Figure 3.11 Photograph of Corinthian-type Hoplite bronze helmet being analysed by synchrotron FT-IR microscopy in reflection mode, on Station 11.1, SRS, Daresbury, UK. To facilitate the analysis, the FT-IR microscope is fitted with the objective mounted on a side-arm port. The helmet is from the collections of the Manchester Museum in the University of Manchester, UK. (Photograph by courtesy of Manolis Pantos, Synchrotron Radiation Source, Daresbury Laboratory, UK. More details may be found on http://srs.dl.ac.uk/arch/)

Figure 5.1 Prehistoric rock paintings from Seminole Canyon, USA.
Figure 5.2  Prehistoric rock paintings from Seminole Canyon, USA.

Figure 5.4  Appearance of a typical rock art specimen, specimen no. 41VV576-5a, showing red, black and white pigments. Microscope objective 20× magnification.
(a) Reconstruction of the north wall of the cubiculum (AK); (b) Cross-section of plaster fragment from atrium (B); (c) Fragment of wall painting from room BC, containing Egyptian Blue; (d) Fragment of wall painting imitating marble, from garden pit.
Figure 7.1 Folio no 1 verso of the Beato de Valcavado representing the Cross of Oviedo. A to E show some selected areas from which spectra were taken from representative pigments. These spectra are presented in Figure 7.2. Note the lack of care in the colouration.

Figure 7.3 The Mapamundi on folios 36–37. Paradise with Adam and Eve can be seen as well as most of the regions and cities known at the time. The Euphrates and Tigris rivers separate the world, which is surrounded by the ocean.
Figure 7.4  The illumination of folio 59 verso. Microphotographs of the pigment microstructure (20x magnification) are also included. It is interesting to note the technique is much more precise than in the first folios. Green is obtained as a mixture of yellow (orpiment) and blue (indigo). Orange is a mixture of minium and cinnabar. The dark-grey tone is obtained with cinnabar and carbon soot.

Figure 7.5  The Baltasar banquet. Illumination was made using very pure materials. The admixtures used in the skin colour of the people were applied with great precision.
Figure 8.1  S. Giovanni Evangelista Abbey (Parma, Italy): detail of the wall painting by Parmigianino in the second chapel in the left nave.

Figure 8.2  Cross-section of a sample collected from a green paint layer of the Parmigianino wall painting (second chapel, S. Giovanni Evangelista Abbey). A = resin, B = paint layer, C = plaster.
Figure 8.4  Raman map of the cross-section of a white sample from the Anselmi fresco (sixth chapel, S. Giovanni Evangelista Abbey). The red colour relates to the 1005 cm\(^{-1}\) feature of gypsum, the green colour the 1085 cm\(^{-1}\) peak of calcite, while the blue colour is the 1095 cm\(^{-1}\) band of dolomite (magnesium and calcium carbonate). The dark parts correspond to the resin used to prepare the cross-section.

Figure 9.1  Experimental set-up showing measurements being made by the portable micro-Raman spectrometer on a 16\(^{th}\) century fresco in the church of S. Michele Arcangelo in Gornate Superiore (Varese, Italy) (a) Raman micro-probe fixed on the tripod; (b) frequency-doubled Nd-YAG laser source; (c) white light halogen source; (d) workstation.
Figure 8.7  Raman maps of the cross-section of a red sample from a fresco painted by Anselmi in S. Giovanni Evangelista Abbey, corresponding to the amount of litharge (yellow lead), minium (red lead) and cinnabar (vermilion). The amount of the mapped pigment is proportional to the brightness (white = highest amount, black = undetectable).
Figure 9.2  Detail of the fresco and Raman spectra obtained on differently coloured areas, in particular St. Roch’s red hat ($\lambda_0 = 785$ nm, power 50 mW) and light blue collar, the Holy Child’s white cloak and the black arc-shaped frame ($\lambda_0 = 532$ nm, 30 mW).

Figure 9.7  A tile with a red and black chess decoration ($6^{th}$–$5^{th}$ century BC) from the excavations of the Etruscan Tarquinia.
Figure 10.2  Reconstruction of the Thorsberg Robe which is estimated to be 1,600 years old and which was woven with yarn dyed with indigo obtained from woad.

Figure 12.2  The 18th century court mantua also known as the ‘Christie’s Dress’, seen from the back. V&A accession number T.260-1969.
Figure 12.4 A 16th century miniature of Elizabeth I, painted by Nicholas Hilliard. V&A accession number 4404-1857.

Figure 12.5 Left: the 16th century miniature of Elizabeth I, also known as the Drake Jewel, painted by Nicholas Hilliard. Right: the Drake Jewel opened, revealing the presence of small grey pebbles.
Figure 12.9  The portrait of Dudley, 3rd Baron North, early 17th century. V&A accession number P.4-1948.

