The Atlas of Analytical Signatures of Photographic Processes

CARBON

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The Atlas of Analytical Signatures of Photographic Processes is intended for practicing photograph conservators and curators of collections who may need to identify more unusual photographs. The *Atlas* also aids individuals studying a photographer's darkroom techniques or changes in these techniques brought on by new or different photographic technologies or by the outside influence of other photographers. For a complete list of photographic processes available as part of the *Atlas* and for more information on the Getty Conservation Institute's research on the conservation of photographic materials, visit the GCI's website at getty.edu/conservation.

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Front cover: Adolphe Brown, *Two Girls* (detail), date unknown. Early carbon photograph. Private collection.

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CARBON

English: carbon
French: *procédé au charbon*
German: Pigmentverfahren, Kohleverfahren

HISTORICAL BACKGROUND

The carbon process was invented by Alphonse-Louis Poitevin (French, 1819–1882) in 1855 and further developed and modified for general application by Joseph Wilson Swan (British, 1828–1914) in 1864.

In 1839 the Scottish scientist and inventor Mungo Ponton (1801–1880) discovered the light sensitivity of paper coated with a solution of potassium dichromate. Ponton did not mix potassium dichromate with gelatin, so the paper (cellulose) substrate and the small concentration of gelatin present in the paper as an internal sizing agent were the only organic materials available for the photochemical reduction of the dichromate salt. The French physicist Alexandre-Edmond Becquerel (1820–1891) repeated Ponton's experiments in 1840 and explained that the internal size in Ponton's paper substrate played an important part in darkening of the dichromate-treated paper. In 1852 William Henry Fox Talbot (1800–1877), the British chemist and pioneer photographer, discovered that a mixture of organic colloids such as glue, gelatin, or starch with potassium dichromate is rendered insoluble by exposure to light. Talbot patented his findings as part of his photomechanical printing process, which he called photoglyptic engraving.

In his search for permanent photographic processes, Poitevin mixed carbon powder into a mixture of gelatin and potassium dichromate. He applied the resulting mixture to a paper surface, dried it, and exposed it to sunlight under a negative. When treated in warm water, the still-soluble gelatin-carbon mixture dissolved, leaving behind the less soluble gelatin-carbon mixture that was exposed to light under the lighter areas of the negative. A similar process was discovered independently in 1858 in England by Thomas Sutton and John Pouncy.

Process Description

Early versions of the carbon process (see the sample photograph in fig. 1) did not provide fully satisfactory results and were difficult to master. The main reason was that when exposed under a negative, the parts of the gelatin-carbon layer receiving the most exposure to light and becoming most insoluble were at the top of the gelatin-carbon layer. This left the image layer closer to the paper surface more soluble. During hot water treatment, the more soluble gelatin closest to the

Figure 1 Adolphe Brown, *Two Girls*, date unknown. Early carbon photograph. Private collection.

substrate was partially dissolved even under the less soluble surface layers. As a result, the image had more contrast and lacked the fine halftone details of the negative image (fig. 2).

Problems of early carbon printing processes were brought to light in 1858 by Abbé Laborde in his presentation to the French Photographic Society. Several different solutions were proposed and tested. That same year J. C. Burnett proposed exposing a sensitized gelatin-carbon layer through the paper substrate with a negative in contact with the back of the coated paper. This solution provided for greater light exposure of the gelatin-carbon layer closer to the paper substrate (fig. 3). Burnett's solution was theoretically sound, but its broader practical application was hampered by the need for long exposure times and the lower resolution of the resulting images due to imprinting of the paper structure of the paper substrate.

The first successful solution for achieving full halftones in carbon printing was developed and patented by Adolphe Fargier in 1860. The Fargier process called for exposure of a sensitized gelatin-carbon layer coated onto a paper substrate under a negative. Next, a thick coating of collodion varnish was laid on the surface of a fully exposed but undeveloped gelatin-carbon layer. The original paper substrate was then stripped off in warm water, and the carbon layer was developed by dissolving the less soluble gelatin-carbon coating from the back of the carbon layer and attaching a new paper substrate to the gelatin-carbon side of the image (fig. 4). Fargier's method allowed for the printing of high-quality carbon prints exhibiting full halftones, but the entire process proved difficult and complicated.

The most important modifications of the carbon process were patented by Swan in 1864. Even though Swan's improvements can be viewed as minor modifications of previously proposed procedures, his work was responsible for the broad use of the carbon process by both professional and, later, amateur photographers.

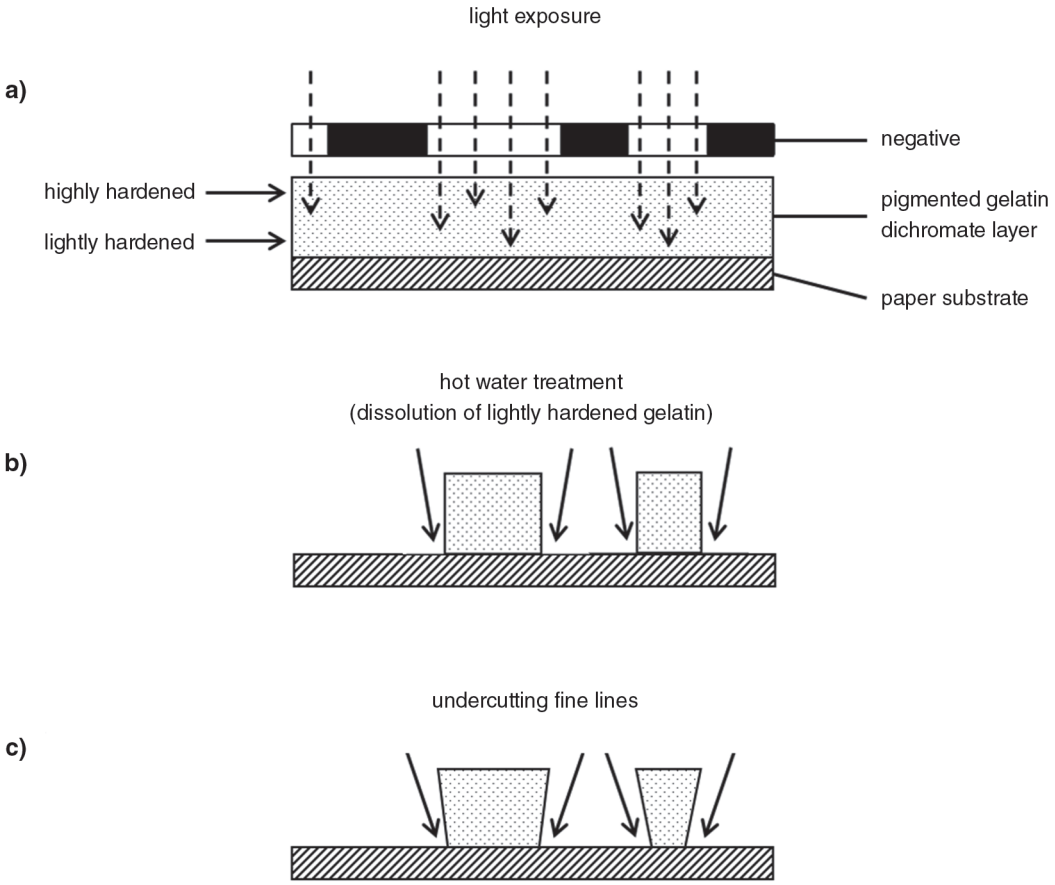
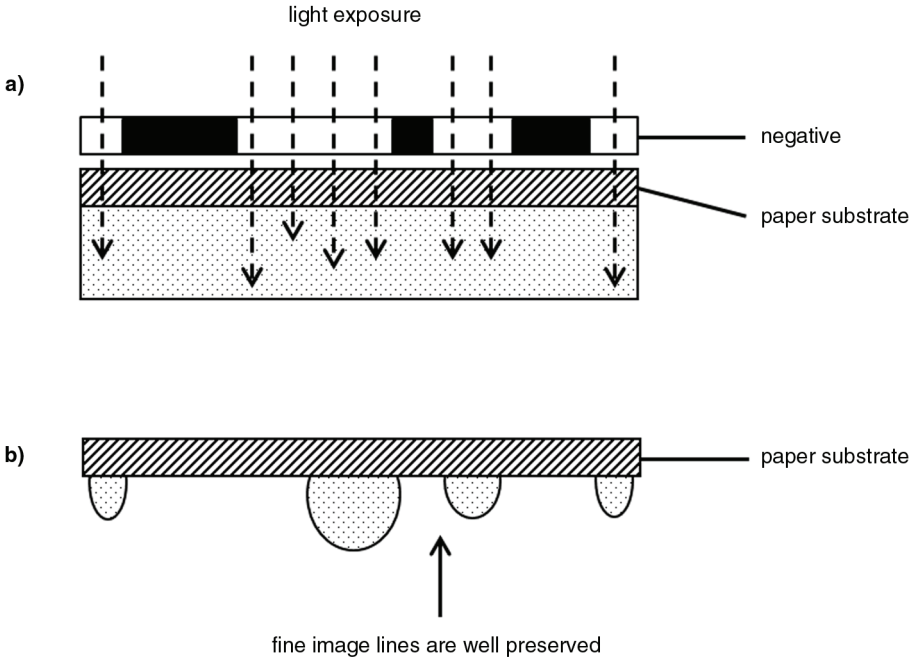


Figure 2 Schematic diagram illustrating the process that led to the lack of fine halftones in early carbon photographs.

Figure 3 Schematic diagram illustrating Burnett's proposed changes to the carbon printing process.



