The Atlas of Analytical Signatures of Photographic Processes

HALFTONE

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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: Halftone print, 1905–6. Printed by the Walker Engraving Co.

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HALFTONE

English: halftone
French: *demi-ton*
German: Halbton, Rasterverfahren

HISTORICAL BACKGROUND

No single individual can be named as the inventor of the halftone photomechanical process. William Henry Fox Talbot (British, 1800–1877) invented and patented his use of textile screens in 1852. Talbot, Georg Meisenbach (German, 1841–1912), Frederic Ives (American, 1856–1937), and Max Levy (American, 1857–1926) can be considered major contributors to the development of the halftone printing process. A halftone print is shown in Figure 1.

Figure 2 shows a historical timeline for the halftone photomechanical process.

Figure 1 Halftone print, 1905–6. Printed by the Walker Engraving Co.

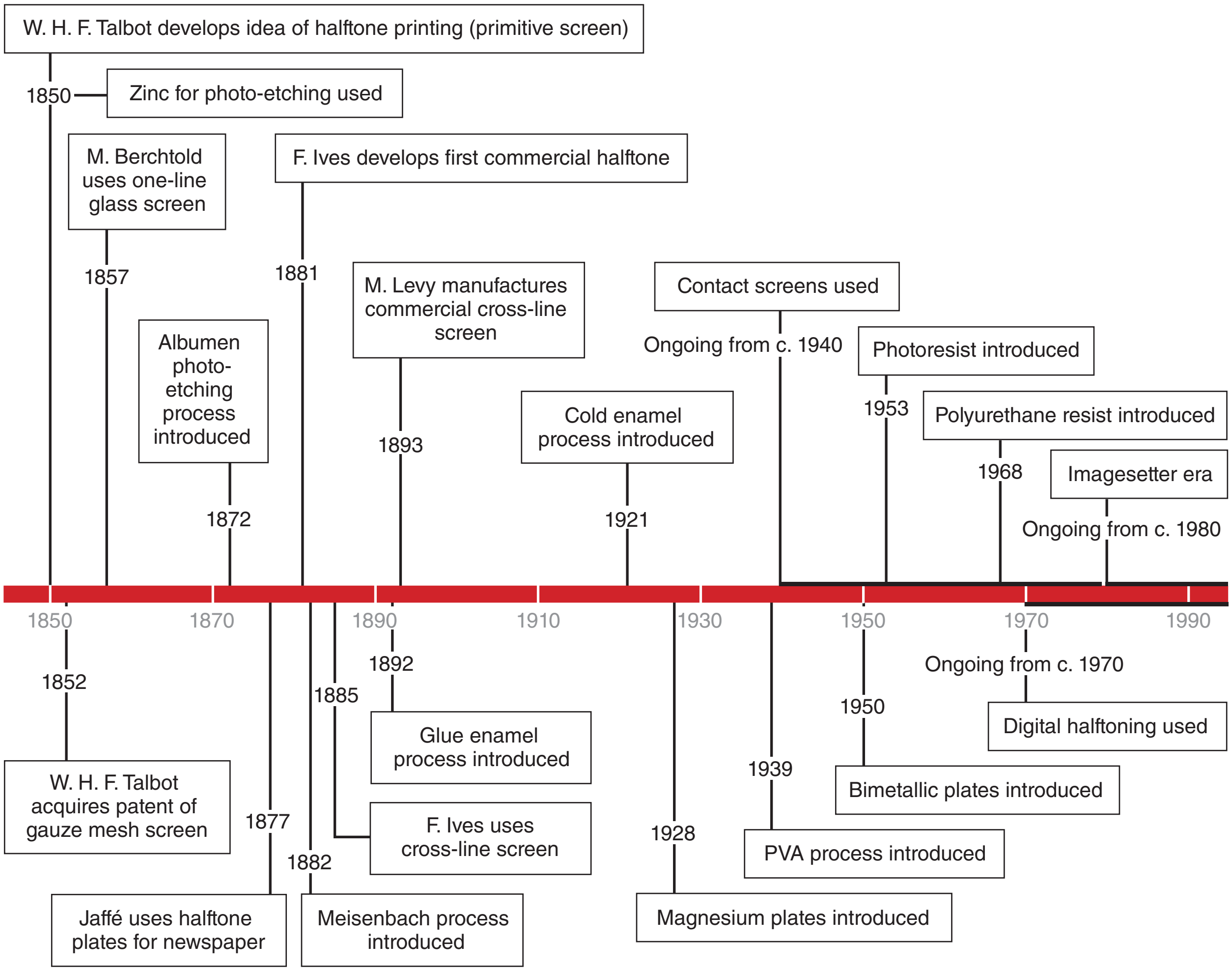

Figure 2 Timeline of the halftone photomechanical process.

Process Description

The halftone process is not a single, well-defined photomechanical printing process. Rather, the term *halftone* describes two processes. The first translates continuous tonalities of photographic prints or negatives into a series of dots. The second uses different methods of mechanical printing to produce a print that simulates the continuous tonality of reproduced photographs.

Most methods of mechanical printing can only print ink or leave blank areas on a printed substrate. The halftone process translates the different tones of a photograph into dots of various sizes (fig. 3).

Note: The binary (black or white) representation of a continuous-tone image is in fact an optical illusion based on the limited optical resolution of the human eye. When observed from a normal, practical distance, a printed field of tiny halftone dots is seen by the human eye as a smooth continuous tone. To achieve an ideal optical blending, *practical distance* depends on the final application of the printed material. When used in printed materials such as books or magazines, the dots have to blend when viewed from a distance of about 1 foot (30 cm). This can be achieved

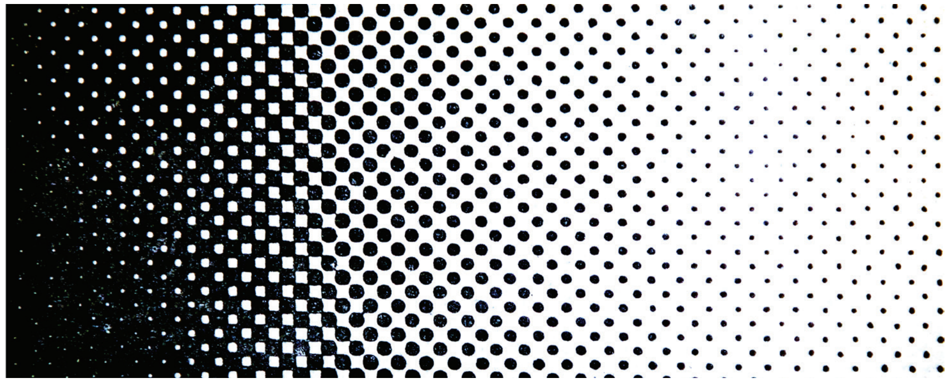

Figure 3 Close-up showing the translation of the continuous tonality of a photograph into printable dots of various sizes.

by using a halftone pattern of 150 lpi (lines per inch), which has a dot spacing of 0.16 mm. The dot pattern of larger posters or advertising billboards needs to appear continuous when observed from a much longer distance (requiring fewer lines per inch).

Figure 4 shows a schematic cross section of a typical halftone print.

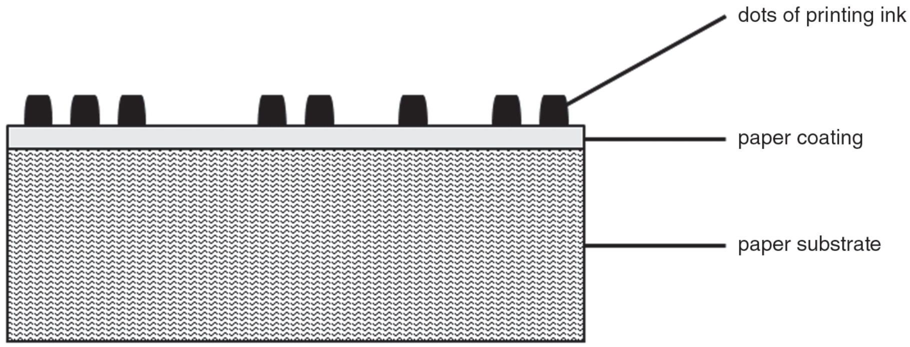

Figure 4 Schematic cross section of a typical halftone print.

Halftone Photography

Producing halftone dots of different sizes requires not only an appropriate halftone screen but also keeping the screen at a certain distance from a light-sensitive plate. Only then will the final dots have different sizes related to the amount of light penetrating each opening of the screen. Halftone dot formation is a complicated phenomenon, and its detailed explanation is well beyond the focus of this text. The interested reader can find more information in the primary literature on the physics of halftone formation. The intensity of light, the aperture of the process camera, and the shape of the aperture are additional parameters that have to be well balanced when making a halftone printing matrix of a reproduced photograph (fig. 5).

Halftone Screens

An early development of halftone printing involved a quest for the perfect halftone screen. A linear screen developed by Georg Meisenbach was twice rotated by 90 degrees. Frederic Ives cemented together, face-to-face, two 90-degree rotated linear glass screens, creating a single

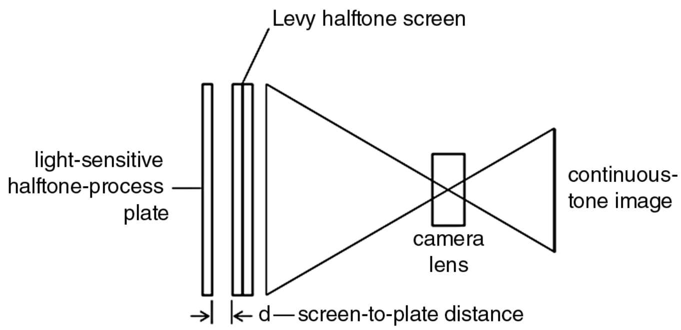

Figure 5 Schematic diagram of a halftone exposure assembly.

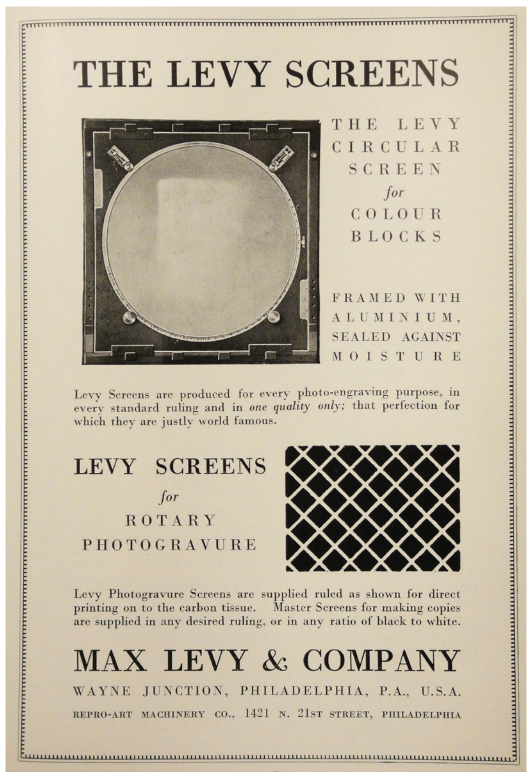

Figure 6 Book advertisement for Max Levy & Company's halftone screens.

halftone screen. Max Levy later perfected the production of high-quality halftone screens and was successful in introducing them commercially through his own company (fig. 6).

The dot pattern was then used to create printing plates or printing cylinders, and the halftone image was printed using a single-color printing ink on a final substrate, most often paper. Large numbers of quality prints could be produced quickly and economically.

The two most common procedures for printing halftone dot-pattern-based images were: (1) photo-etching in combination with letterpress printing and (2) photolithography in combination with offset printing.

When trying to identify photomechanically produced printed images, it is important to remember that in the past a number of hybrid photomechanical processes were also tested and introduced. These processes used halftone screens in combination with both photogravure and collotype printing processes, which did not require the use of a halftone screen. These processes were usually introduced as a solution for a specific printing problem, but most were used only for a limited period and later abandoned. During the time of their use, the resulting hybrid images combined the microscopic signatures of both photogravure and collotype with halftones. This makes the identification of these hybrid photomechanical processes difficult and challenging.

Main Application of the Halftone Process

The halftone process was used for books, newspapers, and magazines, as well as many different forms of printed and visual advertising and product decoration.

Noted Photographers Using the Halftone Process

Unlike the photogravure and collotype printing processes, halftone image making and printing was always viewed as a reproduction process for the mass production of photographic images and, as such, did not attract much attention from members of the photographic art community.

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Halftone Process–Related Patents

William Henry Fox Talbot, English Patent 565 (Oct. 29, 1852)

Printing of Halftone Images

Originally, during the era of letterpress halftone printing and before its replacement by offset printing, a halftone negative was copied onto a metal plate (copper, zinc, special metal alloy) covered by a photosensitive coating. The unexposed parts under the halftone negative were soluble and could be removed from the surface, leaving those plate areas exposed and susceptible to chemical etching using acids (for zinc) or iron (III) chloride solutions (for copper). This is a very simplified description of the process. The actual etching procedure is more complex and is composed of several steps. The first was designed to increase the resistance of the light-hardened photosensitive coating against etching. Multiple-step etching then provided more controlled etching, and steps were taken to protect the walls of the trench against etching under the resist-protected surface, called undercutting. The fully etched and rinsed metal plate was stripped of all of its resist coating, and the plate was then ready for printing using a so-called letterpress.

