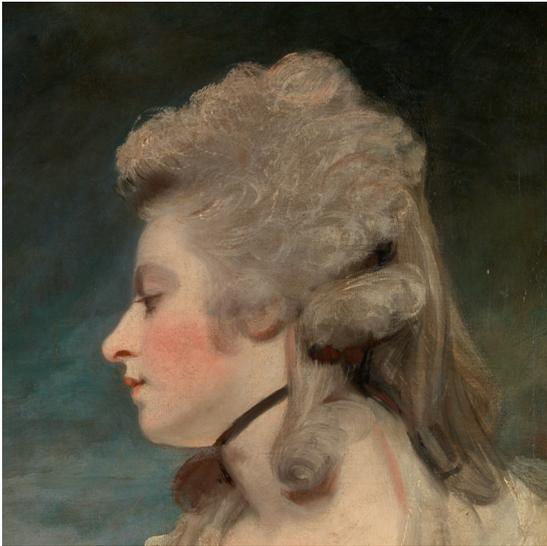


National Gallery Technical Bulletin

VOLUME 35

Joshua Reynolds in the National Gallery and the Wallace Collection



National Gallery Company
London

Distributed by
Yale University Press

This edition of the *Technical Bulletin* has been supported by the American Friends of the National Gallery, London with a generous donation from Mrs Charles Wrightsman

Series editor: Ashok Roy

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First published in Great Britain in 2014 by
National Gallery Company Limited
St Vincent House, 30 Orange Street
London WC2H 7HH

www.nationalgallery.co.uk

British Library Cataloguing-in-Publication Data.
A catalogue record is available from the British Library.

ISBN: 978 1 85709 556 2
ISSN: 0140 7430
1038962

Publisher: Jan Green
Project Manager: Claire Young
Editor: Lise Connellan
Design: Libanus Press
Picture Research: Suzanne Bosman
Production: Jane Hyne and Penny Le Tissier
Repro by Alta Image
Printed in Italy by Conti Tipocolor

FRONT COVER

Joshua Reynolds, *Lady Cockburn and her Three Eldest Sons* (NG 2077), 1773 (detail)

TITLE PAGE

TOP LEFT: Joshua Reynolds, *Mrs Mary Robinson ('Perdita')*, The Wallace Collection (P 45), 1783–4 (detail).
TOP RIGHT: Joshua Reynolds, *Colonel Tarleton*, The National Gallery (NG 5985), 1782 (detail).
BOTTOM LEFT: Joshua Reynolds, *Miss Jane Bowles*, The Wallace Collection (P 36), 1775–6 (detail).
BOTTOM RIGHT: Joshua Reynolds, *Mrs Susanna Hoare and Child*, The Wallace Collection (P 32), 1763–4 (detail).

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Notes

Joshua Reynolds at the National Gallery

- 1 The introduction provided here is heavily indebted to the exemplary accounts of Reynolds's works in the National Gallery and their history provided by Judy Egerton in her comprehensive catalogue, *The British School*, published in 1998 (Egerton 1998).
- 2 The Lewis fund arose from a bequest made by Thomas Denison Lewis, which took effect in 1862 and allowed the purchase of a number of paintings for the Gallery. See Egerton 1998, p. 413.

Joshua Reynolds at the Wallace Collection

- 1 Greville (1905), p. 265.
- 2 For the history of the founders of the Wallace Collection, see Hughes 2011; Duffy and Hedley 2004, pp. xv–xxxix.
- 3 The 1st Marquess may have been introduced to Reynolds by his cousin Horace Walpole, whose portrait by the artist hangs at Ragley Hall, Alcester, Warwickshire. Mannings 2000, no. 1821.
- 4 Mannings 2000, nos. 406, 407 and 410.
- 5 Wallace Collection inventory numbers P31 and P33; Ingamells 1985, pp. 140, 143 and 145; Mannings 2000, nos. 379 and 404; Duffy and Hedley 2004, pp. 353–4. The portraits were started in 1781 but not paid for until 1784.
- 6 P561; Ingamells 1985, pp. 162–3; Mannings 2000, no. 520; Duffy and Hedley 2004, p. 363.
- 7 For the portrait of Miss Jacobs, formerly in the Toledo Museum of Art, Ohio, see Mannings 2000, no. 995; for the portrait of Mrs Mary Robinson, see Mannings 2000, no. 1529. At the Wallace Collection there is a miniature by John Hazlitt (inventory number M40) after the portrait of Mary Robinson, which is now at Waddesdon Manor. For Mrs Robinson's acquaintance with the 2nd Marquess and Marchioness of Hertford, see Ingamells 1978, p. 5.
- 8 Romney P37; Ingamells 1985, pp. 171–2. Gainsborough P42; Ingamells 1985, pp. 93–5.
- 9 P38; Ingamells 1985, pp. 149–50; Mannings 2000, no. 1353.
- 10 On the admiration the painting inspired at the Manchester exhibition, see Cotton 1859b, pp. 74–6.
- 11 P48; Ingamells 1985, pp. 160–1; Mannings 2000, no. 2038; Duffy and Hedley 2004, p. 363.
- 12 N. Penny, 'An Ambitious Man: The Career and Achievements of Sir Joshua Reynolds' in London and Paris 1985–6, pp. 33 and 272–3; Prochno 1990, p. 131.
- 13 For the Reynolds exhibition at the British Institution, see Haskell 2000 (1960–3), pp. 46–63.
- 14 See Ingamells 1981, pp. 12–15.
- 15 For a discussion of the 4th Marquess's taste, see Duffy and Hedley 2004, pp. xxii–xxix.
- 16 P36. Ingamells 1985, pp. 147–8; Mannings 2000, no. 231; Duffy and Hedley 2004, p. 356. The sitter was born in 1772 and Reynolds received payment for the picture in 1775 and 1776, which means that the sitter was aged between three and four.
- 17 There are eighteen paintings by Greuze at the Wallace Collection and three ascribed to him. All but one were acquired by the 4th Marquess of Hertford.
- 18 P40; Ingamells 1985, pp. 151–3; Mannings 2000, no. 2166; Duffy and Hedley 2004, p. 359.
- 19 P32; Ingamells 1985, pp. 141–2; Mannings 2000, no. 911; Duffy and Hedley 2004, p. 354.
- 20 P47; Ingamells 1985, pp. 157–9; Mannings 2000, no. 238; Duffy and Hedley 2004, p. 361.
- 21 Ingamells 1981: Hertford to Mawson, no. 41 (Paris, 11 May 1854); no. 42 (Paris, 21 May 1854): Hertford instructed Mawson to 'arrange the Reynolds in your best manner that I should find Mrs Bradyll [*sic*] a few years younger than she is at present'; Hertford to Mawson, no. 88 (Paris, 11 September 1858): the restoration or 'operation' as Lord Hertford called it, appears to have been completed to Mawson's satisfaction by mid-September 1858.
- 22 P35; Ingamells 1985, pp. 144–6; Mannings 2000, no. 311; Duffy and Hedley 2004, p. 355. Ingamells 1981: Hertford to Mawson, no. 102 (Paris, 11 June 1861).
- 23 *Miss Jane Bowles*: sale of C.O. Bowles, Christie's, 25 May 1850. *Mrs Susanna Hoare and Child*: Christie's, 26 March 1859, lot 70: 'Mrs Hoare of Boreham House, never been out of the possession of the family for whom it was painted.' The portrait of Mrs Elizabeth Carnac was sold at an anonymous sale held by Christie's, 15 June 1861, where it was bought by the 4th Marquess. It had previously belonged to the widow of Mrs Carnac's nephew.
- 24 *Mrs Mary Nesbitt* P43; Ingamells 1985, pp. 153–4; Mannings 2000, no. 1333. *Mrs Mary Robinson* P45; Ingamells 1985, pp. 155–7; Mannings 2000, no. 153. *Ancient and Modern Pictures Collected by the Honourable General Phipps deceased and the property of the Honourable Edmund Phipps, deceased* (25 June 1859), lot 98: Joshua Reynolds, 'Portrait of Mrs Nesbitt in a white dress with a dove in an oval', sold to Mawson for 600 guineas; lot 100: Joshua Reynolds, 'Contemplation: Portrait of Mrs Robinson seated near the Sea', sold to Mawson for 840 guineas.
- 25 Ingamells 1981, nos. 90–4; no. 90, in which Mawson gives his assessment of the portraits; Hertford to Mawson, no. 92: 'I should like Mrs Nesbitt – Mrs Robinson & her will do well for Paris where I have no Sir Joshuas.'
- 26 Ingamells 1981, nos. 102 and 104 (Paris, 11 June 1861 and 4 July 1861).
- 27 Ingamells 1981, Hertford to Mawson, no. 67 (Paris, 5 May 1856).
- 28 Ingamells 1981, Hertford to Mawson, no. 67 (Paris, 5 May 1856).
- 29 Duffy and Hedley 2004, p. xxxiii.

