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Working Methods: The Howard D. Beach Photography Studio of Gelatin Dry Plate Negatives

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Working Methods:
The Howard D. Beach Photography Studio of Gelatin Dry Plate Negatives

By

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An Abstract of a Thesis
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ABSTRACT OF THESIS

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In the spring of 2011, the Buffalo History Museum (BHM) received a donation of over 57,000 gelatin dry plate glass negatives from the Howard D. Beach Photography Studio located in Buffalo, New York and in operation in various manifestations from 1896 to 1954. Beach was a prominent portrait photographer of notable Buffalonians, including Darwin D. Martin, Ansley Wilcox, Katherine Cornell, Margaret Wendt, and F. Scott Fitzgerald.

This paper serves to explore the results of the pilot study of various physical and chemical properties of the gelatin dry plate negatives in order to understand Beach's photographic working methods and compare them to the industry standards. Answers to numerous questions are sought in conducting the research necessary to grasp a somewhat complex and often contradictory story.

Results reveal which brands of dry plates Beach preferred to use for his portrait work and whether or not they were favored by others in the profession. Visual and scientific analyses are used to verify or disprove certain characteristics of the dry plates as described in the literature in order to aid in identification of a specific manufacturer and brand. Examination of Beach's journal brings to light his choice of developers and exposes his propensity for technical experimentation and artistic license in order to create his sitters' images.

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Table of Contents

List of Figures

List of Tables

List of Appendices

CHAPTER 1: INTRODUCTION AND BACKGROUND

In the spring of 2011, the Buffalo History Museum (BHM) received a donation of over 57,000 gelatin dry plate glass negatives from the Howard D. Beach Photography Studio located in Buffalo, New York and in operation in various manifestations from 1896 to 1954. This paper serves to explore the results of the pilot study of various physical and chemical properties of the gelatin dry plate negatives in order to understand Beach's photographic working methods and compare them to the industry standards. Answers to numerous questions are sought in conducting the research necessary to grasp a somewhat complex and often contradictory story.

Results reveal which brands of dry plates Beach preferred to use for his portrait work and whether or not they were favored by others in the profession. Visual and scientific analyses are used to verify or disprove certain characteristics of the dry plates as described in the literature in order to aid in identification of a specific manufacturer and brand. Examination of Beach's journal brings to light his choice of developers and exposes his propensity for technical experimentation and artistic license in order to create his sitters' images.

While the characteristics of gelatin dry plate negatives are well documented from numerous sources, it is rare to have a collection from a single studio that has the majority of supporting documentation relatively intact. From the dates the negatives were taken, to the original manufacturer boxes, supplemented with numerous ledgers, correspondence, and other business records, this collection presents a unique opportunity for study, unlike almost any other known collections.

The choice of supplies and the mastery of the techniques to create a "good negative", how it influenced the photographer's work flow, aesthetics, and brand choices, all of these initial preferences directly affect the final outcome of the positive image otherwise known as a photograph. Knowing which type of negative was used by a photographer is important in gaining insight into his or her aesthetic and scientific working methods.

Before research can begin, it is important to understand why and in what context it is beneficial to both photographic historians and the community at large. At the time the Beach studio was operating, there were numerous dry plate manufacturers in the United States and many more in Europe. Knowing which manufacturers Beach preferred, and why he may have chosen a brand manufactured halfway across the country instead of next door, poses an interesting question. As seen in various correspondence and business records in the collection, Beach operated his business during two world wars and the Great Depression, all of which were a trying time for any business. A plate that allowed him to use less developing chemicals over the ideal plate for portraits may have been a better choice for him.

The terms for the speed of a plate are generally known as fast or slow. The speed is determined by its sensitivity to light. The grain size of the silver is usually the most noticeable difference. Aesthetically, how fast or slow a plate is creates a different outcome in the final print. Larger grains can create a softer image with less contrast whereas smaller grains will produce a greater contrast and enhance the details (Eastman Kodak Company 1921, 14; Ortwein 2013). While one manufacturer may have been known to produce the best quality plate overall, a brand that was fast enough for indoor portraits and of a fine enough grain size for larger sized portraits may have been the best compromise.

The developer chosen by the photographer has a huge impact on the aesthetic outcome of the negative. Certain plates require certain developers, some more expensive and time consuming than others. For example, eikonogen was much more expensive than pyrogallic acid or hydrochinone (Wilson 1890). Others may be more or less toxic to the user. Pyro has a tendency to stain everything with which it comes in contact (Eastman Kodak Company 1921, 19). Shelf life can vary greatly among the developers. And some produce a different effect on the negative. Hydrochinone gives a nice black negative with good contrast, but development of the negative is very slow. Pyro developer tends to produce brownish negatives and has a very short shelf life once mixed in solution. Eikonogen is used to produce a soft negative usually preferred by portrait photographers. And numerous combinations of the developers produce distinct results, often a combination of the traits of the individual developers (Eastman Kodak Company 1921, 19-21; Needham n.d., 58). At the end of the 19th century, a prolific time in photography when the country was focused on technology and using it to streamline production (Barnes 1924, 109-116), Beach may have considered these aspects when choosing his plates.

Since the focus of most photographic research is primarily on the photographs themselves, examination of the negatives adds to the knowledge of an extremely prolific time period in the history of photography. Many museums have glass plate collections where the photographer is completely unknown. The focus is usually on the history of the image represented in the photograph and rarely on how the photographer made the image. If different characteristics of the negatives can be pinpointed and used to distinguish differences in the manufacturers' products, it moves the field toward reliable reference material for use by other collections. Process and examination of a well documented collection would be invaluable in exploring other collections.

In the first part, a review of the literature will bring to light that Eastman, while being the most recognized name and a significant contributor to the field, depended heavily on his contemporaries and competitors to move his company into the spotlight (Ackerman 1930, 240). The second part delves into the collection itself. A survey of the manufacturers' original boxes serves to identify the numerous companies in competition in a rapidly growing market. The third section uses scientific methods to analyze whether or not plates from different manufacturers can be distinguished from each other. In the final part, using support from Beach's actual journals, it is hypothesized why Beach may have preferred one particular manufacturer's brand over another.

Background Information

The Howard D. Beach Photography Studio Collection of Glass Plate Negatives has the potential to become a cornerstone collection for the BHM. With over 57,000 portrait negatives in the collection, 50 years of correspondence and business records, and an extensive card catalog providing details of four prominent Buffalo photographers, organizing, cataloging, and researching the collection is both daunting and life altering for any researcher interested in the history of Buffalo at the beginning of the twentieth century. The studio specialized in capturing images of Buffalo's elite.

The motivation to begin a study of the technical aspects of the Beach collection emerged after surveying the stored boxes of negatives. Although Buffalo is located in close proximity (about an hour drive) to Rochester - which is often considered the be birthplace of modern photography in the United States because it is the location of Eastman Kodak's headquarters - the colorful boxes housing the delicate plates suggest that Eastman may not be the predominant manufacturer used by Howard Beach and colleagues. This became an intriguing puzzle to ponder and then investigate.

Gelatin dry plate glass negatives are a much neglected field of study. Much has been written about the photographs that were produced from them. They are often overshadowed by the “hand crafted” wet plate negative process that was their predecessor or the gelatin film negatives developed by George Eastman. Very little current literature examines the gelatin dry plate process or the numerous manufacturers of these negatives. Correspondence with the Eastman House supports the view that it is not worth studying any other manufacturers but Eastman since almost all of the manufacturers were eventually assimilated by Kodak.

To emphasize the importance of a negative as the fundamental reason for succeeding in the creation of an excellent photograph, Gustav Cramer, founder in 1880 of the Cramer Dry Plate Company, stated, “Consider that the very foundation of [the photographer’s] success is the negative, that good prints cannot be made from bad negatives, although bad prints may be made from good negatives” (Cramer n.d.a, 10).

Most of the later 20^{th} and even 21^{st} century literature reduces gelatin dry plate negatives to a paragraph or two, almost an incidental afterthought (Ritzenthaller 2006, 14; Weinstein 1977, 144). When the significant contribution of dry plate manufacturing to the technological revolution in the United States is considered, it is remarkable that there has not been continued exploration of the medium and the business structures built around it. Not only did dry plates revolutionize the manufacturing processes, the support structure surrounding the manufacturing operations heavily influenced modern day marketing strategies, advertising, and simplifying how the user interfaces with a product (Sarvas 2011, 15).

The primary subjects in the Beach collection are portraits. As a painter and a member of the Buffalo Photo-Pictorialists (Bannon 1981 and Strong 2013), Beach’s poses are often reminiscent of a painting. He was not focused on capturing reality, rather chose to use his technical prowess to manipulate both the atmosphere surrounding the sitter as well as the final image in order to infuse his personal artistic vision when creating the sitter's portrait (Gidley 1994, 180-192; Licata 2002; Tisa 1986).

Like many photographers from this era, Beach's name was virtually lost to history until the collection was donated to the BHM. His partnership with Andrew Simson and affiliation with Eleck F. Hall, both outstanding and well-known portrait photographers in their own right, helped him establish and successfully run a Buffalo business for several decades. His service as an often elected officer to both local and national photographic societies demonstrates how he was respected both for his mastery of photographic techniques and for his artistic sensibility (Beach 1909, 102, 237, 482; French 1915, 148; Strong 2013).

The organization, preservation, and research on this collection are still in their infancy. The questions raised and hopefully answered by this paper will serve to add measurable insight into the working methods of the Beach Studio and the material choices made by the photographer, all of which influenced the final images generated for the client. Using the collection as a reference tool for comparison with other collections will add to the overall knowledge and authority of gelatin dry plate history as well.

Background to the Beach Collection

In the spring of 2011, the Howard Beach Photography Studio Glass Plate Negative Collection was moved from the basement of the original studio located at 469 Virginia Street in Buffalo, New York to the BHM. Over 57,000 gelatin dry plate glass negatives, an abundance of business records, and a multitude of other ephemera were boxed, labeled, and stored at the Julia Reinstein Center. The original card catalog and business ledgers were also included with the collection. This remarkable discovery and the subsequent acquisition of these records is an extreme rarity for most collections of this nature. Since these archives are often separated from the collection and the information is lost over time, the fortuitous donation from the previous owners has proven to be invaluable in seeking an understanding of the inner workings of an early and extremely prominent twentieth century business.

The card catalog consists of a wooden library cabinet of thirty-four drawers (*Figure1*). Records are separated into several categories that include photographers Howard D. Beach, Eleck F. Hall, Beach and Hall together, Andrew Simson, Edith Richardson, as well as contact information for clients of the Beach Lens Company. Each section is further sorted alphabetically and typically includes the subject's name, the negative number, the date the photograph was taken, the photographer, and the type of print ordered.

Figure 1. Card catalog
Source: Wiedemer - photograph from the Beach Collection.

The majority of the images in the collection are portraits. Notable Buffalonians in the collection include: various members of the Knox family (1910 - 1919); Margaret Wendt (1913), founder of the Wendt Foundation; Darwin D. Martin and family (1908), commissioner of the

Buffalo landmark house designed by Frank Lloyd Wright; Ansley Wilcox (1916), owner of the Wilcox Mansion where Theodore Roosevelt was sworn in as President of the United States of America in 1901 after the assassination of sitting President William McKinley; Marion DeForest (1917), founder of the now international organization, *Zonta*, a women's networking organization; famous stage actress Katherine Cornell (1908); and the renowned author F. Scott Fitzgerald (1907) at the tender age of 11 years old.

Howard Dwight Beach: The Man Behind the Camera

The photographer and the man responsible for taking the majority of the images was Howard Dwight Beach (*Figure 2*). He was born in New Britain, Connecticut in 1867. He moved to Buffalo, New York in 1884, and attended Bryant and Stratton as well as the University at Buffalo where he concentrated in photography and chemistry. He then apprenticed with Andrew Simson, Buffalo's oldest photographer. Simson was the official photographer for the 1901 Pan-American Exposition and Beach secured a place in history for his photographs of the Native American Sioux tribe that was in attendance. Many of the images are in the Library of Congress (Howard D. Beach portraits 2012; Strong 2013).