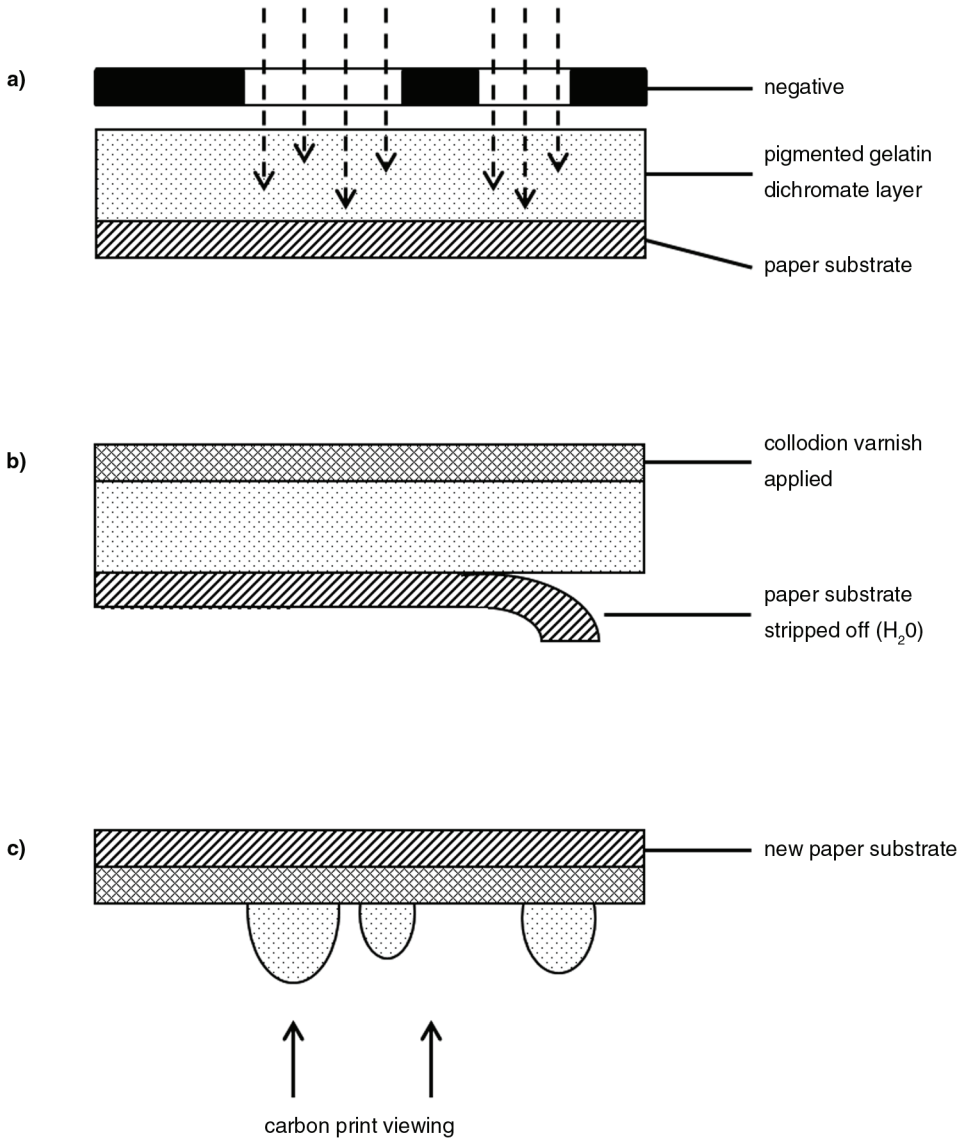


Figure 4 Schematic diagram of the Fargier process.

By adding a small amount of sugar to the gelatin-carbon mixture, Swan produced a less brittle image layer when dried. In Swan's process a sensitized gelatin-carbon coated paper was exposed under a negative and attached facedown on a temporary or permanent final support (paper or other substrate material). The original paper substrate was stripped away in a warm water bath. The carbon image was then developed by dissolving the still soluble gelatin-carbon mixture. Because the less soluble parts of the image layer were directly protected by the new substrate and the more soluble parts of the image layer were exposed to water treatment first, all halftones of the image could be well preserved and developed. The only problem in this procedure was that the final image resulting from this single transfer was reversed. When printing images that needed to be correctly oriented, there was a need for stripping and reversing the negative image or for an application of the so-called double-transfer process that was also developed by Swan. In the double-transfer process, the carbon print from a temporary support was transferred again to a final support; in doing so the final image was correctly oriented. In 1868 Swan sold the

Figure 5 Sample books of carbon tissues produced by the Autotype Company. Collection, National Media Museum (NMeM), Bradford, UK.

rights for his carbon process to John Robert Johnson and Ernest Edwards, who established the Autotype Company, which became a major player in the commercial production of material for carbon printing, in carbon process printing, and in further research and development of the carbon process. The Autotype Company later produced a large number of different carbon tissues of different colors (fig. 5).

The Autotype Company produced material for trichrome carbon printing that was introduced theoretically in 1862 by Louis Ducos du Hauron and practically in 1867–68 by both Ducos du Hauron and Charles Cros. Johnson improved on Swan's process in 1869 by introducing a waterproof temporary support made of metal, glass, or varnished paper treated with wax. In 1870 Johnson modified the formulation of carbon tissue by substituting soap for sugar as a plasticizer. In 1874 John Sawyer patented his Flexible Temporary Support, consisting of paper coated with gelatin made insoluble by means of chrome alum and coated with a second layer of bleached shellac and borax. In January 1876 the Autotype Company purchased patents from Claude Leon Lambert for his Lambertype process, which he christened Chromotype. In 1880 Autotype added the Woodburytype process to its department of photomechanical printing. The so-called Keramic Department of the company also produced carbon prints fired into enamel. The Artistic Finish Department produced carbon prints on opal glass and canvas. These photographs, produced in sizes up to 96 x 40 inches, were also tinted (colored) using watercolor or oil paints. During World War II the Autotype Company printed compass dials on mica substrates using the carbon process. In 2005 Autotype was acquired by MacDermid Inc.

Several other variants of the carbon process were developed and introduced in France and Germany. The *procédé* Marion (1868) used an albumenized paper for the transfer of carbon prints. The *procédé* Jeanrenaud (1869) improved the carbon transfer process, and A. Marion introduced his Mariotype process commercially in 1873. The direct carbon processes are covered

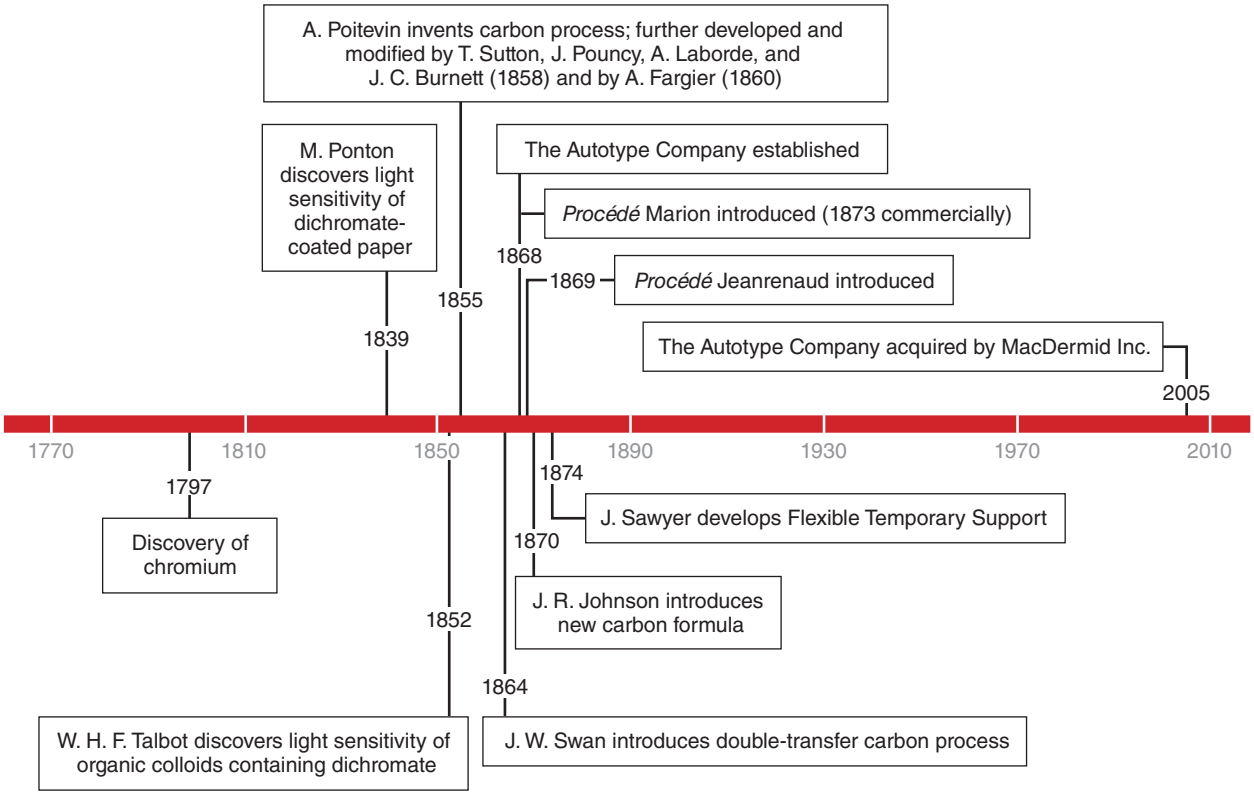


Figure 6 Timeline of the carbon process.

in the forthcoming sections focused on each of these special photographic processes (Artigue process, Fresson process, Ozotype, etc.).

Though still used by members of the alternative process photography movement, a majority of stable carbon processes have not survived the introduction and massive application of ink-jet printing using carbon-based black-and-white and other highly light-stable organic and inorganic pigment inks.

Figure 6 shows a historical timeline for the carbon process.

Main Application of the Carbon Process

A number of photographers worked with the carbon process or used carbon process printing services between about 1870 and the start of World War II. The carbon tissue was used extensively for both photogravure and rotogravure photomechanical processes. The carbon process was revived in 1970 as part of the alternative process photography movement.

Noted Photographers Using the Carbon Process

J. C. Annan
Adolphe Brown
Julia Margaret Cameron

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Key Carbon Process–Related Patents

Alphonse Poitevin, French Patent 24,592 (Aug. 27, 1855)
Alphonse Poitevin, English Patent 2,815 (Dec. 13, 1855)
Joseph Swan, French Patent 46,719 (Sep. 17, 1860)
Joseph Swan, English Patent 955 (Apr. 15, 1861)
Fargier, English Patent 955 (Apr. 18, 1861)
Joseph Swan, English Patent 503 (Feb. 29, 1864)

IMPORTANT VARIANTS OF THE CARBON PROCESS

Single- and double-transfer carbon processes
Carbon transfer processes on different surfaces
Carbon transparencies (see the Photographic Transparencies section, forthcoming)
Direct carbon processes (see the Artigue and Fresson sections, forthcoming)
Ozotypie (see the Ozotype section, forthcoming)
Tri- and quad-color carbon processes (see the Color Photographic Processes section, forthcoming)

Single- and Double-Transfer Carbon Processes

Process Description

Photographers who used the carbon process most often purchased all material needed for carbon printing from manufacturers or suppliers of carbon process material (carbon tissue, transfer paper, and temporary support). Photographers had the option of using a single- or double-transfer carbon process.

Single-Transfer Carbon Process

The single-transfer carbon process produced side-reversed images and was used primarily for printing scenes in which image orientation did not matter (some landscapes) or for printing from glass negatives with reversed emulsion layers.

The potassium dichromate sensitized and dried carbon tissue was exposed under a negative. The exposed carbon tissue was inserted into a bath of cold water with a piece of single-transfer paper or a prepared final paper substrate cut slightly larger than the tissue. After soaking for a prescribed time, the two surfaces were placed into contact underwater. The "sandwich" of attached carbon tissue and final paper was then removed from the water and placed on a solid substrate. A squeegee was used to remove all air and excess water and achieve good contact between both surfaces. The sandwich was placed under pressure for a prescribed period of time, then immersed in a warm water bath, carbon tissue side on top. When the carbon tissue paper started to separate from the sandwich, it was slowly and carefully removed. The unhardened mass of pigmented gelatin was removed by treating it with warm water. After all areas were well developed, the final print was cleared in an alum bath and dried.