Practice Makes Imperfect: Reynolds's Painting Technique

- 1 See M. Kirby Talley, '“All Good Pictures Crack”': Sir Joshua Reynolds's Practice and Studio' in London and Paris 1985–6, pp. 55–6.
- 2 N. Penny, 'An Ambitious Man: The Career and Achievements of Sir Joshua Reynolds' in London and Paris 1985–6, pp. 17–42.
- 3 Hunter, forthcoming.
- 4 Dossie 1758, vol. 1, pp. 176–81.
- 5 Dossie 1758, vol. 1, p. 139. Northcote 1818, vol. 2, p. 20: 'it was Sir Joshua's opinion, that if the vegetable colours (which are infinitely the most beautiful) were enclosed by varnish

- from the external atmosphere, they would not fade’.
- 6 Morrison 2010.
 - 7 Reynolds is reputed to have scraped down pictures he owned to find out about their construction. See Northcote 1818, vol. 2, p. 23, and Malone 1798, vol. 1, p. lvi.
 - 8 Northcote 1818, vol. 2, p. 21.
 - 9 During this study, information about the canvas types used for Reynolds’s paintings was gathered from over a wide date range and from various different collections. The conclusion that there was a shift from the use of plain-weave to twill-weave canvases was based on results from 204 paintings. The paintings examined in detail here follow the same pattern.
 - 10 The standard sizes used by Reynolds are Head (25.5 × 18.5 in.), Bust or three-quarter (30 × 25 in.), Kit-cat (36 × 28 in.), Half-length (50 × 40 in.), Bishop’s half-length (56 × 45 in.) and Whole-length (94 × 58 in.). See Anon. 1808, pp. 66–7, and M. Kirby Talley, “All Good Pictures Crack”: Sir Joshua Reynolds’s Practice and Studio’ in London and Paris 1985–6, p. 58.
 - 11 All of the supports examined in this study were single pieces of canvas. However, some larger canvases used by Reynolds were made from more than one piece of canvas. For example, *The Honorable Henry Fane with Inigo Jones and Charles Blair*, 254.6 × 360.7 cm (The Metropolitan Museum of Art, New York), is made of three pieces of canvas with two vertical seams. Gallagher 2009, p. 68.
 - 12 Cormack 1968–70, p. 169: Ledgers, ii, f.178.v and ii, inside back cover.
 - 13 Cormack 1968–70, pp. 143: Ledgers, i, f.54. This entry relates to a portrait of Elizabeth Lamb, Viscountess Melbourne, which dates from 1770–1. See Mannings 2000, p. 297. Benjamin Haydon thought that this was an unprepared canvas, whereas William Beechey was uncertain whether this meant a prepared or unprepared canvas. Haydon 1960–3, vol. 5, p. 577, and M. Kirby Talley, “All Good Pictures Crack”: Sir Joshua Reynolds’s Practice and Studio’ in London and Paris 1985–6, p. 66.
 - 14 Cormack 1968–70, pp. 143 and 169: Ledgers, ii, inside back cover. Cormack misinterpreted ‘colourmans’ as ‘colouring’ but this was corrected by Hélène Dubois when she reviewed the notes. Dubois 1992–3, Appendix I, p. 13.
 - 15 J. Farington, 3 October 1796, in Farington 1978–84, vol. 3, p. 669.
 - 16 An unlined painting, *Poetua [Poetua], daughter of Oreo, chief of Ulaietea, one of the Society Isles* by John Webber, dated 1785, in the collection of the Museum of New Zealand Te Papa Tongarewa. See Campbell 2011. The stretcher that was present on Joseph Wright ‘of Derby’s *Mr and Mrs Thomas Coltman* (NG 6496) also had a similar construction when it was acquired by the National Gallery. This may date from 1826. See Wyld and Thomas 1986, p. 29.
 - 17 Letter dated 2 November 1775, Ingamells and Edgcumbe 2000, p. 58.
 - 18 See Ingamells 2008, p. 118. Information regarding the sketch from the Yale Center for British Art, New Haven, was supplied by Mark Aronson. The X-ray image of the early *Self Portrait* in the National Portrait Gallery, London, revealed a first version of the same composition, which had been inverted before being painted over. Information supplied by Helen White.
 - 19 George Stubbs and Wright ‘of Derby’ both used panel supports. Rica Jones (Jones 1991, p. 14) quotes Wright ‘of Derby’ speaking of panels: ‘The smooth surface is not calculated for expedition’. Panel supports had become more popular in other European countries as the eighteenth century progressed, especially in relation to wax painting: Mayer and Myers 2004, p. 135. Julius Caesar Ibbetson (Ibbetson 1803, p. 11) mentions both oak and mahogany supports.
 - 20 There are 2,256 paintings listed in the Mannings 2000 catalogue.
 - 21 The data on Reynolds’s panel paintings was collated from Mannings 2000. Of the 37 paintings and sketches identified as panel paintings, eight are untraced.
 - 22 Seven panels have been identified as mahogany and a further two are thought to be mahogany but are not confirmed.
 - 23 The portrait of Mr Wilson Gale Braddyll was examined in the Conservation Department of the National Gallery. Access was provided with the permission of the owner, courtesy of Philip Mould & Company.
 - 24 Communication with Al Brewer at the Royal Collection, 18 December 2012.
 - 25 Information from condition report made by Patrick Lindsay, 22 February 1986, in the picture file at the Royal Academy. Information kindly supplied by Isobel Horowitz.
 - 26 Information from report in Tate conservation file. See also R. Jones, ‘Sir Joshua Reynolds, *George IV when Prince of Wales*, 1785’ in Hackney, Jones and Townsend 1999, p. 146.
 - 27 There are ½ in. additions of unpainted wood on either side. The panel has a vertical grain and is ¼ in. thick. Information from condition report made by A.M. Reeve, 16 December 1988, in the picture file at the Royal Academy. Information kindly supplied by Isobel Horowitz.
 - 28 26 January 1794: ‘She [Lady Inchiquin] offered me such panels as Sir Joshua has bought for painting on.’ Then 29 January: ‘Lady Inchiquin sent me 8 large panels which Sir Joshua had bought to paint upon.’ Farington 1978–84, vol. 1, p. 148.
 - 29 Mannings 2000, p. 208. The present owner (Lord Mountjoy) confirmed that the portrait is on metal and as a result is very heavy (communication with David Mannings, 22 August 2013). The support has been identified as tin but it is likely that the tin is only a surface coating and the panel itself is probably copper.
 - 30 Cat. 1873 in Mannings 2000, p. 470. Mannings notes that a smaller portrait of Whitbread painted by Beechey is also on a copper support.
 - 31 Piozzi 1786, p. 98, and repeated in Northcote 1818, vol. 1, p. 237.
 - 32 James Northcote, in a letter dated 23 August 1771, to his brother (Royal Academy, NOR4).
 - 33 In the sale of Charles Jervas’s painting materials and equipment in 1739 the ‘cloths’ or canvases are described as either ‘raw’ or ‘primed’. See Kirby Talley 1978.
 - 34 In an examination of twenty paintings Barbara Buckley found mostly buff or cream-coloured grounds and noted that unprimed canvas is exceptional. Buckley 1986, p. 360 and p. 371, note 65. The portrait of Rev. William Robertson, 1772 (Scottish National Portrait Gallery, PG 1393), does not appear to have ground layer and the texture of the canvas is prominently visible. We are grateful to Lesley Stevenson for taking a cross-section from this painting to confirm this.
 - 35 The subject of painting in wax and the frequent absence of a ground in these pictures is discussed in R. Jones, ‘Sir Joshua Reynolds, *George IV when Prince of Wales*, 1785’ in Hackney, Jones and Townsend 1999, pp. 146–51.
 - 36 Newman and Jones 1668, p. 92.
 - 37 Kirby Talley 1978.
 - 38 Dossie 1758, vol. 1, p. 202.
 - 39 Ibbetson 1803, p. 11.