Letterpress (plane-plane) printing was very slow and was used only for low-volume printing. Printing halftone images for books usually required faster plane-cylinder printing. Large numbers of halftone images for books, magazines, or newspapers with large print runs called for cylinder-cylinder rotary printing. Rotary letterpress printing required curved printing plates. These plates were prepared by pressing a flat etched halftone plate (or a whole page containing both letters and images) into a papier-mâché mixture called *flong*, bending it to the needed shape and casting it using a metal with a low melting point. The resulting curved printing plate was then mounted onto a rotary plate printing cylinder (molded plastics were later used for the same purpose). Large letterpress newspaper printing machines allowed for high-volume overnight printing on both sides of the paper.

Rotary letterpress printing was eventually succeeded by the more convenient and economical offset lithography printing. Beginning in the 1950s, many rotary letterpress printers and their printing machines were reconfigured into offset printers.

IDENTIFICATION: LETTERPRESS PRINTED HALFTONE IMAGES

Visual Signatures

Visual Characteristics

When properly printed using a quality high-resolution halftone screen, the dot structure of the printed image should not be visible. The dotted image structure is usually detectable when printed using lower-resolution halftone screens (usually below 150 lpi). Most letterpress halftone printing also requires a smooth-coated paper substrate whose stiffness can be identified visually or by touching it between the fingers (even a very thinly coated paper behaves differently than uncoated paper). The lower translucency of a coated paper is also a good visual clue for the identification of a coated paper.

Microscopic Characteristics

A strong loupe or stereomicroscope allows clear identification of a halftone pattern. A higher-resolution (20×–80×) stereomicroscope also allows for the identification of many different types of halftone screens, as long as the screens had a well-defined, consistent, and unique dot shape or pattern.

If a high-quality coated paper was used to print the image, identification of the typical pattern of a halftone dot is difficult under high magnification (40×–100×). The individual dot was printed from a metal plate covered with individual dots. The surface area of each dot was inked using high-viscosity letterpress printing ink. The ink was then pushed or transferred under high pressure to the paper surface, typically causing a small amount of the printing ink to form a dark halo around an individual dot and creating a lighter or white central spot in the dot area (fig. 7). This type of process identification is easy for prints on coated paper. Prints printed on special rough paper or newsprint often cannot be identified with a high level of certainty.

Figures 8a–8i show a halftone print with its dot pattern at various magnifications and image densities, created using a standard Ives/Levy halftone screen.

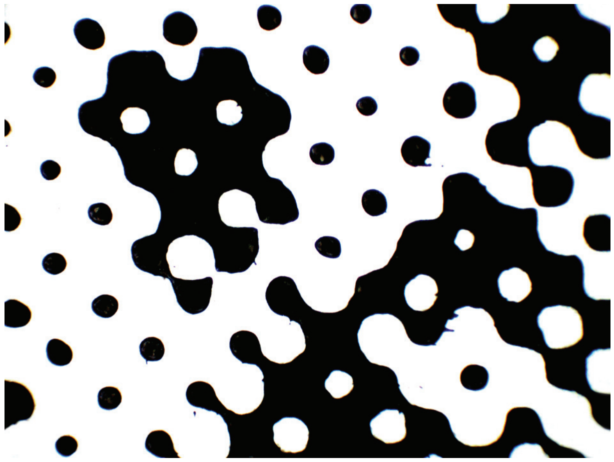


Figure 7 Detail of a dot pattern created by transferring high-viscosity ink under high pressure to the paper surface. Note the resulting halo of dark ink and a lighter central area of the dot.

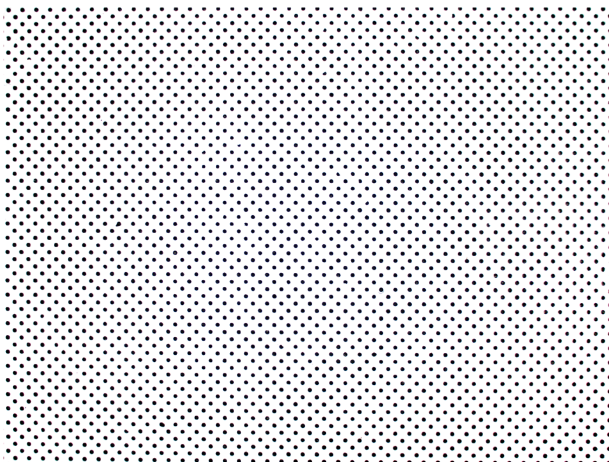


Figure 8a Letterpress halftone print at 50 lpi created using an Ives/Levy halftone screen (6.3× magnification in the Dmin area).

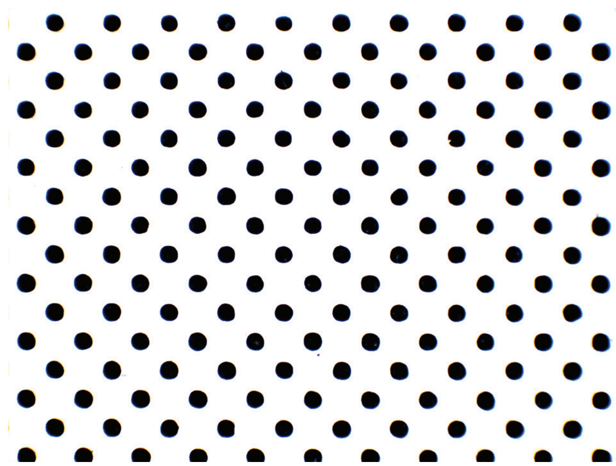


Figure 8b Letterpress halftone print at 50 lpi created using an Ives/Levy halftone screen (25× magnification in the Dmin area).

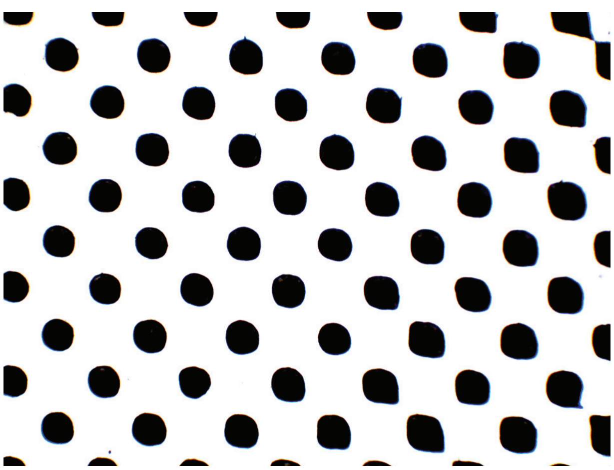


Figure 8c Letterpress halftone print at 50 lpi created using an Ives/Levy halftone screen (40x magnification in the Dmin area).

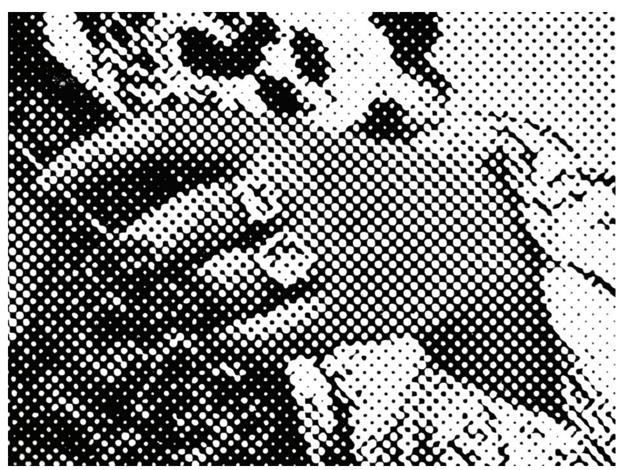


Figure 8d Letterpress halftone print at 50 lpi created using an Ives/Levy halftone screen (6.3× magnification in the Dmid area).

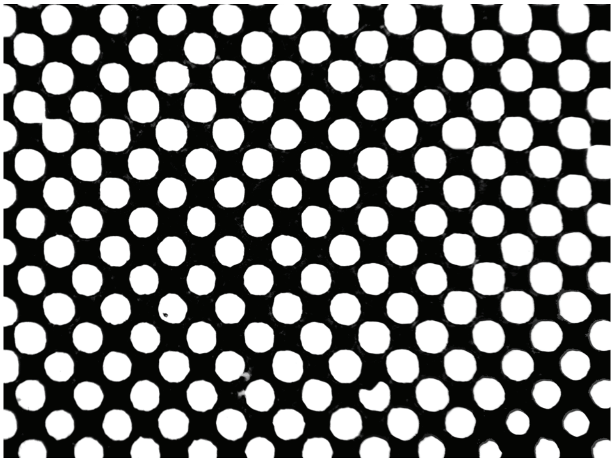


Figure 8e Letterpress halftone print at 50 lpi created using an Ives/Levy halftone screen (25× magnification in the Dmid area).

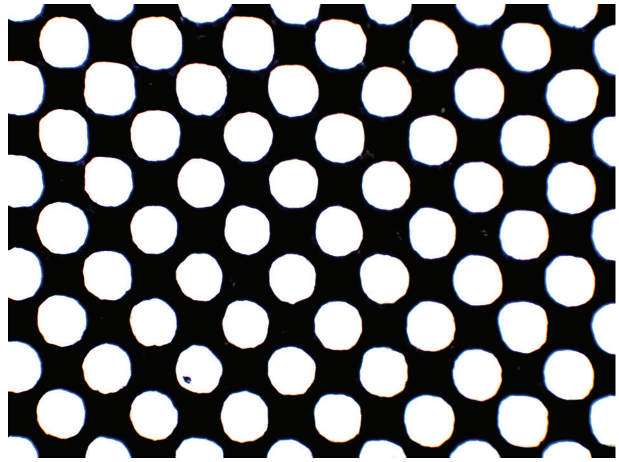


Figure 8f Letterpress halftone print at 50 lpi created using an Ives/Levy halftone screen (40× magnification in the Dmid area).

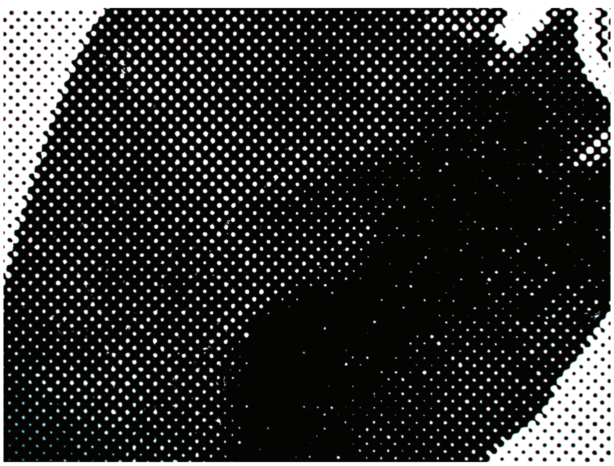


Figure 8g Letterpress halftone print at 50 lpi created using an Ives/Levy halftone screen (6.3× magnification in the Dmax area).

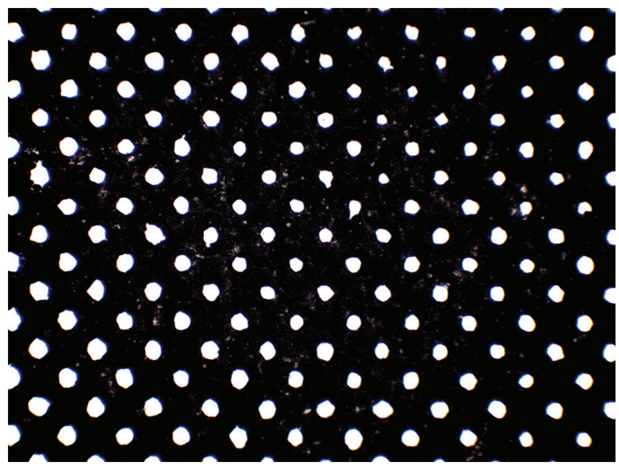
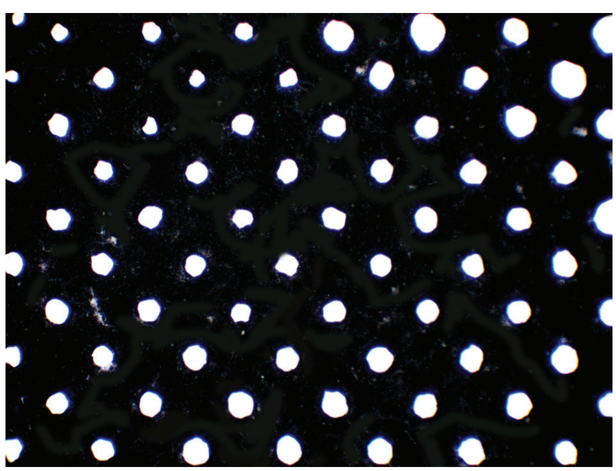


Figure 8h Letterpress halftone print at 50 lpi created using an Ives/Levy halftone screen (25× magnification in the Dmax area).

Figure 8i Letterpress halftone print at 50 lpi created using an Ives/Levy halftone screen (40× magnification in the Dmax area).