Double-Transfer Carbon Process

The double-transfer carbon process was used when printing from negatives that contained orientation-sensitive visual information (letters, wedding-ring position in portraits, or familiar scenery that could not be presented in reverse). The double-transfer process was analogous to the single-transfer carbon process up to the point of the first transfer. Then, instead of a final paper substrate, the exposed carbon tissue was squeegeed together with a special temporary support. After removal of the carbon tissue support paper and development of the carbon image on the transfer paper, the carbon image on the transfer paper was combined underwater with a final paper substrate and squeegeed together. The resulting temporary support–carbon image–final paper sandwich was dried. When fully dried, the temporary support separated on its own or could be easily stripped away, leaving a final carbon print with the correct orientation.

Both single- and double-transfer carbon processes are shown schematically in figures 7a and 7b, respectively. Figure 8 shows a schematic cross section of a typical carbon print.

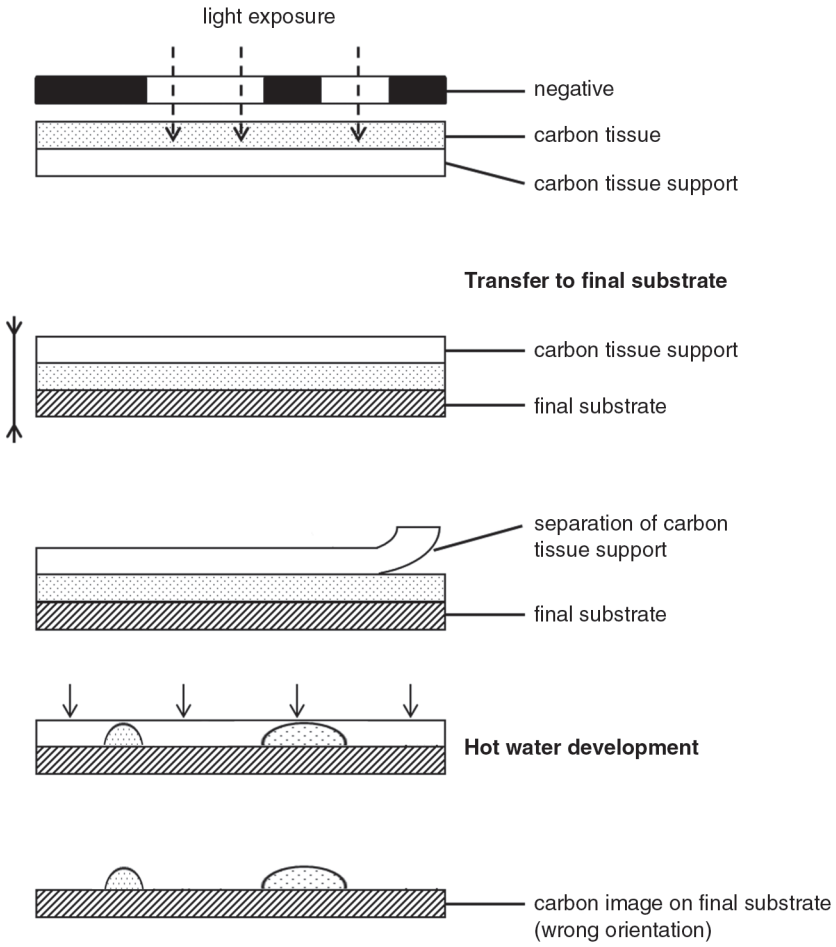


Figure 7a Workflow of single-transfer carbon process.

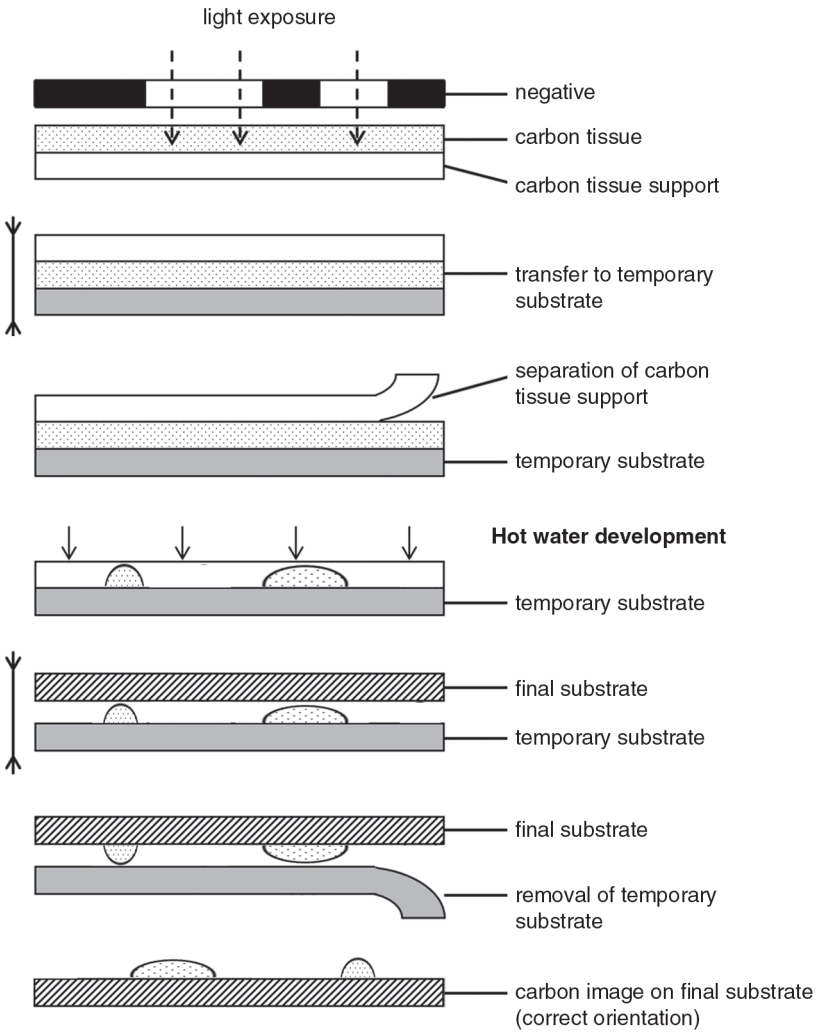


Figure 7b Workflow of double-transfer carbon process.

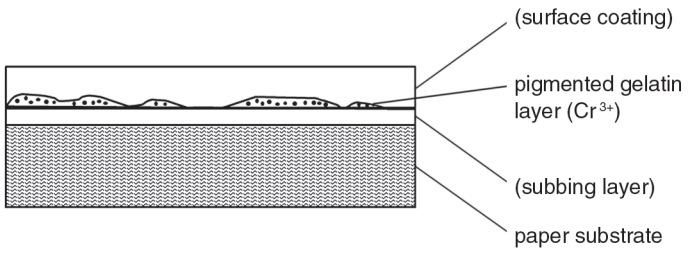


Figure 8 Schematic cross section of a typical carbon print.

IDENTIFICATION: CARBON PROCESS PRINTS

Visual Signatures

Visual Characteristics

Carbon prints were produced in a variety of colors. The most commonly used colors of carbon tissue were dark brown, black, and reddish brown (the latter of which resembled the color of gold-toned albumen photographs). The carbon-image surfaces sometimes exhibit a noticeable relief effect when observed at nearly 180 degrees to the print surface. Dark areas of the print appear slightly higher than the print's highlights (fig. 9).

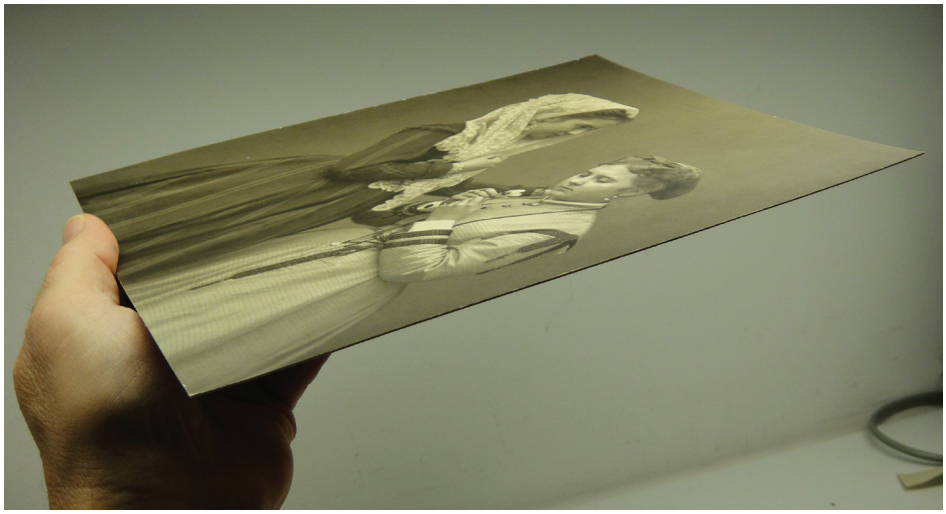


Figure 9 Viewing direction of about 180 degrees during visual identification of a carbon print.

When viewed at certain angles, dark areas of the image also appear glossier (due to the higher concentration of gelatin) than the highlights. Some older carbon prints show surface cracks or fissures that are also more concentrated in the dark (thicker) areas of prints. If there is cracking in the surface, larger cracks might show in the dark areas of the photograph.

Carbon prints are not susceptible to light fading as long as they were made using only carbon-based pigments. If the image was made using organic dyes, it can be susceptible to light fading based on the light sensitivity of the dyes used. Carbon prints do not show any silver mirroring typical for older silver gelatin or some albumen photographs. Many smaller-size carbon prints were mounted on *cartes-de-visite* (CDV) or cabinet card (CC) matte boards, and some of these images might have printed or embossed designations of the carbon process (printed in carbon, *procédé au charbon*, etc.) or the information that the photograph was created using a permanent process (permanent print, permanent photograph, etc.) (fig. 10). Some carbon prints were also described as permanent photographs on the backs of card photographs (figs. 11a, 11b).

Figure 10 Permanent inscription on the front of a 19th-century CC.