Figure 2. Howard Dwight Beach, Negative 32257, April 13, 1909
Source: Wiedemer - digitized photograph from the Beach Collection.
Courtesy of the Buffalo History Museum, used by permission.

Beach married Catherine M. Lobstein (*Figure 3*). Their progeny was a daughter, Margaret Caroline (*Figure 4*), who was born in 1899 (Howard Beach 2014). She was the subject of many of her father's sittings and can be seen growing up throughout the collection.

Figure 3. Mrs. H.D. (Catherine M.) Lobstein Beach, Negative 31378, October 18, 1908
Source: Wiedemer - digitized photograph from the Beach Collection.
Courtesy of the Buffalo History Museum, used by permission.

Figure 4. Margaret C. Beach, Negative 31250, September 15, 1908
Source: Wiedemer - digitized photograph from the Beach Collection.
Courtesy of the Buffalo History Museum, used by permission.

Like many professional men of his time, Beach complimented his career as a professional photographer with several other trades. He was a painter of much regard. As an entrepreneur, he dabbled in the manufacturer of eye glass lenses and eventually formed his own company, the Beach Lens Manufacturing Company. His mastery of this particular craft eventually led him to invent and patent a bifocal lens (Strong 2013).

After a career that spanned more than five decades, Howard Beach died in 1954 (Howard D. Beach portraits 2012).

Various Manifestations of the Studio

Howard Beach's first partner was Andrew Simson (*Figure 5*), a very well known and popular photographer who resided in the Buffalo, New York area. The partnership, formed in 1896, resulted in the Simson & Beach Photography Studio, which was located at 456 Main Street, Buffalo, New York. Four years later in 1900, Beach bought out Simson's interest in the studio (Bartlett 1922, 168). Afterward, they retained a working relationship when Simson became the official photographer for the Pan-American Exposition which was held in Buffalo, NY in 1901.

Figure 5. Andrew Simson, Negative 39935, June 29, 1915
Source: Wiedemer - digitized photograph from the Beach Collection.
Courtesy of the Buffalo History Museum, used by permission.

Following almost a decade of successful business at the Main Street studio, Beach purchased the studio of Eleck F. Hall (*Figure 6*) in 1908. Hall, a nationally renowned photographer was described in his obituary as a "distinguished member" of the photography profession (Adams 1910, 196). The new studio was located at 469 Virginia Street, Buffalo, New York (*Figure 7*).

Figure 6. Eleck F. Hall, Negative unknown, Date unknown
Source: Wiedemer - digitized photograph from the Beach Collection. Courtesy of the Buffalo History Museum, used by permission.

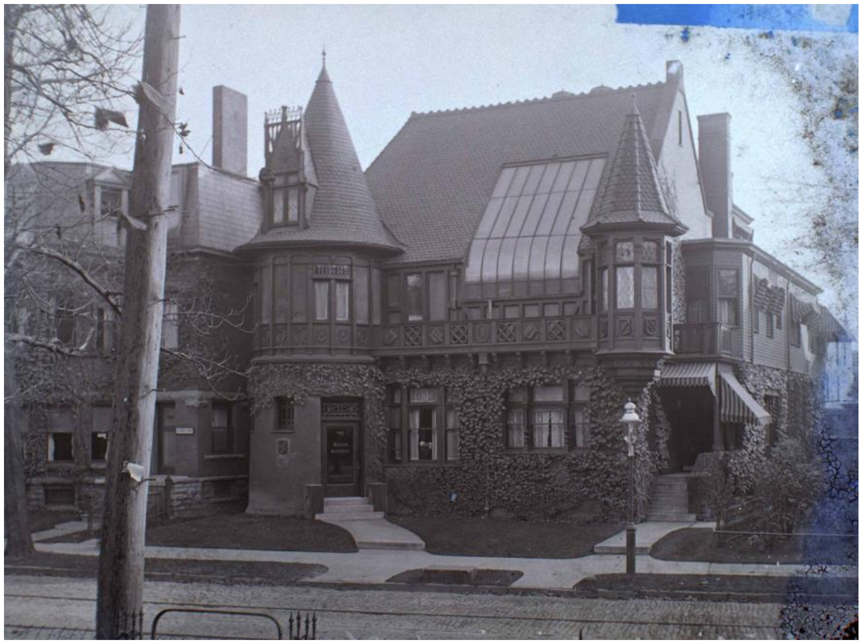


Figure 7. Howard Beach Photography Studio, located at 469 Virginia St, Buffalo, NY, Negative unknown, Date unknown
Source: Wiedemer - digitized photograph from the Beach Collection.
Courtesy of the Buffalo History Museum, used by permission.

At some time in the 1920s, another photographer appeared in the studio records, Edith M. Richardson. Virtually nothing is currently known about this photographer, although there is a wealth of evidence of their partnership in both the card catalog and company correspondence.

The Gelatin Dry Plate Glass Negative

The immediate predecessor to gelatin dry plate negatives was the collodion wet plate negative. In use from 1851 to 1885, it was a labor intensive and extremely time sensitive process that required photographers to not only make their own negatives on site, but also include a mobile darkroom as part of their standard equipment when working outside the photography studio (Bernier 2014, 186; Dawn's Early Light 2011). The quest to create a negative that was able to be stored indefinitely both pre and post exposure led to the development of the gelatin dry plate negative by English photographer and physician Richard Leach Maddox (Eder 1881, 4; Meldola 1889, 114). Popular for over sixty years, from 1878 to 1940, the gelatin dry plate revolutionized professional and amateur photography by lightening the load and leaving the darkroom behind. Dry plates could be developed up to several months after exposure and freed the photographer from having to carry excess equipment and chemicals (Holland 1881, 957).

During the final years of the 19th century, glass dry plate manufacturing changed the face of the photographic industry by moving from the handmade to a mass production industry. The ease of use of dry plate negatives and user friendly cameras placed a huge and increasing demand for photographic supplies. By the early 20th century, there were numerous manufacturers in the marketplace, each promoting their own unique uses and patented formulas. With the plethora of dry plate types for sale, a photographer was left with having to experiment and then choose the best plate for the type of work he intended to pursue (Whitten 1990).

Dry plates were also directly responsible for creating the photographic manufacturing industry (Lavédrine 2009, 244). Mirroring the industrial revolution's move toward mass production, numerous companies were formed throughout Europe and the United States each with their own proprietary dry plate formula (Fisk 2009, 194). Standard sizes were agreed to although there was a different set for America than for Europe. Common sizes used in America were 5” x 7”; 6” x 8” (actually 6 ½” x 8 ½”); 8” x 10”; and 10” x 12”. Less common sizes were 11” x 14”; 18” x 20”; and 20” x 24”. Glass plate sizes played an important role in the tariff hearings where imported glass from Europe was taxed by the U.S. government (GPO 1922, 1584-1592).

Identification of Gelatin Dry Plate Negatives

Unlike their predecessor, the collodion wet plate, gelatin dry plate negatives were mass produced; consequently there is a high degree of uniformity across the board. They have precisely cut edges and are of uniform thickness, usually less than two millimeters. The light sensitive gelatin layer is evenly coated across the plate. The tonality of the plate is a neutral gray-black color (Lavédrine 2009, 245; Ritzenthaler 2006, 44; Valverde 2005, 14-18; Weinstein 1977, 144).

The following table (*Table 1*) summarizes the distinct differences between the dry plate and wet plate negatives. While the time period of popularity for the different plates overlapped somewhat, a mere five years after their introduction to the public, dry plates quickly became the product of choice for both amateur and professional photographers. Dry plates can be easily identified by the smooth, machine cut edges of the glass support. Wet plates tend to have a rough edge because they were cut by hand. Because they were coated by machine, the emulsion on the dry plates is extremely uniform from one edge of the glass to the other. Emulsion on the wet plate often has flow lines from the plate being tilted back and forth by hand to coat the surface of the plate. The tonality of the plate is also a significant factor in identification. The dry plate is a sharp contrast of black and white. The wet plate's black has a gray-black tonality and the white is a creamy white.

Table 1. Comparison of various elements of gelatin dry plate to collodion wet plate negatives (Lavédrine 2009, 251; Ritzenthaler 2006, 44; Valverde 2005, 14-18; Weinstein 1977, 144)

Element	**Dry Plate**	**Wet Plate**
Chronology	~1880 – 1920	~1852 – 1885
Edges	Smooth – machine cut	Rough – hand cut
Emulsion	Uniform from edge to edge	Flow lines from hand coating
Tonality	Stark black and white	Gray-black and creamy white

Chemistry and Composition of Gelatin Dry Plate Negatives

A gelatin dry plate negative is formed by bonding two separate materials to form a cohesive light sensitive plate for capturing an image (*Figure 8*). The glass plate acts as a substrate or support (*Figure 8: layer 1*) for the gelatin silver halide emulsion (*Figure 8: layer 2*) which is the light sensitive part of the plate (Lavédrine 2009, 251).

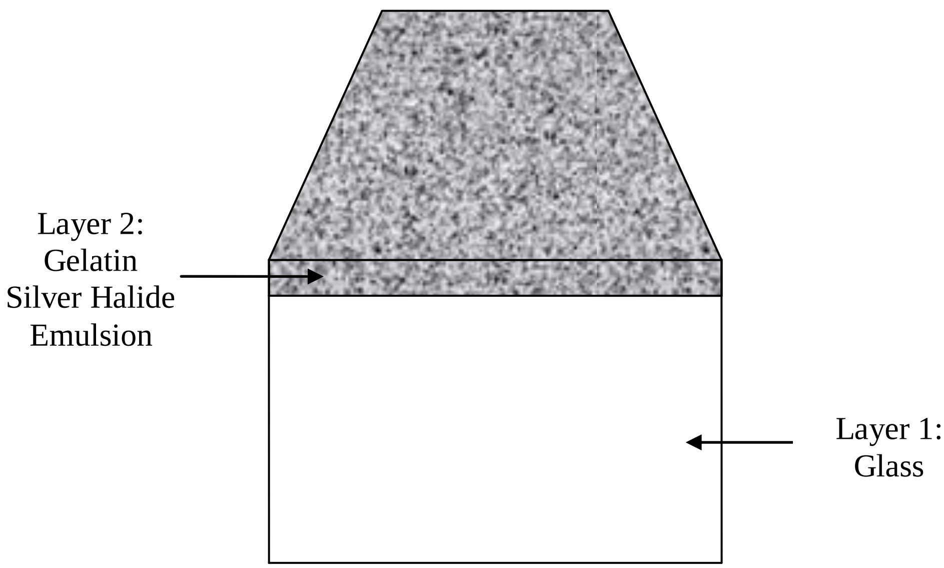


Figure 8. Gelatin dry plate glass negative cross section.
Source: Lavédrine 2009, 251

Photographic grade gelatin or Type B is the highest grade of gelatin manufactured. It has the lowest amount of reducing substances and a low ash content, which both affect fogging and sensitivity. The best gelatin for photographic use is made from cattle hides. It has a high bloom strength which equates to a stronger gel and in turn a stronger adhesive to bind to the glass substrate. Historically, emulsions were often randomly mixed and then analyzed later to determine how and why they worked or did not work as the case may be (Danzing 1999).

Gelatin is an ideal emulsion because it is inexpensive, clear, glue-like, and opens or swells when wet to allow a developer to permeate the layer and develop the latent image (Sheppard 1921, 92).

A silver nitrate solution is added to a warm gelatin and potassium bromide mixture. The following chemical reaction occurs and produces a white suspension of silver bromide:

$$AgNO_3 + KBr \leftrightarrow AgBr + NO_3^- + K^+$$

The suspension is then heated for several hours which allow the silver bromide crystals to form and reform over and over increasing the sensitivity to light over time. The term for this process is “ripening”. When cooled, gelatin becomes firm and can be cut into thin strips known as “noodles”. The noodles are then washed which washes out the unused chemicals, melted, spread on cleaned photographic plate glass, dried in the dark, wrapped, boxed, and shipped to the customer, ready for exposure (Osterman 2007).