- 40 R. Jones, 'Thomas Gainsborough, *The Rev. John Chafy Playing the Violoncello in a Landscape*, c.1750–2' in Hackney, Jones and Townsend 1999, pp. 48–50. Jones 1987, p. 24 and p. 28, note 11. Many of Johann Zoffany's paintings also have a double ground separated by a glue size layer. David 2011, p. 168 and p. 174, note 8.
- 41 Ibbetson 1803, p. 11.
- 42 See Bomford and Roy 1982, p. 60, for a discussion of William Hogarth's grounds and the inclusion of calcium carbonate.
- 43 The blue pigment was probably added to make the ground appear brighter, rather than shifting the tonality significantly. Thomas Gainsborough's *The Watering Place* (NG 109), exhibited in 1777, also has a pure white ground. Egerton 1998, p. 108.
- 44 'My own Picture sent to Plimpton... the cloth varnished first with Copal varnish...' (Cormack 1968–70, p. 169; Ledgers, ii, inside back cover). Dubois 1992–3, Appendix I.
- 45 Whitley 1928, vol. 1, p. 334.
- 46 For further discussion of Reynolds's oil sketches see Mannings 1991.
- 47 For discussion of the Italian sketchbooks see Perini 1988 and Mannings 2006. For the notebooks from Flanders and Holland see Mount 1996.
- 48 For further discussion of Reynolds's art collection see Broun 1987.
- 49 Northcote 1818, vol. 1, p. 83. Bennett and Leonard 1999, pp. 104–5.
- 50 Regularly spaced notches at the edges of paintings are sometimes found but these appear to relate to marking up finished paintings for printmaking rather than Reynolds's painting process.
- 51 For further discussion see Gent, Morrison and Jones 2014.
- 52 See Mannings 2000, pp. 2–6, for a discussion of the 'Sitter' Books'.
- 53 W. Mason, 'Anecdotes of Sir Joshua Reynolds Chiefly Relative to His Manner of Colouring' in Cotton 1859a, pp. 50–1.
- 54 We are grateful to Mark Aronson for giving access to this X-ray image.
- 55 '*Sono Stabilito in maniera di dipingar / Prima e secundo o con olio, o Capivi / Gli cololi / solo nero, ultrami / e biacca / Secundo medesimo, ultimo con / Giallo, okero e lacca e nero e ultramari / senza biacca, retoccato con poca biacca e Gli altri Color*' (Cormack 1968–70, p. 142; Ledgers, i, f.53.v).
- 56 In a letter to Mason, dated 10 February 1783, Walpole states '[Reynolds's] journeyman, as if to distinguish himself, has finished the lock and key of the table like a Dutch flower-painter.' Walpole 1937–83, vol. 29, p. 285.
- 57 Bardwell 1756, pp. 11–14.
- 58 See Mannings 2000, pp. 6 and 7, for further discussion.
- 59 Northcote 1818, vol. 2, p. 27.
- 60 Bennett and Leonard 1999, pp. 115–20.
- 61 '... there were ten pictures under it, some better, some worse' (Northcote 1818, vol. 2, p. 219).
- 62 See also Jones, Townsend and Boon 1999.
- 63 See van de Wetering 1997, p. 205, for Rembrandt's freehand stylus scoring in wet paint.
- 64 See Kalinina, Renne, Korovov and Chudolij 2006; Jones, Townsend and Boon 1999; Mills and White 1977; and Mills and White 1987.
- 65 The most recent medium analyses were carried out on samples from all twelve paintings in the Wallace Collection using the techniques of gas chromatography–mass spectrometry (GC–MS) and Fourier transform infrared microscopy (FTIR microscopy). The five National Gallery paintings had been investigated at different times, but medium analysis results have also been obtained from each of these pictures, mostly using GC–MS. *Colonel Tarleton* was first studied in 1975 when only gas chromatography (GC), without mass spectrometry, was available. However, one archive sample and one additional sample were studied more recently with the current GC–MS equipment.
- 66 Northcote 1818, vol. 1, p. 118.
- 67 National Gallery internal report. This work was undertaken by Raymond White in the 1970s.
- 68 Analysis of *Sarah (Kemble) Siddons as the Tragic Muse* (1783–4, The Huntington Art Collections, San Marino, California, 21.02) showed that walnut oil had been used for the light-coloured paint of the flesh and clouds, and that linseed oil was used elsewhere. Bennett and Leonard 1999, p. 122 and p. 140, note 78.
- 69 The interpretation of heat pre-polymerised oils is based on the ratio of azelate to suberate di-acids detected by GC–MS analysis. For a further discussion of heat-bodying see White and Kirby 1994, pp. 68–71.
- 70 Müntz 1760.
- 71 Caylus and Majault 1755.
- 72 However, Reynolds did not actually attend the meeting. The proposed committee members also included Allan Ramsay, Francis Hayman and Robert Dossie. J.H. Müntz to the Society of Arts, 7 May 1760: RSA/PR/GE/110/8/145, 7/5/1760:f1 in Hunter, forthcoming.
- 73 Reynolds's *Studio Experiments in Colour and Media* (experimental canvas) in the Royal Academy (03/576). Analysis of this paint by direct temperature-resolved mass spectrometry (DTMS) carried out at FOM-Institute for Atomic and Molecular Physics, Amsterdam, gave a clear spectrum for beeswax. Report made by Joyce Townsend, June 1997, in Tate file. For further discussion of Reynolds's use of wax see Dubois 2000.
- 74 '*Le Melior Maniera. con Cera mesticata con Turp di Venetia*' (Cormack 1968–70, p. 168; Ledgers, ii, f.177.v).
- 75 '*Lord Henry and Lady Charlotte Spencer. First olio a poi colori con cera senza olio*' (Cormack 1968–70, p. 169; Ledgers, ii, f.178.v).
- 76 '*Lady Osser primo olio poi Cera solamente pour il viso*' (Cormack 1968–70, p. 169; Ledgers, ii, f.178.v). This could possibly be *Anne Fitzroy, Duchess of Grafton* (Private Collection), c.1770, whose second husband was John Fitzpatrick, 2nd Earl of Upper Ossory. Mannings 2000, p. 194.
- 77 '*Mrs. Sheridan the face in Olio poi cerato*' (Cormack 1968–70, p. 169; Ledgers, ii, f.178v). *Mrs Sheridan as Saint Cecilia* (National Trust, Waddesdon Manor). Mannings 2000, pp. 412–3.
- 78 However, in this case the poor condition of the work, and the many layers of restoration present on the surface, mean that this result should be interpreted cautiously.
- 79 Jones, Townsend and Boon 1999, p. 337. It was said by John Singleton Copley that Benjamin West used spermaceti wax in his retouching varnishes: see Mayer and Myers 2011, p. 13.
- 80 James Northcote, in a letter dated 23 August 1771, to his brother (Royal Academy, NOR4).
- 81 Morrison 2010, pp. 118–19.
- 82 Mills and White 1994, p. 99.
- 83 van der Werf, van den Berg, Schmitt and Boon 2000. Steigenberger 2013.
- 84 Analysis carried out by Raymond White in 1986 of a sample of a brown glaze from Reynolds's *Self Portrait* in the Royal Collection (1788, RCIN 400699) also suggested the presence of a Leguminosae resin, thought to be a type of copaiba balsam.

- 85 The Pettenkofer treatment for blanched paintings, and other forms of deterioration involving disrupted paint medium effects, using alcohol vapour and copaiba balsam, is described in Schmitt 2000.
- 86 Nicolas L'Emery stated in the late seventeenth century that material termed 'Venice Turpentine' could have been obtained from species of pine and fir as well as larch, at least in France. See White and Kirby 1994, p. 71. Recent PhD research by Steigenberger has characterised several samples of natural resin from the Vignani Cabinet, which date from the early eighteenth century and were purchased in London. This research confirms that the composition of materials labelled as 'Venice Turpentine' was variable. See Steigenberger 2013. Traces of fir balsam were identified by GC-MS analysis on several paintings, most often in samples containing glaze layers and the lowest, oldest layers of varnish. With the exception of *The Strawberry Girl* where there is a substantial varnish layer consisting mainly of fir balsam, the quantities detected were low and it was difficult to draw conclusions about the significance of this material. Fir balsam could be related to subsequently applied varnishes but it is possible that this type of resin was present, perhaps as an adulterant, in varnishes used by Reynolds's studio.
- 87 W. Mason, 'Anecdotes of Sir Joshua Reynolds Chiefly Relative to His Manner of Colouring' in Cotton 1859a, p. 51.
- 88 Mannings 2000, p. 4.
- 89 W. Mason, 'Anecdotes of Sir Joshua Reynolds Chiefly Relative to His Manner of Colouring' in Cotton 1859a, p. 59.
- 90 Dubois 1992–3, Appendix I, p. 15.
- 91 Cormack 1968–70, p. 141: Ledgers, 1, f.52.v. Cormack mistakenly transcribes 'Rock Alum' as 'Rock Album'. 'Sal Saturni' is identified as sugar of lead (or lead acetate) by Leslie and Taylor 1865, vol. 1, p. 265, and Eastlake 1847, vol. 1, p. 539. Eastlake also comments that the recipe, excepting the dryer, is similar to a recipe from Armenini 1587, p. 129. This recipe would have produced a gelled medium, which Reynolds has used as a varnish with a little pigment added.
- 92 'Mrs Cholmondly con olio e Vernicio di cera. poi/ Vernicato con yeos lake e magilp' (Mrs Cholmondly painted with oil and the wax varnish then varnished with Yeo's lake and magilp; Cormack 1968–70, p. 141: Ledgers, 1, f.52.v).
- 93 A self portrait in 1772 is 'varnished with Egg after Venice Turpentine' (Cormack 1968–70, p. 143: Ledgers, 1, f.54), 'Mrs Joddach Head oil. Cerata. Varnish with Ova / poi, varn. con Wolf. Panni Cera senza / olio. Verniciata con ova poi con Wolf' (Cormack 1968–70, p. 169: Ledgers, 2, f.178.r).
- 94 Cormack transcribes 'Brim' as 'Brion...'. (Cormack 1968–70, p. 169: Ledgers, 2, f.178.v). Haydon 1960–3, vol. 5, p. 580.
- 95 Cormack 1968–70, p. 169. Haydon 1960–3, vol. 5, p. 579. The inscription on the canvas is partially covered by paint and so reads 'wolfs va...'. 'Mr Wolff' is likely to be the chemist Peter Woulfe (1727–1803) who also was in contact with Josiah Wedgwood around this time (information provided by Matthew Hunter).
- 96 '... e poi tutto verniciato con colori in polvere senza olio e magilp' (Cormack 1968–70, p. 141). Eastlake (Eastlake 1847, vol. 1, p. 540) suggests that the varnish would have been mastic and that the pigments may have been spread in a dry state onto the varnished surface or simply mixed with the varnish. Reynolds refers to the sitter as 'Speaker' in this note as Sir John Cust was Speaker in the House of Commons (Mannings 2000, p. 157).
- 97 Malone 1798, vol. 1, p. lv.
- 98 Dossie 1758, vol. 1, pp. 8–9 and 162–5.
- 99 Reynolds makes a distinction in his 'Technical Notes' between carmine and lake, presumably on the basis of the intensity of colour achieved by the manufacturing process and the cost of the pigment. At this date, both would have been derived from cochineal. See Kirby, Spring and Higgitt 2007.
- 100 Harley 1982, pp. 99–100.
- 101 'Sir Joshua was ever careful about procuring unadulterated articles of every sort, and has often desired me to inform the colour-man, that he should not regard any price that might be demanded, providing the colours were genuine' (Northcote 1818, vol. 2, p. 22).
- 102 Letter from Reynolds to Lord Barrington, 24 June 1780: 'In regard to the Admiral's picture, I could scarce believe it to be the picture I painted, the effect was so completely destroyed by the green sky. This was occasioned by a blunder of my colourman, who sent blue verditer (a colour which changes green within a month), instead of ultramarine, which lasts forever. However I have made such a background now as I think best corresponds with the head, and sets it off to the best advantage.' (Ingamells and Edgcumbe 2000, pp. 231–2). The painting is now in the collection of the Royal Museums Greenwich (Mannings 2000, cat. 120, fig. 1306).
- 103 Thomas Bardwell (Bardwell 1756, p. 17) defines 'Murrey' as a 'principal Teint [tint] composed of 'Indian Red, White, and a little Black, mixt to a kind of Purple, of a Middle Teint'. The origin of the name may be 'morello'.
- 104 William Mason commented that the face of Lord Holderness faded but his robes, which were glazed with lake, remained coloured. W. Mason, 'Anecdotes of Sir Joshua Reynolds Chiefly Relative to His Manner of Colouring' in Cotton 1859a, pp. 50–1. See also Brett et al. 2011.
- 105 Northcote 1818, vol. 2, p. 18.
- 106 Whitley 1928, vol. 1, pp. 368–9.
- 107 Morrison 2010, p. 125.
- 108 W. Mason, 'Anecdotes of Sir Joshua Reynolds Chiefly Relative to His Manner of Colouring' in Cotton 1859a, p. 54.
- 109 From microscopical examination of samples, and micro-chemical tests, specimens of yellow ochre in eighteenth-century paint samples seem sometimes to have been improved in colour by the addition of yellow organic dyestuffs. No formal identification of these dye materials has been undertaken, but the method may relate to the preparation of yellow lake type pigments with unreactive substrates such as chalk or gypsum.
- 110 Reynolds refers to 'yeos lake' and 'Yeos yellow' in the 'Technical Notes': Cormack 1968–70, p. 141: Ledgers, 1, f.52.v and f.53.r. Yeo's yellow is a yellow lake made by Richard Yeo (M. Kirby Talley, "All Good Pictures Crack": Sir Joshua Reynolds's Practice and Studio' in London and Paris 1985–6, p. 65, and Haydon 1960–3, vol. 5, p. 575). It appears that Richard Yeo made both red and yellow lake pigments. Alongside his collection of coins and medals, both red and yellow lakes, as well as a box of cochineal, were sold at auction in 1780, following his death (Langford 1780, pp. 7–8).
- 111 One such recipe for a yellow lake of this type is given in Dossie 1758, vol. 1, p. 96.
- 112 We are grateful to Janet Ambers and Andrew Meek at the British Museum for conducting the Raman analysis. Comparison was made with spectra of a National Gallery Scientific Department nineteenth-century specimen labelled 'Roberson' and 'patent yellow', identified as genuine patent yellow by A. Roy in 1984 using X-ray powder diffraction analysis (unpublished; powder pattern Ref. 152a, 5 March 1984). A patent had been granted to James Turner for the manufacture of patent yellow in 1781, some few years before