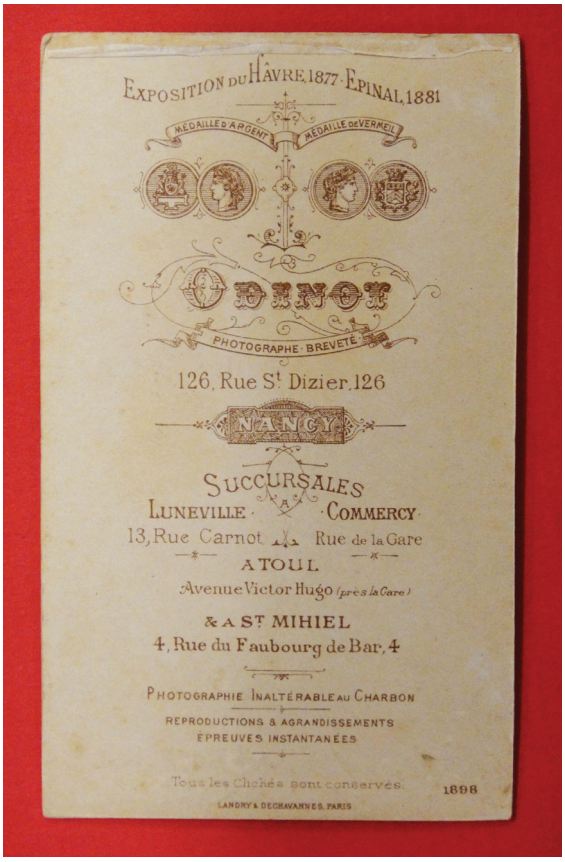


Figure 11a Permanent inscription printed on the back of a 19th-century CC.

Figure 11b Detail of the lower third of the inscription in fig. 11a.

Microscopic Characteristics

Examination under higher magnification (>25×) shows the presence of larger carbon (pigment) particles or carbon (pigment) clusters irregularly distributed within the lighter but still pigmented areas of the print (fig. 12). In the case of reddish-brown images, careful examination might also detect some smaller but brighter particles of red-lake pigment that were often added to carbon pigment prints to impart image color similar to that of gold-toned albumen prints (fig. 13). The examination of the edges or corners of a loose, unmounted carbon print might reveal small areas of delamination or lifting of the pigmented gelatin layer (fig. 14). It is important to remember that both particle clusters and red particles can also be found in Woodburytype prints.

Analytical Signatures

XRF

The most important feature of the XRF spectra of carbon prints is the total absence of silver. Carbon particles of the carbon print cannot be detected using typical XRF instruments used in the examination of photographs, but carbon prints always contain small amounts of photochemically produced chromium embedded in the image layer. Washing and clearing procedures used in the production of carbon prints cannot remove all chromium, and the presence of chromium in photographic images that do not contain silver may indicate that the print was created using one of the chromium-based photographic processes. Figure 15a shows an early carbon print

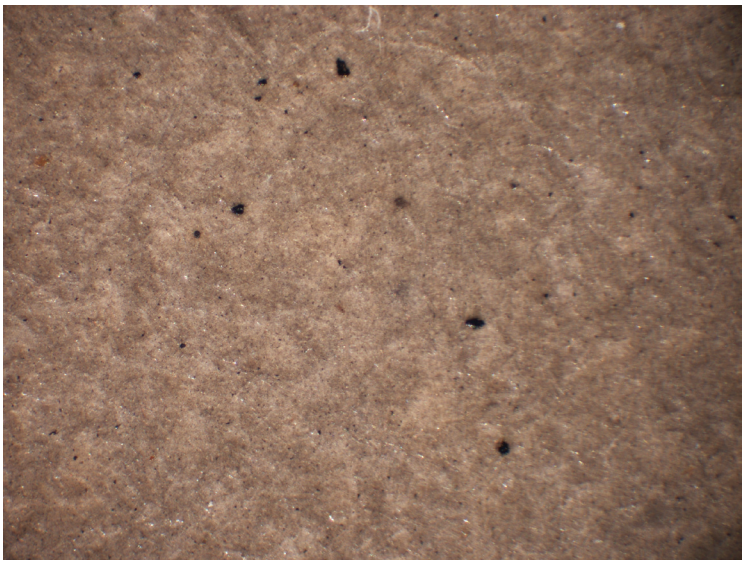


Figure 12 Optical micrograph of a typical carbon particle cluster in a carbon print (40× magnification).

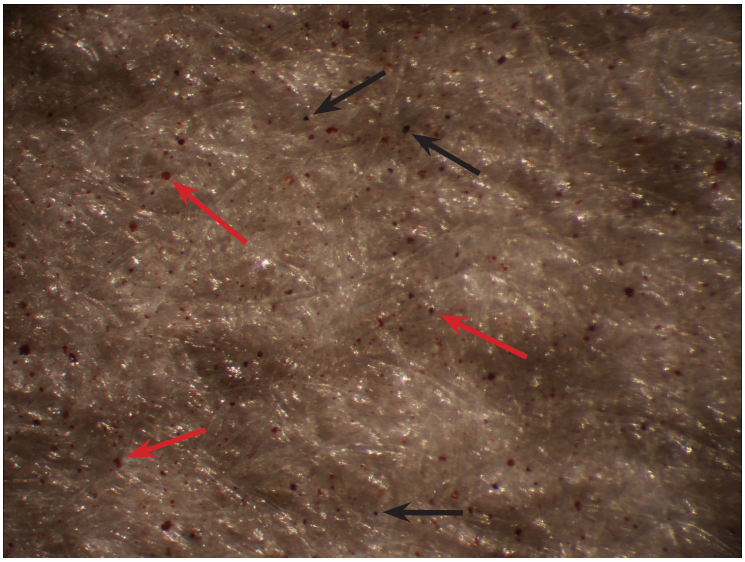


Figure 13 Bright-red particle clusters of a red-lake pigment of a reddish-brown carbon print (80x magnification). Black arrows = black particles; red arrows = red particles.

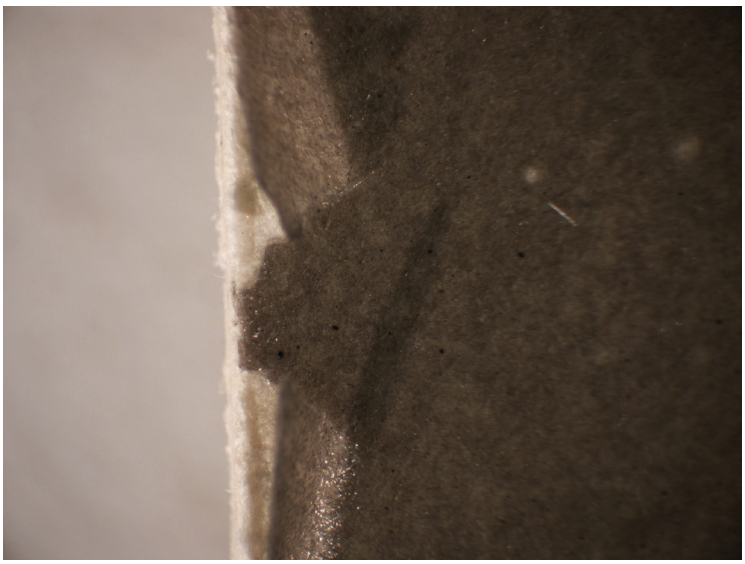


Figure 14 Delamination of the pigmented gelatin layer observed at the edge of a carbon print (25× magnification).

Figure 15a *Two Girls*, an early carbon photograph by Adolphe Brown (date unknown).

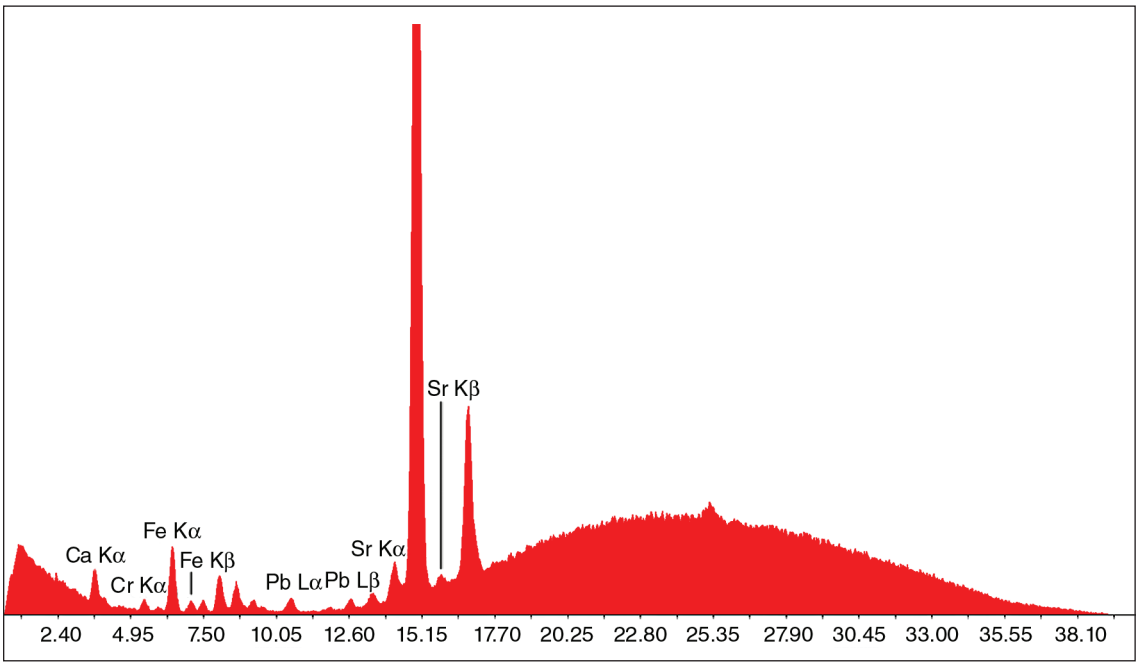


Figure 15b XRF spectrum recorded at the Dmax area of the photograph in fig. 15a.

by Adolphe Brown; figure 15b shows its XRF spectrum, recorded in the highly pigmented area of the print. Details of the XRF spectrum (figs. 16a, 16b) show that chromium is absent in the Dmin (light area) and present in the Dmax area of the image. The concentration of chromium is roughly proportional to the tonality of the photograph.

XRF analysis of sample photographs created for the 1907 carbon tissue catalog of the Autotype Company (fig. 17) shows that only a limited number of carbon tissues available during that time contained inorganic pigments other than carbon. Different carbon tissues were available under more descriptive names than the chemical composition of the pigments and dyes used in the manufacturing of the carbon tissues (terra-cotta, chocolate brown, warm sepia, platinum black, lilac, ruby brown, standard purple, sea green, etc.). XRF analysis of the photographs in figure 17, prepared using platinum-black (cat. no. 160) tissue, shows the absence of any inorganic pigments (fig. 18).