After an image has been captured, the negative is developed at the photographer’s leisure. An organic reducing agent such as hydroquinone, also known as the developer, converts the silver bromide to silver particles. The plate is “fixed” with sodium thiosulfate and then washed to stop the chemical reaction (Osterman 2007).

Physical Deterioration, Chemical Alteration, and Environmental Impact

While gelatin dry plate negatives are usually considered to be fairly stable and inert by themselves, they are still subject to various types of deterioration. Physical changes are the most common issue. Breakage and cracking can occur from improper or rough handling during storage, reprinting, or moving. Delamination of the gelatin layer can occur for a number of reasons. If the glass surface was prepared improperly by the manufacturer the gelatin layer will not bind properly to the glass. If the gelatin is spread on an inferior quality glass that in itself suffers from deterioration, there will be a direct effect on the gelatin-glass bond. Finally, if the negatives are exposed to extreme fluctuations in temperature (greater than 64°F) or relative humidity (less than 30%), the gelatin layer will expand or contract thereby stressing the physical bond (Hendricks 2007, Lavédrine 2009, 248).

Oxidative deterioration can also occur for various reasons in which a number of different results can interfere with image quality. Oxidation will cause fading of the image, yellowing of the gelatin layer, and silver mirroring which results in a bluish metallic sheen on the image. Most often, oxidation occurs because the negatives are stored in the original cardboard boxes that stored the unexposed plates shipped from the manufacturer. Off gassing from the cardboard affects the negatives, especially where it is in direct contact with the emulsion. Silver is oxidized by oxygen or sulpher and consequently becomes mobile. When it migrates to the surface of the emulsion, a reduction agent in the air changes the ionic silver to metallic silver which gives the silvering quality noted on many dry plate negatives (Bahnemann 2012; Lavédrine 2009, 248; Ritzenthaller 2006, 255).

Preservation

Gelatin dry plate negatives should be stored in individual envelopes specifically made for long term preservation. They should then be placed in custom sized boxes that support and protect the plates from movement and accidental breakage. Plates should be stored vertically with the longest edge on the horizontal. The temperature of the storage area should be no greater than 68°F (20°C) with a relative humidity between 20% and 40% (Iraci 2007).

Manufacturers

While Eastman and the Kodak brand may be the most familiar names to the public, it was certainly not the only manufacturer or brand known to photographers in the early history of glass plate negative production. Many direct competitors of Eastman, namely Cramer Dry Plate, Hammer Dry Plate, and MA Seed Dry Plate, were based in St. Louis, MO. The advantage Eastman had over his competitors was his early partnership with a distribution company that made his brand a house hold name. He also saw the advantage in not having to reinvent the wheel and proceeded to woo the inventors into his fold or simply bought out the competition in order to incorporate their brand under his own company name (Brayer 2006, 35-36).

Scientific Analysis

By identifying the materials used by a manufacturer, the processes and technology that was used to create the glass plate and therefore the final image can be better understood. Both qualitative and quantitative chemical analyses are important in understanding the material composition, the manufacturing methods, the integrity of the material, the environmental impact, any prior conservation intervention, and the development of a preservation plan for cultural heritage materials. The primary focus behind both types of analyses is non-destructive methodologies. There are numerous non-invasive techniques available to the conservation scientist (Leyshon n.d., 83).

Ultraviolet Radiation Induced Visible Fluorescence

One type of non-destructive examination technique used on cultural heritage materials is ultraviolet radiation induced visible fluorescence. There are two types of ultraviolet radiation commonly used for analysis. Ultraviolet A (UVA) has a long wavelength of 320 to 400 nm, while ultraviolet C (UVC) has a short wavelength of 100 to 280 nm. Some materials may respond to irradiation from an ultraviolet source by giving off visible light of a particular color. The color of the fluorescence is related to a particular energy that is given off by a specific material. It has been observed that glass composed of different elements may or may not fluoresce when irradiated by UVA or UVC; therefore, glass can be differentiated into groups of similar visible fluorescence color (Tragni 2005).

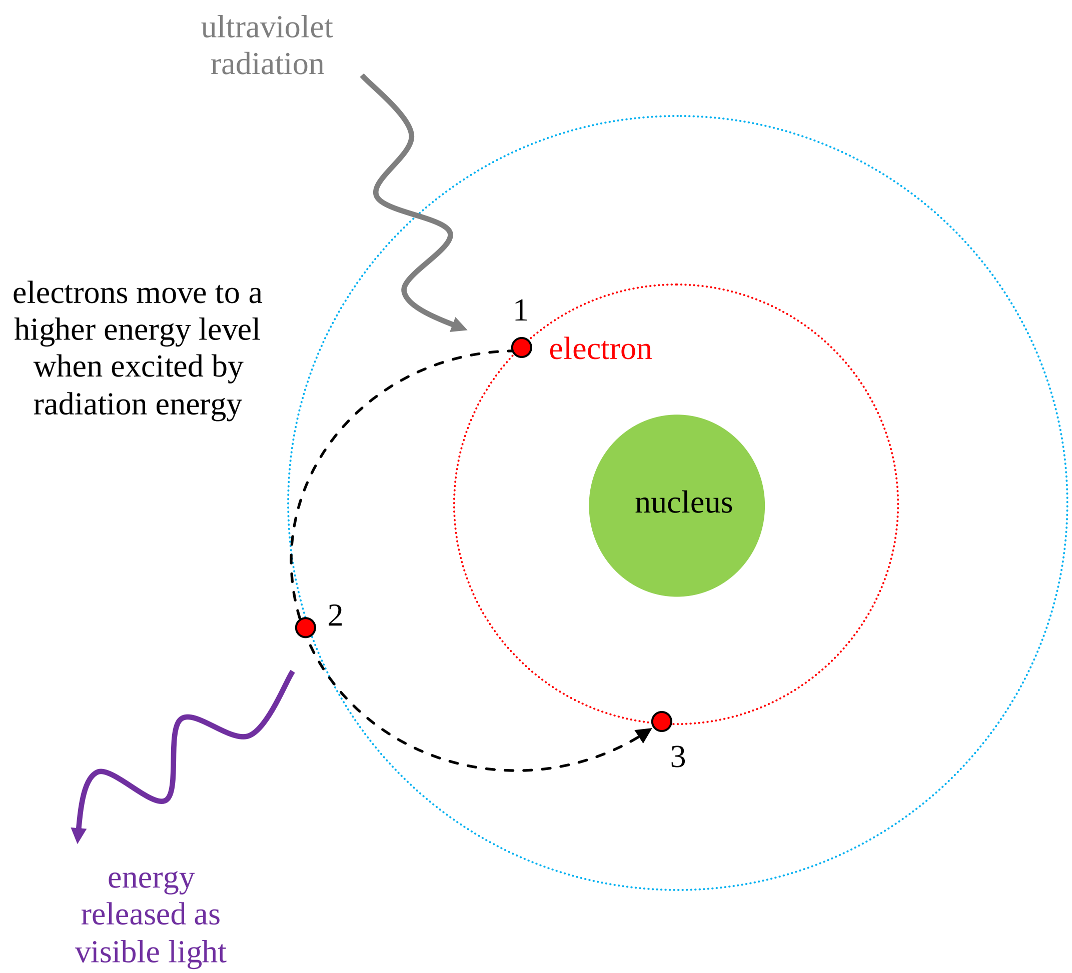


Figure 9. Ultraviolet radiation induced visible fluorescence

X-ray Fluorescence

Another example of non-destructive analysis of cultural material is X-ray fluorescence or XRF analysis. When a beam of x-rays is directed at the targeted material, in this case the glass negative and in particular the glass itself, the energy from the x-ray beam is strong enough to knock electrons from their orbits (*Figure 10)*. The energy lost by the electron moving into the vacated space is called fluorescence. This energy is measurable and unique for each element and can be captured and interpreted by dedicated software (Handheld 2014).

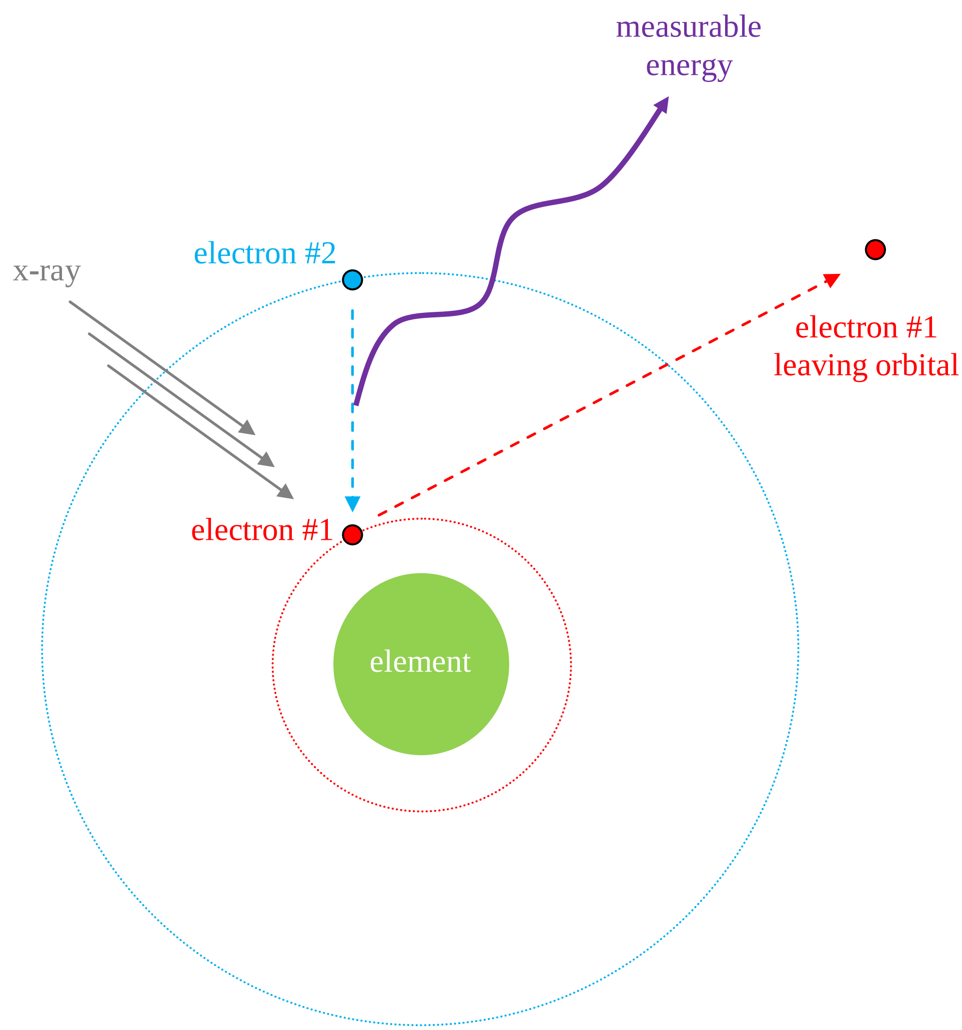


Figure 10. X-ray fluorescence
Source: Handheld 2014 and Jenkins 1995

Timeline

Examination and comparison of the various working methods of the four different photographers in the Beach studio and placing them and their choices contextually in a timeline of world events and significant photographic events from 1834 to 2012 would be invaluable in understanding some of the seemingly contradictory or non-intuitive decisions. Such a timeline can be found in Appendix 1.

Terminology

Various terminology and technical terms are unique to the photographic environment. An alphabetical list of unique terms is included in Appendix 2.

CHAPTER 2: REVIEW OF THE LITERATURE AND RESEARCH

A review of the literature and research for dry plates reveals that it is filled with a tremendous amount of contradictory information. Very little current literature examines the gelatin dry plate process and those that brought it to the masses. Much of the research dates to the end of the 19th and the beginning of the 20th century when the industry was at its peak. Delving into the flowery prose of the day is an exercise in delightfulness that appears to have been lost in contemporary articles.

This review begins with an examination of some of the manufacturers who entered the field around 1880 and proved to have staying power well into the twentieth century. The literature will bring to light that Eastman, while being the most recognized name and a significant contributor to the field, depended heavily on his contemporaries and competitors to move his company into the spotlight (Ackerman 1930). In a staggeringly cutthroat industry, it was often simpler and more effective to assimilate the competition and incorporate the company and all of its assets.

