

A Methodology For Dating Photographs Relative to 1950.

Paul Messier, Conservator of Photographs
Boston Art Conservation
pm@paulmessier.com

[Author's Note: This presentation was originally given during the AIC conference on June 11, 2000. This online version is an abbreviated version of this talk. The intent of this web-based version is not to create a definitive repository of information on the subject, but to document the "state of the art" on June 11, 2000. As such, this presentation will not be updated, even as new information becomes available. I retain copyright on this presentation. Any application of this information is at the sole risk of the user. Unauthorized duplication or distribution of this material is not permitted].

About a year and half ago a client posed a problem. He wanted to know if I could date 20th century photographs using empirical, non-subjective means. He knew I could offer him my subjective opinion of when something was made, based on an assessment of deterioration and other observations, that wasn't good enough.

He was asking for a dating methodology based on material fact and I didn't have one.

This was the beginning of the ongoing project that I am speaking of today.

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Dating 20th Century Photographs: The Methodology

- Optical Brightening Agents (OBAs)
- Paper Fiber Content
- Manufacturer Markings
- Paper sizing

In many cases photographs made after 1950 or 1955 are manifestly different than photographs made earlier in the century. The methodology for determining these differences, such as it is, is currently based on the four criteria in the slide. Some of these criteria are more well-developed than others, for instance the information we have regarding sizing is very preliminary. All of the criteria need more work. Furthermore, the list is by no means comprehensive, as other strands useful in dating photographs are sure to emerge. This talk looks at each of these criteria in turn.

Optical brightening agents

- Special class of dyes that absorb ultraviolet radiation and emit a bluish-white light.
- Brighteners fluoresce strongly when exposed to near ultraviolet radiation.
- When present, OBA's are found in paper base and baryta layer.
- Manufacturers of photographic paper begin incorporating OBA's in the mid to late 1950's.

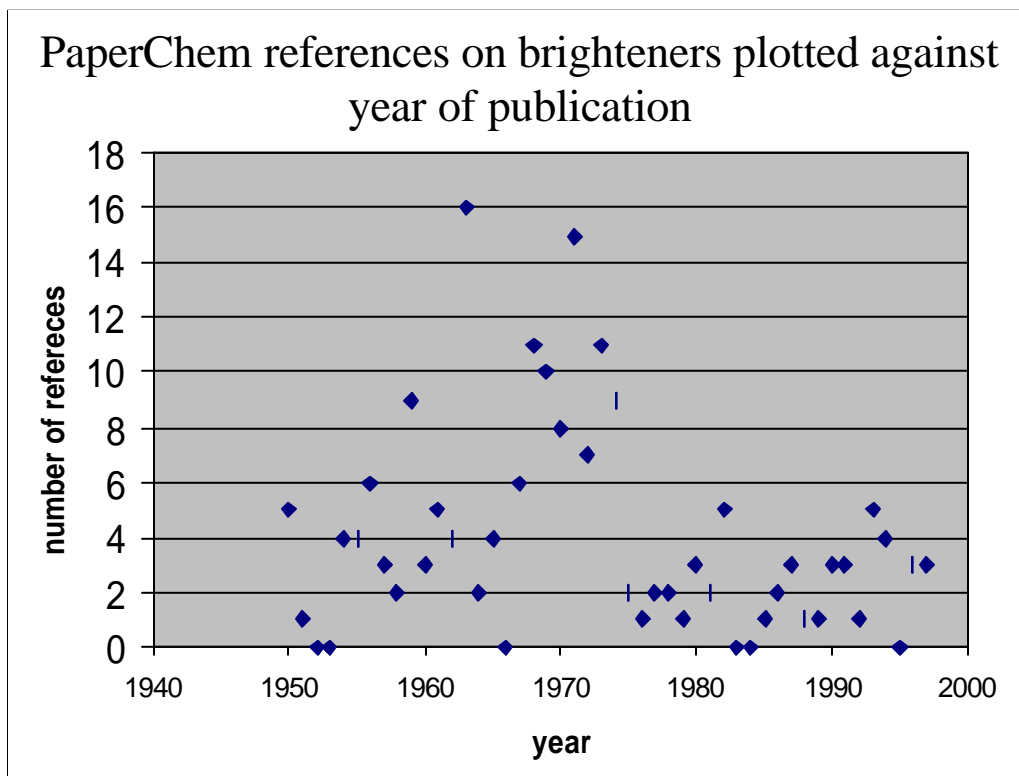
The first part of the methodology deals with the presences of optical brightening agents (OBA's). Optical brightening agents are chemical compounds that absorb ultraviolet light and emit visible light. For the manufacturers of photographic paper, optical brighteners are a convenient way to make highlights areas appear brighter and whiter.