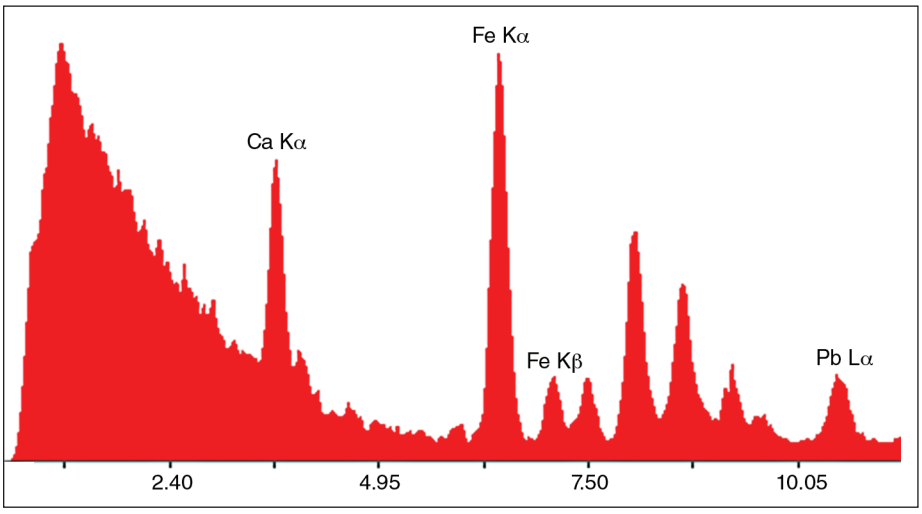


Figure 16a Detail of the XRF spectrum in fig. 15b, showing the absence of chromium in the Dmin area.

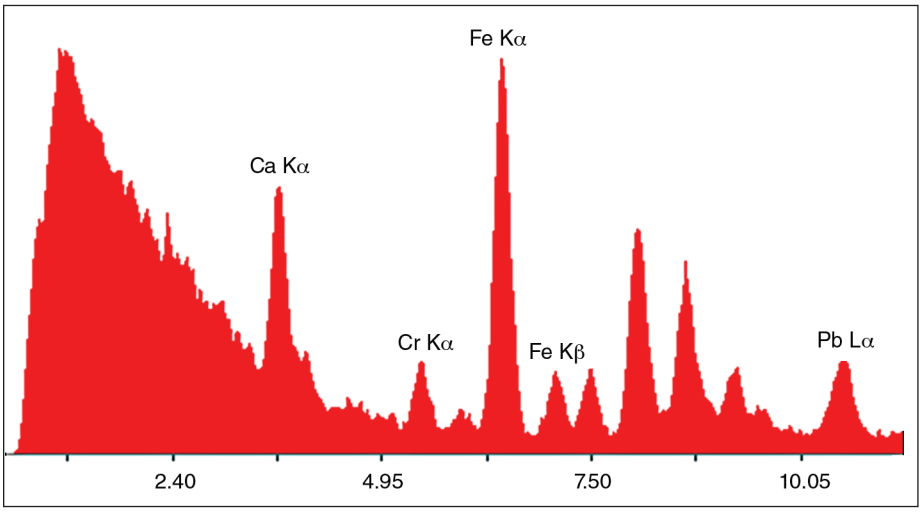


Figure 16b Detail of the XRF spectrum, showing the presence of chromium in the Dmax area.

Figure 17 Catalog of different carbon tissues available from the Autotype Company, 1907. Collection, National Media Museum (NMeM), Bradford, UK.

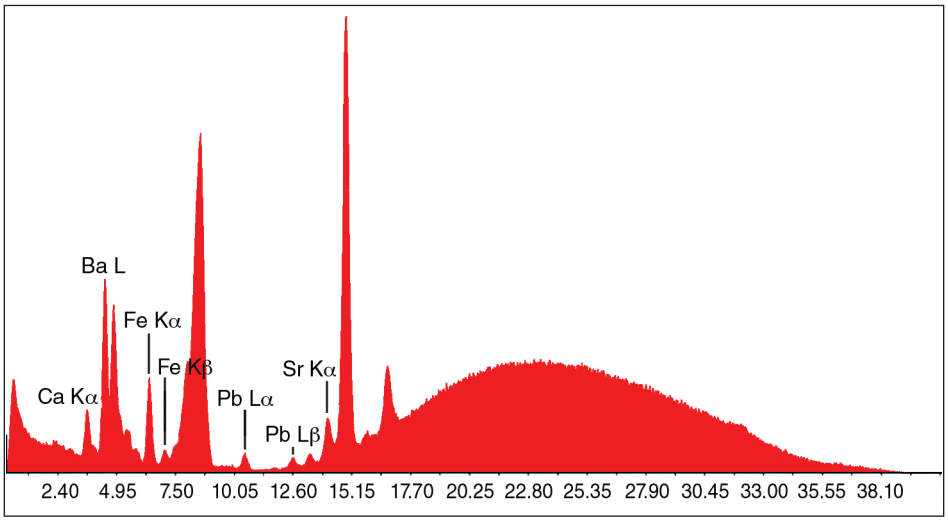


Figure 18 XRF spectrum of image 160 (upper left) in fig. 17, created using platinum-black carbon tissue.

The XRF spectrum shows spectral peaks of calcium (Ca) and barium (Ba) present in the final paper substrate used for the production of the sample photographs. Only some sample photographs in the catalog exhibited the presence of a high concentration of iron. This indicates that the carbon tissue was made using carbon mixed with organic dyes and a small concentration of iron-containing pigment. Only the XRF spectrum of the warm-sepia (cat. no. 97) and the Italian-green (cat. no. 165) sample photographs showed a large presence of iron (figs. 19a, 19b).

Some sample photographs also exhibited higher concentrations of calcium (Ca). These concentrations might be due to the presence of so-called mordant pigments formed by precipitation of organic dyes on particles of an inorganic (in this case, calcium based) carrier. Figure 20 shows the XRF spectrum of a standard purple carbon photograph that contains an unusually high concentration of calcium.

Figure 19a XRF spectrum of the warm-sepia carbon photograph containing iron-based colorants.

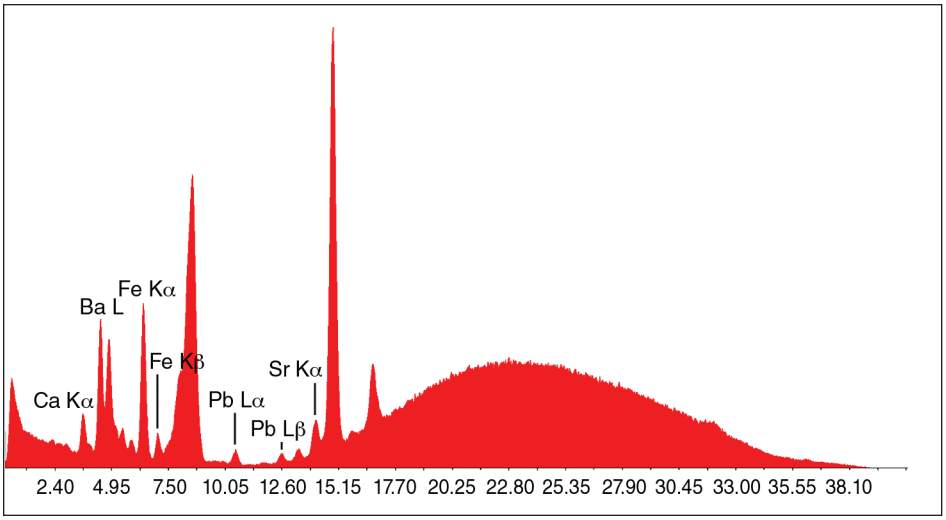


Figure 19b XRF spectrum of the Italian-green carbon photograph containing iron-based colorants.

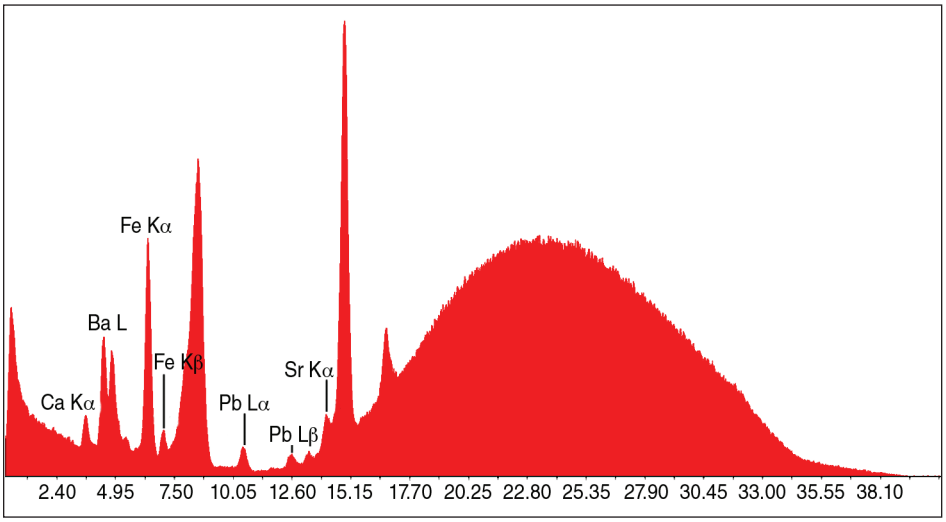
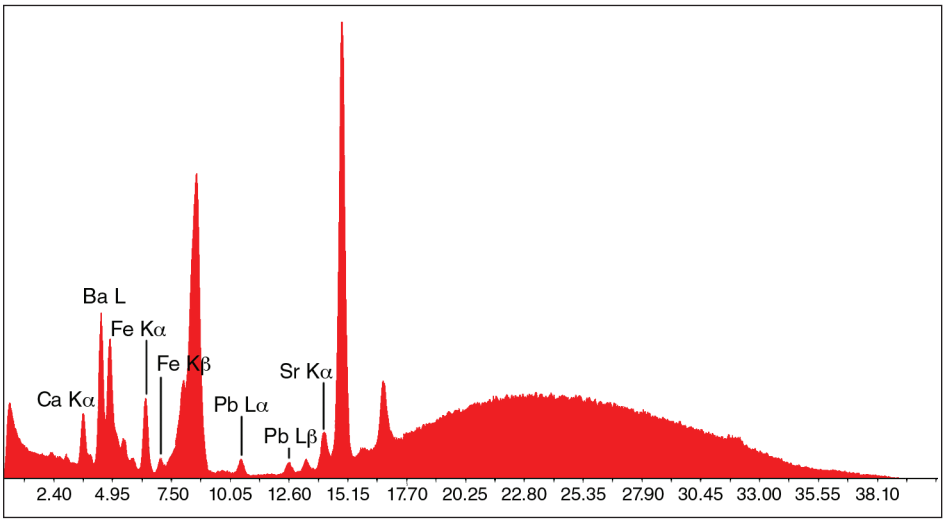


Figure 20 XRF spectrum of a carbon print, created using standard purple carbon tissue.



Visual inspection of the later 1927 carbon tissue catalog reveals that the number of available carbon tissues from the Autotype Company had been greatly reduced (fig. 21). The names of many of the carbon tissue colors were modified or replaced, and new descriptive color names such as ivory black, portrait brown, and olive brown were added. XRF analysis of the sample photographs shows a slightly modified chemical composition of carbon tissues and different chemical composition of the final paper substrate used for printing of the sample photographs. Chromium, as expected, is present in all of the sample photographs (fig. 22).

Figure 21 Carbon tissue catalog of the Autotype Company, 1927. Collection, National Media Museum (NMeM), Bradford, UK.

