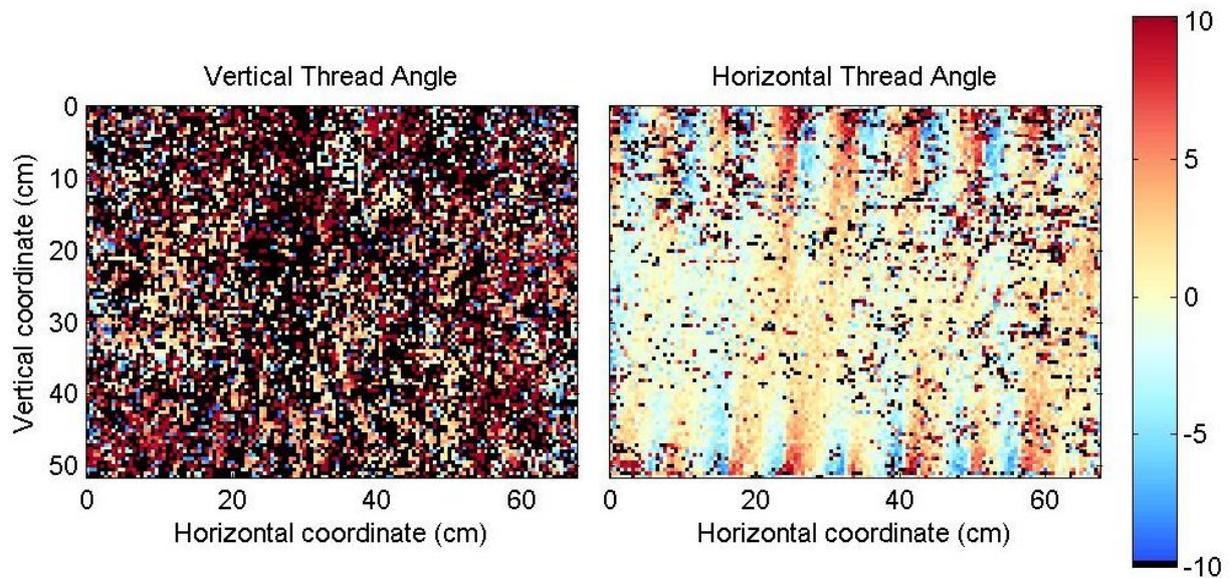


Plate 9.a Maps showing variation in canvas thread angle.

The registration of the cusping in the horizontal direction is rendered difficult by the double threading of the canvas in that direction; in addition, the canvas is not stretched on the vertical. The weave is aligned at an angle that runs from lower left to upper right.

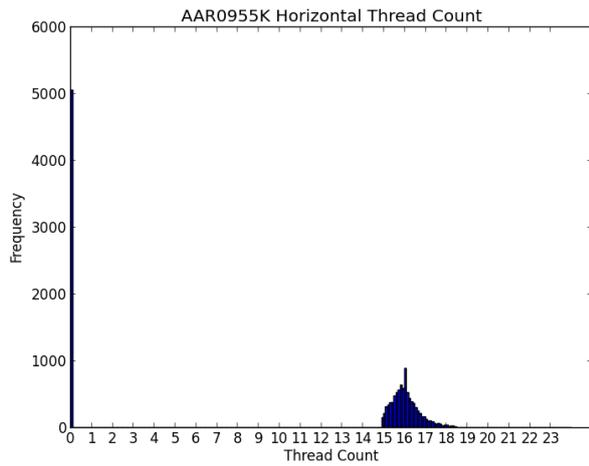


Plate 9.b Histogram of horizontal thread (in this case related to the warp) count readings.

Showing variation in thread count per centimetre.