Figure 13.7  Bowl analysed by Raman spectroscopy.
Figure 13.1  Schematic of the analysis of different parts of a ceramic: glaze, interphase and body. Shard excavated from Termez (Uzbekistan) and the spectra recorded from the surface into the body using a confocal Raman micro-spectrometer. 252/2-7 is the Registry number of the piece.
Figure 13.3  Plots of the area ratio of Si-O bending ($A_{500}$) and stretching ($A_{1000}$) envelopes derived from Raman spectra: (a) Enamel/glass; Key: gC, Carthage glass; Timour, Samarkand Bibi Khanum mausoleum; IDG, Islamic Dougga potteries; ITZ, Islamic Termez and Sind ceramics; SVR, Sèvres porcelains; IMRF, Islamic ceramics from Iran and Syria; VHL, Vietnamese Ha Lan celadon; VCL, Vietnamese Chu-Đầu porcelains; StC, Saint-Cloud porcelains; NG, modern hard-paste porcelains). (b) Different glasses from Punic/Roman times. (c) Different product from Chantilly (solid circles), Saint-Cloud (triangle symbols) and Mennecy (square symbols) factories.
Figure 13.4  Left, deconvolution of representative Raman spectra of the 13th century Ha Lan celadon after baseline subtraction. The different components are shown. In a modern copy (the lower spectrum) the narrow peaks of \(\alpha\)-wollastonite precipitate dominate. Right, spectral positions and relative areas of the components extracted from the Raman spectra recorded (solid squares) normal to the glaze surface and (solid triangles) across the shard section of 13th century Ha Lan celadon (* symbols) and 15th century Chu-Dâu porcelain (open circles).
Figure 15.1  Micro-photographs of ceramic samples from Tell Beydar. Images were acquired on cross-sections by a 20× magnification objective. (a) calcareous ware: view of the amorphous structure full of pores; (b) calcareous ware: image of a well-defined quartz crystal cemented in the glassy phase; (c) non-calcareous and (d) intermediate wares: the inner ceramic bodies reveal a quite similar amorphous structure wherein very small reddish features are present; (e) and (f) standard wares: vitrification is quite absent here in favour of an almost reddish crystalline structure.
Figure 16.5  *Qilakitsoq* ice-mummy (Grave 1, mummy no. 1); a six-month-old baby girl dating from 1475 AD. 
(Reproduced with permission from reference 16, M. Gniadecka *et al.*, John Wiley & Sons Ltd.)

Figure 16.9  *The Alpine Iceman*; a Neolithic ice-mummy dating from 5,200 years BP. 
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Figure 16.10  A hot-desert mummy; mummified body of a woman, light-brown pigmentation, from the Chiribaya Alta desert in Southern Peru, dating from 1,000 years BP.
(Reproduced with permission from reference 16, M. Gniadecka et al., John Wiley & Sons Ltd.)

Figure 16.12  Sarcophagi of the ‘Two Brothers’ from an Egyptian XIIth Dynasty burial, ca. 4,000 years BP; the coffin of the younger brother Nekht-Ankh is at the right, and Khnum-Nakht is on the left.
(Reproduced with permission from reference 18, S. Petersen et al., John Wiley & Sons Ltd.)
Figure 16.18  Roman ivory die, ca. 1,800 years BP, from the archaeological excavations at Frocester Villa, Gloucester, UK.
(Reproduced with permission from reference 24, Edwards et al., John Wiley & Sons Ltd.)

Figure 16.37  Photograph of an insect ‘inclusion’ in Baltic amber.
Figure 16.21  (a) Selection of ornamental antique jewellery consisting of three bangles assumed to be ivory but which were all shown to be fake by Raman spectroscopy; the scarab necklace is genuine. (b) carved ivory cat; shown to be fake by Raman spectroscopy.
Figure 16.39  *Egyptian cat (Felis silvestris libyca) mummy from Beni Hassan, ca. 1800 BC, from Manchester Museum Collection before and after unwrapping. The vacant eye-socket contained the orange-brown bead subjected to Raman spectroscopic analysis.*  
(Reproduced with permission from reference 37, Edwards *et al.*, John Wiley & Sons Ltd.)
Figure 18.1  *Diamond Sutra.*
(Reproduced with permission from The Stein Collection in the British Library)

Figure 19.1  *Sarcophagi of the Egyptian XIIth Dynasty (ca. 2000 BC) Nekht-ankh and Khnum-Nakht*, excavated by Flinders Petrie in 1907 from a rock tomb near Assiut.
(Reproduced with permission from Professor A.R. David, ref. 4)
Figure 19.6 Specimen of Qumran textile, ca. 2,000 years old; 20× magnification. The fibre degradation is clearly seen along with the presence of a dyed fringe component.