the date of this painting. However, the pigment had been in existence in England for some time before this date. See also Pisareva 2005.

- 113 Morrison 2010, pp. 122–3 and 125.
- 114 Roy and Berrie 1998.
- 115 R. Jones, 'Sir Joshua Reynolds, *The Age of Innocence*, c. 1788' in Hackney, Jones and Townsend 1999, p. 63.
- 116 Ingamells and Edgcumbe 2000, p. 136. R. Jones, 'Sir Joshua Reynolds, *The Age of Innocence*, c. 1788' in Hackney, Jones and Townsend 1999, p. 63.
- 117 The only other identification of this pigment in the work of eighteenth-century British School artists appears in paintings that were completed in India.
- 118 Analysis was carried out by Raymond White in 1986. A series of peaks for hopanes with a base mass of 191 were detected, indicating that a bituminous material was present. A small amount of dehydroabietic acid and some 7-oxo dehydroabietic acid were also detected in addition to the partially heat-bodied linseed oil. See Mills and White 1987, pp. 94–5, and Egerton 1998, p. 210.
- 119 M. Kirby Talley, "All Good Pictures Crack": Sir Joshua Reynolds's Practice and Studio' in London and Paris 1985–6, pp. 63–4.
- 120 White is mentioned twenty times as either 'white' or 'biacca'.
- 121 W. Mason, 'Anecdotes of Sir Joshua Reynolds Chiefly Relative to His Manner of Colouring' in Cotton 1859a, p. 51.
- 122 Northcote 1818, vol. 1, p. 78.
- 123 W. Mason, 'Anecdotes of Sir Joshua Reynolds Chiefly Relative to His Manner of Colouring' in Cotton 1859a, p. 52.

CAT. 1

Captain Robert Orme

- 1 Egerton 1998, p. 206.
- 2 Egerton 1998, p. 208. David Mannings has suggested that the figure's pose is derived from an Apollo. Mannings 2000, vol. 1, p. 358.
- 3 In a survey of 204 paintings by Reynolds this was the earliest example of twill-weave canvas. See note 9 in 'Practice Makes Imperfect: Reynolds's Painting Technique' in this present volume, p. 98.
- 4 Coccoliths indicate natural calcium carbonate.
- 5 Although Egerton (Egerton 1998, p. 208) comments that the articulation of the shoulder is not entirely successful, Reynolds must have been pleased with the stance of the sitter as he repeated it, almost without change, in the portrait of Nehemiah Winter (Southampton City Art Gallery, 113.5 × 137.5 cm) some three years later, in 1759. Hallett 2014, pp. 170–2.
- 6 White and Pilc 1995, p. 90.
- 7 SEM–EDX of the lake substrate found Al, small S, Ca and K. FTIR showed hydrated alumina with very little sulphate. Kirby, Spring and Higgitt 2007, p. 88.

CAT. 2

The 4th Duke of Queensberry ('Old Q') as Earl of March

- 1 Mannings 2000, vol. 1, p. 169, and Cormack 1968–70, p. 128; Ledgers, i, f.24.r.
- 2 Ingamells 1985, p. 163.
- 3 The presence of both calcium carbonate and lead white was confirmed by FTIR microscopy and SEM–EDX analysis. The

binding medium of the ground was identified by GC–MS analysis.

- 4 FTIR microscopy confirmed that the translucent interlayer was a proteinaceous material, presumably glue size.
- 5 Ingamells 1985, p. 162. There is a note dated July 1946 in the Wallace Collection object file, transcribed from the records of W. Holder and Sons, stating that the painting was 'Patched, repaired and varnished for the Collection by Mr Vallance'.
- 6 In Joseph Wright 'of Derby's' account book there are instructions for lining a canvas using the cold paste method. The lining canvas is first strained and the paste is applied on the canvas and the back of the painting before the two are brought together and the paint surface is rubbed all over. See Jones 1991, p. 20, and Hodkinson and Child 1995, p. 42.
- 7 For stretchers of a similar construction see Campbell 2011 and Wyld and Thomas 1986, p. 29.
- 8 Much of this restoration along the wide cracks was removed in the recent conservation treatment.
- 9 For example, a note relating to Miss Kirkman(?) states 'Gum Dr. et Whiting / poi cerata poi ovata poi verniciata e retocata / cracks.' (Gum tragacanth and whiting, then waxed then varnished with egg then varnished and retouched. Cracks.) (Cormack 1968–70, p. 168; Ledgers, ii, f.178.r). For translation see Dubois 1992–3, Appendix I. James Northcote also mentions, in a letter to his brother dated 23 August 1771 (Royal Academy, NOR4), the fact that paintings cracked while still in Reynolds's studio: 'this method of his has an inconvenience full as bad which is that his pictures crack, sometimes before he has got them out of his hands'.
- 10 There is a payment recorded in the Duke of Queensberry's account at Coutts from the Duke of Queensberry to 'J. Reynolds' on 23 February 1780 for £7 14s, although there is no indication as to what this payment was for. In the ledgers (Cormack 1968–70, p. 151; Ledgers, ii, f.17.r), a payment on 28 November 1783 'For mending a picture' is recorded as £5. Thanks to Assistant Archivist Isobel Long at Coutts for looking through the Duke of Queensberry's accounts.
- 11 There was no question of removing the repaint in the recent conservation treatment since it probably dates from relatively early in the painting's lifetime and covers layers of original paint known to be severely cracked.
- 12 Identified by SEM–EDX analysis.
- 13 Analysis of the particles was carried out by SEM–EDX, giving spectra with a large peak for aluminium with only a small peak for sulphur. ATR–FTIR imaging of the same particles suggested that this is in the form of hydrated alumina. The extracted ATR–FTIR spectra from these particles are characterised by a broad band in the region of 1100–1040 cm⁻¹ and a further broad band at approximately 1630–1585 cm⁻¹. The spectra match well with library standards of hydrated alumina lake substrates prepared in the National Gallery laboratory.
- 14 Reynolds's 'Technical Notes' mention both 'lake' (assumed to be a red lake) and '*lacca giallo*' (presumably a yellow lake). Entries that stipulate 'Yeos yellow' may also refer to a yellow lake made by Richard Yeo. See M. Kirby Talley, "All Good Pictures Crack": Sir Joshua Reynolds's Practice and Studio' in London and Paris 1985–6, p. 65.
- 15 HPLC analysis identified the dyestuff as cochineal from the New World insect *Dactylopius coccus* Costa.
- 16 David Mannings (Mannings 2000, vol. 1, p. 169) suggests that the presence of Lord March's name in a list of pictures in Reynolds's ledgers for the week beginning 14 April 1760 may indicate that the painting was to be sent to, or returned from,

a drapery painter. John Ingamells (Ingamells 1985, p. 163) considered the robes to be the work of the studio. See M. Kirby Talley, ‘All Good Pictures Crack’: Sir Joshua Reynolds’s Practice and Studio’ in London and Paris 1985–6, pp. 57–8, for a discussion of the use of studio assistants and drapery painters.

- 17 Medium analysis was carried out by GC–MS.
- 18 The presence of a little methylated copalic acid in the GC–MS chromatogram suggests a Leguminosae resin. This has not been identified further but is perhaps either a hard copal or of the copaiba balsam type from the *Copaifera multijuga* Hayne species. Van der Werf, van den Berg, Schmitt and Boon 2000.