The second part of the literature review explores the characteristics of different types of dry plates such as sensitivity and speed. The various components that make up the distinct manufacturer brands are directly related to the applications for which they were designed. Often the manufacturer's intention in developing the plate is not consistent with the photographer's use in the end.

The third and final section investigates the different types of developers used to produce the negative's image, showing that manipulation of the chemicals and their numerous interactions with each other and the emulsion became an art form. The photographer was able to control and exploit this synergy for his benefit in crafting his final vision.

As Gustav Cramer, founder of the Cramer Dry Plate Company, suggested, the photographer should, "Consider that the very foundation of [the photographer's] success is the negative, that good prints cannot be made from bad negatives, although bad prints may be made from good negatives." (Cramer n.d. a, 10) It is not surprising that one of the original manufacturers of the gelatin dry plate glass negative in the United States should emphasize the importance of his livelihood.

Gelatin Dry Plate Manufacturers in the United States

The title for the "most recognized name and brand in photography" to this day is George Eastman and the Kodak brand. Much of the current literature supports the view that Eastman was either the first or nearly the first to offer gelatin dry plates in the United States. Mary Lynn Ritzenthaler of the National Archives and Diane Vogt-O'Connor of the Library of Congress, both extraordinary archivists with extensive experience, attribute the first sale of dry plates in the United States to John Carbutt in 1879 followed shortly by George Eastman (Ritzenthaler 2006, 44). In *Photographs of the Past: Process and Preservation*, Bertrand Lavédrine, director of the Centre for Research on the Conservation of Collections (CRCC) in Paris, includes Eastman from the US in the list of international manufacturers of dry plates that were emerging in the 1880s. The list also includes Lumiere from France, Agfa from Germany, and Ilford from the United Kingdom (Lavédrine 2009, 244). While Eastman was definitely in the forefront, there were several companies that preceded his entry into the market.

In 1878, when the dry plate manufacturing industry began in the United States, there were actually numerous contenders for the title of "most recognized name." Although he is often given credit for being the first, Eastman was not actually the initial manufacturer and supplier of gelatin dry plates. *The Encyclopedia Americana* from 1904, states that “Cramer & Norden, photographers in Saint Louis, Mo., and John Carbutt in Philadelphia” were the first manufacturers (Beach 1904). A popular trade magazine, *The Photographic Times* from 1884, includes a list of dry plate manufacturers as follows: Crowell Dry Plate Co., Rochester, Minn., Monroe Dry Plate Co., Rochester, N. Y., James Inglis, Rochester, N. Y., G. Cramer, St. Louis, Mo., St. Louis Dry Plate Co., St. Louis, Mo., Eastman Dry Plate Co., Rochester, N. Y., Taylor & Green, Rockford, Ill., John Carbutt, Philadelphia, Pa., and M. A. Seed, Dry Plate Co., St. Louis, Mo. (Taylor 1884, 450). While associate professor at Case Western Reserve University, Dr. Reese Jenkins’ research on George Eastman reveals that while he was an established manufacturer of gelatin dry plates by 1880, he was not the sole source. His competition included “Cramer and Norden of Saint Louis; John Carbutt of Philadelphia; and D. H. Cross of Indianola, Iowa” (Jenkins 1975, 3).

Three of Eastman’s competitors were all located in Saint Louis, MO. The company of Cramer and Norden, reestablished as the Cramer Dry Plate Company, was already receiving awards at the Chicago National Photographers Convention in 1880 (Palmquist 2005, 184). The Hammer Dry Plate Company, while not officially incorporated until 1890, became a leading manufacturer and continued to make dry plates into the 1950s (Chandler 1902, 42; Mauk 1956, 121). M. A. Seed Dry Plate Company released their dry plates into the market in 1879 and, “because of its reliability and uniformity, it was often considered to be the leading dry plate in the world” (Homans 1918, 88).

By the early 1900s, Eastman found it easier to assimilate his competitors in order to gain access to their talent and products. Carl Ackerman (Ackerman 1930, 181), in his 1930 book

George Eastman: Founder of Kodak and the Photography Business, describes Eastman's business strategy as follows:

> The final phase of Eastman's business strategy included the dry-plate business. Writing his solicitors in London he stated: 'The Seed concern [dry-plate manufacturers] makes from 40% to 50% of all the dry plates manufactured in this country. Their reputation as a business concern is of the very best. The only reason for their wanting to consolidate is that Mr. Henry C. Huskamp, the principal owner, is getting to be a pretty old man and wants to put his property in a more secure position. … If the Seed Company agrees to come in I shall propose the same kind of a deal to the three other large concerns. They will comprise all of the American concerns desirable to include.'
>
> In May, 1902, Eastman acquired control of the M. A. Seed Dry Plate Company of St. Louis [and] the Standard Dry Plate Company of Lewiston, Maine …

The addition of the Seed and Standard companies was followed soon after by the Stanley Dry Plate Company in 1905, and Wratten & Wainwright in 1912 (Frederick 2012).

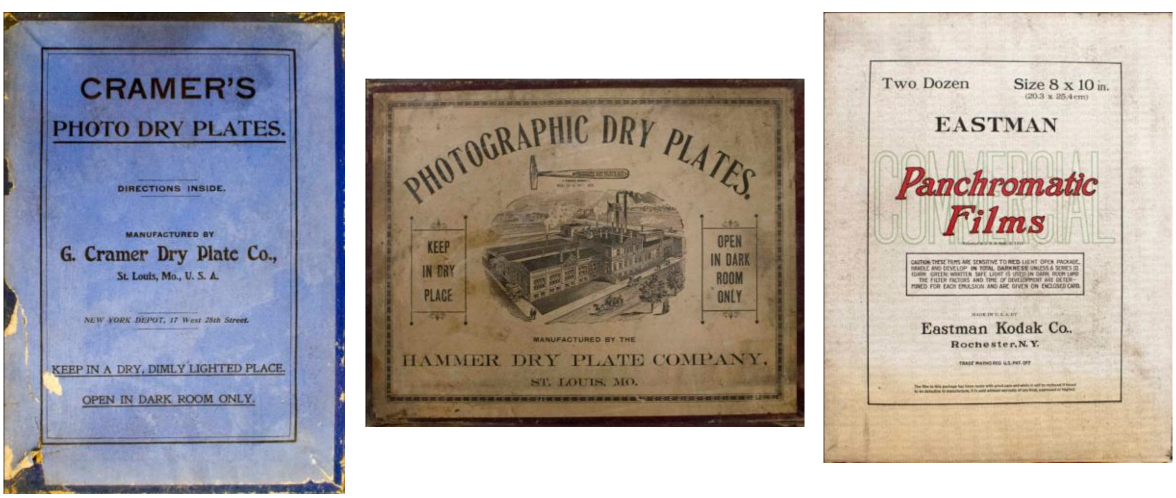


Figure 11. Various manufacturers' boxes
Source: Wiedemer - photographs of the Beach Collection.

Characteristics and Applications

Brand

Each manufacturer created several different brands of plates with different characteristics. The most common characteristic is the speed of the plate. The relative speed refers to the negative's sensitivity to light. A "fast" negative will produce a grainy image while a "slow" negative will produce a highly detailed image with little visible grain. The more sensitive a plate, the more rapid it is considered to be. The sensitivity of a dry plate to light is determined by the formation of the silver particles in the emulsion during the boiling process - the larger the particle, the greater the sensitivity (Chambers 1916, 39).

Sensitivity is only one of the factors in choosing the right negative for the job. Gustav Cramer of the Cramer Dry Plate Company describes a good negative as such:

> The exposure of the plate to the action of light in the camera, is of the greatest importance, and most of the failures in negative making are due to incorrect exposure. It depends on many conditions such as:
> The speed of the plate.
> The time of the day and the season.
> Quality and strength of the light.
> Kind of lens and size of diaphragm used,
> And
> Nature of object to be photographed.
> (Cramer n.d.a, 6)

In the competitive dry plate market, each manufacturer came up with a clever description of their brand of plates to be used in the popular trade magazines. For example:

> **Hammer's Little Book**
>
> A BRIEF DESCRIPTION OF HAMMER DRY PLATES
> That you may know their advantages and special qualities, the first pages of this little book are devoted to a brief description of the various brands of Hammer Dry Plates. All Hammer Plates have the same uniformity and dependability (Hammer characteristics)

> but are different in speed and adaptability, each plate being especially adapted for the work for which it is intended.
> (Hammer n.d., 7)

Applications

In addition to describing the characteristics of the plates, the manufacturer also made recommendations in which type of situation or application for which their plate should be used. For example:

> **Cramer Lightning Plates.**
> **<u>"Crown"</u> Brand.**
> This plate is the most rapid made.
> It has good latitude, all the mellow printing qualities that are so distinctive a feature of the CRAMER PLATE, and gives a clear, quick printing negative without the veiling so often found on other rapid plates.
> We recommend this plate especially for hand-cameras and instantaneous work.
> For large work and groups in the studio it has no equal.
> (Cramer n.d.b, 7)

> **Hammer Special Extra Fast Plates (Red Label)**
> The most rapid plates made, obtaining high speed without sacrifice of quality. Made of especially selected and analyzed chemicals and material, they are coated upon extra selected glass, examined by experts and packed with the utmost care. Great care must be taken with this plate in the dark-room, as its extreme sensitiveness will not permit the same volume of red light as the Extra Fast.
> It is especially adapted for studios making large portrait negatives and for large group work where time and small stops are necessary. Suitable for flashlight work, laughing babies and difficult groups of children. They are soft and mellow in the whites, retaining detail down in the deepest shadows.
> Instantaneous under the skylight, it is the ideal plate for dark and dreary days.
> For field work, instantaneous landscape photography, rapidly moving objects, such as horse and automobile races, moving trains, aeroplanes, field sports, and flying birds, where

focal plane shutters are necessary, this plate should be used because of shortness of exposure necessary.

Where speed is essential, a fully timed negative can be obtained with this plate under conditions impossible with any other plate.

(Hammer n.d.)

Plates for Portraiture and General Work

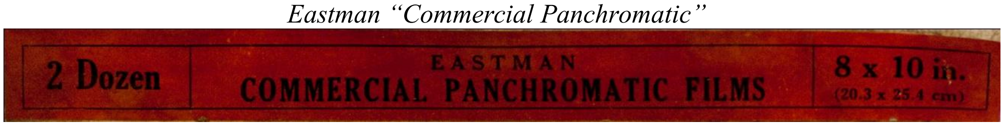
Seed 26x.

Our 26x is the most extensively used plate we make. For general portrait work it cannot be surpassed. It gives roundness in gradation from the highest lights to the deepest shadows. There is brilliancy, harmony and detail through the whole picture. Light the subject as you would have your picture. Only extremes, i.e., light so strong and concentrated as to show unusual harshness, or so broad and so much diffused as to give no point to highlight or shadow, need be avoided. The plate will give you what you see under most adverse circumstances. The 26x plate has a wider latitude than any other portrait plate in the world. It requires ¼ more exposure than the Gilt Edge 27.

(M.A. Seed n.d.a, 16).

Cramer "Crown" Lot ending in 8795

Eastman "Commercial Panchromatic"



Hammer "Slow"

Hammer "Special" Record 7658

Figure 12. Original manufacturer box showing brand, size, and lot number
Source: Wiedemer - photographs of the Beach Collection.

Description of Cramer Crown plates follows:

CRAMER CROWN PLATES.

CRAMER CROWN PLATES are the most rapid plates made. They work with great softness and shadow detail, which qualities especially recommend them for focal plane shutter-exposures, hand cameras, and all instantaneous work. For large negatives and groups in the studio, and for exposures in a poor light or with slow lenses, they should always be used (Schriever 1909, 226).

CRAMER CONTRAST PLATES.

For copying drawings, engravings, photographs etc., for half-tone plates (Line screen or Process Work) (Schriever 1909, 226).

HAMMER'S SLOW PLATES.