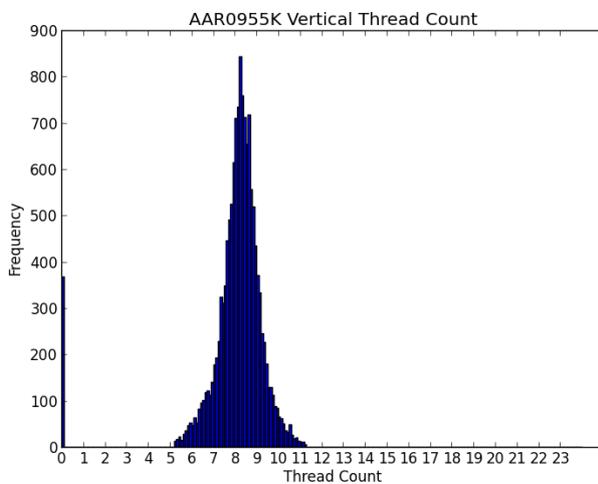


Plate 9.c Histogram of vertical thread count readings (in this case related to the weft).

Showing variation in thread count per centimetre.

Plate 9.d Table of thread count data (threads per centimetre)		
	Mean	Estimated thread count (mode)
Horizontal	16.1	16.0*
Vertical	8.2	8.2

* Note: or, 8 sets of double threads.



Plate 10. Inscription, 'M. Larionov', lower right corner.



Plate 11.a Detail of canvas, verso.

The canvas is a thin, plain weave type with a single thread in the vertical orientation (to the canvas) and a double thread in the horizontal (no selvedge is preserved). The fibre type is apparently linen (*Linum usitatissimum* L.). The white priming may be seen to penetrate the canvas slightly. Many slubby inclusions may be seen.



Plate 11.b Macro detail of canvas, verso, showing inclusions of linen husks.

Bits of red paint may be seen penetrating through to the verso of the canvas.

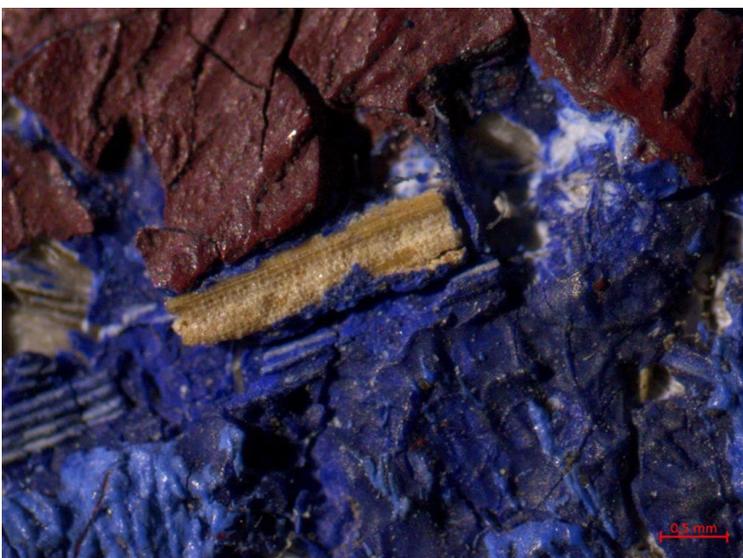


Plate 11.c Macro detail of the paint, recto, showing an inclusion of a bit of linen husk from the canvas, which resembles wood.



Plate 12.a Detail of top tacking margin, showing lack of ground on the edges of the canvas.



Plate 12.b Macro detail of ground, showing its poor adhesion to the canvas.



Plate 12.c Macro detail of the ground, with white paint above left, and blue, right.

The canvas fibres and weave texture are clearly visible. Equally, cracks in the ground may be seen to extend under the adjacent layers of paint.