CAT. 3

Anne, 2nd Countess of Albemarle

- 1 Egerton 1998, p. 202. Mannings 2000, vol. 1, p. 287.
- 2 Egerton 1998, p. 202.
- 3 For a discussion of fading in the portrait and the fading of red lake pigments see Saunders and Kirby 1994.
- 4 Kirby, Spring and Higgitt 2007, p. 89. HPLC analysis was carried out by Jo Kirby in 1993 and identified the dyestuff as cochineal from the New World insect *Dactylopius coccus* Costa. Some additional peaks gave a suggestion of additional, although unidentified, components however, these may not be dyestuff related. SEM–EDX analysis of the cross-section identified aluminium as the major component of the red lake substrate, with medium amounts of sulphur. FTIR analysis indicated a hydrated alumina substrate in the paler areas with a suggestion of carmine bands and protein in the deeper pink parts.
- 5 For further discussion of fading in Reynolds portraits see Brett et al. 2011.
- 6 Kirby and Saunders 2004.
- 7 For further discussion of lead-tin-antimony yellow see Roy and Berrie 1998.
- 8 As with other paintings by Reynolds from this period the drying defects in the background are concentrated around the sitter’s face. See CAT. 2 and Brett et al. 2011.

CAT. 4

Miss Nelly O’Brien

- 1 Leslie and Taylor 1865, vol. 1, p. 213. Mannings 2000, vol. 1, p. 335.
- 2 Ingamells 1985, pp. 149–51.
- 3 Cusping is visible along all four sides, although it is less pronounced along the right edge.
- 4 Pigments identified by SEM–EDX. A small amount of zinc was detected in one earth particle.
- 5 SEM–EDX analysis was carried out by Gabriella Macaro, Scientific Department, The National Gallery.
- 6 The prints were made by Charles Phillips (24 August 1770), Samuel Okey and S.W. Reynolds. See Mannings 2000, vol. 1, p. 355.
- 7 HPLC analysis identified the dyestuff as cochineal from the New World insect *Dactylopius coccus* Costa. SEM–EDX analysis of the cross-section confirmed the presence of vermilion and bone black and identified aluminium as the major component of the red lake substrate, with only small amounts of sulphur, calcium and phosphorus, suggesting that the substrate of the lake is hydrated alumina with very little sulphate present. For

further discussion of the manufacture of eighteenth-century lake see Kirby, Spring and Higgitt 2007.

- 8 Pigment identification by SEM–EDX analysis. Some calcium was also detected in this layer, which may be present as calcium carbonate.
- 9 The uppermost layer, which appears dark under ultraviolet light, is probably not part of the original build-up since it appears to run into a crack in the lower layers. SEM–EDX analysis suggests this is most likely to be a layer of deposited dirt.
- 10 van der Werf, van den Berg, Schmitt and Boon 2000. The detection of the methyl ester of 16 β -kauran-19-oic acid, along with small amounts of the dimethyl ester of pinifolic acid, suggests that a copaiba balsam from the *C. Langsdorffii* L. species is present in the sample.
- 11 The ratio of palmitic and stearic acids in this sample falls near to the boundary between walnut and poppyseed oil, but was significantly higher than in any of the other samples analysed, which may suggest a difference in the type of oil used for this passage.

CAT. 5

Mrs Susanna Hoare and Child

- 1 Mannings 2000, vol. 1, p. 258.
- 2 The child is probably Mrs Hoare’s eldest daughter. Ingamells 1985, pp. 141–2; Duffy and Hedley 2004, p. 354; Mannings 2000, vol. 1, p. 258.
- 3 Mannings 2000, vol. 1, p. 258.
- 4 At 53 × 42½ in. (134.5 × 107.8 cm), the canvas is between the standard sizes of a half-length (50 × 40 in.; 127 × 101.6 cm) and a bishop’s half-length (56 × 45 in.; 142.2 × 114.3 cm). Some cusping is visible along the vertical edges and the ground layer extends slightly beyond the paint layers at the upper edge. It does not appear that the dimensions of the painting have been significantly altered.
- 5 Pigment analysis was carried out by SEM–EDX. The presence of both lead white and calcium carbonate was confirmed by FTIR microscopy.
- 6 It is possible that Reynolds may have been influenced by Allan Ramsay who was known for underpainting his faces in a red. See Jones 2013 for a discussion of Ramsay’s technique. Joseph Wright ‘of Derby’ also used a reddish brown undermodelling in some portraits from around 1770, such as *Thomas Staniforth of Darnall, Co. York* (Tate, T00794). See Jones 1991.
- 7 Pigment identification by SEM–EDX.
- 8 Interestingly, there is no evidence of any priming layer on the related sketch in Boston.
- 9 Mannings 2000, vol. 1, p. 258.
- 10 Rhona MacBeth (Eijk and Rose-Marie van Otterloo Conservator of Paintings and Head of Paintings Conservation at the Museum of Fine Arts, Boston) kindly provided a tracing of the unfinished painting.
- 11 Gent, Morrison and Jones 2014, pp. 125–6.
- 12 Analysis by SEM–EDX. Two colourless particles in the mixture gave EDX spectra with substantial peaks for aluminium and may suggest that a little lake pigment was also included.
- 13 A higher palmitate to stearate ratio was obtained from the sample of white paint from the drapery than from any other sample. While this was still within the range expected for walnut oil it is possible that a mixture of oils is present, perhaps including some poppyseed oil.
- 14 FTIR microscopy of the blue glaze identified Prussian blue and

suggested the presence of a natural resin.

- 15 In some paint samples, traces of both pine resin and mastic resin were detected by GC–MS, although only at very low levels. However, both resins are present in the varnish layers and it seems most likely that these components represent a little varnish contamination, although similar materials could be present in glazes or interlayers. No other types of resin were detected in any of the paint samples analysed.

CAT. 6

The Strawberry Girl

- 1 This portrait is also known as ‘The Girl with a Muff’. The identity of the sitter is not certain but it is believed to have been painted in 1767, although it may have been repainted at a later date. See Mannings 2000, vol. 1, p. 363, cat. 1391.
- 2 Ingamells 1985, pp. 151–2. For further descriptions of the ‘type A’ and ‘type B’ versions see Martin Postle in Mannings 2000, vol. 1, p. 564.
- 3 Mannings 2000, vol. 1, p. 565. An engraving was made by Samuel Cousins after this version, but not until 1873.
- 4 For discussion of *The Age of Innocence* see R. Jones, ‘Sir Joshua Reynolds, *The Age of Innocence*, c. 1788’ in Hackney, Jones and Townsend 1999, pp. 60–5. Examination of the X-ray image of *The Age of Innocence* in comparison with the Wallace Collection X-ray suggests that the concealed version of *The Strawberry Girl* was closer to a ‘type A’ composition. See also Gent, Morrison and Jones 2014.
- 5 The Bowood House *Strawberry Girl*, *Theophila Palmer* and *The Age of Innocence* are also all bust-length canvases.
- 6 Pigment analysis was carried out by SEM–EDX.
- 7 For further discussion see Gent, Morrison and Jones 2014.
- 8 The outline of the large rock behind the girl was also altered and the tuft of grass at the edge of the rock was painted out.
- 9 For example, the small preparatory sketch of Elizabeth, Duchess of Buccleuch, and her daughter, 1772 (Duke of Buccleuch and Queensberry, Bowhill, D162), where the folds of the drapery have been indicated and the limbs and hands outlined. See Mannings 2000, vol. 1, p. 406, cat. 1584.
- 10 Northcote 1818, vol. 2, p. 7.
- 11 There are three lining canvases attached to the original canvas. These all appear to be linen attached with a glue paste adhesive. The earliest lining canvas has had the tacking margins removed and is visible at the edges of the original canvas. The two subsequent lining canvases appear to have been attached at the same time. There are a large number of tacks visible in the X-ray, which probably indicates that the stretcher was reused when the painting was relined the second time.
- 12 There is no reserve left for the bow on the Bowood House painting and the blue ribbon has been painted over the textured drapery paint.
- 13 For provenance of the picture see Ingamells 1985, p. 152.
- 14 Analysis of the varnish layers by GC–MS identified fir balsam and some mastic resin. A little oil may be present in some of the varnish layers, although this does not seem to be a major component of the varnishes. It is not possible to determine the distribution of the two resins within the different varnish applications.
- 15 It is interesting to note that there is a marked difference between the white paint of the apron and the ochre-coloured skirt in the Bowood House picture. In addition, a cross-section sample from the lower edge of *The Age of Innocence* suggests

that the underlying *Strawberry Girl* image had a pink skirt.

- 16 Pigments identified by SEM–EDX analysis. One particle of earth pigment contained a little manganese, indicating a little umber may be included in the mixture.
- 17 SEM–EDX analysis of these particles indicated that they contain mainly aluminium with a little sulphur. The ATR–FTIR spectrum obtained from the same particles is consistent with a hydrated alumina substrate.
- 18 In the article Gent, Morrison and Jones 2014 it was postulated that the glaze layer contained a faded red lake. However, further study and comparison with other pictures in this project suggests that a mixture of lakes is a possibility and the presence of a yellow lake cannot be ruled out.
- 19 For example, ‘Yellow lake and Naples mixed with the varnish’. Cormack 1968–70, p. 141; Ledgers, i, f.52.v.
- 20 The large fluorescent particle visible in the UV light image of the cross-section illustrated in FIG. 06.12 was identified by ATR–FTIR as a proteinaceous material. The type of protein has not been identified and the significance of this finding is unclear. No other particles of this type have been observed.
- 21 Cormack 1968–70, p. 168; Ledgers, ii, f.177.v.