841. This brand of plates allows great latitude in the exposure; has exceptionally fine grain, and is what its name implies – Slow, being about one-fourth the rapidity of Hammer's Extra Fast Plate.

842. It is just the right rapidity and quality for view work, where there are no moving objects, such as the ordinary views that are taken by professional and amateur photographers.

843. This plate is extensively used:

For copying
For process work
For button work
For commercial work

and any photographic work that does not require a short exposure.

844. These plates, when developed with a normal developer and the development carried reasonably far, will give strong negatives with clear shadows.

845. But if a dilute developer is used, one can get a fine soft chemical effect (Schriever 1909, 297).

Hammer Special brand of plates are described as follows:

HAMMER'S SPECIAL EXTRA FAST.

> 821. This plate is of special use during the dark winter months, and for objects where the shortest exposure possible must be given.
>
> 822. They are invaluable for flash-light exposures, extremely short snap-shot exposures, etc.
>
> 823. In the Hammer Special we retain the fine grain of the slower plates, even with this extreme rapidity.
>
> 824. In all ordinary cases our Regular Extra Fast Plate will be found rapid enough for all requirements, but we offer this Special Plate for special cases where nothing else will do (Schriever 1909, 295).

A typical description of a photograph in a trade article often includes the name and brand of plate used by the photographer. For example:

> A late characteristic likeness of Sadakichi Hartmann (Sydney Allan), the well-known author and critic. Data: September 22, 1911; 3 P.M.; in studio of Howard D. Beach, Buffalo; 3 A Dallmeyer; Portrait lens; for 8 x 10; full opening; light good; ¾ second; **Hammer Red Label**; Pyro tank; Haloid print, 4 ½ x 6 ¾
> (*Photo-Era* 1912, 140).

The literature also suggests a clear preference for one manufacturer over another for certain applications. For example, astronomer Robert James Wallace experimented with the Seed 27 "Gilt Edge", Cramer "Crown", Cramer "Instantaneous Isochromatic", and Hammer "Special Extra-fast" dry plates. His preference was for the Seed 27 "Gilt Edge" because it has the smallest grain, the most sensitivity, and is extremely uniform throughout the emulsion (Wallace 1904, 113). Photomicrographer Thomas J. Bray researched plates from Seed, Cramer, Eastman, Stanley, Carbutt, and Hammer. He preferred the slow ISO of the Cramer "Crown" for similar reasons (Bray 1897, 114). A photographer of furniture, George Wallace Hance also preferred a slow negative with a fine grain. His choice was the Hammer "Aurora", a double layer plate (Hance 1914, 20). Portrait photographers such as James Boniface Schriever, clearly liked Hammer "Extra-fast" plates because they were fast and therefore required a short exposure and gave a clear, sharp image (Schriever 1909).

Gelatin dry plate negatives are composed of two layers – the emulsion and light sensitive layer attached to the glass support. Each of these layers was unique to a particular manufacturer. Trade secrets abounded at this time; this may have been one of the reasons it was easier for Eastman to simply acquire a company and enfold its technology into Kodak, rather than trying to analyze what components and techniques they used.

Emulsion

Gelatin at its most basic is a combination of 50.5% carbon, 6.8% hydrogen, 17% nitrogen and 25.2% oxygen (GMIA 2012, 6). While the exact emulsion formula was a closely guarded secret held by each manufacturer, in general the following two formulas were used:

[Formula I]

(a) gelatine	30 grains	water	1 oz.
(b) silver nitrate	175 grs.	water	½ oz.
(c) potassium bromide	140 grains	water	1 oz.
(d) gelatine	240 grs.	water	2 oz.

A more rapid emulsion formula follows:

[Formula II]

(a)	Nelson’s gelatine No. 1 soluble	30 grs.	water	1 oz.
(b)	silver nitrate	175 grs.	water	½ oz.
(c)	potassium bromide	130 grs.	water	1 oz.
(d)	potassium iodide	5 grs.	water	1 oz.
(e)	hard gelatine	240 grs.	water	2 oz.

(Hasluck 1907, 60).

Muddying the water further, C. E. K. Mees, founder of the Kodak Research Laboratories, insists that “emulsion making is a complicated art … whereas a great deal has been done to reduce this art to a science, nevertheless in a practical industrial laboratory the development of the art itself cannot be neglected, and a large part of the work in the Kodak Research laboratories has been applied to the advancement of the art.” He further argued that “like emulsion-making, gelatin making is an art rather than a science.” And yet, a few paragraphs later states that “the purpose of the laboratory from the beginning was the production of scientific knowledge, the polices of the laboratory have always been directed toward that end.” (Mees 1948, 145).

Glass

The second component of the gelatin dry plate negative is the glass support. There is ample evidence that some manufacturers used Belgian glass while others used American made (GPO 1922, 1584-1592). Like the gelatin, each glass manufacturer had trade secrets with regard to their glass recipe.

William Leyshon compiled a valuable article entitled *Photographs from the 19th Century: A Process Identification Guide* for the Sharlot Hall Museum in Prescott, Arizona. His research into the glass manufacturers often met with dead ends as described here:

> … the most likely source [of glass for gelatin silver dry plates] was soda lime cylinder glass, selected for uniform thickness within lots, and minimum waviness. It seems unlikely that it was ground and polished because of cost and industrial capacity; the fact that the plates had as-cut edges argues for cost constraints even in early days of factory production. Slight variations in thickness would probably have been tolerated at a time when attention was concentrated on the sensitivity question (Leyshon n.d., 51).

The anecdotal and unreliable references Leyshon is referring to can be seen in an example from *The Photographic Times* published in 1884, "Messrs Heroy & Marreaner, Chicago, Ill., exhibited two cases of Chance's sheet glass, now so much in favor among dry plate manufacturers because of its evenness and fine texture." (Taylor 1884, 449).

Glass for photographic use needs to be of the purest quality. It has to be clear, devoid of any impurities that may interfere with the transmission of the light, free of bubbles and blemishes, and thin (Whitman 2007, 3). The quality of the American glass was usually considered to be inferior to that made in either Belgium or England. *The Architectural Record* of 1910 states that "the best quality of blown glasses are the English, and only the best grades are imported, as their prices are high and it pays to use them only where the best is needed" (Carrère 1910, 352).

Reliable references for glass manufacturing sources that directly reference dry plate manufacturers or the city where many of them were located can be seen in the National Glass Budget Weekly Review from 1915.

May Window Glass Imports

During the month of May 4, 1977 boxes of cylinder glass were imported into this country, carrying a value of $32,570. Imports were confined almost exclusively to dry plate glass, the Eastman Kodak Co., of Rochester, N. Y., having received 3,497 boxes of what came in. The remainder, with the exception of a few boxes, went to St. Louis and New York. In the following table imports by custom districts are shown:

Districts	Pounds	Boxes	Dollars
Maine & New Hamp.	60	1	8
New York	23,449	391	3,348
Philadelphia	514	9	130
San Francisco	1,062	18	67
Buffalo	1,069	18	185
Rochester	209,842	3,497	23,167
Colorado	300	5	101
St. Louis	62,300	1,038	5,564
Total	298,596	4,977	32,570

The decisions made by dry plate manufacturers for their choice of glass supplier were often not driven by preference, but by extenuating circumstances. Belgian glass was inarguably superior to American made, but the first World War interfered with supply and the demand for photographic glass far exceeded the supply. A *New York Times* article from 1920 shortly after the end of the war describes the reason for the short supply. “The exportation of plate glass is also considerable. Many countries are buying it, but France is taking the largest tonnage, especially for its devastated regions. Prices are going up, since raw materials have been appreciably increased in price" (*New York Times* 1920). Consequently, in order to force manufacturers to purchase glass made in the United States, the government imposed a tariff on imported Belgian glass. Both Gustav Cramer and Ludwig Hammer protested and attended the hearing before Congress protesting the tariff. Highlights from the hearings follow:

- Unpolished sheet glass commonly called photo dry-plate glass or window glass – high-grade window glass, devoid of all foreign substances, scratches, bubbles, etc.
- Four dry-plate manufacturing concerns in the US – Eastman Kodak Co, Hammer, Cramer, Central
- Only one concern in the US manufacturing photo glass (American Window Glass Co.), but doesn't produce an amount which will supply the demands and is not of the superior quality of the glass manufactured in Belgium.
- 100,000 to 120,000 boxes of dry-plate glass imported into the country each year
- Main importations of unpolished sheet glass are from Belgium and England
- Main sizes used by dry-plate manufacturers are as follows: 5 x 7, 6 x 8, 8 x 10, 10 x 12
- As mentioned above before the war this glass could be bought for $5.40 in the US and at a lesser price imported from Belgium, but during the war we were unable to receive the importations and the American manufacturer raised its prices (not having any competition in this country) to the price mentioned above, while the dry-plate manufacturers were driven to purchase old negatives and use a chemical process to remove the film therefrom, and was also driven to buy this glass at any price fixed by the American manufacturer while said dry-plate companies did not increase the price of their productions.
  (GPO 1922, 1584-1592).

The American Window Glass Company refuted the claim that their glass was inferior. In 1926, the company published *Window Glass in the Making An Art, A Craft, A Business* which advocates for their product:

> MICROSCOPIC SLIDES, LANTERN SLIDE GLASS, PHOTO DRY PLATE GLASS, AND DIAGNOSTIC X-RAY GLASS
> The above named productions are all of the same general class. They are much thinner than other glass, and they require absolute flatness and the very best quality. We are the only manufacturer in this country who can produce such glass. Years ago attempts were made to produce it here by the hand blowing method, but without success. In 1913, after some years of experimenting and an enormous expenditure of money, we began its production on a commercial scale, and succeeded in producing a quality superior to that of imported glass. Shortly after the close of the war, the European manufacturers resumed the production of this glass and sold it in this country at prices with which we could not compete, notwithstanding our superior quality. As a result, we were obliged to curtail very greatly our production of this kind of glass.
> (Monro 1926)

The book also lists the thickness of photo dry plates as having a minimum thickness of 0.062 inches (1.6 mm) and a maximum of 0.071 inches (1.8 mm).

While the physical characteristics are extremely important, the chemical characteristics are equally relevant. Like the emulsion layer, glass composition and formulas were closely guarded secrets. Minute differences were believed to increase the superiority of one manufacturer over another. The American Window Glass Company describes their process in general and promotes their superior product:

> Today, window glass is made from silica (sand) mixed either with sulphate of soda (salt cake) or carbonate of soda (soda ash), or with a combination of these two forms of soda. To these ingredients is added lime, either in the form of ground limestone, burnt lime, or dolomite. With sulphate of soda, a small amount of carbon is added, either in the form of crushed coal or coke, or ground charcoal. Sometimes arsenic, manganese, or other decolorizers, in small quantities, are introduced into the mixture, whenever it is desired to obtain glass free from the usual greenish tint which is caused by a small percentage of iron in the materials or in the clay of the pots or blocks of the furnace.

> Upon the purity of the materials, their degree of fineness, and the proportion in which they are used, depend the color, quality, toughness or brittleness, and density of the glass produced. The American Window Glass Company uses the purest materials obtainable, ground to the requisite degree of fineness. They are mixed in certain proportions, determined after years of study and experiment, and produce "The Best Glass" possible, as is shown by every chemical and physical test to which it can be subjected.
>
> The table on the next page represents about an average analysis of the window glass produced by the American Window Glass Company.
>
> Window glass of approximately this analysis, made by our process, will have greater tensile strength, a higher modulus of rupture, and more resistance to the action of moisture than glass having a lower percentage of silica or lime, or a higher percentage of soda:
>
> Silica 73.25%
> Lime 12.50
> Soda 12.50
> Alumina .75
> Other Ingredients 1.00
> Total 100.00

In 1920, a geological survey was conducted in Kentucky to determine "the actual chemical analysis of photo glass as manufactured by the American Window Glass Company for the Eastman Kodak Company of Rochester, N. Y. ….:"

SiO_2	73.06
CaO	12.68
Na_2O	11.86
MgO	.16
Fe_2O_3	.12
SO_3	.66
	98.54

> The specific gravity of this glass is 2.552 and the quality is considered excellent (Richardson 1920).