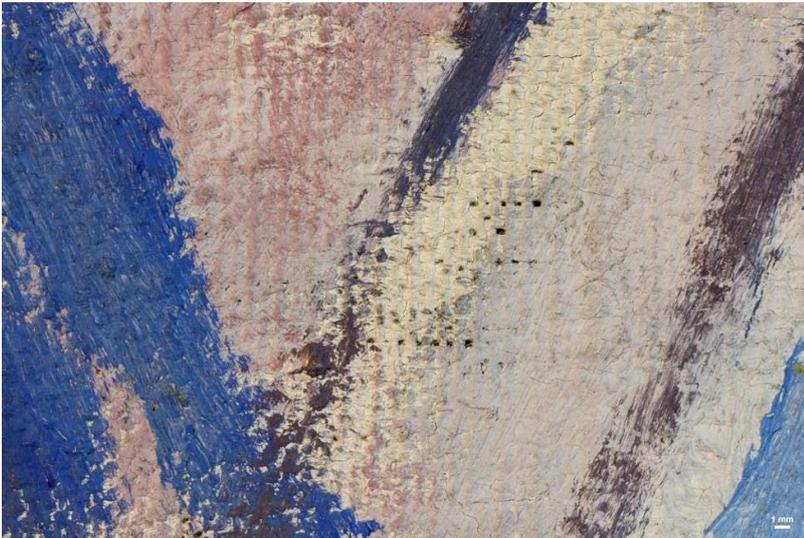


Plate 13.a Detail of paint surface, recto.

The obvious canvas texture and exposed white ground between the brush strokes. Also visible are small voids where the ground has not filled the interstices of the canvas.

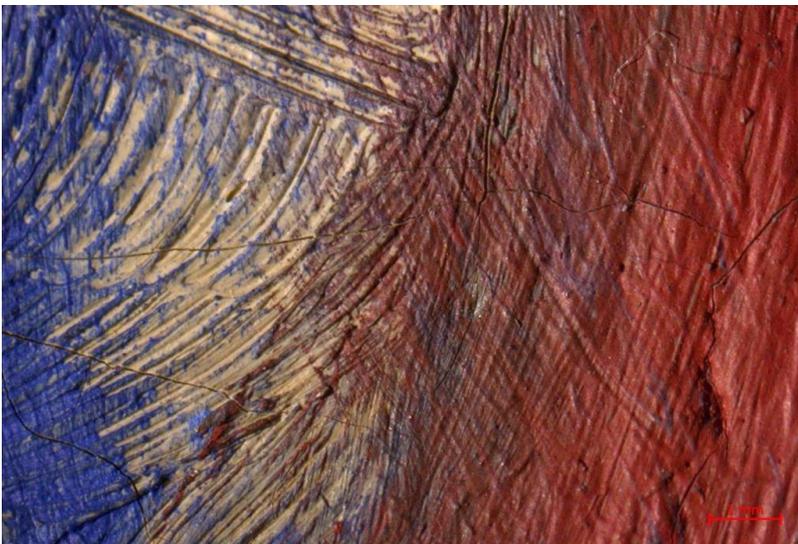


Plate 13.b Macro detail of paint surface, recto.

The flesh tone of the underlying portrait beneath the red and blue paint shows well-defined brush structure indicating that the underlying painting was dry before the present composition was executed.