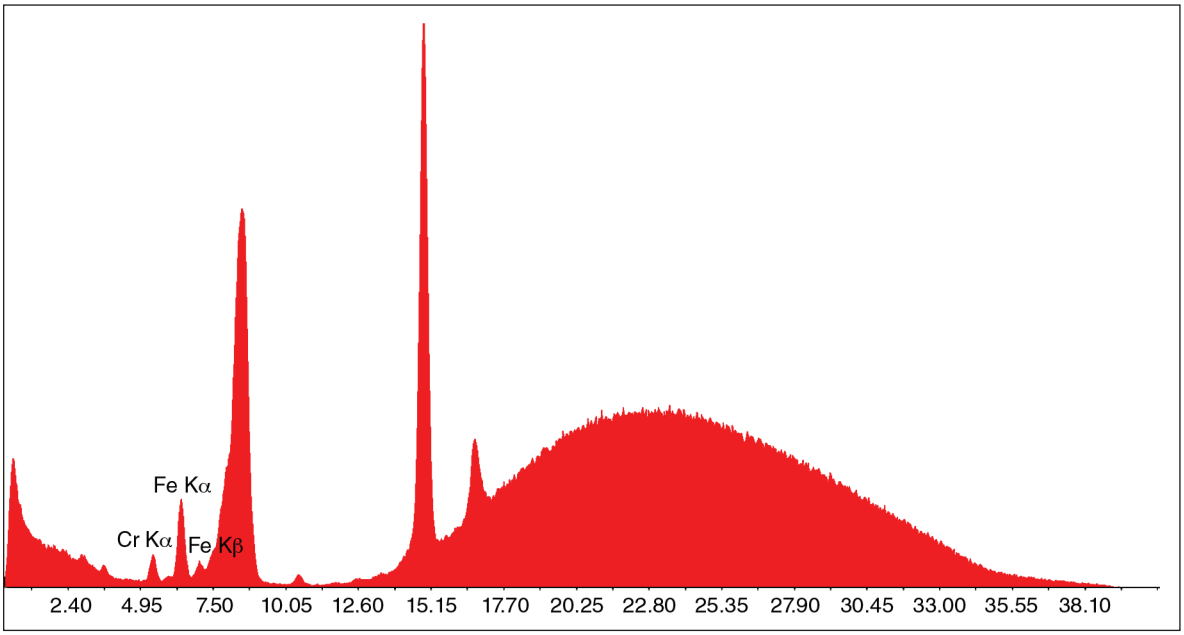


Figure 22 XRF analysis of a photograph in fig. 21, created using the Autotype Company's portrait-brown carbon tissue.

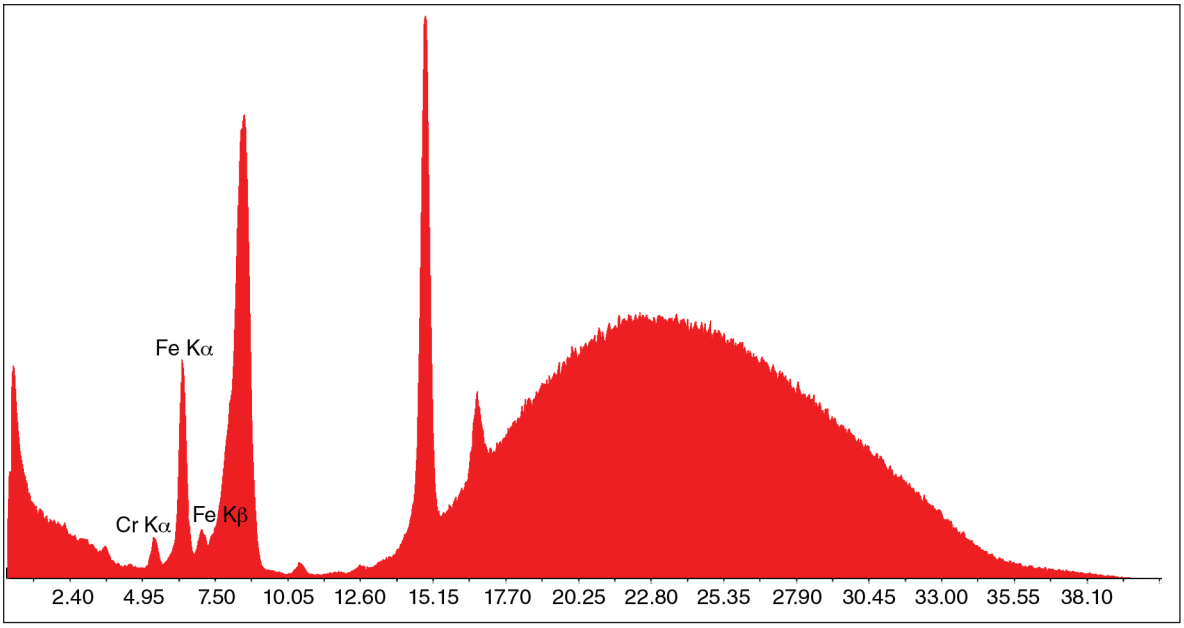


Figure 23 XRF spectrum of a photograph in fig. 21, created using the Autotype Company's terra-cotta carbon tissue.

The spectrum shows that the portrait-brown carbon tissue was manufactured using just carbon and organic dyes. Only the terra-cotta (fig. 23), red-chalk, and olive-brown carbon tissues from the 1927 catalog contained some amounts of iron-based colorants.

XRF analysis of the sample photographs also shows that prior to 1927 the Autotype Company modified the carbon tissue manufacturing process and eliminated the use of mordant pigments used earlier. Other manufacturers of carbon tissues and material for carbon printing were in operation, but the Autotype Company was, for a long period of time, the most important manufacturer of materials for carbon printing.

XRF analysis of sample books and different carbon photographs also shows that the final paper substrates of carbon prints might contain large or small amounts of inorganic additives, colorants, or fillers that are uniformly distributed across the paper. When analyzing carbon prints, it is important to compare the concentration of these impurities in both the Dmax, Dmin, and paper substrate of the photographs. This allows for differentiation between the chemical elements contained in the image layer of the carbon print and inorganic material present in the final substrate of carbon prints.

FTIR

The main organic component of carbon photographs, which can be easily detected using ATR-FTIR spectrometry, is gelatin. Carbon cannot be detected using IR spectrometry. Other organic components and organic additives, if any, are in such low concentrations in comparison with the amount of gelatin that almost all ATR-FTIR spectra of carbon prints look identical. Figure 24 shows the ATR-FTIR spectrum of the Dmax area of the carbon photograph shown in figure 1.

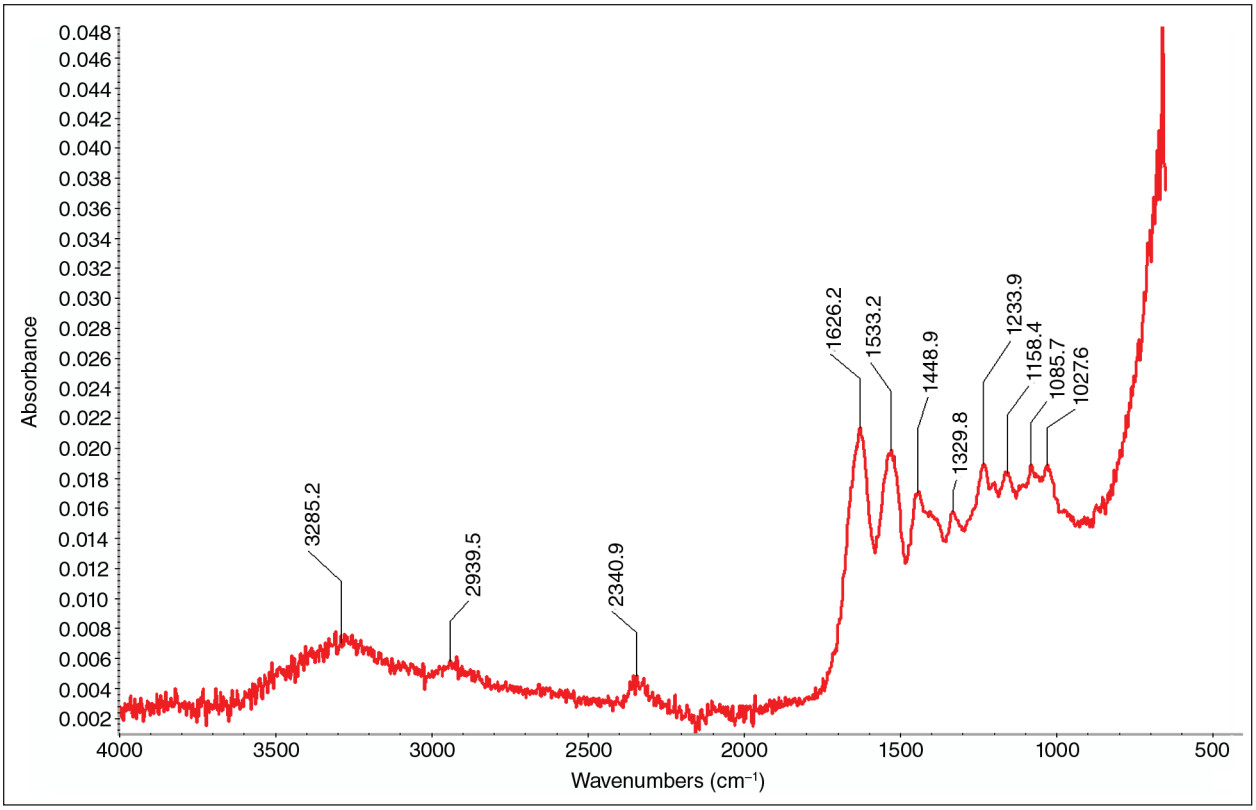


Figure 24 ATR-FTIR spectrum of the Dmax area of the carbon photograph in fig. 1, created using black carbon tissue.

The presence of gelatin can be identified based on a presence of the well-developed Amide I (at 1626 cm^{-1}) and Amide II (1533 cm^{-1}) spectral peaks that are typical for most proteinaceous materials. The position and relative ratio of spectral peaks between 1450 and 1300 cm^{-1} is more specific and allows differentiation between gelatin and albumen. ATR-FTIR analysis of the gelatin layer in the Dmax and Dmin areas of carbon photographs provides important analytical information about the internal structure of the analyzed carbon photograph (figs. 25a, 25b).

White or light areas of an unvarnished carbon print contain only very thin layers of pigmented gelatin, if any, and the infrared beam of the instrument easily samples both the gelatin layer and the surface layer of the paper substrate. The IR spectrum recorded in the Dmin area of the carbon photograph (see fig. 25b) shows the presence of a spectral envelope of peaks (~1100 cm^{-1}) typical for paper and other cellulosic material. The gelatin layer in the Dmax area of the carbon print is usually too thick to show the well-developed and defined spectral peaks of the paper substrate.