CAT. 7

Lady Cockburn and her Three Eldest Sons

- 1 Mannings 2000, vol. 1, p. 137.
- 2 Egerton 1998, p. 215.
- 3 Egerton 1998, pp. 210–13.
- 4 Interestingly the bishop’s half-length (56 × 45 in.) is the standard size closest to the dimensions of Van Dyck’s *Charity*: 148.2 × 107.5 cm (58 × 42 in.).
- 5 Egerton 1998, p. 210.
- 6 It has been noted that the later pictures often contain vermilion in the flesh tones. Even if a fugitive red lake is also present, the loss of colour in that component of the mixture is less noticeable and the overall colour appears better preserved.
- 7 Close examination of these areas showed a slight beading of dark surface layers in places, which could relate to the inclusion of bitumen.
- 8 Northcote 1818, vol. 1, pp. 29–30.
- 9 Mills and White 1987, p. 94.
- 10 See note 9 in ‘Practice Makes Imperfect: Reynolds’s Painting Technique’ in this present volume, p. 101. Recent analysis by Nelly von Aderkas, Scientific Department, The National Gallery, of a sample of the thick, brown glaze layer on yellow drapery, above the date on the left-hand side, gave partial evidence for asphalt/bitumen in this layer, but the results did not provide definitive proof of its presence. Small peaks at R_T 23.27, 23.7, 26.35 and 26.4 min had a base peak of m/z 191, a fragment mass that can be used to identify hopanes. However, these peaks did not have the correct (approximate) retention times nor did their mass spectra have the correct molecular weight, especially when compared to a reference sample of asphalt. It is not clear whether these peaks represent fragments of hopane molecules, or whether these B^+ 191 peaks come from another molecule. Further evidence for asphalt was the presence of a B^+ 253 peak, which is suggestive of a C-ring monoaromatic sterane compound, another marker for asphalt.
- 11 Orpiment was originally identified by SEM–EDX at the time of cleaning, and reconfirmed for this study.

CAT. 8

Miss Jane Bowles

- 1 Oldfield Bowles (1739–1810) was a keen amateur artist and was taught landscape painting by Thomas Jones. Bowles's *Landscape with a small Lake and a Tower* is in the collection of the Ashmolean Museum (WA1845.51). His *Self Portrait in Van Dyck Dress at an Easel* is in the National Trust collection at Clevedon Court.
- 2 Leslie and Taylor 1865, vol. 2, pp. 134–5.
- 3 Mannings 2000, vol. 1, pp. 101–2.
- 4 There is cusping along both the sides and the upper edge, but not along the lower edge. The tacking margins have been removed, probably when it was paste lined in the mid-nineteenth century but the dimensions of the painted surface are little changed.
- 5 Medium analysis of the ground was carried out by GC–MS. SEM–EDX confirmed the presence of both lead and calcium.
- 6 Adjustments have also been made to the overskirt on the left side near the sitter's waist and below the sharply shadowed folds lower down.
- 7 One dash of black paint was added to the proper left eye, which registers in the infrared reflectogram.
- 8 'July 29th 1768- *in vece di nero. Si puo servire di Turchino e cinabro-e Lacca Giallo- probatum est.*' Cormack 1968–70, p. 141.
- 9 Much of the shadowing on the drapery has also been painted without black pigment and so the appearance of the folds is much less defined in the infrared reflectogram than in the finished painting.
- 10 Smalt has also been identified, added to the drapery paint in small quantities, in *Mrs Susanna Hoare and Child* (CAT. 5), *The Strawberry Girl* (CAT. 6) and *Mrs Mary Robinson ('Perdita')* (CAT. 14).
- 11 Identified by SEM–EDX analysis.
- 12 The upper varnish was identified by GC–MS analysis as a synthetic cyclohexanone resin, probably AW2, which was presumably applied in the documented conservation treatment carried out in 1953. This layer of varnish may also include a little beeswax and possibly some heat-bodied linseed oil. GC–MS analysis of the older varnish layers identified both mastic resin and pine resin, probably again with some oil, although the type has not been determined. Traces of fir balsam have also been identified, which appear to relate to the remnants of fluorescent layers over the surface rather than paint and are likely to be connected with an old varnish layer. All of the paint samples analysed contained trace quantities of methylated eperuic acid. This was not detected in any of the samples of varnish and may indicate that trace quantities of a Leguminosae resin are present in some of the paint layers. However, the quantities detected were so low that it is difficult to assess the significance of this finding.
- 13 GC–MS analysis detected trace quantities of the characteristic norambrienolide component, possibly indicating that traces of fir balsam were also present in addition to the pine resin, although comparison with the other results suggests that this is more likely to relate to traces of a later surface coating.
- 14 GC–MS analysis identified a substantial peak for (iso) masticadienoic acid methyl ester, a component normally observed in fresh mastic resin. This was not identified in the samples of varnish and may indicate that there is some mastic resin present in a lower layer which, having been covered with additional paint layers, has not been oxidised to the same degree.

- 15 GC–MS analysis of several samples of this layer detected long chain fatty acids and hydrocarbons in relative proportions consistent with beeswax.
- 16 An earlier entry also relates to the portrait of Mrs Montague and states '*Olio e cera / Asphaltum nero. e cinabro*', meaning that the painting was begun in oil and wax using the pigments asphalt, black and vermilion. Cormack 1968–70, p. 169: Ledgers, ii, f.178.v.
- 17 Separating the individual glaze and varnish layers for analysis has not been possible, but the difference in fluorescence may indicate that the glazes are richer in oil, containing less resin.

CAT. 9

Mrs Elizabeth Carnac

- 1 Ingamells 1985, p. 146. See also Reynolds's portrait *Georgiana, Duchess of Devonshire*, c.1775–6, The Huntington Art Collections, San Marino, California, 25.20.
- 2 The proof impression is now in the British Museum (1830.0612.2).
- 3 Ingamells 1985, pp. 145–6.
- 4 The canvas is a standard full-length size and there is cusping at the left and right edges but not at the top and bottom. Although the tacking margins have been cut off during lining, the canvas does not appear to be reduced. The lack of cusping at two edges probably indicates that the canvas was prepared with ground before being cut to size. The stretcher is contemporary with the glue lining and bears the stamp 'W. MORRILL LINER' and a pencil inscription 'Mr Buttery 75'. This information was supplied by Simon Bobak at Ebury Street Studio, who strip lined and restretched the canvas in 2010. FTIR microscopy of the ground identified both calcium carbonate and lead white.
- 5 All the cross-section samples were taken and prepared by Libby Sheldon (independent consultant) during the recent conservation treatment. She kindly shared her report with us and allowed us to study the samples. A similar ground, also including a little blue pigment, was observed on *Frances, Countess of Lincoln* (CAT. 12b), which dates from a few years later. Blue particles were also visible in the ground of *Mrs Mary Nesbitt* (CAT. 11), although here some red earth pigment was also present in the mixture.
- 6 For comparison, see the looser painting style of the drapery in *Georgiana, Duchess of Devonshire* (note 1) and *Lady Bampfylde* (Tate, London, N03343), which are more likely to be the work of Reynolds's own hand.
- 7 It is not completely clear whether this pentimento relates to an extra ostrich feather or simply that the existing pink feather was longer.
- 8 The painting was restored by Anna Sanden at Ebury Street Studio, who kindly allowed access to the painting for sampling during treatment and generously shared her observations.
- 9 The resin has not been fully characterised but GC–MS analysis of these samples detected a series of peaks, all with a base mass of 121. Small amounts of dimethyl pinifolate were present. The other components have not been identified but are likely to be labdane esters characteristic of resins from the Leguminosae family.
- 10 The pigments were identified by FTIR microscopy.
- 11 GC–MS analysis detected methylated eperuic acid, not observed in the samples from the fluorescent brushstrokes, along with small quantities of dimethyl pinifolate. The additional unidentified peaks were not present in these

samples. The results again point to the presence of a Leguminosae resin, although perhaps from a different source. The same components were identified in samples from *Mrs Mary Nesbitt* (CAT. 11) and *Frances, Countess of Lincoln* (CAT. 12b). See van der Werf, van den Berg, Schmitt and Boon 2000. This paper suggests that eperuic acid and pinifolic acid are stable marker compounds found in samples of copaiba balsam produced by *C. Langsdorfii* L. However, the absence of any components with a kaurane structure is inconsistent with the sample composition reported by the authors.

CAT. 10

Saint John the Baptist in the Wilderness

- 1 Mannings 2000, vol. 1, pp. 516–17, as *Child Baptist in the Wilderness*; Ingamells 1985, pp. 160–1.
- 2 Cormack 1968–70, p. 143; Ledgers, i, f.54. There is no date associated with this entry, but it is written on the back cover of the first ledger after a note on the previous page from 12 June 1770 referring to a landscape and before an entry for a portrait of Lady Melbourne, which is dated to 1770.
- 3 Dubois 1992–3, Appendix I, p. 8. Eastlake (Eastlake 1847, vol. 1, p. 542) interprets this to mean that the application of wax and copaiba over the wax alone caused the picture to crack and that this is contrasted with the following entry where the entire painting is in copaiba balsam and wax.
- 4 The transfer process is discussed in a letter dated 2 September 1935 from Kenneth Clark, Director of the National Gallery, to Captain Roberts-Wray at Kenwood House, in relation to Reynolds's portrait *Lady Louisa Manners*. (The letter is now in a conservation file for *Lady Louisa Manners* at English Heritage.) Clark states 'This is quite a different process from relining and I am sorry to say that it is a far more costly one, but it would finally settle the paint ... Not only is transferring costly, but it involves a certain amount of risk, and with a picture in such a condition it would probably mean losing a certain amount of the old paint.' Interestingly, *Lady Louisa Manners* was not transferred as the flaking was only in 'unimportant' parts of the painting, so the expense of transfer was not deemed necessary.
- 5 Details of treatment from Wallace Collection picture file.
- 6 A localised area of lifting was consolidated during examination at the National Gallery in 2012.
- 7 Thanks to Paul Ackroyd, Conservation Department, The National Gallery, for discussion of the transfer and the X-ray image.
- 8 Mannings 2000, vol. 1, p. 517, cat. 2040.
- 9 The presence of a little beeswax in each of these samples made the identification of the type of oil more difficult and the ratio of the fatty acids should be interpreted with caution. For the sample of foliage the P/S ratio fell near the boundary between linseed and walnut oil. The sample of flesh paint, however, gave a P/S ratio well within the range expected for walnut oil. The samples also included mastic resin and varying amounts of pine resin but since these materials were detected in the varnishes they may not relate to the medium of the original paint.
- 10 van der Werf, van den Berg, Schmitt and Boon 2000. This paper suggests that eperuic acid and pinifolic acid are stable marker compounds found in samples of copaiba balsam produced by *C. Langsdorfii* L. However, the absence of any components with a kaurane structure is inconsistent with the sample composition reported by the authors. These types of

resins are very varied in their composition and it is not possible to specify the source in this case. However, it is evident that a Leguminosae resin of some kind is present.