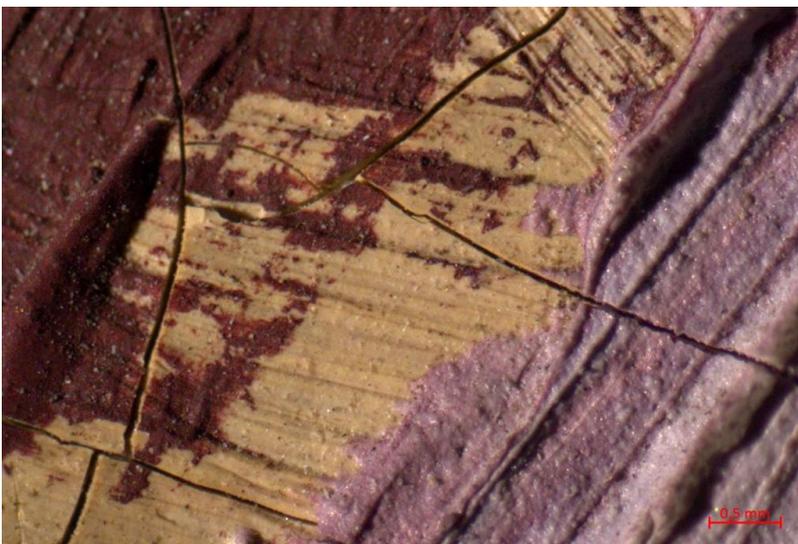


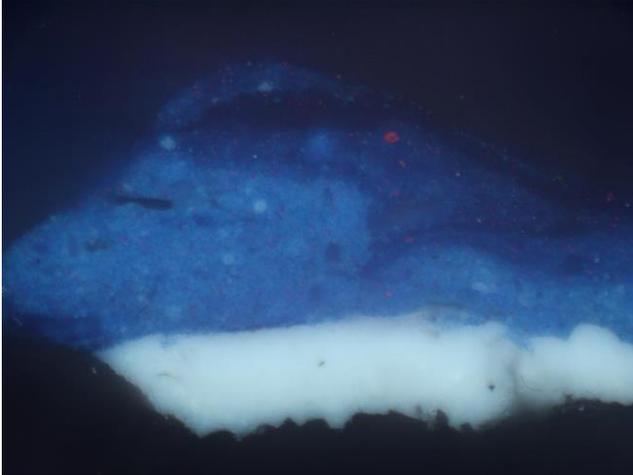
Plate 13.c Macro detail of paint surface, recto.

The yellowish flesh tone of the underlying portrait is visible below the red and pink paint of the visible image.

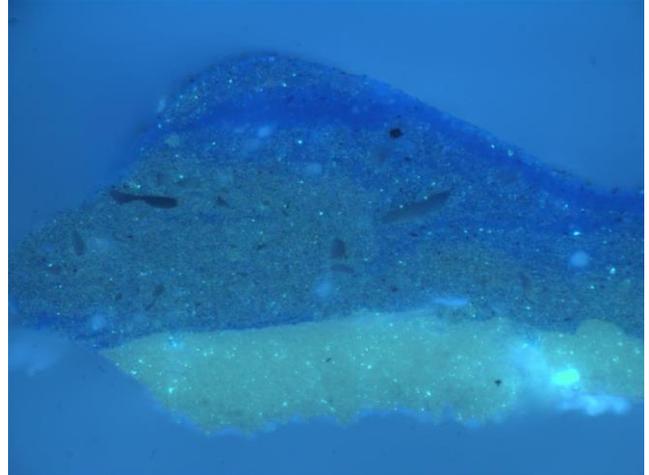


Plate 14. Image showing approximate location of samples taken for materials analysis.

App.5 Cross-sections³⁸



a.

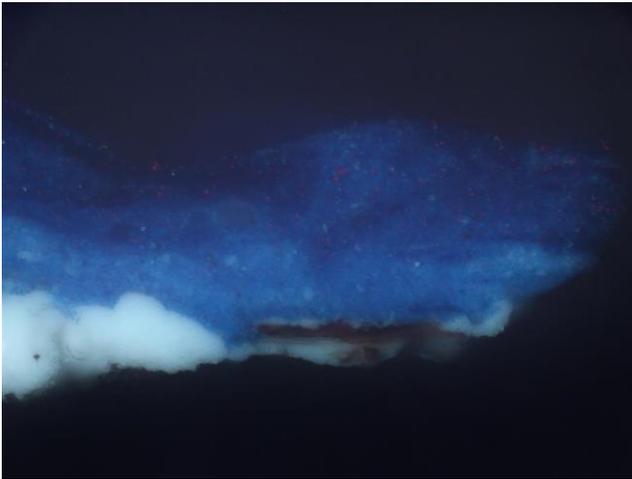


b.

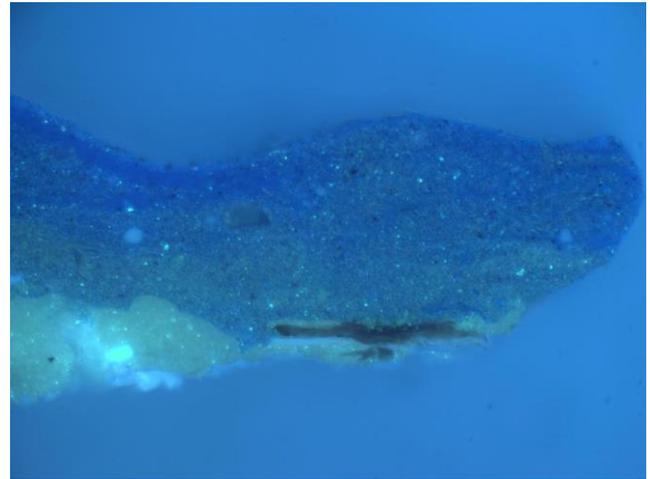
Plate 15. Cross section, Sample [14].