Identification Problems

Carbon process photographs and Woodburytype photomechanical prints have almost identical visual and analytical signatures. Our analytical research has shown that Woodburytype prints are often printed on a smooth paper substrate treated with shellac varnish. In most cases ATR-FTIR

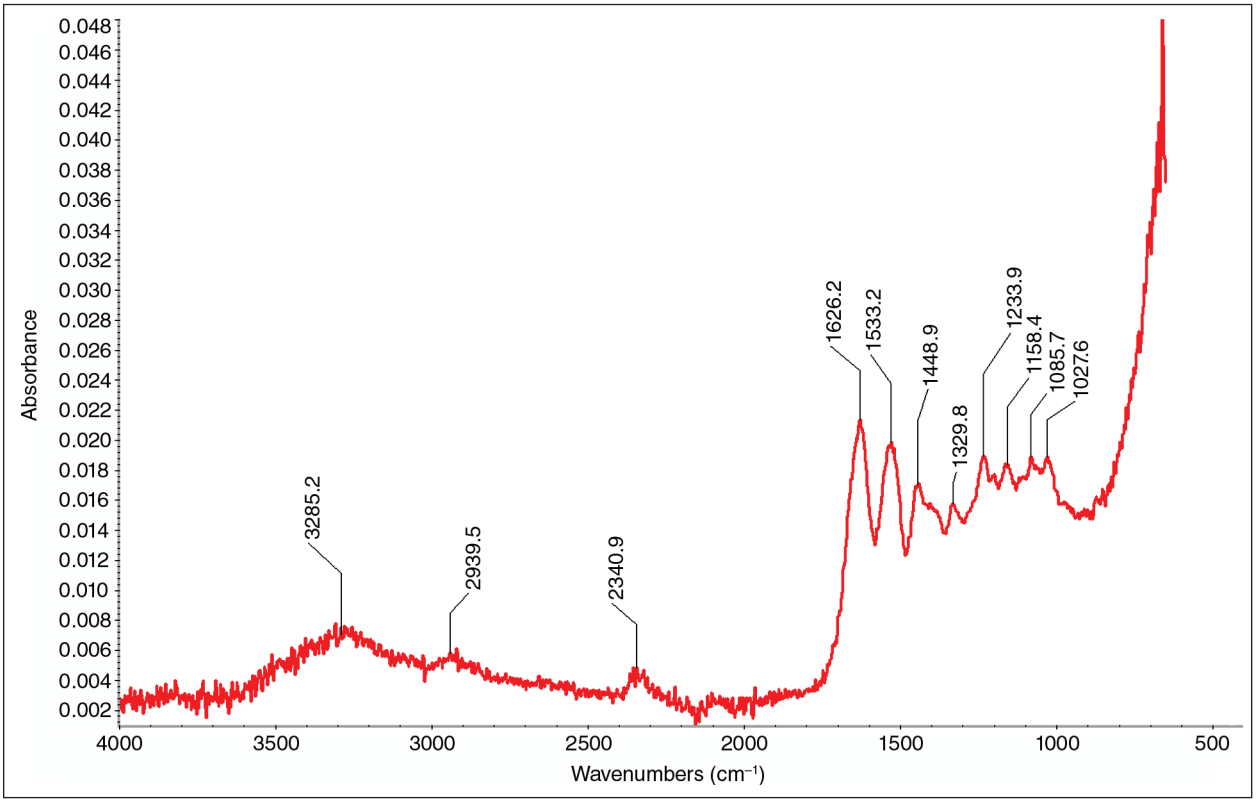


Figure 25a ATR-FTIR spectrum of a carbon photograph recorded at Dmax image area.

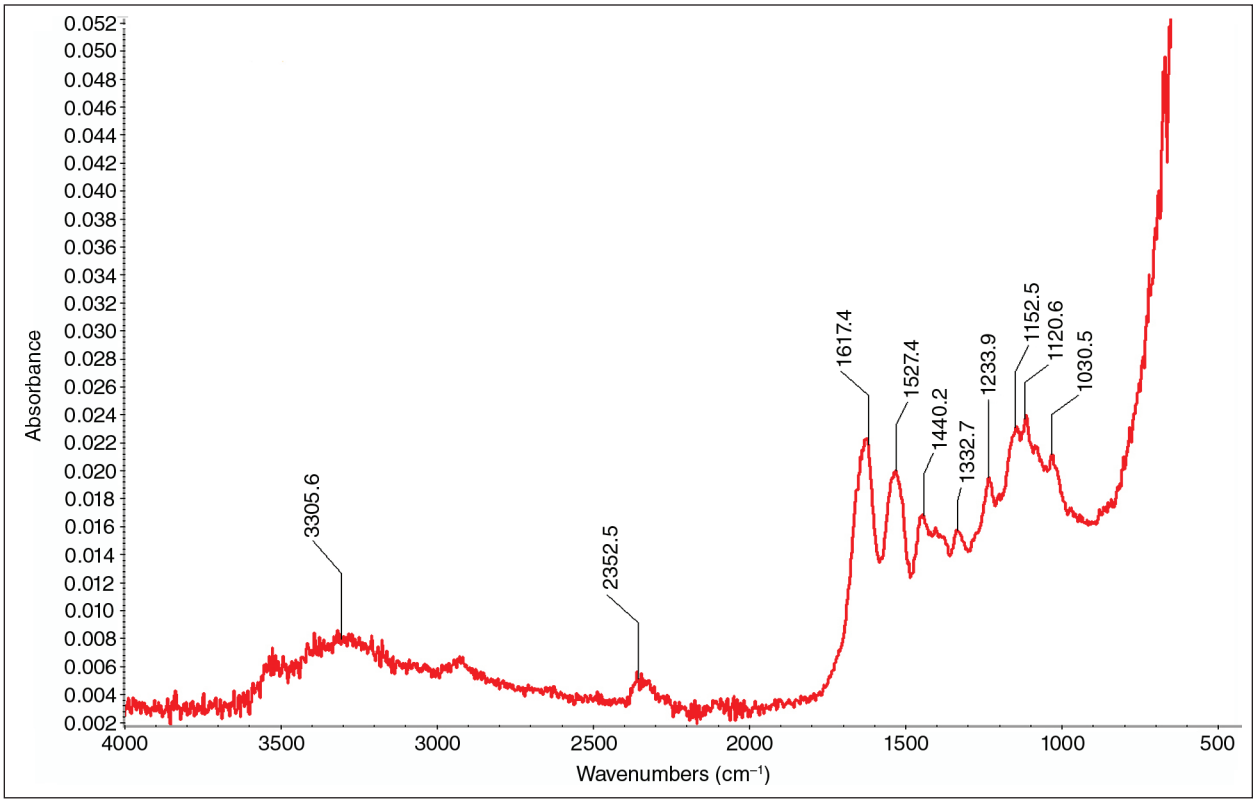


Figure 25b ATR-FTIR spectrum of a carbon photograph recorded at Dmin image area.

spectroscopy is able to identify a shellac layer in the Dmin areas of a Woodburytype print. Such a layer usually is not present in carbon process photographs.

Post-Process-Treated Carbon Prints

Fully processed and dried carbon prints are semi-glossy due to the presence of gelatin. Many larger carbon prints were left in their original state, but some—namely smaller portrait carbon prints—were varnished to make their surfaces glossier or to protect the delicate carbon layers against mechanical damage when handled (fig. 26). The most common material used to varnish carbon photographs was collodion varnish. The ATR-FTIR spectrum of a collodion-varnished photograph shows the presence of all three typical spectral peaks of collodion at 1637, 1274, and 838 cm^{-1} (fig. 27).

The layer of varnish often complicates the identification of a photograph. Even when using FTIR analysis, there is a danger that collodion-coated carbon prints might be misidentified as collodion photographs. Only careful and more detailed inspection of the ATR-FTIR spectrum allows the detection of spectral differences from a common glossy collodion photograph. The spectrum of a collodion photograph does not exhibit a spectral peak at ~1530 cm^{-1} belonging to the Amide II spectral peak of gelatin, which can often be detected in a collodion-varnished carbon print. The main spectral peak of gelatin (Amide I at 1630 cm^{-1}) almost completely overlaps with the 1637 cm^{-1} of collodion, but the presence of gelatin under a thin layer of collodion varnish can be detected based on the presence of the Amide II peak of gelatin. When a varnish layer is thicker, it may be more difficult to do a clear identification. However, because collodion varnish was usually applied in a very thin layer, this usually is not a problem.

Figure 26 Varnished "Permanent Photo" CDV photograph.

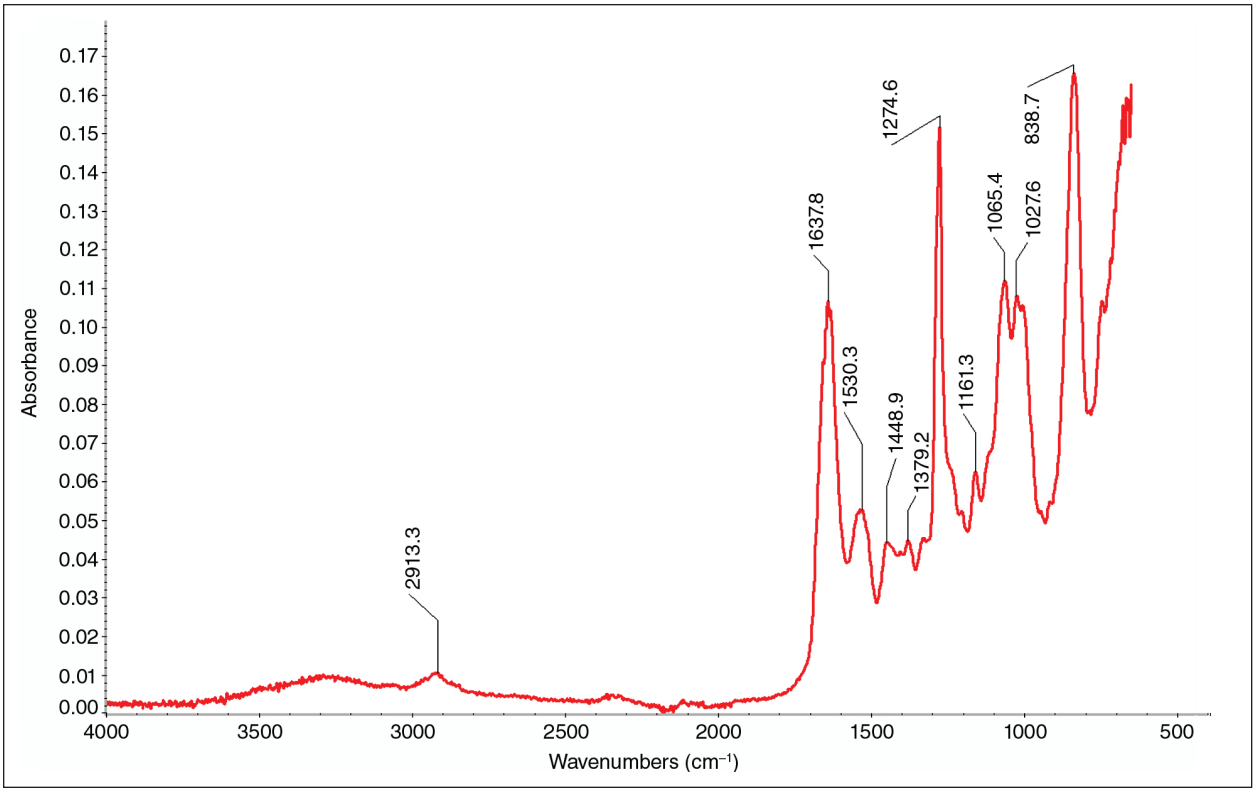


Figure 27 ATR-FTIR spectrum of the collodion-varnished photograph in fig. 26.