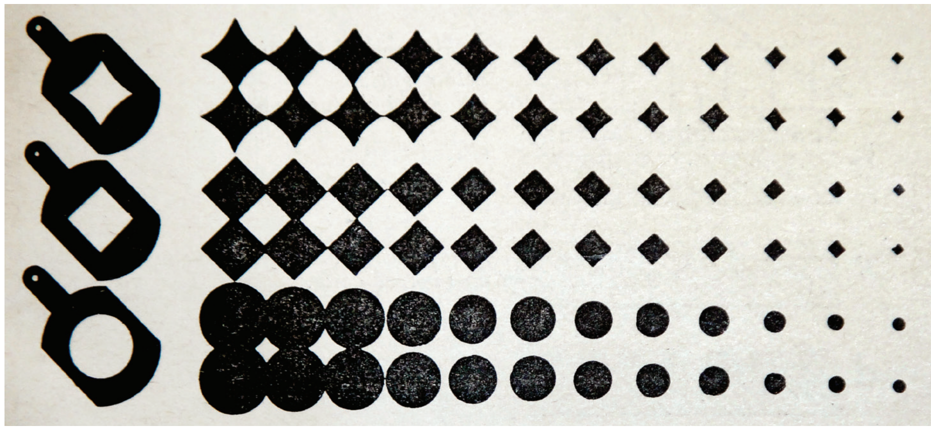


Figure 9 Image showing the relationship between the shape of the individual dots of an image and the shape of the process camera aperture.

To identify the dot pattern and dot shape, it is best to inspect areas from light to medium tonality. These areas are optically open enough to show the shape of individual dots and the growing size of individual dots in slightly darker areas. The round shape of the individual dots indicates the use of the round aperture of the process camera (fig. 9).

A higher-power measuring stereomicroscope can also be used to assess the resolution of the halftone screen. Three different halftone images (figs. 10a, 10c, 10e) were made using three standard Ives/Levy screens measuring 55, 150, and 400 lpi, respectively; each is accompanied by a microscopic detail (figs. 10b, 10d, 10f).

Figure 10a Halftone print created using a standard Ives/Levy halftone screen at 55 lpi.

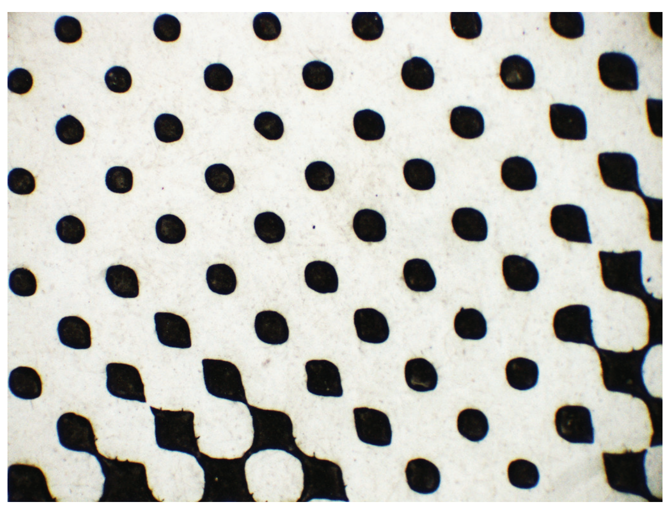


Figure 10b Detail of fig. 10a at 40× magnification.

Figure 10c Halftone print created using a standard Ives/Levy halftone screen at 150 lpi.

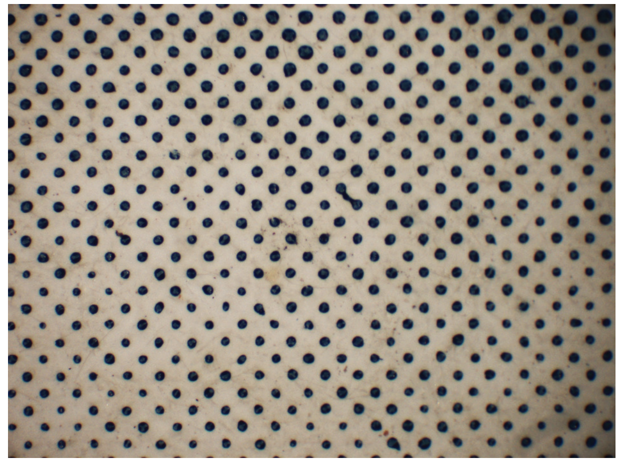


Figure 10d Detail of fig. 10c at 40× magnification.

Figure 10e Halftone print created using a standard Ives/Levy halftone screen at 400 lpi.

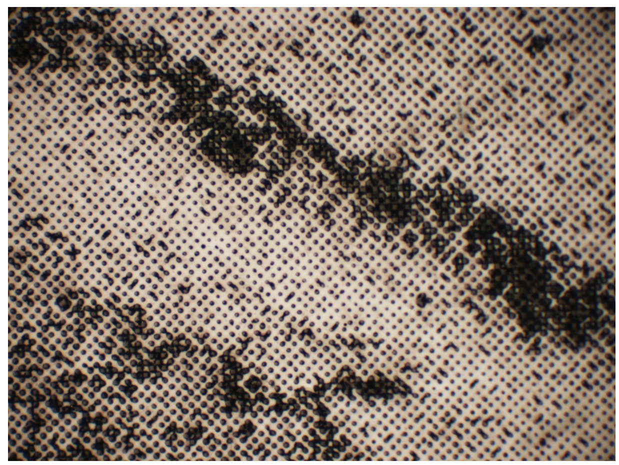


Figure 10f Detail of fig. 10e at 40× magnification.

The resolution of the halftone screen can be measured using a well-calibrated linear scale of a stereomicroscope. We have tried to identify the metal of the printing plate based on the detailed structure of the dot shape, which may be different when using metal plates of different hardness. Our comparison of prints did not provide any clear and consistent differences that would allow for such an identification.

Other halftone processes described in the literature, such as Palmertype, Paynetype, and Silvertype, as well as Andsleigh, Branfill, and Meisenbach processes, exhibit dot patterns similar to those produced using the standard Ives/Levy halftone screen. We could not detect any differences of individual dot patterns that could be used in identification.

Halftone Duotones

Using a single ink does not provide a full scale of black-and-white or color tonalities because the dark areas of an image cannot be printed to full tonal value without saturating and losing details.

Figure 11a Black-and-white duotone print.

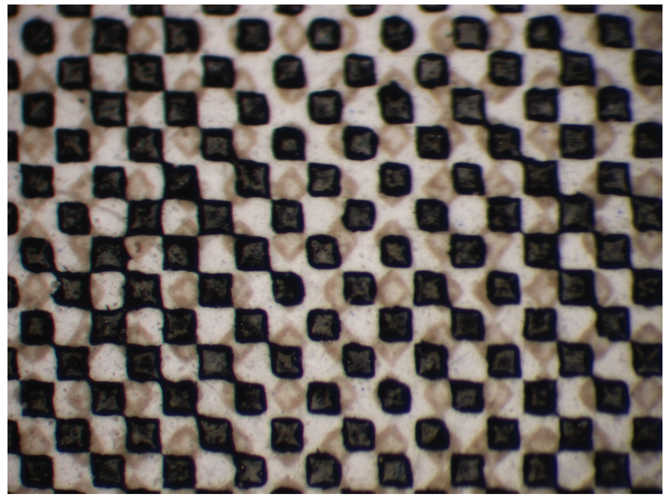


Figure 11b Detail of the light area of the print in fig. 11a at 80x magnification, showing the presence of a light-gray image with black overprint.

A solution for expanding the tonal scale involved printing in two passes, using both black and gray inks from plates adjusted for print highlights and for dark areas of the image. These images were called duotone, or duplex, images. A careful and systematic inspection of lighter areas of the print usually allows the identification of the presence of a second, light-gray image (figs. 11a, 11b).

A number of duotone prints were also printed using color printing inks of different hues. Duotones were also produced in two printings using inks of different colors. The first printing was done using a light color that was later overprinted using a dark-black ink. The resulting print had a pleasant, slightly shifted tonality (figs. 12a, 12b). Printing duotones using two different inks when neither was black produced interesting quasi-color images (figs. 13a, 13b). When the two inks were carefully selected and adjusted to the simple color schematic of a depicted scene or to the desired mood of the final print, duotone printing was capable of producing successful and pleasing images.

Three-Color Halftone Letterpress Images

Printing three-color halftone images using halftone plates and the letterpress was attempted shortly after the invention of halftone screen printing. The results, however, were not successful or faithful to the original color of a photographed object or scene because at that time (the last quarter of the nineteenth century) the photographic material used was not fully panchromatic. This prevented photographers and printers from making good color separation negatives for

Figure 12a Duotone print made using a light color and overprinted using dark-black ink.

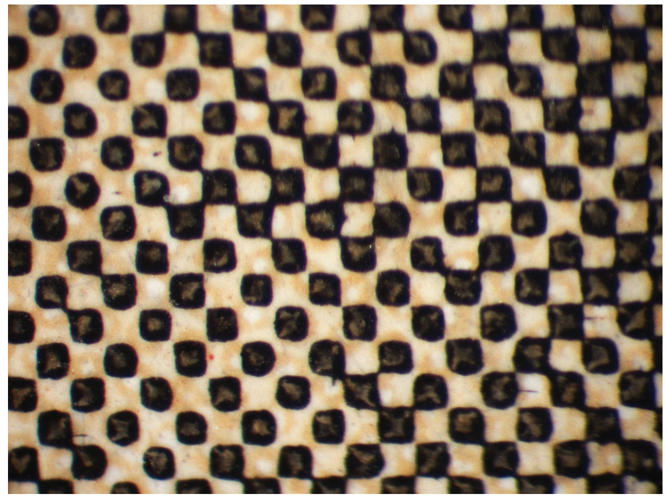


Figure 12b Detail of the lighter area of the print in fig. 12a, showing the dot pattern using a light color ink overprinted with a black ink (80× magnification).

Figure 13a Duotone print made using two inks of different color (neither of which was black).

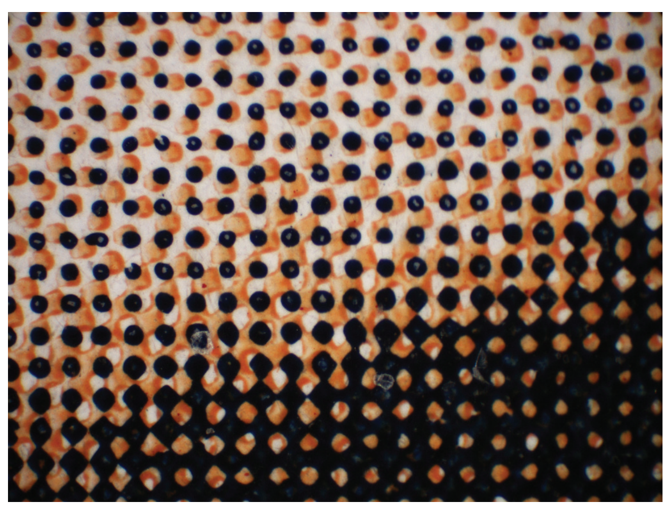


Figure 13b Detail of the dot pattern of the print in fig. 13a, showing superposition of two-color dot patterns (40× magnification).

producing good halftone negatives for yellow, magenta, and cyan printing. The color balancing of individual halftone negatives relied on the guesswork and experience of individual printers. Two three-color prints from two separate printers would be different from each other and usually from the natural colors of the scene. The first fully panchromatic black-and-white photographic material needed for both three-color photography and the production of color separation negatives for color printing was available only after 1906. The first fully successful color material available to photographers was Lumière's Autochrome, which was introduced in 1907. A number of very good three-color halftone prints were made after that time, often using an Autochrome positive as the starting image in creating separation negatives.

Figure 14 shows a three-color halftone print using yellow, magenta, and cyan inks with a solid gold-toned border. The detail of the same image shows a superposition of dot patterns of all three colors at different magnifications (figs. 15a–15c). Microscopic details of figure 14

Figure 14 Three-color halftone print using yellow, magenta, and cyan inks with a gold-toned border.

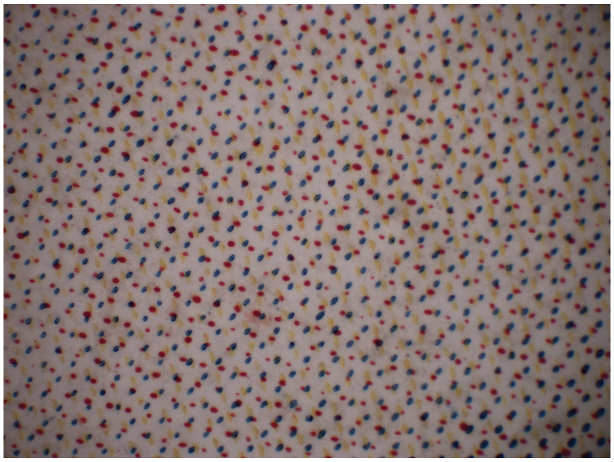


Figure 15a Detail of fig. 14, showing a dot pattern superposition of the color yellow (40× magnification).