Image ~260 μ m high. Blue paint from lower edge (left hand side of sample). The white ground layer displays the characteristic green luminescence of zinc white under UV illumination. This is covered with a thick bright blue paint layer containing blue and white particles, and a few red particles. The darker blue paint above contains some larger red particles, and a streak of darker unmixed blue can be seen near the top of the layer. The different shades of blue do not appear as distinct separate layer, but are mingled throughout, particularly at the right-hand side of the sample.

³⁸ Photographed under visible light, left (a.), and with ultraviolet illumination, right (b.), unless otherwise stated.



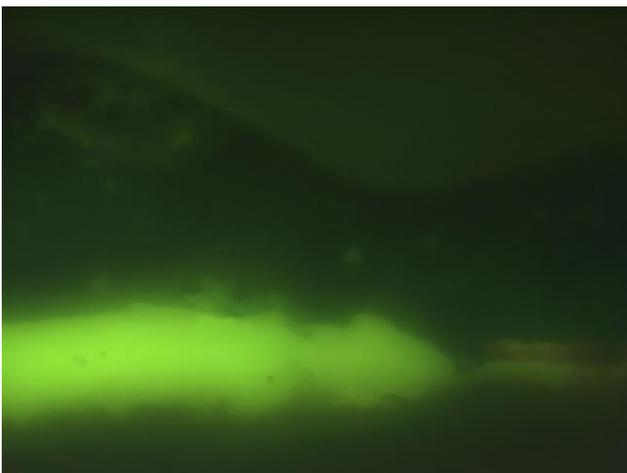
a.



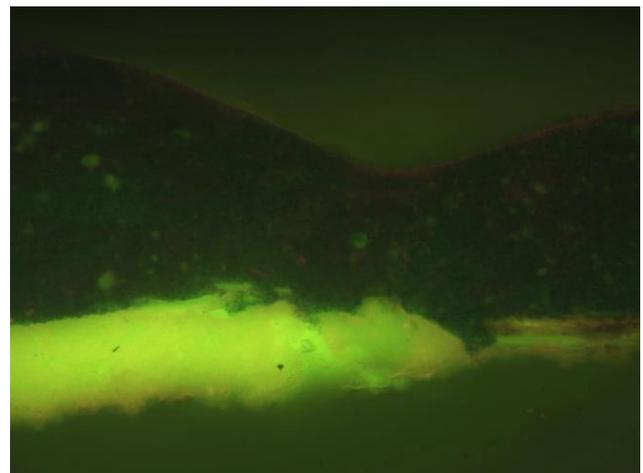
b.

Plate 16. Cross-section, Sample [14].

Image ~260µm high. Blue paint from lower edge (right hand side of sample). The white ground contains an inclusion of brown fibrous material. The characteristic green luminescence of zinc white can be seen in all layers under UV illumination, and an area of bluish fluorescence is visible at the base of the sample, possibly from a size layer. Any layering of the blue paint is even less distinct in this part of the sample.



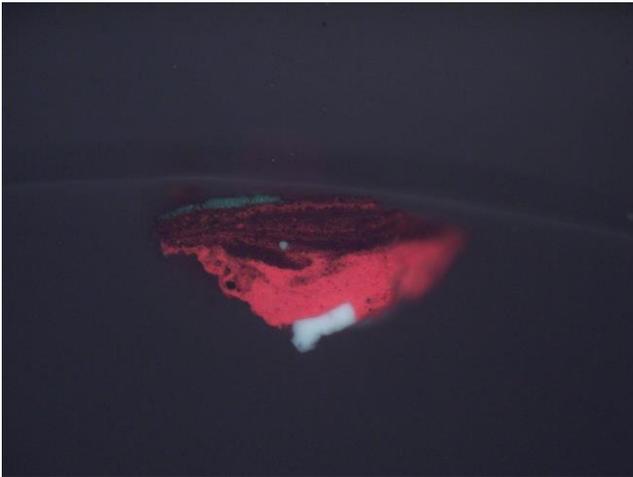
a.