Developing the Negative

While each manufacturer has a recommended formula for developing their particular negatives, the basic method begins with a reducer, often some type of acid, which reduces the exposed silver bromide in the emulsion to the basic silver form of the element. An alkaline accelerator is sometimes added to aid the reducer in completing the reaction. The combination of the reducer and accelerator will often cause a reaction that is too rapid which may cause fogging of the negative image. Therefore a restrainer is used to slow down the reaction. Finally, a preserver may be necessary to prevent the developer from oxidizing. Control of the temperature (60° to 65° F) and dilution factors are also extremely important (Hasluck 1907, 109).

Cramer Dry Plate Company, for example, suggests the use of "Cramer developing formulas on Cramer plates, for these formulas are fitted to the plates." (Cramer n.d.a, 12). The two recommended developers are Pyro and Edinol.

Pyro Developer

A.	Pure Water	16 oz
	Oxalic Acid	12 grains
	Pyrogallic Acid	1 oz
B.	Pure Water	16 oz
	Cramer's Dry Sulphite of Soda	2 ozs
	If negatives are too yellow use more sulphite.	
C.	Pure Water	16 oz
	Cramer's Dry Carbonate of Soda *	1 oz
	Mix for immediate use	

A	1 oz
B	1 oz
C	1 oz
Water (65° to 70° F)	

In summer the developer should be used cooler (about 60° F), or with more water.

In winter it should be used warmer (about 75° F), or with less water.
Less water hastens development and increases contrast.
More water slows development, gives less contrast and is better for short exposures.
*If Cramer's Dry Carbonate of Soda is used, Solution C, as given above, is of the proper strength. When other brands are used it may be necessary to vary the strength of the solution, bearing in mind that an excess of Carbonate blocks the light, and increases contrast.

Edinol Developer

A.	Pure Water		30 ozs
	Cramer's Dry Sulphite of Soda		2 ozs
	Acetone-Sulphite		¼ oz
	Edinol		1 oz
B.	Pure Water		30 ozs
	Carbonate of Potassium		4 ozs
	For use	A	1 oz
		B	1 oz
		Water	6 to 10 ozs

The developer can be used several times in succession, and keeps well (Cramer n.d.a, 22-24).

Different chemicals will yield distinctly different results. An eikonogen and metol developer produces a soft negative; carbonate of sodium and pyrogallic acid developer results in a strong negative; and a hydrochinon-metol developer generates a negative with significant contrast (Hiscox 1922, 523).

From "The Book of Photography, Practical, Theoretic and Applied" edited by Paul Hasluck in 1907, the recommended formulas for pyro and metol-hydroquinone developers follow:

> **Metol and Hydroquinone**
>
> | | | |
> |---|---|---|
> | No. 1. – | Metol | 40 grs. |
> | | Hydroquinone | 48 grs. |
> | | Sodium sulphite | 120 grs. |
> | | Water | 8 oz. |
> | No. 2. - | Potassium carbonate | 1 oz. |
> | | Water | 40 oz. |
>
> This gives the greatest degree of control possible with a two-solution developer. For use with normal exposures, take 1 oz. of No. 1 and 3 oz of No. 2. For over-exposure use less of No. 2, or add a few drops of bromide solution; for under-exposure, use more of No. 2. The metol and hydroquinone developer, like most of the non-staining reducers, may be used repeatedly but becomes gradually slower with use (Hasluck 1907, 110).

Henley's Twentieth Century Book of Recipes, published in 1922, provides several different formulas. Under the heading of photography:

> Various developing agents give different results. Pyrogallic acid in combination with carbonate of sodium or carbonate of potassium gives strong, vigorous negatives. Eikonogen and metol yield soft, delicate negatives. Hydrochinon added to eikonogen or metol produces more contrast or greater strength.
>
> **Pyro and Soda Developer**
>
> | | | |
> |---|---|---|
> | I. | Pure water | 30 ounces |
> | | Sulphite soda, crystals | 5 ounces |
> | | Carbonate soda, crystals | 2 ½ ounces |
> | II. | Pure water | 24 ounces |
> | | Oxalic acid | 15 grains |
> | | Pyrogallic acid | 1 ounce |

To develop, take of

Solution No. I	1 ounce
Solution No. II	½ ounce
Pure water	3 ounces

More water may be used in warm weather and less in cool weather.

Metol and Hydrochinon Developer

I.	Pure hot water	80 ounces
	Metol	1 ounce
	Hydrochinon	1/8 ounce
	Sulphite soda, crystals	6 ounces
II.	Pure water	80 ounces
	Carbonate soda, crystals	5 ounces

To develop, take of

Pure water	2 ounces
Solution No. I	1 ounce
Solution No. II	1 ounce

Schriever's *Complete Self-Instructing Library of Practical* Photography from 1909 includes special developing sections for Cramer, Hammer, and Seed plates. Cramer's follows:

> 564. A few years ago the G. Cramer Dry Plate Co. put on the market their acetone, and during this time it has earned a well deserved place on the dark room shelf. Acetone is a neutral liquid which replaces the alkali in developing solutions. Combined with sulphite of soda and a developing agent it makes a far more regular working developer than any form of alkaline developer can. As no alkali is used there is less danger of the film softening in warm weather, the false densities common with an alkaline developer are avoided and chemical fog from a developer which is too warm or too strong in alkali entirely absent.
>
> …
>
> 565. With the pyro-acetone formula, any temperature between sixty-five and eighty degrees Fahrenheit can be used with perfect safety (Schriever 1909, 226).

Standard Formulae for Cramer Plates:

Pyro-Acetone Developer

Works quick and uniform, without frilling; can be used in warm climates without ice, and does *not stain the hands*.

A.	Pure water	16 ounces	640 c.c.m.
	Oxalic Acid	12 grains	1 gram
	Pyrogallic Acid	1 ounce	40 grams
B.	Pure water	20 ounces	600 c.c.m.
	Cramer's Dry Sulphite Soda	2 ounces	60 grams

(Or 20 ounces Sulphite Soda solution 48 degrees hydrometer test.)

Cramer's (Liquid) Acetone	40 ounces	120 c.c.m.

For use take:

A.	1 ounce	30 c.c.m.
B.	2 ounces	60 c.c.m.
Water	8 to 12 ounces	240 to 360 c.c.m.

(Schriever 1909, 226).

> **Special Pyro Developing**
>
> Stock Solution No. I.
>
> | | |
> |---|---|
> | Water | 24 ounces |
> | Pyrogallic acid | 1 ounce |
> | Sulphuric acid | 8 drops |
>
> Stock Solution No. 2.
>
> | | |
> |---|---|
> | Sulphite soda | hydrometer test 70 |
>
> Stock Solution No. 3.
>
> | | |
> |---|---|
> | Carbonate soda | hydrometer test 40 |
>
> To develop take one ounce of No. I, one ounce of No. 2, and ten to twelve drops (no more) of No. 3, and add twelve ounces of water.
>
> Before beginning to develop let us consider again the nature and objects of each chemical used in developing. Stock Solution No. I is your pyro solution, or (developing agent) strength producing agent. Stock Solution No. 2, sulphite soda, is your color regulating chemical. Stock Solution No. 3, carbonate of soda, is your detail-producing chemical.
>
> In ordinary developing if you desire more contrast you would increase your pyro, because pyro being your developing agent gives you strength, builds up your highlights. If your plate developed yellow in color, you would increase your sulphite of soda in order to retain the proper color. If your plate lacked detail, and developed too contrasty, you would add carbonate of soda, because it opens the pores of the film and permits the pyro to get to the shadows, and, therefore, is your detail-producing chemical. (Schriever 1909, 226).

The recommendation for Hammer Plates is to use a pyro and soda developer with the following formula:

> 763. For professional work we think pyro and soda produces negatives that have the best printing quality.
>
> …
>
> 765. … Most other developers are stronger than necessary for this plate. The quality is in the Hammer emulsion and does not require any forcing to bring it out. Chemical actions that are forced through hurriedly will result in loss of quality (Schriever 1909, 279).

GOOD DEVELOPING FORMULAE FOR HAMMER PLATES.

767. The quantity of sodium sulphite in the developer must be regulated to produce the color desired. It is to the photographer's advantage, when using pyro developer, to use our formula, as most other formulae call for more pyro than is necessary for our plates.

Pyro and Soda (*By Weight)*

No. 1

English Weights and Measure.		Metric Weights and Measure.
30 ounces	Pure water	900 c.c.
5 ounces	Sodium Sulphite (crystals)	150 grammes
2 ½ ounces	Sodium Carbonate (crystals)	75 grammes

No. 2

24 ounces	Pure water	720 c.c.
15 grains	Oxalic acid (dissolved)	1 gramme
And then add -		
1 ounce	Pyrogallic Acid	30 grammes

To develop, take:

1 ounce	Solution No. I	30 c.c.
½ ounce	Solution No. 2	15 c.c.
6 to 8 ounces	Pure water	180 to 240 c.c.

More water may be used in warm weather, and less in cool weather (Schriever 1909, 279).

Schriever also describes why certain developers of greater or lesser dilution may be recommended. The following table (*Table 2)* provides his recommendations for pyro developer.

Table 2. Manufacturer emulsion thickness and recommended developer solution (Schriever 1909, 36, 135)

Manufacturer	Emulsion Thickness	Recommended Dilution
Hammer	Thinner	3 oz pyro + 1 oz water
Seed	Very heavily coated	4 oz pyro + 1 oz water
Cramer	Thicker	5 oz pyro + 1 oz water

Pyro developer gives a very strong contrast to the negatives. Hammer plates, which have a relatively thin emulsion when compared to the other two brands, are already a high contrast plate. Therefore, in order to produce the same end result with regard to contrast, less pyro is recommended for Hammer and more for Cramer which is considered to be a thick emulsion and lower contrast plate (Schriever 1909, 135).

Cost of the Negative

Negative prices were self-regulated by the manufacturers. In this way, it eliminated competition based solely on price, since a box of 12 plates from Eastman was the same cost as a box from Cramer or Hammer. Photographers could chose the product they liked based entirely on the quality and characteristics they needed for their particular application. The following table (*Table 3*) compares the prices of the glass plate negatives.

Table 3. Price of dry plates per dozen (Cramer n.d.b, 15; Eastman 1886, 22; Hammer 1936; Seed n.d.b, 34)

	Cramer "Crown"	**Eastman "Special"**	**Hammer "Special"**	**MA Seed "26"**
5 x 7	1.10	1.10	1.10	1.10
6 ½ x 8 ½	1.65	1.65	1.65	1.65
8 x 10	2.40	2.40	2.40	2.40

In 1883, the dry plate manufacturers held a meeting at which they agreed to regulate the prices they charged for their product.

> Chicago, May 16, 1883
> At a meeting of the leading dry plate manufacturers, held in Cleveland, May 15, 1883, the present status and future prospects of the business were matters of grave and careful discussion.
> Cleveland, May 15, 1883.
> We, the undersigned, manufacturers of gelatin dry plates, do hereby agree to the following list of prices as the one to which we will faithfully adhere, and to continue it in force until January 1, 1884. To take effect immediately.

Size.	Doz.
4 x 5	.90
5 x 7	1.55
6 ½ x 8 ½	2.30
8 x 10	3.40

H. Norden, Dry Plate Works, St. Louis
G. Cramer, Dry Plate Works, St. Louis
The Chicago Dry Plate and Manufacturing Company, "Beebe Plate," Chicago
Taylor & Green, Rockford, Ill.
Walker, Reed & Inglis, Rochester, N. Y.
Crystal Dry Plate Co., Indianapolis, Indiana
John Carbutt, Philadelphia, Pa.
(Taylor 1883, 308)

All of the above manufacturers agreed to charge the customer the exact same price as their competition. Since price was not the deciding factor in selecting a certain manufacturer, other aspects of the negatives would have been taken into consideration before selection was made.

As competition among the manufacturers intensified, the price of the negatives dropped. The price list in Figure 14, dated around 1906, shows the negative prices had dropped significantly since 1883. A 4” x 5” plate that was sold for $0.90 in 1883 was now being sold for $0.65, a 28% drop in price. 5” x 7” plates dropped 39% from $1.55 to $1.10. Similarly, 6 ½” x 8 ½” and 8” x 10” dropped 39% and 29% respectively (M.A. Seed n.d.b, 34; Taylor 1883, 308).