Evidence that manufacturers of photographic paper began incorporating OBA's in the mid to late 1950's is very strong. The mid to late 1950's as a starting point for OBA's in photographs is based on a great deal of original research by Val Baas, at the the Detroit Institute of Arts with some supporting evidence that I developed.

OBA's: A Brief History

- 1920's - First experiments with naturally occurring fluorescent materials.
- 1934 – The English firm Imperial Chemical Industries prepares first synthetic brightening agent.
- 1943 - CIBA produces brighteners based on stilbene derivatives that have broad application for use with cellulose-based materials.
- Early to mid 1950's - Photography manufacturers first propose use of brighteners
- Late 1950 - First photographic papers with brighteners appear.
- Early mid 1970's - Manufactures dramatically increase amount of OBA's in paper base and baryta.

While brighteners were available in the early part of the twentieth century, the first practical uses of OBA did not occur until the mid-1940's when compounds with a high affinity for, and compatibility with, cellulose-based materials began to emerge. I credit Val with most of this chronology.



In part, this chronology was derived from a comprehensive literature search conducted at the Institute of Paper Science and Technology. The literature search was performed using the PaperChem database at the Institute of Paper Science and Technology. This is an international database covering the published literature pertaining to all aspects of pulping and papermaking dating back to 1930. The database was searched for the following keywords: optical brighteners, optical brightening agents, optical bleaches, fluorescent brighteners, fluorescent dyes and stilbene. The earliest articles found date from 1950 with 5 articles. The year with the most occurrences for articles was 1963 with 19 articles. The search was performed by Clara Williams, A.M.L.S, Reference Librarian at the Institute.

The chart plots the 193 technical articles appearing in the PaperChem database based on number of articles in a given year. As an illustration, the chart is interesting in that the number of articles in the papermaking literature rises rapidly from 1950 and really peaks in the early 1970's. If you plotted a regression of these data, you get a nice bell shaped curve, starting in 1950 and peaking in the 70's, key periods for the incorporation of brighteners in photographs.

OBA's: Photography Manufacturers

- Agfa did not start incorporating brighteners until the mid 1950's (Record Rapid 1957 and Portriga Rapid 1958 /59).
- Kodak memo from February 1951, proposed the use of brighteners in paper raw stock, emulsions, baryta layers, and processing. Kodak's first use of OBA did not occur until the mid 1950's.
- Dr. Peter Krause, former president of Ilford Corporation said he would "bet his last dollar" that brighteners were not used prior to the 1950's.

Based on correspondence with Agfa, the corporation did not start incorporating brighteners until the late 1950's. Agfa based its own dating on some questioned Man Ray and Lewis Hine prints primarily on the presence of brighteners.

According to Kodak research staff, an internal memo from February 1951 proposed the use of brighteners in raw stock, emulsions, baryta layers, and processing, but use in their product manufacturing did not occur until the mid 1950's.

Dr. Peter Krause, who broke into the photography industry in 1939 with Agfa and is a former president of Ilford Corporation said he would "bet his last dollar" that brighteners were not used prior to the 1950's.

OBA's: Surveys of Study Collections

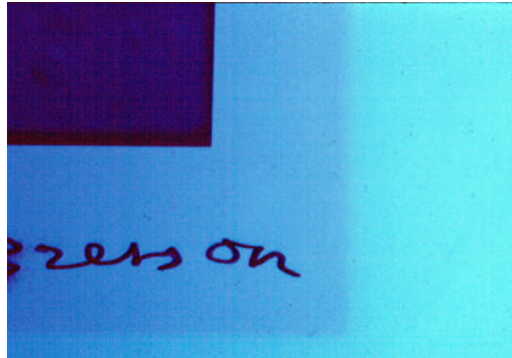
- Valerie Baas' survey of Detroit Institute of Arts event photographs and other dated materials has found no fluorescence prior to 1955.
- David J. Valvo of the Eastman Kodak Company performed a recent survey of Kodak products dating from 1961. He found some fluorescence in scattered paper fibers on the reverse of some products made in 1961, but only 1 paper (Kodak Velox) showed fluorescence on the image side. Occurrence of brighteners in Kodak papers increases steadily through 1960 and 1970's.