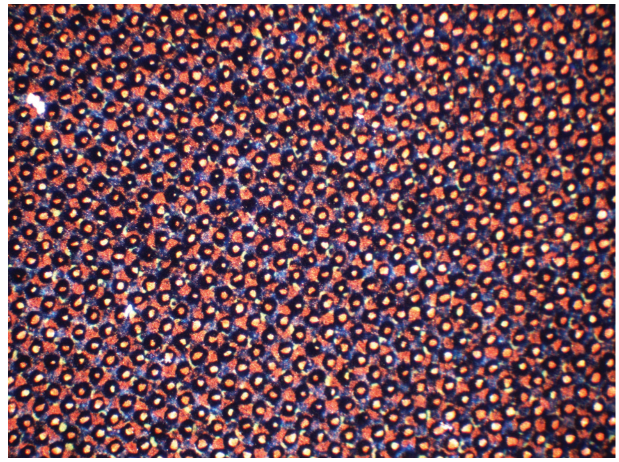
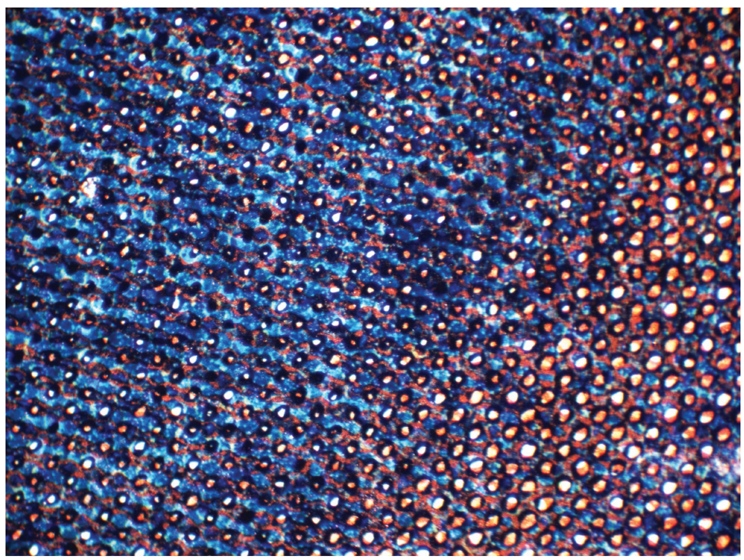


Figure 15b Detail of fig. 14, showing a dot pattern superposition of the color magenta (40× magnification).

Figure 15c Detail of fig. 14, showing a dot pattern superposition of the color cyan (40× magnification).



recorded at different magnifications show superposition of all three color print layers (figs. 16a–16c).

Results of combined XRF and ATR-FTIR analyses of the print in figure 14 clearly show that the image was printed on a clay-coated paper substrate using a combination of both inorganic and dye-based inks. Areas analyzed are highlighted in figure 17. Figures 18a–18f show XRF and FTIR spectra from areas rich in yellow, magenta, and cyan pigments and dyes.

Figure 19 shows the XRF spectrum of the gold-toned image border in figure 17 clearly identifying the use of brass-based pigment ink when printing (stenciling) the image border.

Figure 16a Microscopic detail of fig. 14, recorded at 10× magnification, showing superposition of all three color print layers.

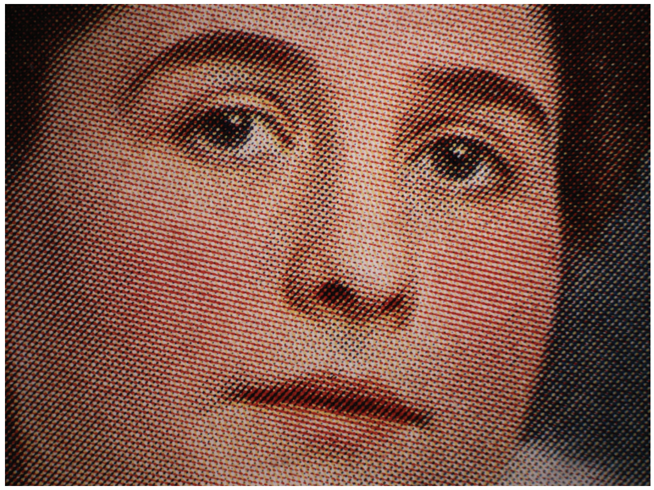


Figure 16b Microscopic detail of fig. 14, recorded at 25× magnification, showing superposition of all three color print layers.

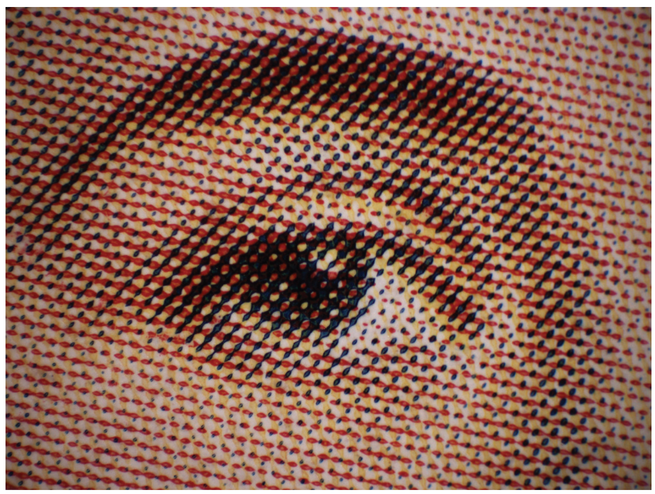


Figure 16c Microscopic detail of fig. 14, recorded at 40× magnification, showing superposition of all three color print layers.

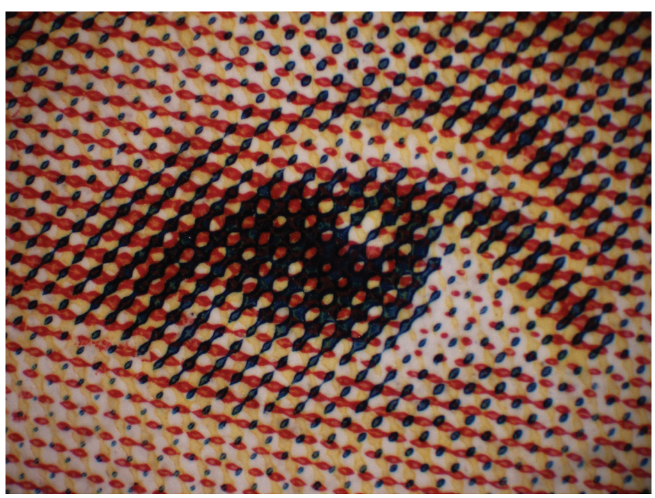
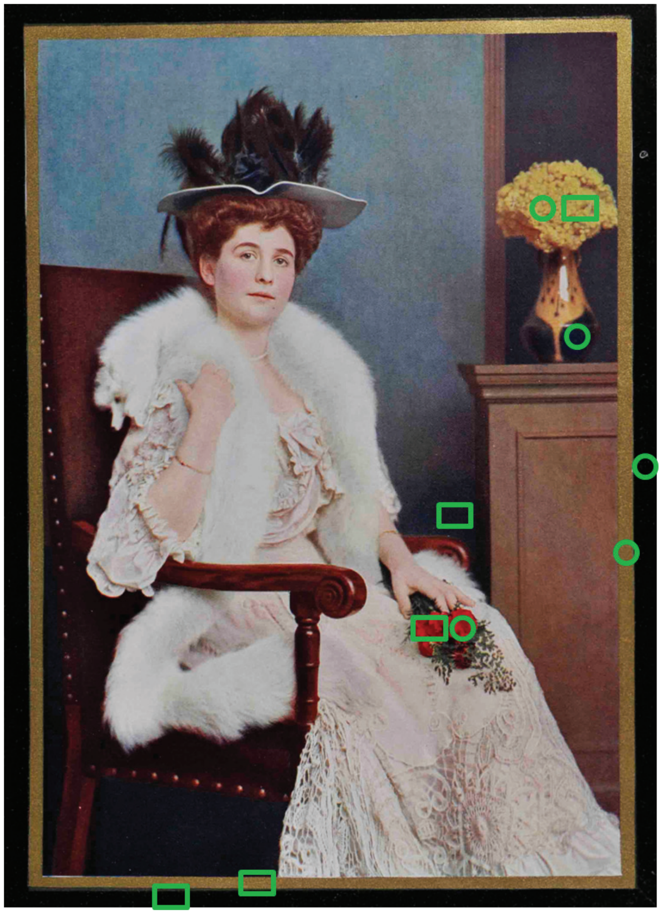


Figure 17 Fig. 14 showing highlighted areas. Rectangles indicate XRF analysis; circles indicate FTIR analysis.



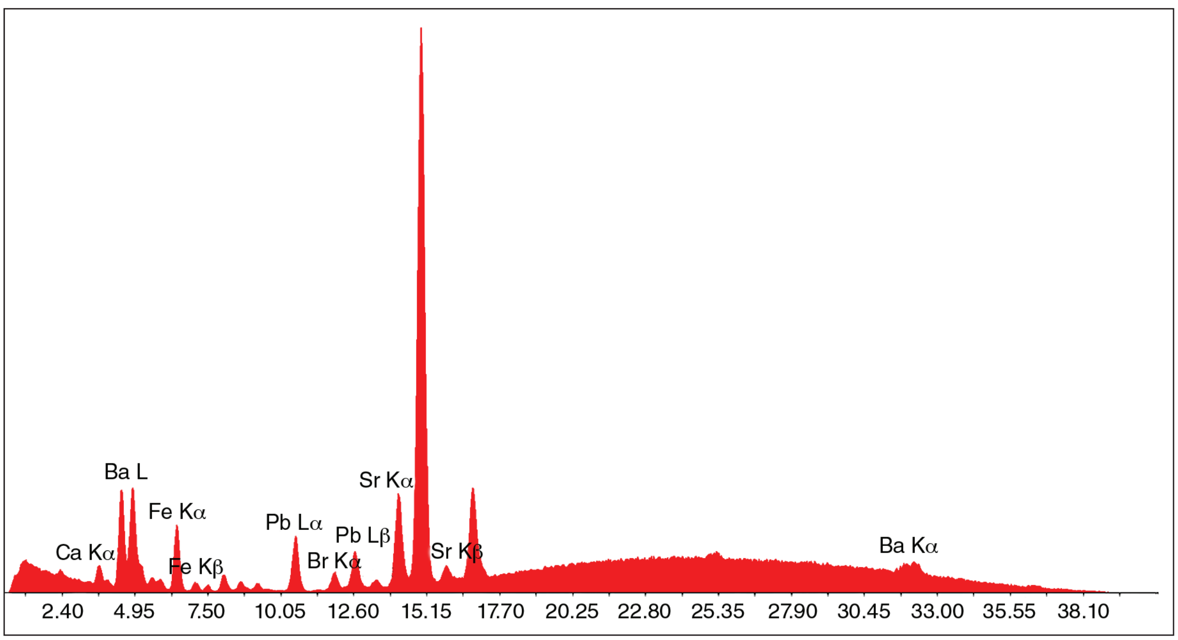


Figure 18a XRF spectrum of the blue area of the halftone print in fig. 17.

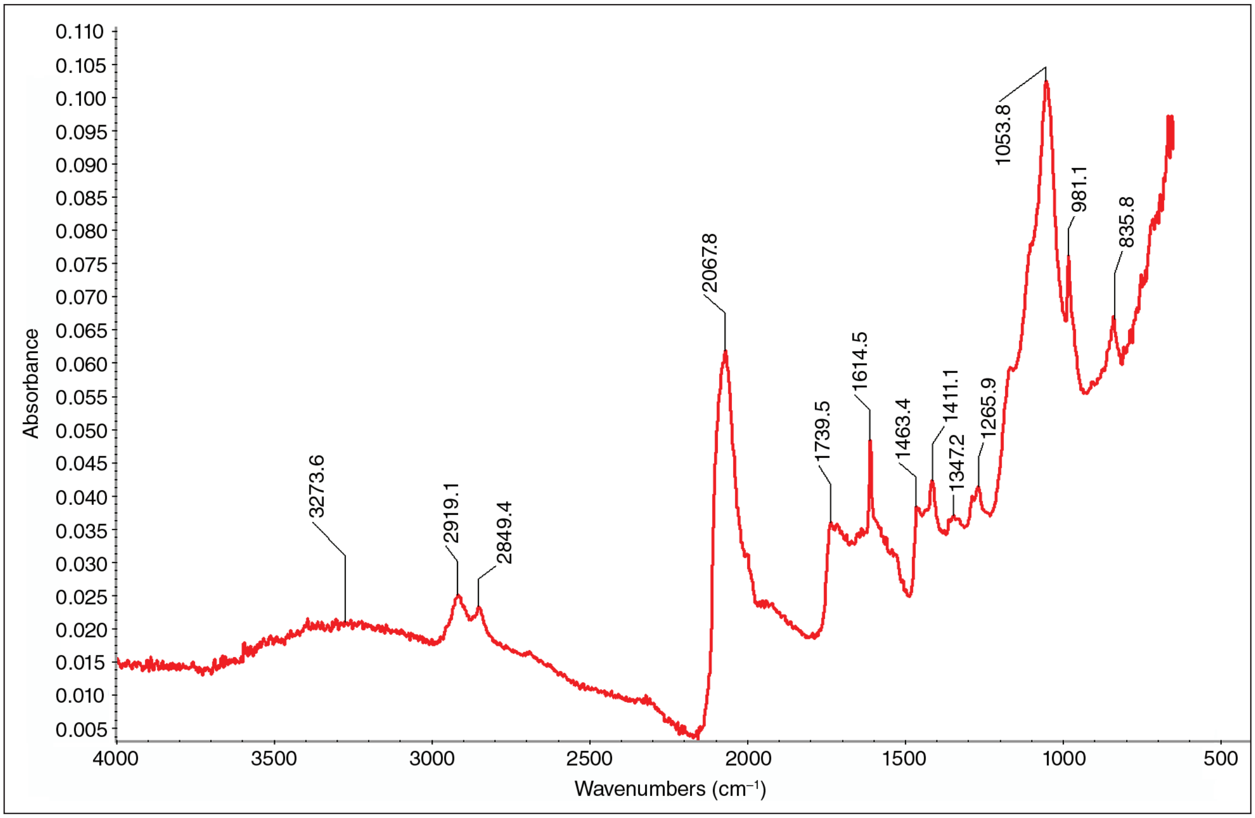


Figure 18b ATR-FTIR spectrum of the blue area of the halftone print in fig. 17.