Seed Dry Plates

PRICE PER DOZEN.

SIZE	23	26X	27	Non-Hal	Ortho	Ortho Non-Hal
3½ x 3½	$ .40	$ .40	$ .40	$ .50	$ .40	$ .50
3¼ x 4¼	.45	.45	.45	.55	.45	.55
3½ x 6½	.75	.75	.75	.95	.75	.95
4 x 5	.65	.65	.65	.80	.65	.80
4¼ x 4¼	.60	.60	.60	.75	.60	.75
4¼ x 6½	.90	.90	.90	1.10	....	1.10
5 x 7	1.10	1.10	1.10	1.40	1.10	1.40
5 x 8	1.25	1.25	1.25	1.55	1.25	1.55
6½ x 8½	1.65	1.65	1.65	2.10	1.65	2.10
8 x 10	2.40	2.40	2.40	3.00	2.40	3.00

Figure 14. Seed prices (M.A. Seed n.d.b, 34)

CHAPTER 3: STATEMENT OF THE QUESTION

This paper serves to explore the results of the pilot study of various physical and chemical properties of the gelatin dry plate negatives in order to understand Beach's photographic working methods and compare them to the industry standards. Answers to numerous questions are sought in conducting the research necessary to grasp a somewhat complex and often contradictory story. An attempt has been made to answer these questions using the research presented in this paper as well as new scientific analyses conducted at the SUNY Buffalo State Art Conservation Department.

There does not seem to be any specific research aimed at identifying the unique components in the gelatin of the various manufacturers of dry plates. There also does not seem to be any significant research directed toward identification of the components of the different glass supports used by these same manufacturers. Lack of quantitative standards hinders any type of analysis that may be performed by the research for this project.

An exploration of the developing methods during the time the Beach Studio was in operation also seems to have been overlooked. There are often subtle and sometimes not so subtle differences and practices by photographers and recommendations by manufacturers for one type of chemical over another. An exploration of what drives these choices and recommendations has not been explored in the current literature.

The lack of written records that describe the working methods of the photographer of a particular collection are rare. Loss of the same is occurring rapidly as holders of the information rarely understand the significance of the collection they may have. Current literature provides little insight into the choices made by the majority of professional photographers practicing their trade during the early 20th century, unless the photographer was a well known name such as Alfred Stieglitz or Ansel Adams.

Identification of the components of the gelatin and glass layers of the dry plate negatives and the relationship to specific manufacturers is the first step in establishing reference samples for continuing the research on this collection and others of a similar nature. Mapping the intricate relationships between supplier and manufacturer or manufacturer and customer provides some understanding of a complicated and complex industry that was often riddled with trade secrets and takeovers. Confirmation or rejection of subjective information from the trade magazines of the early 20th century, such as relative plate thickness, can corroborate or contradict the assumed truths related to various brands.

Enlightenment of an artistic nature can be revealed through the exploration of a photographer’s adherence to recommended guidelines for developing specific brands or the straying of said photographer into the realm of creative license in order to manipulate the final image. Knowing that a well-regarded photographer purposely wielded the chemicals of his trade contrary to the prescribed instructions offers a unique perspective on a craft that is often considered rigid and methodical. Following Beach’s creative journey by revealing his preferences as penned in his journal elevates the technical aspects of photography into the domain of a true master of his art.

Preserving and compiling this information before it is lost completely is an important step in understanding an industry that helped change the way business was conducted when bringing a manufactured product to the public.

CHAPTER 4: PRESENTATION OF WORK

Survey of Manufacturers

The first objective was to determine the primary manufacturers of the gelatin dry plate negatives found in the Beach studio collection. The original manufacturer boxes were retained and used to store the processed negatives, however, it is likely that the entire box does not consist of a homogeneous set of the same brand of plates. Each box contains an average of ten to twelve negatives. At the time of the study, it was determined that surveying over 3,000 boxes was time prohibitive. Instead, approximately twenty-five percent of the boxes were sampled across the time period of the collection, from 1906 to 1922 - a period spanning 16 years. Of the 765 boxes surveyed, there are six different manufactures represented. The list follows:

1. Cramer Dry Plate Company of Saint Louis, Missouri
2. Eastman Dry Plate Company of Rochester, New York
3. Hammer Dry Plate Company of Saint Louis, Missouri
4. MA Seed Dry Plate Company originally of Saint Louis, Missouri and acquired by Eastman Dry Plate Company in 1902 (M.A. Seed 2012)
5. Stanley Dry Plate Company originally of Lewiston, Maine and acquired by Eastman Dry Plate Company in 1899 (Two Heads are Better 2014)
6. Wratten & Wainwright Dry Plate Company originally of London, England and acquired by Eastman Dry Plate Company in 1912 (Frederick Charles Luther Wratten 2012).

Table 4 shows the tally and percent of gelatin dry plate manufacturers represented in the survey of 2.5% of the collection. A total of 765 boxes were surveyed. Six distinct manufacturers were represented; Cramer Dry Plate Company, Eastman Dry Plate Company, Hammer Dry Plate Company, MA Seed Dry Plate Company, Stanley Dry Plate Company, and

Wratten & Wainwright Dry Plate Company. There were also a very small number of boxes that could not be identified because they were too damaged or the box top was from one manufacturer and the bottom was from another. These are tallied under the "unknown" category.

Table 4. Tally of manufacturers represented in the survey of the collection

Manufacturers	**Number of Boxes**
Cramer Dry Plate Company	105
Eastman Dry Plate Company	1
Hammer Dry Plate Company	603
MA Seed Dry Plate Company	52
Stanley Dry Plate Company	2
Wratten & Wainwright Dry Plate Company	1
Unknown	1
TOTAL	**765**

The data in the above table was then converted to a percent of total boxes counted and represented as a pie chart (*Figure 14*). The chart allows an immediate visual reading of the most common manufacturers in the collection.

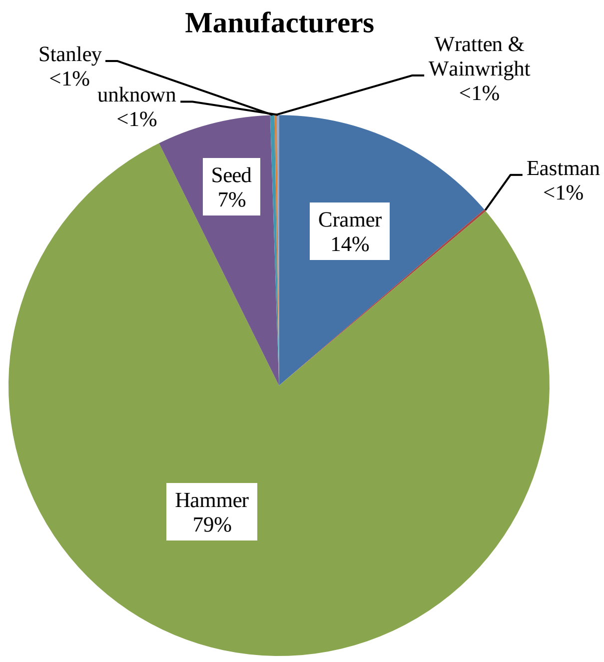


Figure 14. Percent of manufacturers represented in the survey of the collection

To determine if there is a difference in manufacturers based on plate size, the tally from the survey was broken down between 5”x7” plates and 8”x10” plates. The 6.5”x8.5” plates were excluded from the survey because the supplies necessary to re-house these negatives are a special order item and were cost prohibitive at the time the study was conducted.

The results of the tally 5”x7” plates are shown in Table 5. There are only three manufacturers represented in the 5”x7” survey; Cramer Dry Plate, Hammer Dry Plate, and MA Seed Dry Plate. There was only one box where it was not possible to determine the manufacturer.

Table 5. Tally of manufacturers represented in the survey of the collection for 5”x7” plates

5”x7” Manufacturers	**Number of Boxes**
Cramer Dry Plate Company	102
Hammer Dry Plate Company	570
MA Seed Dry Plate Company	52
Unknown	1
TOTAL	**725**

The tally for the 5”x7” plates were then calculated using the same method for the total tally and represented in a pie chart (*Figure 15*) for easier reading of the data.

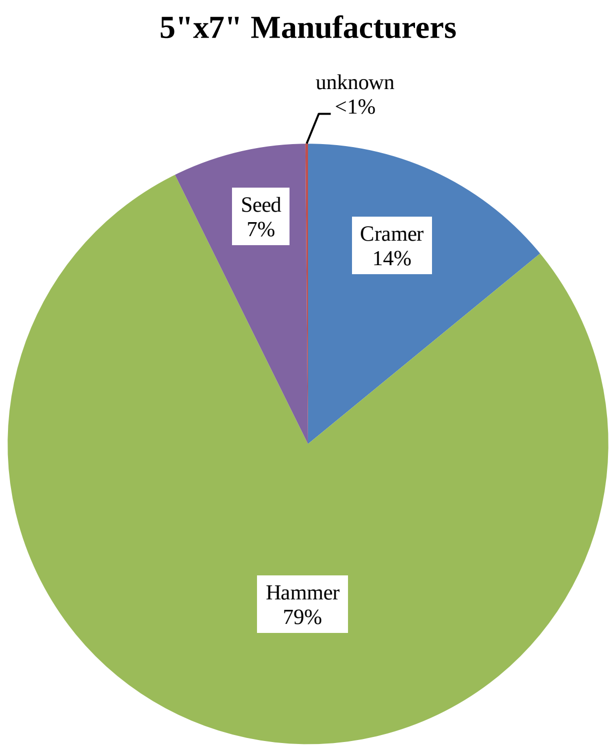


Figure 15. Percent of manufacturers represented in the survey of the collection for 5”x7” plates

The tally for the 8”x10” plates is shown in Table 6. There were five manufacturers represented in this survey; Cramer Dry Plate, Eastman Dry Plate, Hammer Dry Plate, Stanley Dry Plate, and Wratten & Wainwright Dry Plate. All of the boxes were identified in this tally.

Table 6. Tally of manufacturers represented in the survey of the collection for 8”x10” plates

8”x10” Manufacturers	**Number of Boxes**
Cramer Dry Plate Company	3
Eastman Dry Plate Company	1
Hammer Dry Plate Company	33
Stanley Dry Plate Company	2
Wratten & Wainwright Dry Plate Company	1
TOTAL	**40**

Like the total tally and 5”x7” tally, the 8”x10” data was converted to a percent of total 8”x10” plates and represented as a pie chart in Figure 16.

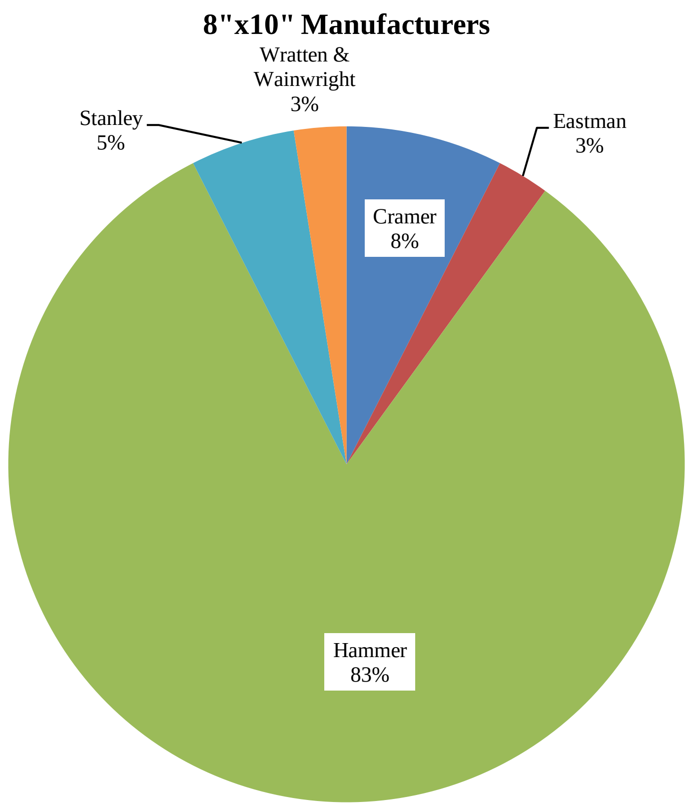


Figure 16. Percent of manufacturers represented in the survey of the collection for 8”x10” plates

Visual Examination

Visual examination during the cleaning and re-housing process was the first analysis used to see if there was a noticeable difference among the different manufacturers. Some plates appear to be thicker or thinner when compared with each other. Any differences noted are included in the cleaning paperwork and archived with the collection. Results of the four 5”x7” negatives examined are noted in Table 7 below.