In her comprehensive and ongoing survey of photographs held by the Detroit Institute of Arts and other institutions, Conservator Valerie Baas has not found any fluorescence on photographs dating before 1950. The earliest fluorescence that could be attributed to brighteners was a was Kodak Velox paper processed in July 1955. On this print, fluorescence was found on the recto only.

In a similar study of Kodak Products, David Valvo of Eastman Kodak found scattered fluorescence on the paper base of some Kodak Papers dating from 1961. One paper from 1961, Kodak Velox, showed fluorescence on the image side. Occurrences of brighteners in the paper base and baryta increased in Kodak products through 1960's and 1970's.

Some Weaknesses of OBA's for Dating

- OBA's fade in light.
- They can be washed out in ordinary processing.
- They can be deliberately extinguished.



Weaknesses of OBA's for dating:

- OBA's fade in the light: Shown is a detail of Henri Cartier-Bresson, Rue Mouffetard, Paris, 1954 (printed later), photographed using ultraviolet radiation. Brighteners have faded in areas exposed by the mat and remain intact in passages covered by the mat.
- OBA's are affected by processing: KODAK POLYMAX Fine art Paper warns about excessive washing and soaking so as not to lose brighteners during processing.
- OBA's can be deliberately extinguished: Paper manufactures, especially those dealing in recycled pulp have techniques to extinguish brighteners.
- Detecting OBA's can be subjective: There is a need to train your eye (gelatin and papers made with sulfite pulp both have natural fluorescence).

So from the standpoint of dating:

- If fluorescence attributable to OBA's is observed, then the photograph dates from post-1950, and likely very likely post 1960.
- If there is strong fluorescence of the image, the photograph most likely dates from post-1970.

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• If there is no fluorescence attributable to OBA's then the test yields no result, as the photograph could have been manufactured at any point in the 20th Century.

Paper Fiber Content

- Cotton and flax from rag appear to be the main sources for photographic papers made up to the 1910's to 1920's.
- Starting probably in the 1910's, sulfite wood pulp is used. Sulfite pulp alone is used almost exclusively by the 1930's into the 1960's. Sulfite pulp predominates in photographic papers made to the present time.
- Starting in the late 1950 or early 1960's hardwood kraft pulp (sulfate process) appears in small quantities. Hardwood kraft pulp generally appears in small proportions mixed with sulfite pulp.

After brighteners, the next characteristic that can be used to distinguish a post-1955 print is the presence of hardwood kraft papermaking fiber.

This last bulleted point on the slide is the key to dating. If hardwood kraft papermaking fiber appears there is a very high level of certainty that the photograph was made after 1955.

This chronology is backed up by the available literature but is almost entirely based on the expertise and direct testing of photographic paper performed by Walter Rantanen of Integrated Paper Services. I'm sure he will elaborate on his work during his upcoming talk.

In the scant literature I have been able to dig up on wood pulps bases used for photographic papers, the sulfite process is mentioned exclusively. I have yet to find a single reference that mentions kraft pulp for use in photography.

Background of the Sulfite Process

- 1857 - Benjamin Tilghman, a Philadelphia chemist, finds that wood is softened and defibered through processing with sulfurous acid.
- 1867 - Tilghman patents a refined version of his discovery.
- 1874 - First commercial sulfite pulp is produced in Sweden.
- 1890's - 1930's - Sulfite pulping dominates, giving over to the kraft (sulfate) process in the 1930's.
- 1950 - Major processing breakthrough (use of so-called soluble bases) allows sulfite mills to use a wider variety of species and become more efficient.

The sulfite process really opened the door for use of wood pulp in the mid 19th Century and is still thrives today for the production of high quality wood pulp papers. While the Kraft process came to dominate in the 1930's, Sulfite retained the lead in the production of "high performance" applications such as photographic papers.