- 11 For example, *Mrs Elizabeth Carnac* (CAT. 9), *Mrs Mary Nesbitt* (CAT. 11) and *Frances, Countess of Lincoln* (CAT. 12b).
- 12 While fir balsam was not detected in the various samples of the upper varnish layers from this picture, it was observed in a sample of the brown glaze-like layers directly on the surface of the flesh paint. The status of these layers is ambiguous and may include original glazes, retouchings or older layers of varnish. Only traces of fir balsam were observed in the sample of the foliage paint.

CAT. 11

Mrs Mary Nesbitt

- 1 Stevenson 1994 and Coulter 1996.
- 2 Mannings 2000, vol. 1, pp. 350–1.
- 3 The Earl of Bristol's son contested the will but the court decided in Mrs Nesbitt's favour in 1781.
- 4 The sitter has been identified as Mrs Fox in relation to a print after Reynolds from 1825 by S.W. Reynolds which is titled 'Honble. Mrs C. J. Fox'. Two variations of this portrait exist, one in the Indianapolis Museum of Art (C10064), and a further version at Tate (N00891). Both paintings depict the sitter with her back facing the viewer and her head turned in strict profile, although in the Tate version the sitter is shown holding a child, who is glimpsed peeping out from over her shoulder and looking towards the viewer.
- 5 There are additional thick brushstrokes in the X-ray image towards the bottom of the oval that must relate to the initial design of the drapery since they cross the direction of the folds in the finished sleeve. These roughly correlate with the form of the draped shawl worn by Mrs Fox.
- 6 The dove was inserted once the portrait had been partially completed. John Ingamells (Ingamells 1985, p. 153) suggests that the dove was perhaps intended to rehabilitate Mrs Nesbitt's reputation, following the death of her protector.
- 7 Although a fictive painted frame would be somewhat archaic at this date, Reynolds continued on occasion, well into the 1780s, to use an oval format for bust-length portraits on rectangular canvases, such as the unfinished portrait of Archibald Montgomerie, 11th Earl of Eglinton, in the Royal Collection (405953).
- 8 Identified by SEM–EDX analysis. Some barium sulphate was also identified which seemed to be associated with the fine red particles and probably represents an impurity in the earth pigment.
- 9 One sample also shows a single black particle in the ground layer, which based on the microscopic appearance is likely to be charcoal.
- 10 Identified by GC–MS analysis. Large amounts of methyl dehydroabietate were detected with lesser quantities of the oxidation compounds. Small amounts of methyl seco-dehydroabietate type components were observed along with several constituents with a pimarane structure. These peaks are not normally seen in the analysis of varnish layers containing pine resin and suggest that the resin has not oxidised to the same degree. Some methyl sandaracopimaric acid was identified but only in similar quantities to the methyl pimaric acid detected. This is most likely to be a component of the pine resin but it is difficult to specify if a small amount of a Cupressaceae resin, such as sandarac, may also be present. A

little mastic was also identified in samples from the brown oval but this is likely to be connected to the later varnish layers.

- 11 van der Werf, van den Berg, Schmitt and Boon 2000. This paper suggests that eperuic acid and pinifolic acid are stable marker compounds found in samples of copaiba balsam produced by *C. Langsdorfii* L. However, the absence of any components with a kaurane structure is inconsistent with the sample composition reported by the authors. These types of resins are very varied in their composition and it is not possible to specify the source in this case. However, it is evident that a Leguminosae resin of some kind is present.
- 12 Pigment identification by SEM–EDX analysis.
- 13 GC–MS analysis again identified small amounts of methyl eperuate and dimethyl pinifolate along with several unidentified components which may be additional diterpenoid resin acids. The P/S ratio for this sample was on the boundary between linseed and walnut oil and so the type of oil in this sample cannot be confirmed.
- 14 Orpiment was also found in the mixed brown underlayer beneath the blue sky background.
- 15 Pigments identified by SEM–EDX analysis.
- 16 Starch was identified by ATR–FTIR imaging of the cross-section. Starch has also been identified in white-containing paint in the draperies of *Lady Elizabeth Seymour-Conway* (CAT. 12a) and *Mrs Jane Braddyll* (CAT. 16).
- 17 This was remarked upon by Mawson, the 4th Marquess of Hertford’s agent, when he purchased the painting in 1859. Ingamells 1981, p. 113.
- 18 Similar cracks can be seen in the X-ray image of the portrait *Lady Cockburn and her Three Eldest Sons* (CAT. 7).
- 19 There is no evidence in the infrared reflectogram or X-ray image that the area of the face was prepared differently from the surrounding parts. GC–MS analysis gave some indication that the drying of the oil has not proceeded in the normal way. In addition to the normal saturated fatty acids and di-acids, two isomers of the doubly unsaturated C18 fatty acid were also detected. These components usually react, cross-linking to form a polymerised network.

CATS 12a and 12b

Lady Elizabeth Seymour-Conway *Frances, Countess of Lincoln*

- 1 Cormack 1968–70, p. 155: Ledgers, ii, f.32.r.
- 2 Although this could have been connected to the payment Lady Lincoln made for the portrait of her daughter, which is recorded in the ledger in March 1782. See Mannings 2000, vol. 1, p. 136, and Cormack 1968–70, p. 158: Ledgers, ii, f.42.r.
- 3 The ‘Sitter Book’ for 1783 is lost. Mannings 2000, vol. 1, pp. 135–6 and 142.
- 4 There is cusping along the bottom edge of *Countess of Lincoln* that extends almost to the centre of the canvas; otherwise cusping is minimal along the other edges of both paintings. This probably indicates that the canvases were prepared as a larger piece and then cut to size, the wide band of cusping on the *Countess of Lincoln* canvas indicating that it was cut from the edge of the larger piece. Both canvases have had their tacking margins removed, probably when they were lined. The paste lining appears to date from the mid-nineteenth century, although there is no record of treatment in the Wallace Collection files.
- 5 Although this was not observed in the ground of *Lady*

Seymour-Conway, a similar mixture may have been used but the blue pigment added so sparingly that it is not evident in the few samples available.

- 6 GC–MS analysis identified heat-bodied linseed oil. Some mastic and pine resin were detected in the sample of ground but these resins may be connected with traces of surface varnish. No ground sample from *Lady Seymour-Conway* was available for GC–MS analysis.
- 7 The shoulder has also been narrowed and the sleeve made more fitted, no longer extending to the edge of the canvas as is visible in the X-ray image.
- 8 ATR–FTIR imaging of the cross-section suggested that the translucent layer contains both a resinous component and some oil. Peaks at ~ 1450 and 1380 cm⁻¹ are likely to relate to a natural resin and a band at ~1250 cm⁻¹ suggests this may be of a diterpenoid type. The peak at ~1170 cm⁻¹ is probably related to oil and the band at ~1710 cm⁻¹ with a shoulder at ~1730 cm⁻¹ indicates the presence of both acids and glyceride esters. In addition a band at ~1534 cm⁻¹ suggests that some lead soap is present in this layer.
- 9 The flowers have been created with a mixture of lead white and vermilion, with also a little black pigment and traces of Prussian blue. The rounded translucent particle in the upper pink paint was identified by ATR–FTIR analysis as starch. Similar grains of starch have been found in white-containing paint in the flesh of *Mrs Mary Nesbitt* (CAT. 11) and the drapery of *Mrs Jane Braddyll* (CAT. 16).
- 10 There is no evidence (although only a limited number of samples were taken) for the use of different oils in different passages as has sometimes been the case in other paintings in this study. Medium analysis was carried out by GC–MS.
- 11 It should be noted that paintings were often paid for long after they had been finished and Reynolds was paid for many portraits posthumously. However, the date of the payment and the later sittings for the *Countess of Lincoln*, together with the changes to the hair, seem to indicate that the paintings were completed in around 1784.
- 12 GC–MS analysis identified the same components in a sample of varnish. However, these resins seem to be present in the paint, since they were detected even when all traces of varnish had been removed and where the paint sample was taken from a lower layer only exposed after sampling the upper layers of paint.
- 13 The rounded translucent grain, visible in the brown layer beneath the blue paint at the centre of the sample, was identified by ATR–FTIR imaging as starch.
- 14 The extracted ATR–FTIR spectrum from the fluorescent interlayer contains peaks at ~ 1455 and 1385 cm⁻¹, likely to be associated with a natural resin.
- 15 GC–MS analysis identified long chain fatty acids and hydrocarbons in relative amounts typical of beeswax. A possible trace only of beeswax was detected in a sample of varnish, but it was detected in greater quantities in the two samples of paint where the surface varnish was not present.
- 16 van der Werf, van den Berg, Schmitt and Boon 2000. This paper suggests that eperuic acid and pinifolic acid are stable marker compounds found in samples of copaiba balsam produced by *C. Langsdorfii* L. However, the absence of any components with a kaurane structure is inconsistent with the composition reported by the authors. These types of resins are very varied in their composition and it is not possible to specify the source in this case. However, it is evident that a Leguminosae resin of some kind is present. The same compounds were detected in samples from *Mrs Mary Nesbitt*

(CAT. 11), also painted in 1781.