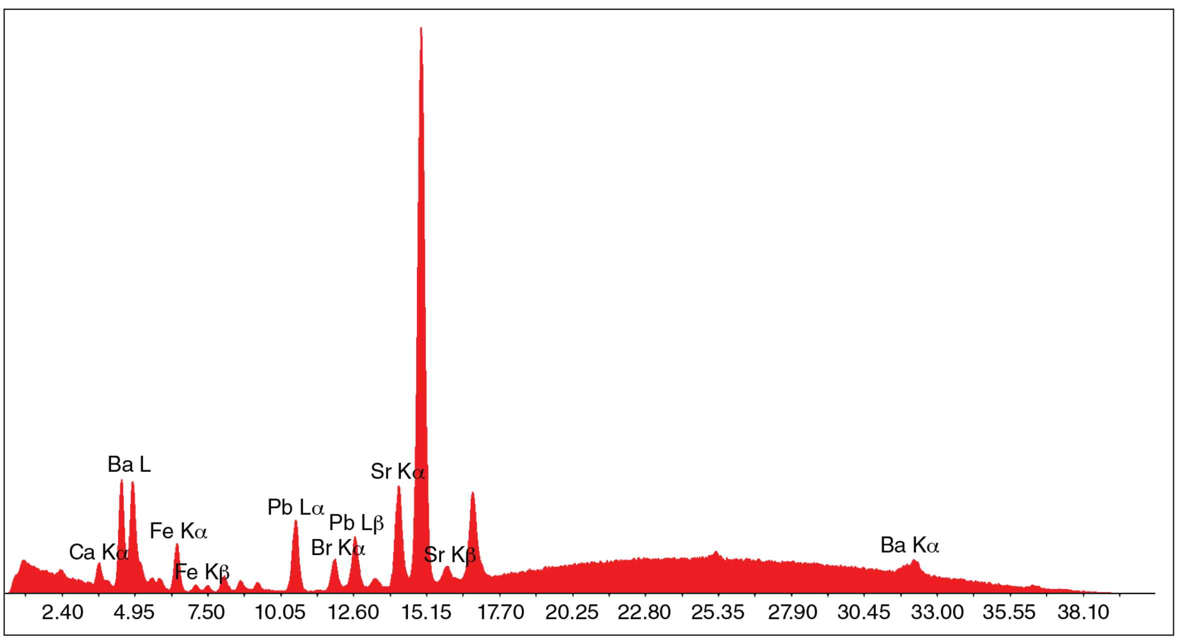


Figure 18c XRF spectrum of the red area of the halftone print in fig. 17.

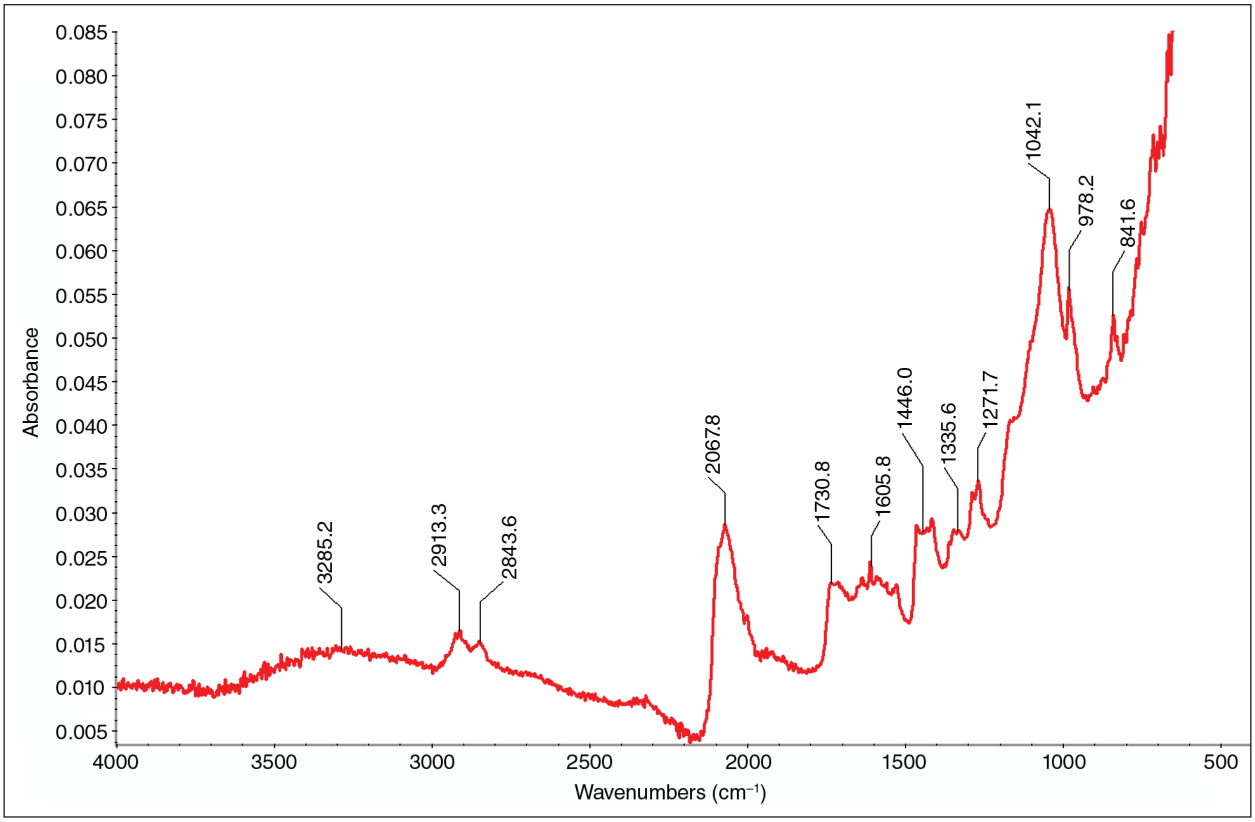


Figure 18d ATR-FTIR spectrum of the red area of the halftone print in fig. 17.

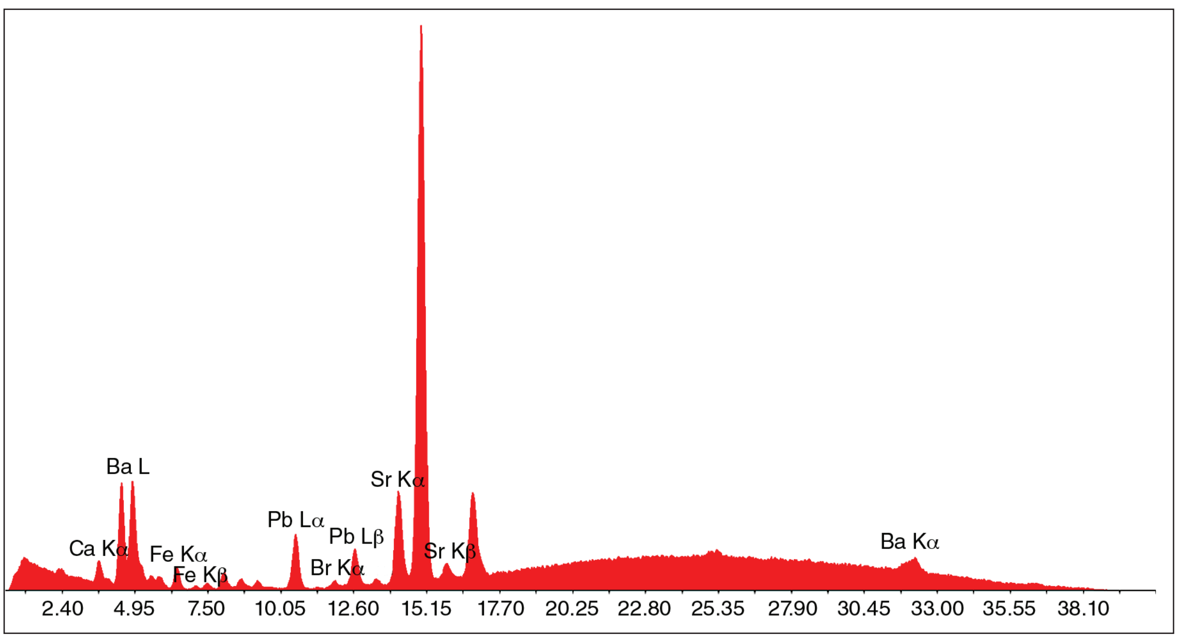


Figure 18e XRF spectrum of the yellow area of the halftone print in fig. 17.

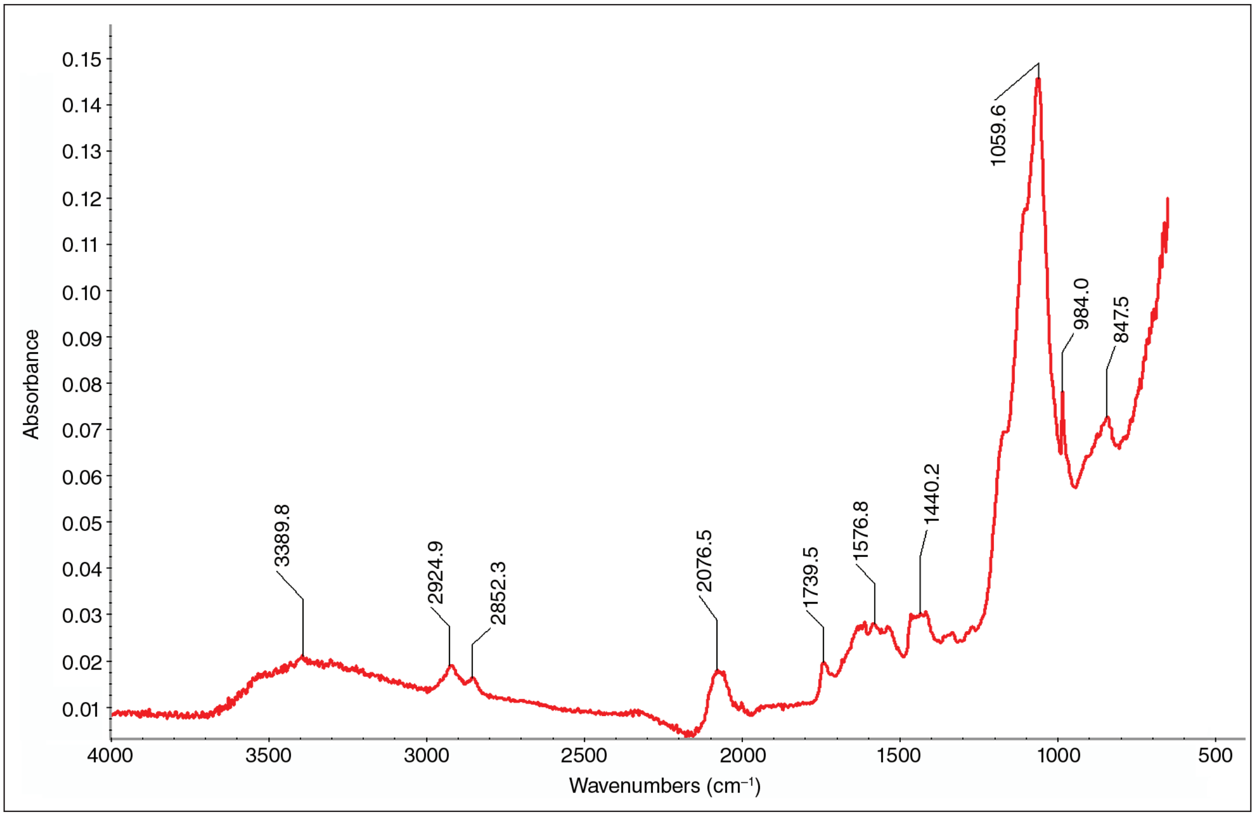


Figure 18f ATR-FTIR spectrum of the yellow area of the halftone print in fig. 17.