Background of the Kraft (sulfate) Process

- 1884 - Chemist C.F. Dahl obtains patent for use of sodium sulfate in pulp processing.
- 1885 - First commercial use by a Swedish mill (“Kraft” is the Swedish and German word for “strength”).
- 1930’s - While generally darker than equivalent pulp produced by the sulfite process, kraft pulp becomes dominant for most uses due to its overall economy.
- Early 1950’s – Chlorine dioxide bleaching produces kraft pulp comparable to sulfite pulp in terms of whiteness / brightness.

The Kraft process, also known as the sulfate process, really made significant gains in the early to mid 20th century in terms of overall production of wood pulp. A key point in the chronology, from our standpoint, is the last bulleted point since Kraft pulp could never really compete with sulfite pulp for high quality uses due to its overall lack of brightness / whiteness. This changes with the advent of chlorine dioxide bleaching.

Comparison of Sulfite and Kraft

Sulfite

- Advantages
 - Whiter yields
 - Better sheet formation
 - Increases lignin removal
- Disadvantages
 - Less economical
 - Better on more expensive low resin woods, such as softwoods.

Kraft

- Advantages
 - Strength
 - Both hard and softwoods can be used
 - More economical
- Disadvantages
 - Requires significantly more bleaching for same whiteness achieved in sulfite process.

The main differences of sulfite and kraft pulp are presented above. For photography, the overall quality of Sulfite pulp, particularly its whiteness has traditionally given it the advantage over Kraft pulp, despite the fact the Kraft pulp is more economical.

Use of Fiber Identification for Dating

- Presence of hardwood kraft has never been observed prior to late 1950's in photographic bases.
- Photographic papers continue to be made using 100% sulfite pulp.
- For photographic papers that contain hardwood kraft, the kraft pulp is present in trace amounts up to roughly 35%, mixed with sulfite pulp.
- Fiber identification demands a high level of expertise.

Some observations on using fiber analysis for dating photographs:

- While we have looked, we have never seen hardwood kraft in a photograph made prior to late 1950's.
- Also, while the presence of hardwood kraft pulp is a very strong indicator that the paper was manufactured after the late 1950's, the absence of hardwood kraft pulp is useless from the standpoint of dating since photographic papers are still made using 100% sulfite pulp.
- When hardwood kraft is present, we have found trace amounts to up to 35% mixed with sulfite pulp.
- This type of fiber identification requires an expert microscopist.

Manufacturer Markings - Agfa

- For existing products, Agfa used a two part logo (manufacturer name “Agfa” and the product name, i.e. “Brovira”) up to mid 1950’s.
- For new products introduced after 1945, and for existing products produced after the mid 1950’s, Agfa used a 1 part logo (“Agfa” alone) .



- Throughout the 20th C. Agfa also produced brands of paper without a logo.

Manufacturer markings can also yield some very telling information. To date I really only have information from one company: Agfa. I have really have made no headway with other manufacturers, mostly since their marking of the gelatin silver papers is pretty spotty or non-existent.

However, this information is great if you have a paper with a two part Agfa logo since it could only have been produced prior to the mid 1950’s or if you see a one part logo since it couldn’t have been made pre-1945.

Illustrated is a two part logo, typical of that used before the mid 1950’s.

Sizing – Some Preliminary Work

- Late 1930's - Use of rosin-based size ends, replaced by stearates and polmates.
- Early to mid 1940's - Starch replaces gelatin for tub sizing.
- Mid 1940's – Use of melamine formaldehyde begins. Kodak licensed a process to use MF with aluminum chloride instead of aluminum sulfate (alum). Yields significant gain in wet strength and more economical.

A potentially useful avenue that definitely merits further work is sizing.

Entirely based on a conversation with Glen Gray, for many years he headed Kodak's paper manufacture.

There is strong potential that this information can yield some very significant clues when it comes to dating. We need more research and testing to see if it holds up based on an analysis of actual historic photographs.

Testing also poses challenges, since, for example, a test designed to detect the presence of formaldehyde might have very little value since the presence of formaldehyde could be the result of many, many manufacturing and processing techniques, not just sizing.