- 17 ATR–FTIR imaging of the sample suggested that the glaze layer has a resinous medium.
- 18 FTIR microspectroscopy suggested that the particles of red lake have a sulphate-containing hydrated alumina substrate.

CAT. 13

Colonel Tarleton

- 1 Egerton 1998, pp. 220–3.
- 2 Egerton 1998, pp. 218 and 224. Mannings 2000, vol. 1, pp. 439–40.
- 3 Mills and White 1977, p. 59.
- 4 Spectral lines for arsenic in a sample of yellow pigment were recorded in 1977 by emission spectrography using the LMA technique (spectral plate no. 92). Pigment particles were microscopically characteristic of orpiment. The analytical results indicated that earth pigments were also present in the sample.
- 5 Egerton 1998, pp. 218–20.
- 6 Morrison 2010, pp. 120–1. The medium of the brown paint from the horse's neck was identified as heat-bodied linseed oil with both pine and mastic resins. In addition, a trace quantity of methylated copalic acid was also detected suggesting that an additional resin from the Leguminosae family, such as a copaiba balsam or a hard copal, may be present.
- 7 A further sample of brown paint showing evidence of drying cracks was taken near to the sitter's proper left foot and GC–MS analysis was carried out by Nelly von Aderkas, Scientific Department, The National Gallery. No trace of hopanes, characteristic of asphaltum, could be detected. The medium was identified as heat-bodied linseed oil with pine resin. Although no copalic acid was detected in this sample a small quantity of an oxygenated labdane derived component was observed, again indicating that a Leguminosae resin was present. This was assigned as 18-hydroxy-ent-labdane-8(20)-en-15-oate by comparison with mass spectra published by Steigenberger. See Steigenberger 2013.
- 8 Egerton 1998, p. 220 and fig. 1.
- 9 Egerton 1998, pp. 223–4, fig. 5.

CAT. 14

Mrs Mary Robinson ('Perdita')

- 1 The Prince Regent, later King George IV (1762–1830; reigned 1820–30).
- 2 Mannings 2000, vol. 1, pp. 393–4.
- 3 The tacking margins have been removed during lining, and the cuts have been made slightly into the picture plane, but the dimensions remain very close to a standard bust-size canvas and the image seems not to have been significantly reduced. Cusping is visible at the lower edge and less prominently at the left edge. Only minimal cusping is visible at the other edges, which may indicate that the canvas was prepared in a larger format before being stretched to the standard size.
- 4 Pigment identification was carried out by SEM–EDX analysis. As in the other grounds in this study, the calcium carbonate is present as large irregular particles with some curved needle-like inclusions, suggesting the source may be a natural form of chalk. Analysis by transmission FTIR microscopy identified lead white in both basic and neutral forms of lead carbonate:

hydrocerussite and cerussite.

- 5 The painting may be lot 3 in Reynolds's sale at Greenwoods in 1796. Mannings 2000, vol. 1, p. 394.
- 6 Birch also produced an enamel copy of the painting.
- 7 Birch c.1800, p. 5.
- 8 Some of the unfinished paintings were completed by Reynolds's assistant, Giuseppe Marchi. James Northcote stated that after Reynolds's death Marchi 'completed, as well as he was able, several pictures which Reynolds had left unfinished'. Northcote 1818, vol. 1, p. 57. However, this does not appear to be the case for the portrait of Mrs Robinson.
- 9 Farington 1978–84, vol. 1, p. 153: 1 February 1794. The portrait of the Duchess of Gordon was in the studio on Reynolds's death.
- 10 Similar broad brushstrokes are also visible at the opposite shoulder and under the proper left arm, again probably relating to the initial marking out of the position of the figure.
- 11 Similar reserves are present along the top of the proper left shoulder and the profile of the face, which originally had a higher more vertical shape to the forehead.
- 12 Some adjustments were also made to the hair by painting out a long falling lock of hair or ribbon that extended from the crown of the head and by enlarging the curl next to the sitter's ear. The trailing curls at the back of the sitter's head were also extended further across the shoulder, and the earlobe, which was initially painted in, is now partially obscured by the addition of more soft wisps of hair.
- 13 This painting was recently restored by Mark Aronson, Chief Conservator, Yale Center for British Art, who kindly shared his research with us during the course of this project.
- 14 SEM–EDX analysis also identified a particle of ilmenite, presumably an impurity in the earth pigment.
- 15 SEM–EDX analysis of the pale yellow particles detected mainly lead with small amounts of chlorine and a little silicon. Raman microscopy was kindly carried out by Janet Ambers and Andrew Meek at the British Museum. The largest particles gave a Raman spectrum similar to that from a reference standard manufactured by Roberson. X-ray diffraction analysis of the Roberson sample has confirmed that it is the true form of the lead oxychloride pigment (PbCl₂·5-7PbO). See also note 112 in 'Practice Makes Imperfect: Reynolds's Painting Technique' in this present volume, p. 100.
- 16 Pigments identified by SEM–EDX analysis.
- 17 No additives were detected that could explain the more pronounced drying defects visible in this area, which may simply be a product of the use of a less well drying pigment.
- 18 Medium analysis was carried out with GC–MS.
- 19 van der Werf, van den Berg, Schmitt and Boon 2000. The authors of this paper have suggested that copalic acid is one of the stable marker compounds for copaiba balsams of the *Copaifera multijuga* Hayne species. However, the lack of any additional labdane esters detected by GC–MS in these samples makes it difficult to positively identify the source of this resin and it is possible that a type of hard copal from the Leguminosae family rather than a copaiba balsam may have been used.
- 20 Traces of a brown layer trapped in the paint texture are certainly present over much of the background.

CAT. 15

Lord Heathfield of Gibraltar

- 1 Mannings 2000, vol. 1, pp. 180–1.
- 2 Egerton 1998, p. 231.
- 3 Morrison 2010.
- 4 Egerton 1998, p. 231.
- 5 The presence of lead-tin-antimony yellow is unusual in a painting of this date as Naples yellow would have been used more commonly. However, the same pigment was also identified in *Anne, 2nd Countess of Albemarle* (CAT. 3). For further discussion of lead-tin-antimony yellow see p. 42, and Roy and Berrie 1998.
- 6 Morrison 2010.

CAT. 16

Mrs Jane Braddyll

- 1 Mr Braddyll was a Groom of the Bedchamber to the Prince and seems to have been given the portrait, for which 50 guineas had been paid sometime between 6 May 1786 and February 1790. Mannings 2000, vol. 1, p. 216, and Cormack 1968–70, p. 167; Ledgers, ii, f.81.r. The portrait of Mr Wilson Gale Braddyll was examined in the Conservation Department of the National Gallery. Access was provided with the permission of the owner, courtesy of Philip Mould & Company.
- 2 Tree ring analysis was carried out by Ian Tyers (independent consultant). There was no match between the wood and other contemporary panels, although there is relatively little comparative data from this period.
- 3 The two central boards measure 21 cm (8¼ in.) in the vertical direction. The upper and lower boards measure 18.2 cm (7¼ in.) and 15.2 cm (6 in.) respectively.
- 4 Analysis by FTIR of the adhesive from the panel joins indicated a proteinaceous material, presumably animal glue.
- 5 A wooden button is not present at the top joint but residue from glue seems to indicate that originally this joint was also reinforced. There is no clear evidence that the joints were ever reinforced along the proper right side. Wooden buttons were also present only along the proper left side on the reverse of the portrait of Mr Braddyll.
- 6 The pendant portrait of Mr Braddyll is executed on an oak panel of similar construction with five horizontal boards

but the reverse of the panel was more roughly finished. No dendrochronology was undertaken.

- 7 GC–MS analysis of the preparatory layers also detected trace quantities of the labdane ester methyl pinifolate. This has been identified elsewhere in samples thought to contain copaiba balsam. However, the tiny quantities detected here and the absence of any other marker compounds mean the presence of a copaiba balsam type resin cannot be confirmed in this case.
- 8 This is advised rather than the more common practice of applying an initial layer of chalk and glue size, which Dossie comments can be susceptible to flaking. Dossie 1758, vol. 1, pp. 203–4.
- 9 Identified by SEM–EDX analysis.
- 10 GC–MS analysis of a sample of ground identified heat-bodied linseed oil. The sample also contained a proportion of both pine and mastic resins, but since it was not possible to fully separate the ground from traces of the overlying medium-rich paint or from the sealing layer underneath, it is most likely that these components are not related to the ground layer. However, it is not possible to rule out the addition of some resin to the binding medium of the ground.
- 11 The presence of starch has often been associated with high-tinting-strength pigments such as Prussian blue or red lake but this does not seem to be the case here. Starch has also been identified, for example, in white-containing paint in the flesh of *Mrs Mary Nesbitt* (CAT. 11), in the drapery of *Lady Elizabeth Seymour-Conway* (CAT. 12a), in the sky of *Mrs Elizabeth Carnac* (CAT. 9) and in an underlying grey paint layer in *Saint John the Baptist in the Wilderness* (CAT. 10).
- 12 See CAT. 2, note 9, and CAT. 10 for references to cracking in Reynolds's 'Technical Notes'.
- 13 Pigments identified by SEM–EDX analysis.
- 14 Mastic was not detected in any of the samples of varnish and it is clear that this is a constituent of the paint medium. Analysis indicated that pine resin is the major component of the subsequent varnish layers, although there is good evidence to suggest that pine resin was also added in significant quantities to the paint medium. Care was taken to remove the varnish prior to sampling and the quantities of pine resin detected in the paint were relatively high.
- 15 The type of oil was determined by comparison of the ratios of the di-acids detected by GC–MS analysis.

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