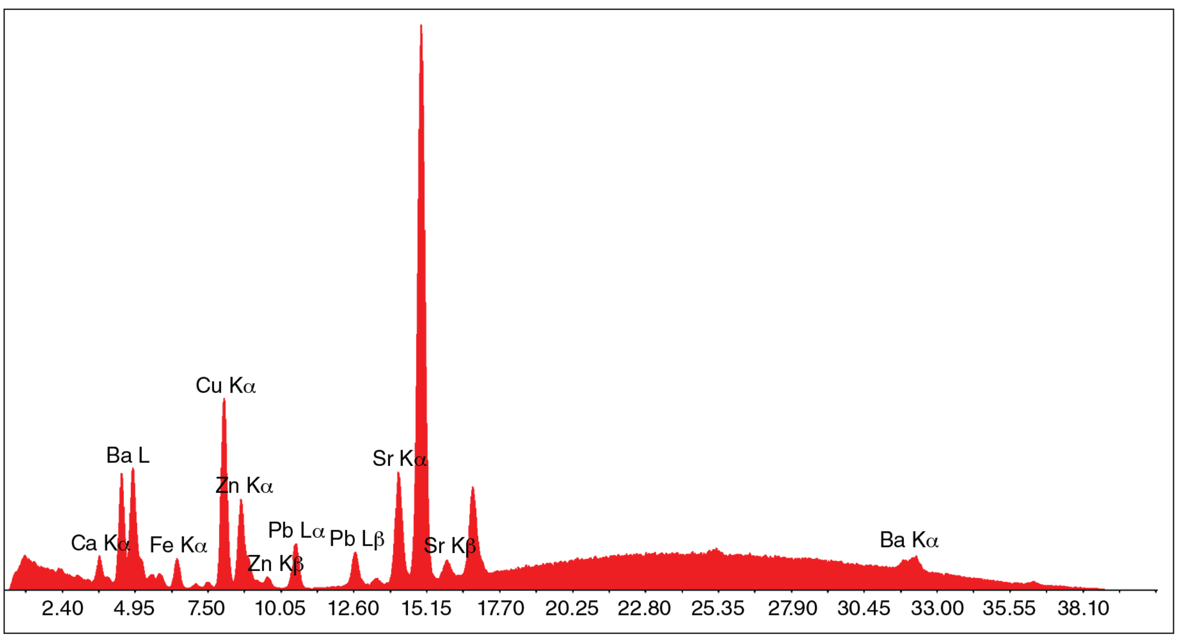


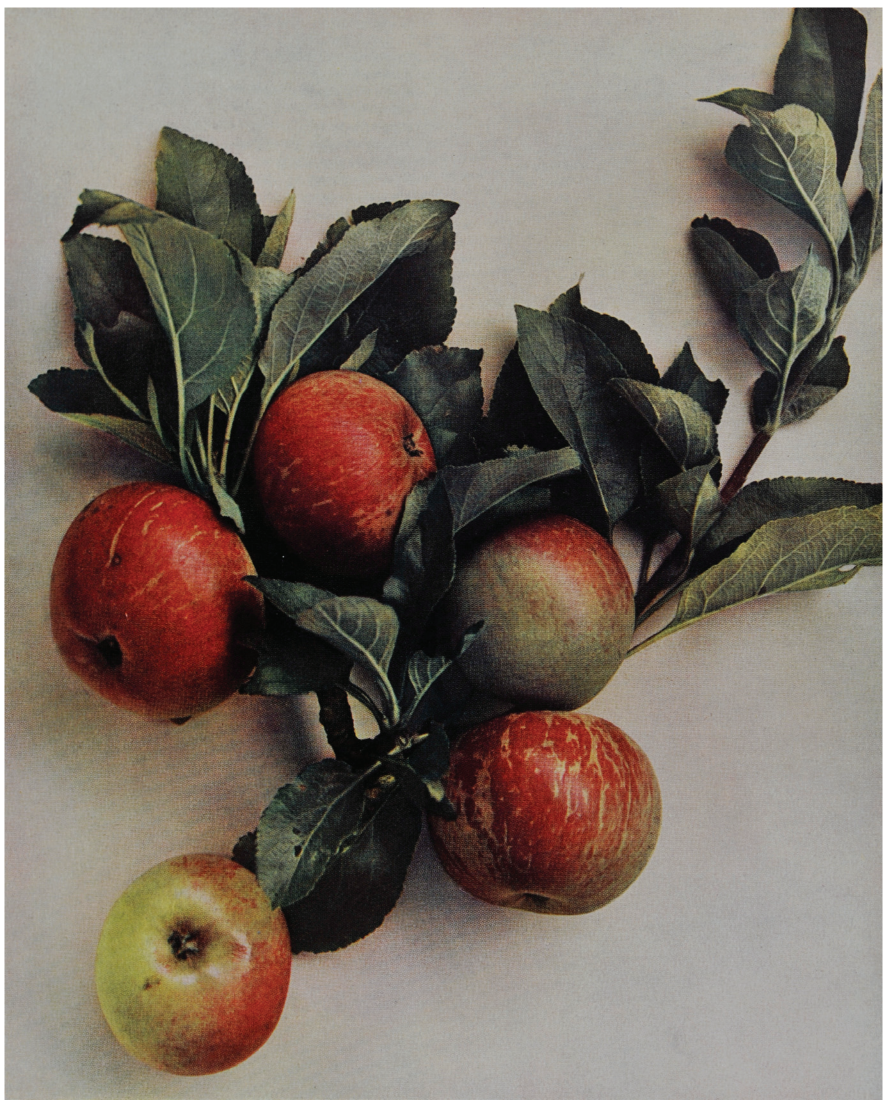
Figure 19 XRF spectrum recorded from the gold-toned border of the print in fig. 17.

Four-Color Halftone Letterpress Images

In theory, all colors should be printable using just a combination of yellow, magenta, and cyan inks. Early experimentation with different types of three-color printing led to the realization that the optical properties of real color pigments used for color photomechanical printing did not produce a good black color. Even the best three-color printed images lack the contrast and color saturation of the color photograph being reproduced. That was the reason for adding a fourth color, black (K, meaning key)—usually but not always overprinting—to the standard printing using cyan (C), magenta (M), and yellow (Y) halftone separation negatives (fig. 20). This was similar to today's high-performance color inkjet printers that also use the CMYK color system and sometimes add pigmented inks to produce perfect prints.

The microscopic details of figure 20 recorded at different magnifications (figs. 21a–21c) show superposition of all four color print layers (CMYK).

Figure 20 A four-color halftone letterpress print made using black as the fourth color.



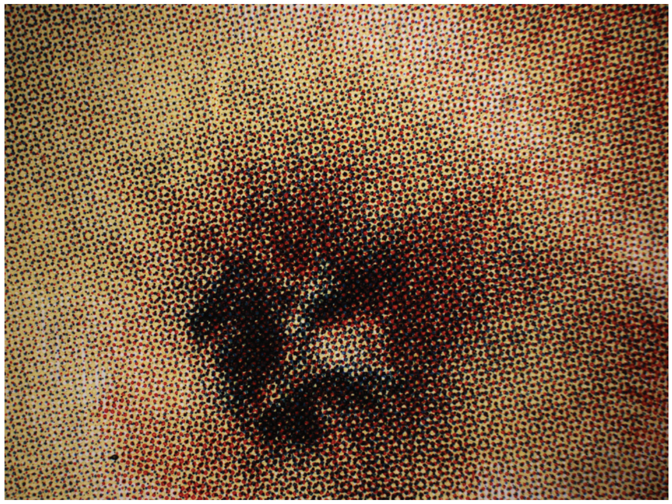


Figure 21a Microscopic detail of fig. 20, recorded at 10× magnification, showing superposition of all four color print layers.

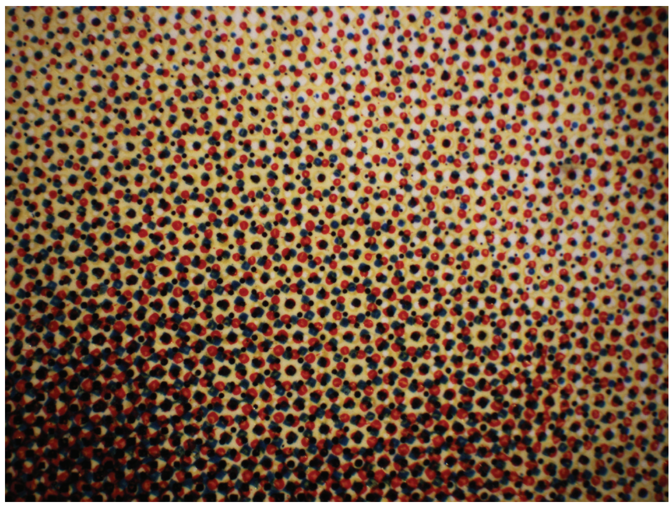


Figure 21b Microscopic detail of fig. 20, recorded at 25× magnification, showing superposition of all four color print layers.

Figure 21c Microscopic detail of fig. 20, recorded at 40× magnification, showing superposition of all four color print layers.

Irregular and Special Halftone Screens

Immediately after the invention of the halftone screen in the 1880s and well into the first part of the twentieth century, efforts focused on improving halftone screens, developing new screen types, and producing screens that were cheaper and better suited to specialized tasks. Many different halftone screens were patented, tested, and introduced, but most were quickly abandoned, leaving the standard Ives/Levy halftone screens the undisputed champion of halftone photography and printing. A number of prints produced using these special screens can be found in books, magazines, and specialized publications (for example, the *Process Work* books and the *Penrose Annuals*).

Some of these halftone screens produced an image pattern quite different from the dot pattern produced by the Ives/Levy halftone screens. When the pattern is regular, reproducible, and easy to differentiate, the microscopic signature of the halftone pattern can be used to identify the screen used.

Grain Autotype Screen

Figure 22 shows a typical halftone print created using the grain Autotype screen. The name of the process is quite confusing. It is probably specific to the screen manufacturer, but its microscopic grain pattern, shown in figures 23a–23c, differs enough from other grain pattern screens to allow its identification.

Figure 22 Halftone photomechanical image printed using the grain Autotype halftone screen.

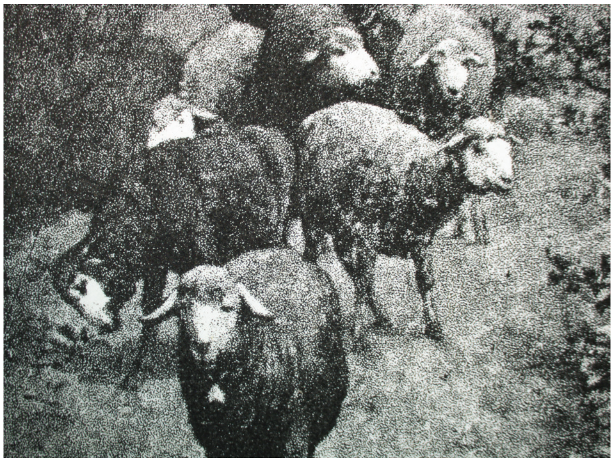


Figure 23a Detail of the grain Autotype print in fig. 22, recorded at 6.3× magnification, showing an irregular dot pattern.

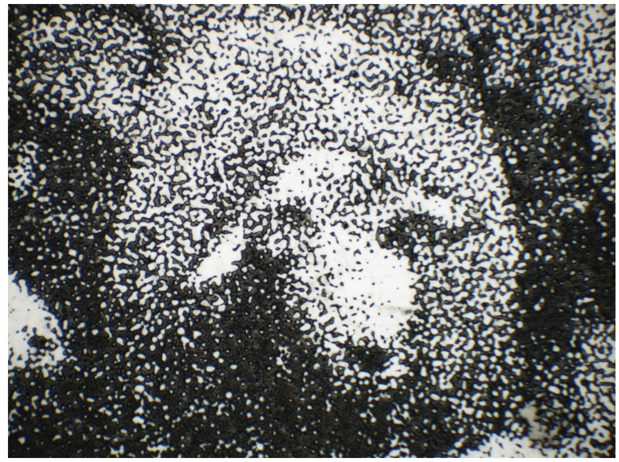
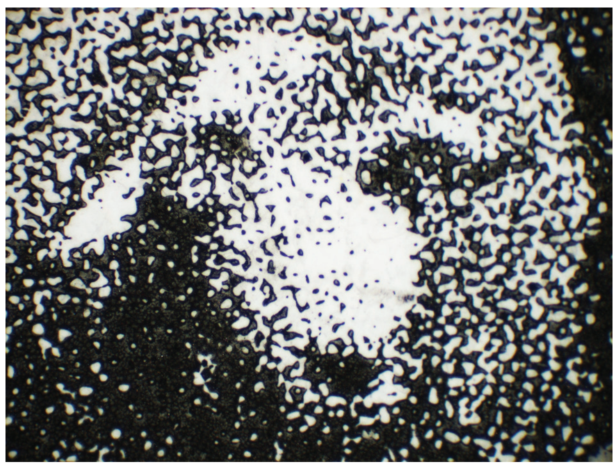


Figure 23b Detail of the grain Autotype print in fig. 22, recorded at 25× magnification, showing an irregular dot pattern.

Figure 23c Detail of the grain Autotype print in fig. 22, recorded at 40× magnification, showing an irregular dot pattern.



Metzograph Screen

The irregular Metzograph halftone screen, invented by James Wheeler, attracted attention during the early twentieth century. Its irregular pattern was etched into the surface of a glass plate through a cracking pattern of a special resist using hydrofluoric acid. The screen promised easy manipulation with the needed screen-to-plate separation provided directly by the thickness of the screen glass and a short light-exposure time. Use of the irregular screen also eliminated the problems of the moiré effect when printing color prints. All these advantages were negatively counterbalanced by the lower quality of the printed images. This might have been the main reason why the Metzograph screen was not widely used. Figure 24 shows an image printed using a Metzograph grain screen. A stereomicroscopic image of the print is shown in figure 25.

An interesting example shows a two-color duotone printed first with a very light yellow-orange ink from a printed plate produced using the Metzograph screen and then overprinted in black with a printing plate produced using a standard Ives/Levy screen (figs. 26a, 26b). The image detail shows a weak but easily identified Metzograph screen pattern.

Figure 24 Image printed using a Metzograph grain screen.

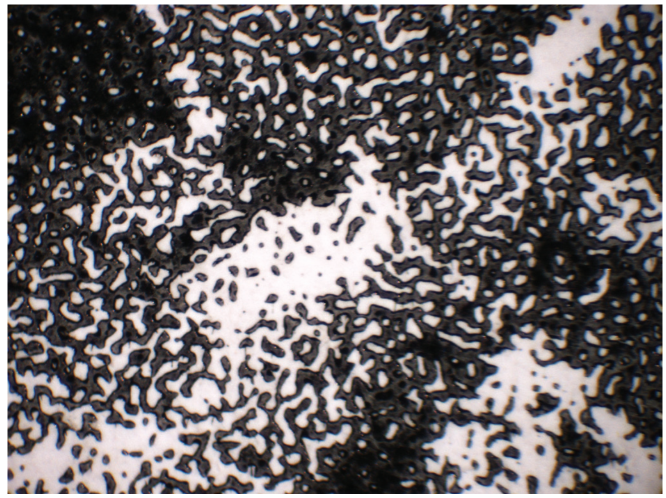


Figure 25 Microscopic detail of the structure of the Metzograph print in fig. 24 (40× magnification).