OTHER IMPORTANT VARIANTS OF THE CARBON PROCESS

Carbon transfer processes on different surfaces

Carbon Transfer Processes on Different Surfaces

Historical Background

One of the main advantages of carbon process photography was that a carbon print could be transferred to the surface of almost any material (fig. 28). All practical operations of the transfer were almost identical. Just two general rules needed to be followed. First, if the final surface was not flexible, a temporary flexible support needed to be used. Carbon transfers to the matte side of opal plates or to celluloid using the single-transfer process required no special preparation beyond surface cleaning. The surface of other materials needed to be prepared by coating with chromated gelatin before receiving the carbon image. In transferring to wood or other porous surfaces, the pores of the material needed to be filled and sealed. An often cited sealer and coating was Aspinall's Enamel, thinned with turpentine and rubbed into the pores of the material using a textile pad. Carbon prints on metal surfaces were produced also by single transfer and developed directly on the metal surface. Only in the case of brass, nickel-coated copper, or bronze substrates was it recommended that the surface of the metal be prepared by coating with a collodion varnish to prevent interaction of the chromium salts with the metal support, which often spoiled the final print. Aluminum surfaces were often grained by a solution of a strong base (lye). Preparing canvas, silk, or linen for the transfer of carbon prints required multiple coatings—usually three

Figure 28 Examples of carbon photographs transferred to the surfaces of various materials.

or four—using a solution of gelatin, glycerin, sugar, and chrome alum and smoothing the surface using sandpaper.

Process Description

Both single- and double-transfer carbon processes were used. The process selection was often governed by the choice of material used as the final substrate.

IDENTIFICATION: CARBON TRANSFER PROCESSES ON DIFFERENT SURFACES

Visual Signatures

Visual Characteristics

All different colors of carbon prints could be found transferred onto other materials. Carbon prints were the images most often used for transfers onto solid or irregular three-dimensional objects.

Microscopic Characteristics

The edge of a carbon transfer layer can sometimes be detected when examining an object under a stereomicroscope (figs. 29a, 29b). Microscopic examination also allows the detection of halftone, some digital, and other types of transfer materials. Higher magnification and a detailed examination of the surface of an object may detect the presence of pigment or carbon particle clusters.

Analytical Signatures

XRF

XRF analysis of objects with carbon transfer images should provide analytical results similar to those obtained in the analysis of carbon prints on paper. The presence of a low but detectable

Figure 29a Photograph of a china plate decorated with a carbon transfer image.

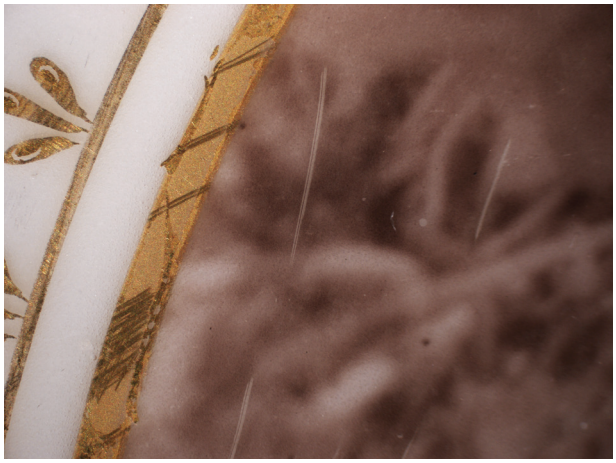
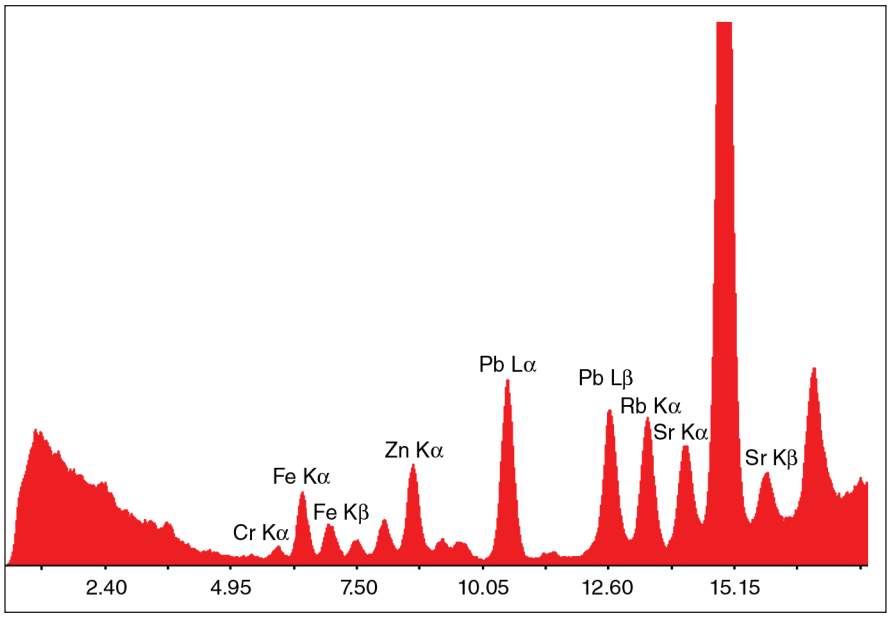


Figure 29b Detail of fig. 29a, showing the edge of the carbon transfer layer visible under a stereomicroscope at 10× magnification.

concentration of chromium and the absence of silver or other image-forming elements are the most important but not foolproof markers for the identification of a carbon transfer image (figs. 30a, 30b). The presence of chromium (Cr) in the image area indicates the use of carbon transfer. This finding is confirmed by the absence of silver, which is typical in transfers of collodion, gelatin, and albumen images.

Figure 30a XRF spectrum of the carbon transfer image shown in fig. 29a (image area).



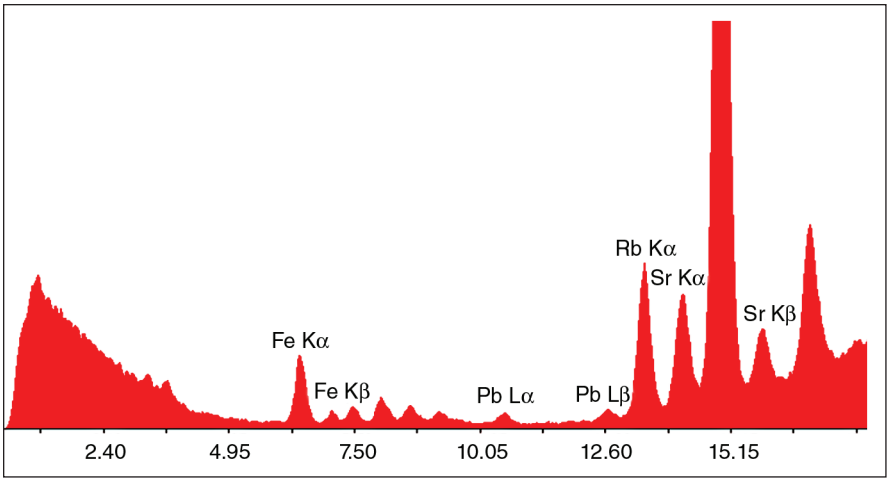


Figure 30b XRF spectrum of the carbon transfer image shown in fig. 29a (plate area).

The analysis of some carbon transfer images on solid and three-dimensional surfaces is much more complicated. The carbon layer is very thin, and both the chromium and/or iron signal can be hidden under much stronger and more complicated signals of other elements present in the thick substrate.

FTIR

ATR-FTIR analysis of rigid material is rather difficult, and some experience is necessary in obtaining good contact between the object's surface and the window of the spectrometer. The analysis of 3-D objects can be even more complicated or impossible without the use of a noncontact reflection version of the FTIR spectrometer. The identification of pigment particles and particle clusters, in combination with XRF analysis that shows an absence of silver, is usually a good indication that the studied image is likely a carbon transfer.

Identification Problems

Several other transfer processes (collodion, albumen, and gelatin transfers) were used to transfer images onto other substrates. The availability of liquid emulsion material also produced material with visual characteristics of carbon transfers. Silver-based emulsions are easily detectable using XRF spectrometry (the presence of silver in Dmax areas of an image). Modern digital and halftone transfer images that have an appearance similar to that of carbon transfers can be detected under a microscope.

Post-Process-Treated Carbon Transfer Images

To protect mechanically fragile carbon transfer layers, many objects were treated with scratch-resistant coatings. The presence of these coatings makes the identification of carbon transfer objects much more difficult and complicated.

INTERPRETATION GUIDE

Table 1 Summary of the main microscopic and analytical signatures of carbon photographs and some processes commonly misidentified as carbon photographs. The information below is for typical versions of each process. Exceptions to each entry may exist but are rare.

Carbon Prints

Process	Surface Coating	Paper Fibers	Fe	Cr	Ba	Other Inorganics	Cellulose	Gelatin	Collodion	Albumen	Other Organics	Tonality	Notes
Carbon	(X)***	(X)	(X)	X !	–	(X)**	–	X !	(X)***	–	–	Brown > violet-brown > black > other colors	Particle clusters present; relief
Woodburytype	(X)***	(X)	(X)	(X)	–	–	–	(X !)	(X)***	–	Shellac in Dmin		Particle clusters present; no border, usually mounted, relief
Albumen	(X)	X	–	–	–	Ag, (Au), (Pt), (Ti)*	X	–	–	X	(coatings)		Brown to purple
Gelatin	(X)	–	–	(X)	X	Ag, (Ti)*	–	X	–	–	(coatings)		Baryta layer visible
Oil	–	(X)	–	X	–	–	X	X	–	–	Ester bonds		Gelatin in Dmin, usually black
Bromoil	–	–	–	X	X	Sr, (Cu)	–	X	–	–	Ester bonds		Gelatin in Dmin, baryta layer visible

X Present
– Absent
( ) May be present
! Key signature

(X)** Range of colors can be achieved depending on pigments/dyes used
(X)*** Carbon and Woodburytype prints were sometimes coated with collodion
(Ti)* Some modern prints on 20th- and 21st-century substrates containing TiO_2

The Getty Conservation Institute