Figure 20.1 Iron corrosion surface containing iron sulphate, akaganeite, goethite, magnetite and haematite.
Figure 20.3  *Detail of the Egyptian bronze eye EA 6895.*
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Figure 22.1  *The silver gilded Reliquary Cross (around 1440/1460 AD) is adorned with rock crystal, amethyst, smoky quartz, citrine, turquoise, coloured glass and doublets.*
(Historical Museum Basel, photo by Peter Portner, Basel)
Figure 21.6 MRM analyses of garnets mounted in Barbarian cloisonné gold jewellery at the Musée d’Antiquités Nationales, St. Germain-en-Laye, France, 2000, using a Dilor® Raman spectrometer equipped with optical fibres and a green 532 nm laser: (A) A fibula of garnet-incrusted cloisonné jewellery from Middle Age civilisations analysed during this operation: a fibula from Brut, Northern Ossetia; (B) The analytical set-up showing two optical fibre connections arriving at the ‘superhead’ box with its objective, all being suspended from a photographer’s tripod (one foot visible); the green laser beam is focused on a selected crystal in the artefact placed below: a fibula from Vicq, France; (C) A closer view of a circular fibula from Brut, Northern Ossetia, under analysis (tripod foot out-of-focus); (D) A closer view of the fibula of photo B (in the form of a horse’s head) showing the precise crystal being analysed; (E) At the Musée de l’Homme, Paris, 1999, verification of the alpha-quartz nature of the famous Aztec polished sculptured skull in ‘rock crystal’, using the horizontal microscope of a Dilor® Labram® spectrometer and its red 633 nm laser (adjustment of the laser focusing by the author’s hands; laser reflected in various directions).

(All photographs © D.C. Smith)
Figure 21.10  MRM analyses of jades in the Trésor at the Muséum National d’Histoire Naturelle, Paris, 2000, using a Kaiser® Holoprobe® equipped with optical fibres and a green 532 nm or a red 633 nm laser. (A) A Chinese nephrite jade cup through which the laser beam can be seen coming from the objective suspended from the tripod; (B) Two Chinese jade pendants of contrasting appearance, both are of jadeite jade; (C) An intricately-carved Chinese grasshopper cage, nephrite jade; (D) Analysis of an inlaid jade dagger handle from the Mogul period, the matrix is nephrite jade; (E) A close-up of the analysis of a red crystal in a ‘flower’ in the Mogul dagger handle, emerald (top left) and small diamonds (around the emerald), the red crystals are variably of ruby or spinel.
(All photographs © D.C. Smith).
Figure 21.12  MRM analyses of gemstones incrusted into Florentine stone marquetry tables in the Trésor at the Muséum National d’Histoire Naturelle, Paris, 2000, using a Kaiser® Holoprobe® equipped with optical fibres and a red 633 nm laser. (A) Analysis of a yellowish-white petal of an inlaid flower in a table of black marble, note that the computer keyboard and mouse as well as the tripod were placed over this precious work because it is protected by 1.6 cm thick plate glass (invisible); hence all the analyses were made through glass; (B) Close-up of the yellowish-white petal being analysed by the laser beam (pinkish circle), dolomite; (C) Red pips of a pomegranate fruit in the same black marble table, some of garnet but others of ruby; (D) Analysis of a blue tulip-like flower inlaid in a white marble Florentine table: lazarite; the white mark is at the end of the objective and the shadows come from the tripod legs; (E) Analysis of the green thorax of an insect close to a bird, green quartz; in this photo the reflections reveal the presence of the plate glass (the white part on right is the computer, also resting on the glass).

(All photographs © D.C. Smith).
Figure 22.2  This carved carnelian (1st century) shows the figure of a goat and has been reused in the Dorothy Monstrance.
(Photograph by H. A. Hänni)

Figure 22.3  This reused sapphire with drill-hole is set in the Cross of the Church of St. Clara.
Figure 22.4 Working Situation: the Reliquary Cross under the laboratory Raman microscope at SSEF.
(Photo by H. A. Hänni)

Figure 22.5 Working Situation: the Dorothy Monstrance being examined with the remote Raman system at the Historical Museum Basel.
(Photo by Sabine Häberli)
Figure 22.6  The silver gilded Agnus Dei Monstrance (1460–1466) is decorated with six gemstones (clockwise from the top): rock crystal, sapphire, almandine, sapphire, layered rock crystal doublet, and fluorite. (SMPK, Kunstgewerbemuseum, Berlin. Photo by Hans-Joachim Bartsch)

Figure 22.9  The diamond being analysed lies on the top of the sample holder of a home-built cryogenic cell filled with liquid nitrogen. The laser beam passes through an open window and focuses on the diamond’s surface. During the analysis, a continuous evaporation of the liquid nitrogen creates a flow, which avoids any humidity getting inside the cell and therefore no ice forms on the analysed area. To compensate for this evaporation, while keeping the diamond at a constant low temperature (ca. −120 °C), some liquid nitrogen can be added during the analysis. (Photo by H. A. Hänni)
Figure 22.17  Black natural pearls, probably from Mexico. This necklace sold at a recent auction for more than 1 million US$. (Photo by H. A. Hänni)

Figure 22.18  From left to right: white cultured saltwater pearl, black Tahiti cultured pearl, Akoya cultured pearl artificially coloured by silver nitrate, irradiated saltwater pearl, irradiated freshwater pearl, shell from a Mexican pearl oyster with natural coloured pearls from this oyster.
Figure 25.1  Photographs of a selection of the minerals presented in this database (magnification from $3 \times$ to $44 \times$).

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