Figure 26a Metzograph standard screen duotone print.

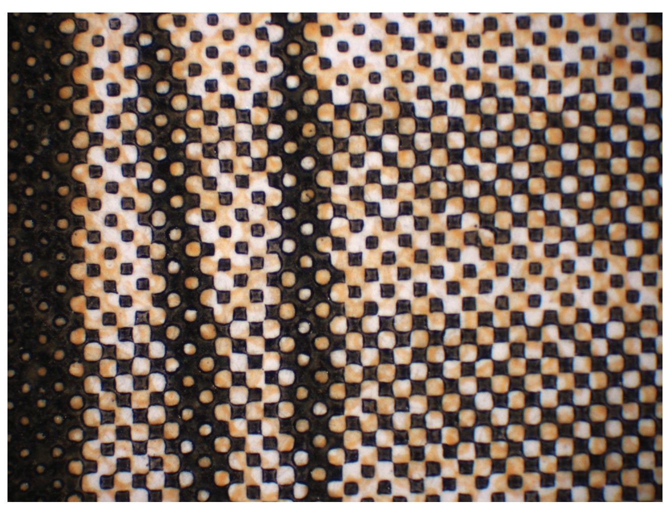


Figure 26b Detail of the print in fig. 26a, showing the distinct patterns of both screens (40× magnification).

Erwin Grain Screen

In 1926 T. C. Erwin patented his irregular pattern halftone screen. His reticulated gelatin was produced by forming, on a glass or other support, a layer of plain gelatin hardened to such an extent as to be insoluble in hot water. The gelatin was then reticulated using an acid solution. Tanning agents such as alum, formalin, and bichromates were used to harden the gelatin, either before or after coating it on the support, and hydrochloric, acetic, sulfuric, nitric, or phosphoric acid was used for reticulating the gelatin. Erwin's reticulated halftone screens could be enclosed between two cover plates, the thickness of which was chosen according to the use of the screen and the amount of reticulation. Figure 27a shows a pair of prints created using Erwin grain screens of different grain sizes and printed on a high-quality coated paper substrate. A microscopic detail of one of the prints is shown in figure 27b.

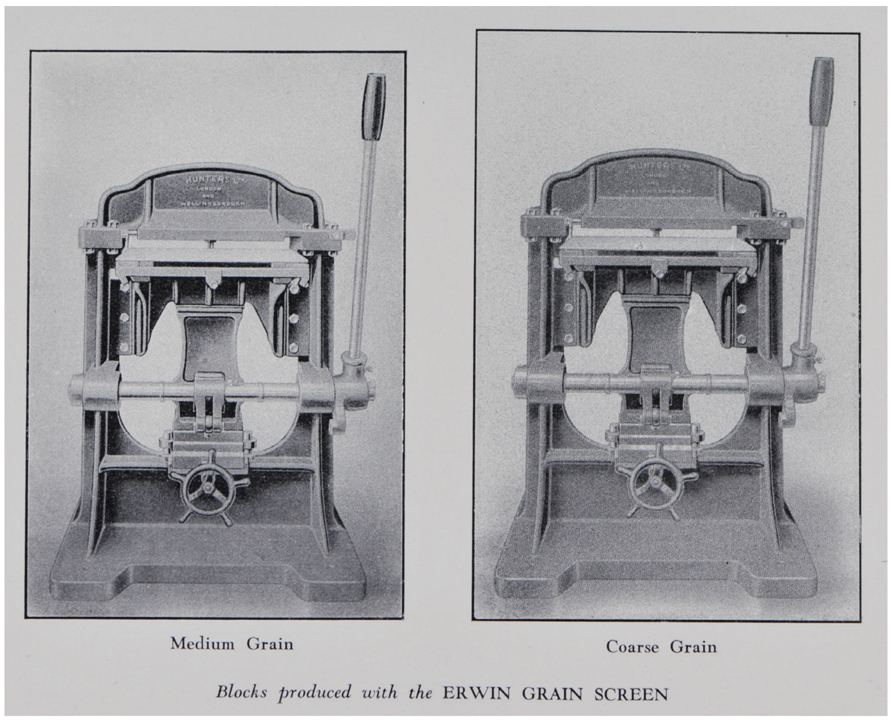


Figure 27a Two halftone prints created using an Erwin grain screen.

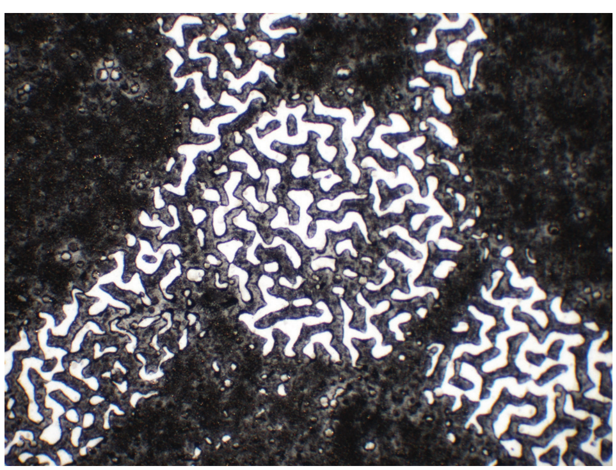


Figure 27b Detail of the print on the left ("medium grain") in fig. 27a at 40× magnification.

Figure 28a Halftone print created using an Erwin grain screen and printed on rough paper stock.

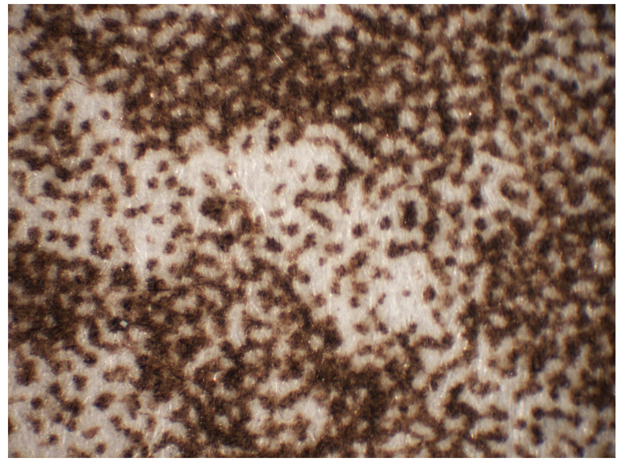


Figure 28b Detail of the same print in fig. 28a at 40× magnification, identifying it as a print made using a grain screen.

Figure 28a shows another print created using an Erwin halftone grain screen. Unlike the print in figure 27a, this image was printed on a rough-surface paper. The microscopic detail of the screen pattern (fig. 28b) shows that even when the image can be clearly identified as a print made using a grain screen, the pattern is greatly distorted by the roughness of the paper, making the identification of the exact type of grain screen difficult.

Wavy-Line Screen

Figure 29 shows an example of a halftone image printed using the so-called wavy-line screen. Even when the image provides good picture quality, the typical screen pattern is easy to identify during a careful visual inspection and without the aid of a loupe or microscope. Microscopic details of the same image (figs. 30a–30c) show the screen pattern and the way it modulates the tonalities of the printed image.

Figure 29 Halftone image print created using the so-called wavy-line screen.

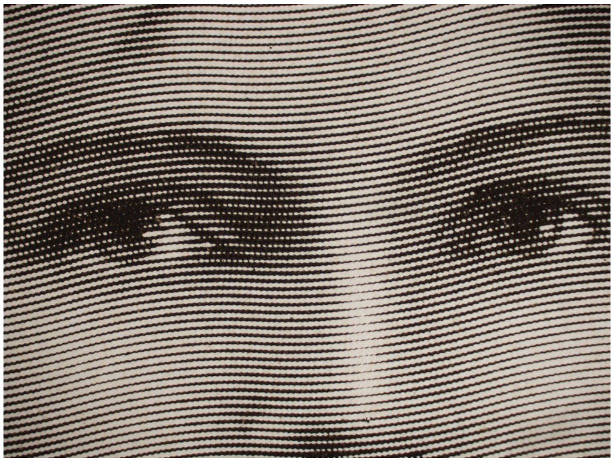


Figure 30a Microscopic detail of the wavy-line screen pattern at 6.3× magnification.

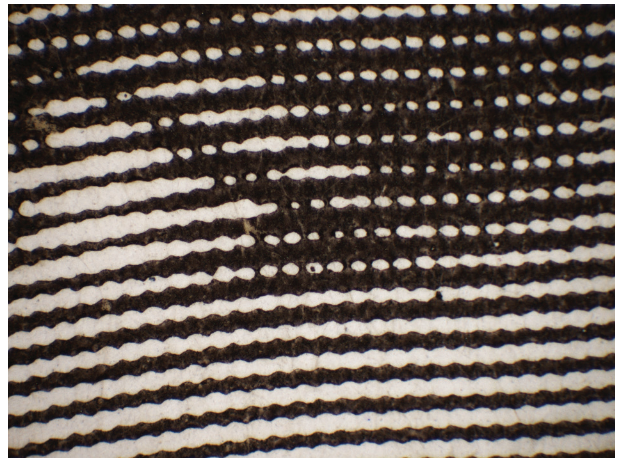
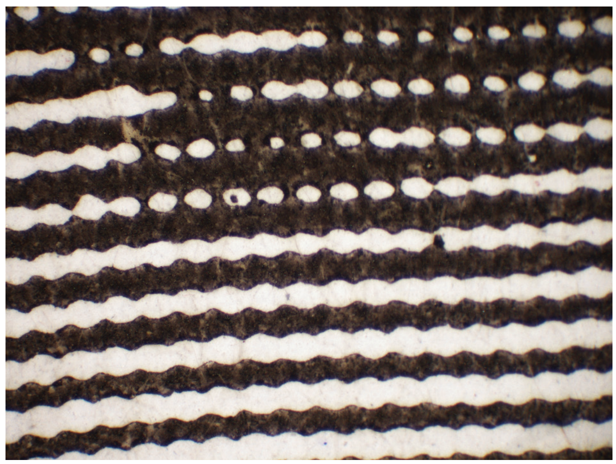


Figure 30b Microscopic detail of the wavy-line screen pattern at 25× magnification.

Figure 30c Microscopic detail of the wavy-line screen pattern at 40× magnification.



Special Halftone Printing Process: Akrography

Figure 31 shows an original 1908 photomechanical print created using the so-called Akrography process. The Akrotone tint print was created using a 100-lpi screen, ruled vertically and printed in tan. The image on the right in figure 31 shows this Akrotone image overprinted in black using a 150-lpi regular halftone screen. A detail appears in figure 32.

Post-Process-Treated Halftone Prints

Printed halftone images were sometimes varnished over to modify the gloss or its apparent optical saturation. Some halftone prints were also hand tinted or colorized using geometric stencils, rubber stamps, or air-spray machines.

Figure 33 shows an example of an early twentieth-century halftone print that was colored using a new air-spray gun called the Aerograph Spray Printing Machine. Red paint was sprayed through a prepared stencil. Holding the stencil a certain distance above the print prevented the creation of

Figure 31 Photo-mechanical print, 1908, made using the so-called Akrography process.

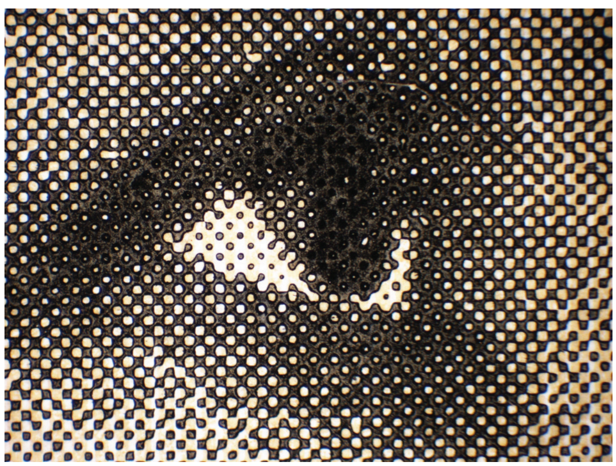


Figure 32 Detail of the print in fig. 31 at 25× magnification, showing the Akrotone tint overprinted with black ink.

sharp edges of the color fields and gave the image a more painterly character. Stereomicroscopic images of the print at different magnifications are shown in figures 34a–34c.

Analytical Signatures

XRF analysis of the red Dmax area of the oversprayed print shows that the paper substrate is baryta coated. The XRF spectra also show a relatively high concentration of lead (fig. 35a). In comparison, the XRF analysis of the green mounting paper shows only a high concentration of iron (fig. 35b). Comparison of both spectra reveals that the red ink in the oversprayed picture contains an organic colorant.

Figure 33 Halftone print, 1907, locally oversprayed with red paint using an air-spray gun called the Aerograph Spray Printing Machine.