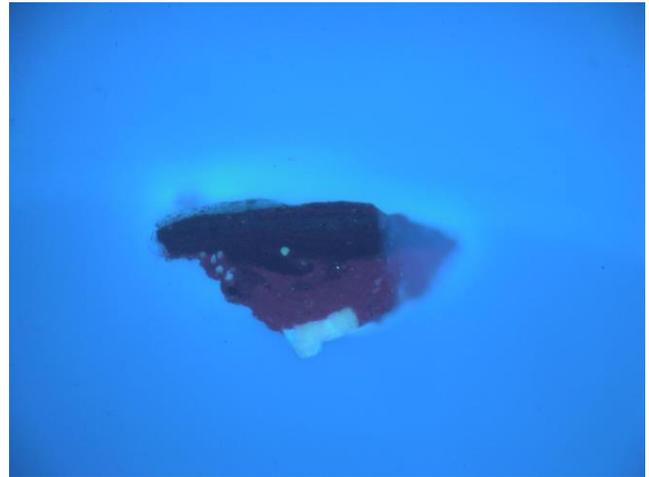
b.

Plate 17. Cross-section, Sample [14], stained with SYPRO[®] Ruby.

Image ~260µm high, viewed with Leica I3 filter before (left) and after (right) staining. Pale pink staining of the ground layer suggests that the protein detected by FTIR is a component of the priming, along with the oil. The pink staining of light and dark blue paint (lowest part of blue layer stained to a lesser extent) indicates that a protein is present in the paint layers.



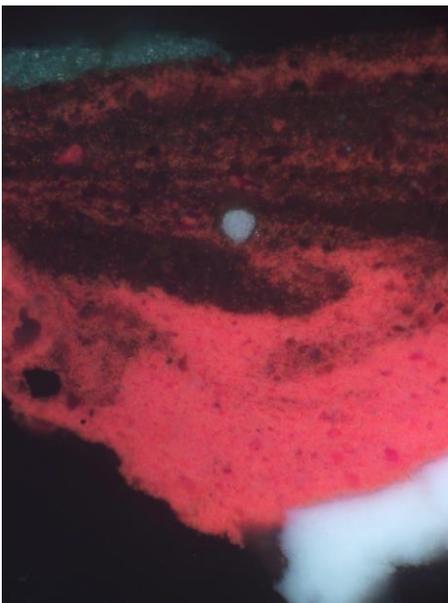
a.



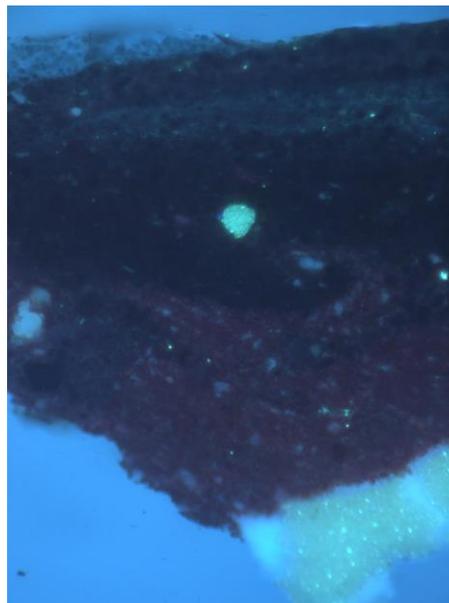
b.

Plate 18. Cross-section, Sample [15].

Image ~1mm high. Green (left) over brown over red with a bit of white ground, lowermost. The white ground layer displays the characteristic green luminescence of zinc white under UV illumination. Over this is a thick bright orange-red layer containing some larger red particles, which is swirled extensively into the dark brown layer above. A partial green layer with a distinct boundary is present at the left-hand side.



a.



b.

Plate 19. Cross-section, Sample [15].

Image ~260µm high. Brown over red, detail at higher magnification. The white area centre shows green luminescence under UV illumination, indicative of zinc white. Several other areas (one visible at the middle, left edge of this detail) have a bluish luminescence but appear dark in visible light, suggesting an organic material.