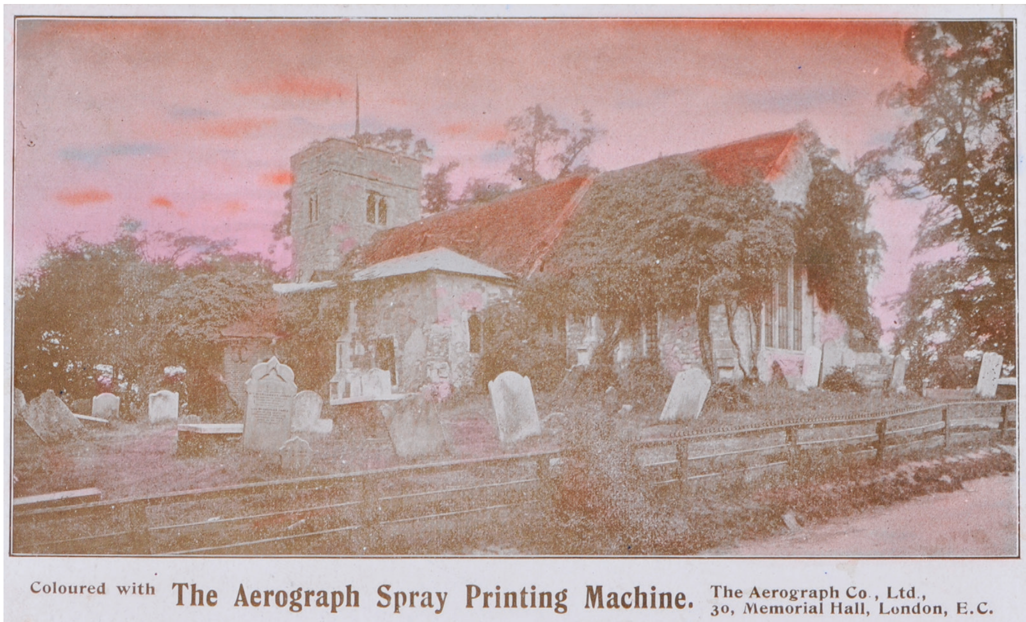


Figure 34a Detail of the print in fig. 33 at 6.3× magnification.

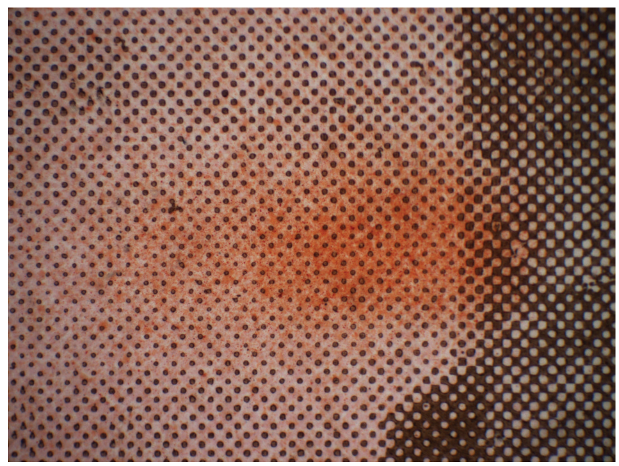
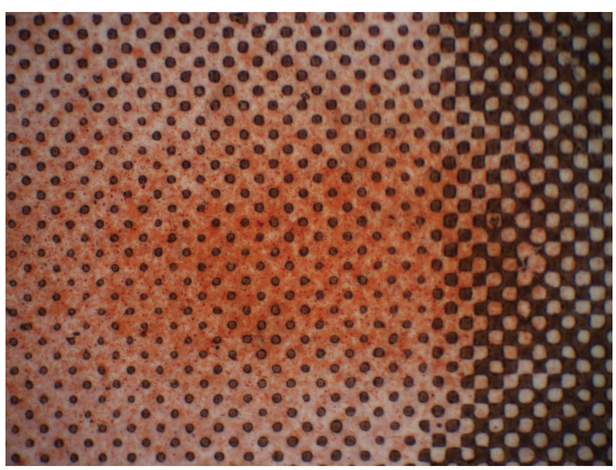


Figure 34b Detail of the print in fig. 33 at 25× magnification.

Figure 34c Detail of the print in fig. 33 at 40× magnification.



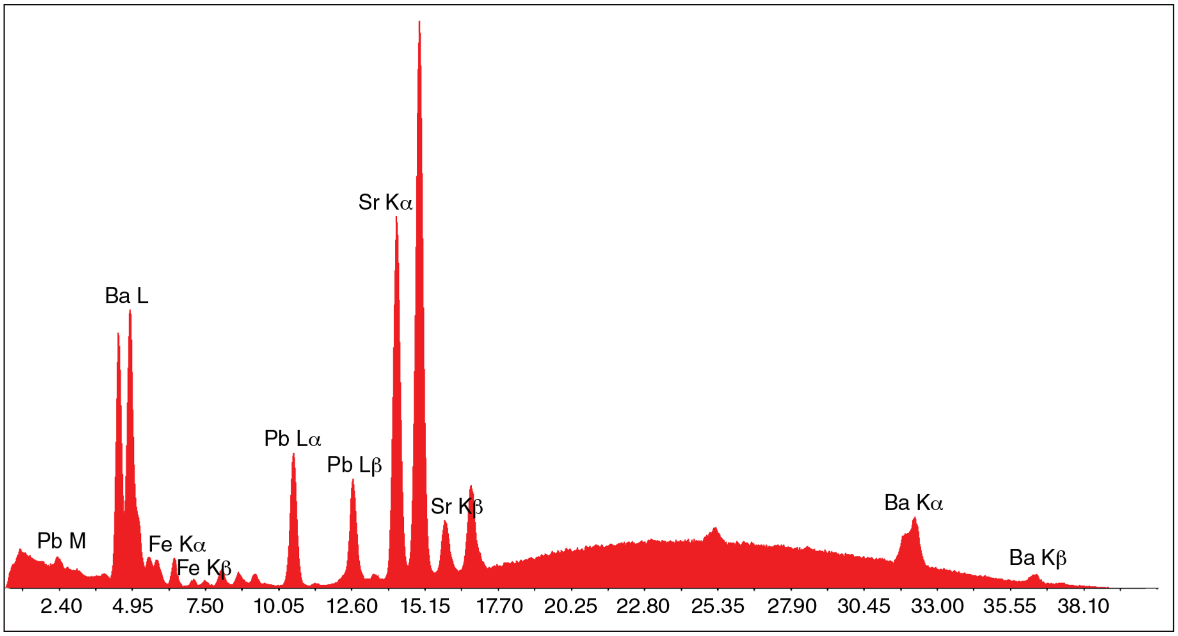


Figure 35a XRF spectrum from the Dmax area of the halftone print in fig. 33.

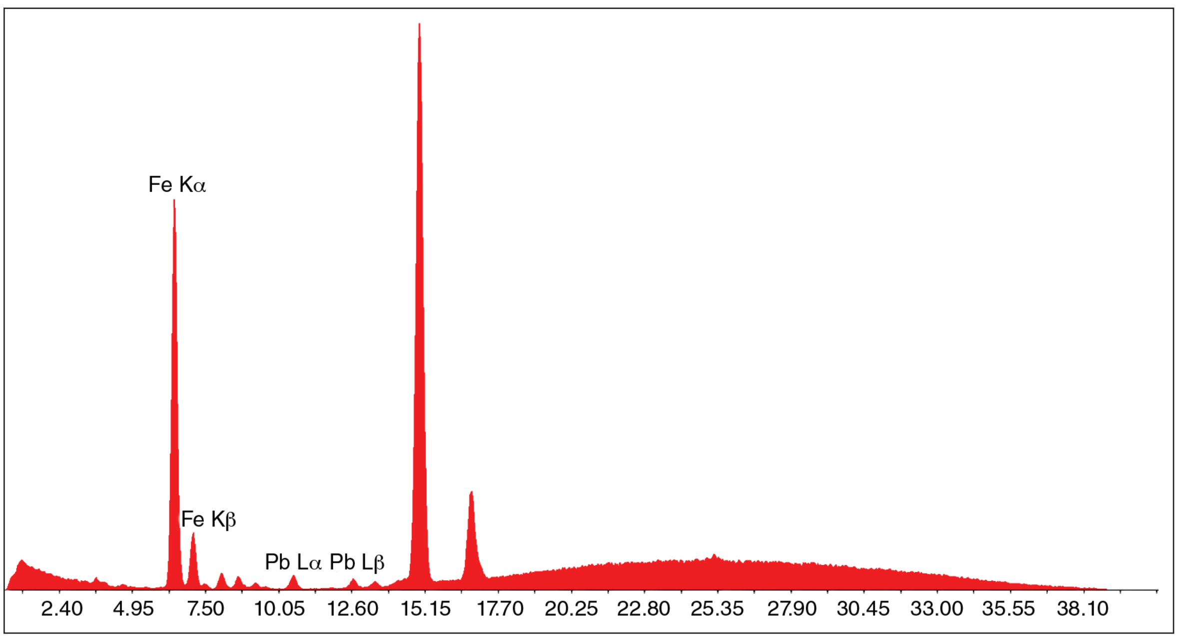


Figure 35b XRF spectrum from the paper support of the halftone print in fig. 33.

The ATR-FTIR spectrum (fig. 36) confirms the presence of a baryta coating (978.2 cm^{-1}), but the concentration of the organic colorant in the ink is too low to be identified without physical sampling.

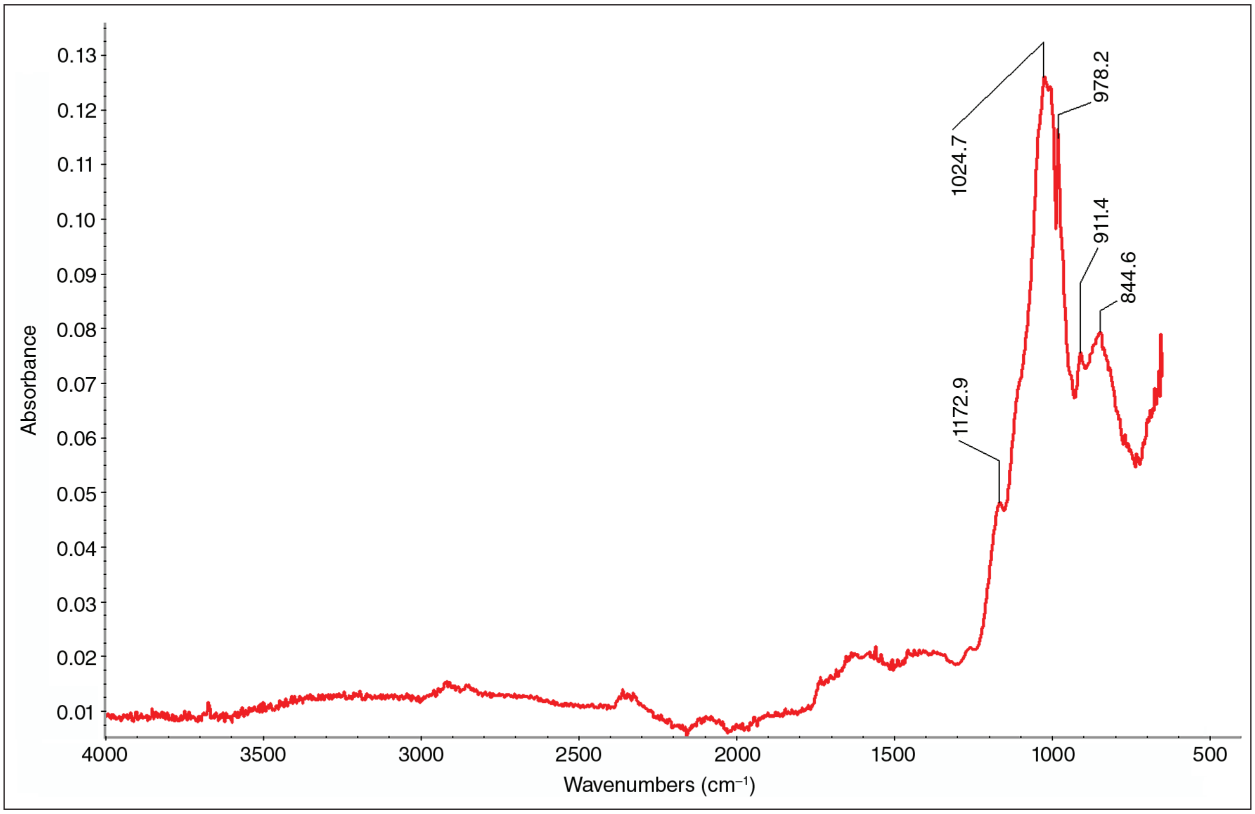
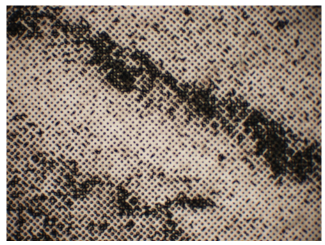
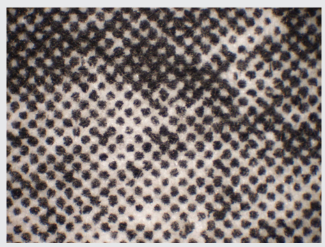
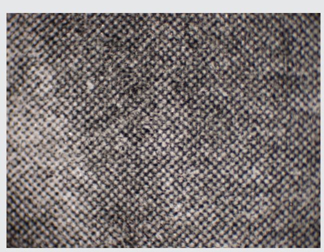


Figure 36 ATR-FTIR spectrum of fig. 33, confirming the presence of a baryta coating.

INTERPRETATION GUIDE

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

Halftone Letterpress

Process	Image Structure	Dot Definition	Images (40×)	Coated Paper	Tonality	Notes
Halftone “letterpress”	Halftone pattern	Well-defined, light center often visible		(X) often	black > brown > other colors	Coated paper components (XRF, FTIR)
Halftone “photolithography”	Halftone pattern	Low definition, flat deposit of ink		(X) often		Coated paper components (XRF, FTIR)
Rotogravure	Light, symmetrical lines	Different thickness of ink deposits		–		Ink pigments when no carbon used, low binder
Hybrid-collotype	Halftone pattern	Low-definition collotype pattern		–		Ink pigments when no carbon used, low binder

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