Table 7. Notes on visual examination of four 5”x7” plates noted during cleaning and re-housing

Neg #	**Manufacturer**	**Relative Thickness**	**Edges**
31140	Cramer	Thin	red edges
30402	Hammer	Thick	no color on edges
30403	Cramer	Thin	no color on edges
30565	Seed	Thick	red bottom edge

The thickness of the plates was determined by comparing the relative thickness in relation to the other three plates. Differences were also noted with respect to the color of the edges of the plates. One of the plates had a red matte paint on all four edges. Two plates had no color, simply the natural color of the glass. The fourth plate had red matte paint only on the bottom edge. An additional 146 - 5” x 7” plates and 51 - 8” x 10” plates were examined. Results are tabulated in Appendix 3 and Appendix 4 respectively. Overall, it can be said that there are noticeable differences between the plates. Correlation between these differences and specific manufacturers is discussed in the conclusion.

Scientific Analytical Examination

To determine if the different brands of gelatin dry plates can be distinguished from one another using scientific analysis, three different methods were used for comparison. The first two analyses focused on the glass support only. First, the four plates from Figure 21 were subjected to ultraviolet A (UV-A) and ultraviolet C (UV-C) radiation to determine if there was a noticeable difference in fluorescence color which would indicate a different chemical composition in the glass support. Second, x-ray fluorescence (XRF) was used to determine if there were chemical differences in the glass from different manufacturers. Finally, the cross-section photograph that was taken during UV analysis was used to measure the thickness of both the glass support and the gelatin layer.

Ultraviolet Radiation Induced Visible Fluorescence

Initially, analysis was performed on four 5”x7” negatives dating to 1908.

Specifications for the UV equipment used follow:

UV apparatus:

SuperBright II - UV Systems, Inc

UV-A: model LW3368 with a wavelength of 370 nm

UV-C: model 3254 with a wavelength of 253.7 nm.

Camera and lens:
Nikon D800E
AF Micronikkor 105mm
1:2.8D
Shutter speed: 20 sec
Aperture: f/5
Exp comp: +1/3 EV
ISO: 200
White balance: shade

Photoshop:
Temp: 10,000
Tint: +32

Figure 17 depicts the setup that was used for the UV analysis. A camera was mounted above the subject area on a fixed mount with the lens pointed downward. The glass negative was placed perpendicular to the table on the long side with the emulsion facing the analyst. Two mat boards cut to match the size of the negative were placed on each side to minimize any reflection from the emulsion or transmission of the light through the glass layer. A jig was placed on each side of the negative to support it during analysis. A handheld UV radiation source was placed above and slightly to the side of the negative, out of range of the camera lens and a cross section image was recorded. The image was used to determine if there was a color change in the glass which would indicate a difference in the chemical composition of the glass support.

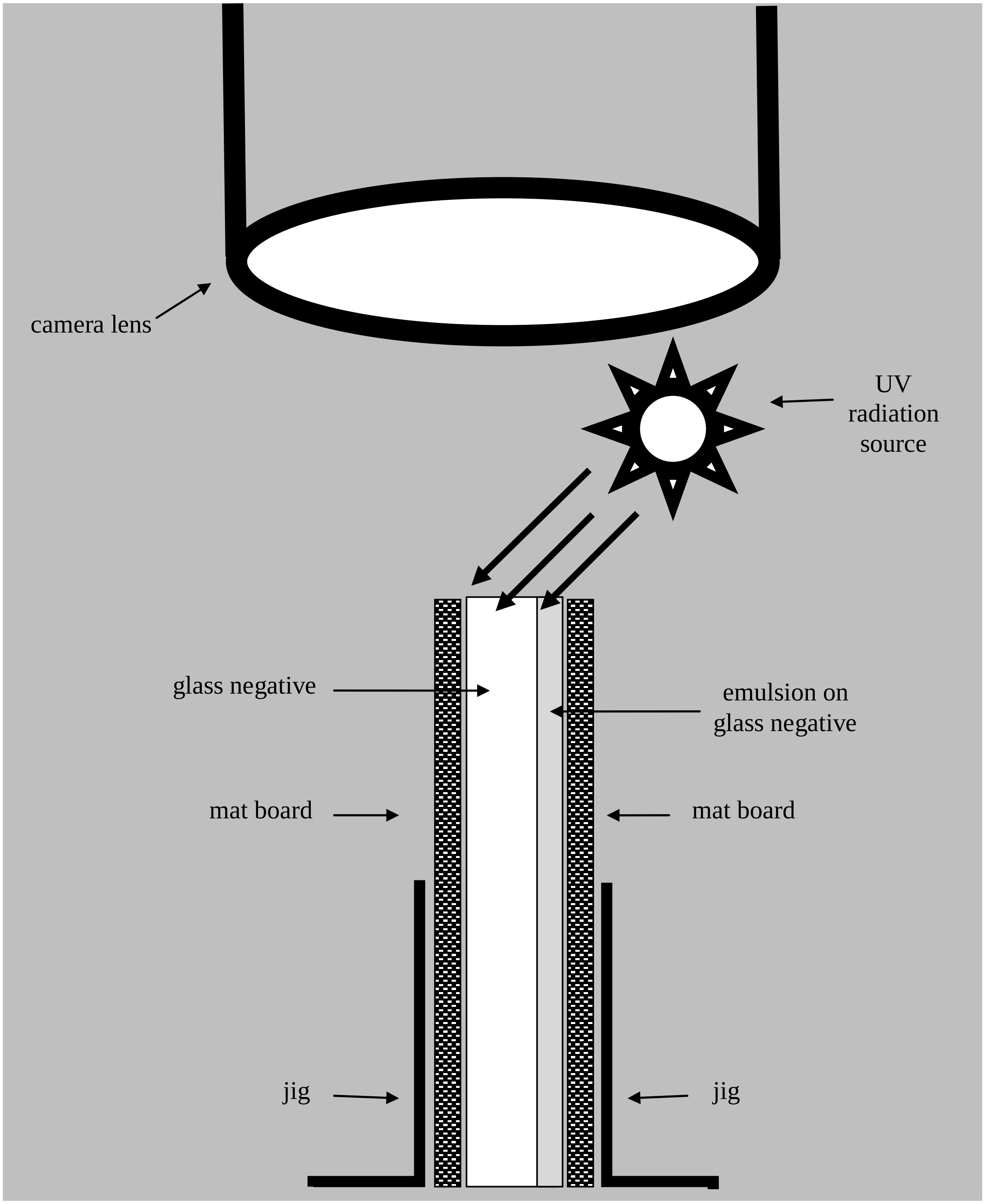


Figure 17. Setup for photographing UV visible fluorescence

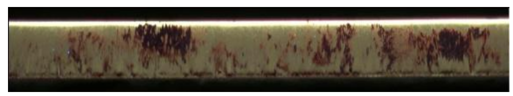
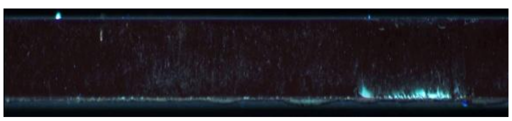
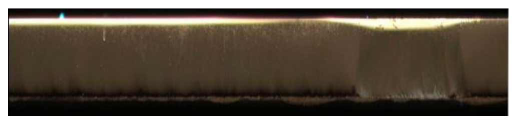
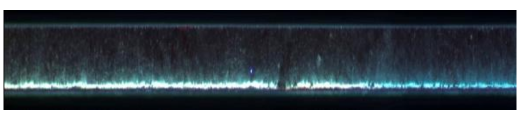
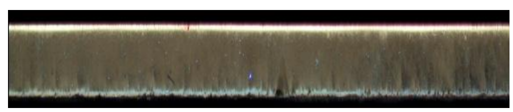
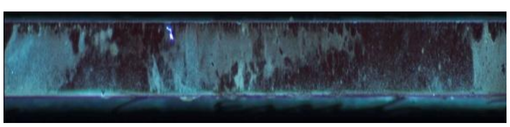
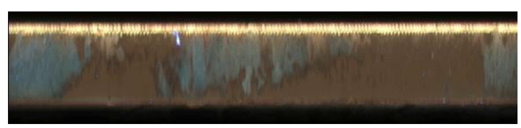
Table 8 is a tabulation of the UV analysis. The original negative number is used as an identifier. The date the negative was taken was recorded from the index card found in the card catalog. The name of the manufacturer was determined from the box the negative was removed from for analysis. Finally, any noticeable fluorescence in the glass support was recorded for each type of UV source.

Table 8. UV-A and UV-C analysis

Negative Number	**Date**	**Manufacturer**	**UV-A**	**UV-C**
31140	Aug 18, 1908	Cramer	pale yellow	orange
30402	Mar 21, 1908	Hammer	no reaction	orange
30403	Mar 21, 1908	Cramer	no reaction	orange
30565	Apr 16, 1908	Seed	no reaction	orange

Table 9 shows the actual image of the cross section under the two different UV radiation sources. When examined under UV-A, the gelatin emulsion fluoresces bright blue and the glass support appears to be non-fluorescent for three of the four negatives. Only negative 31140 appears to be a very pale yellow when interpreted by an expert analyst. All four negatives fluoresce orange under UV-C.

Table 9. Images of UV-A and UV-C visible fluorescence

Neg #	**UV-A**	**UV-C**
31140		
30402		
30403		
30565		

An additional fifty 8”x10” negatives were analyzed and a photograph of the cross-section of the reaction was taken. Tabulation of this data can be found in Appendix 5.

X-ray Fluorescence

The same four negatives in Figure 21 were examined using X-ray fluorescence. Specifications for the setup follow:

Instrument

Bruker Handheld XRF Tracer detector

Measurement

High voltage/kV: 15

Current/μA: 55

Time/s: 57

Energy range/keV: 0.0

Optic: none

Atmosphere: air

Evaluation

Corrections: escape background

Stripping cycles: 8

Elements: Al Ar Ca Cr Cu Fe K Mn Ni Pd Rh S Si Ti Zn

Deconvolution method: Bayes

In Table 10, the qualitative elemental analysis by x-ray fluorescence is tabulated for the four samples in Table 9. While an exact measurement is not possible since there are no reference samples with which to compare the results, the elemental counts can be compared to each other and a relative amount determined. The elements highlighted for negative 31140 indicate the three elements that have a significant difference when compared to the other three negatives. These elements are aluminum (Al), potassium (K), and titanium (Ti).

Table 10. X-ray fluorescence elemental analysis

Neg #	Al K12	Ca K12	Cr K12	Cu K12	Fe K12	K K12	Mn K12	Ni K12	Rh L1	S K12	Si K12	Ti K12	Zn K12
31140	358	319718	122	2671	30276	3567	1634	2469	31168	509	66377	5152	1494
30402	919	314174	118	2136	30132	8160	1328	2137	31168	456	67171	2590	1060
30403	803	313699	407	2476	30657	8007	1274	2536	31168	443	67548	2846	1385
30565	746	310815	550	2690	32157	8417	1059	2548	31168	303	66673	2879	1201

Figure 18 shows a graph of the four negatives from Table 9 and compares four different elements, potassium (K), manganese (Mn), nickel (Ni), and titanium (Ti), relatively for each negative. For example, negative 31140 has a potassium (K) level less than half of the potassium level for the other three negatives. Titanium is almost twice the level for negative 31140 than the other three negatives.

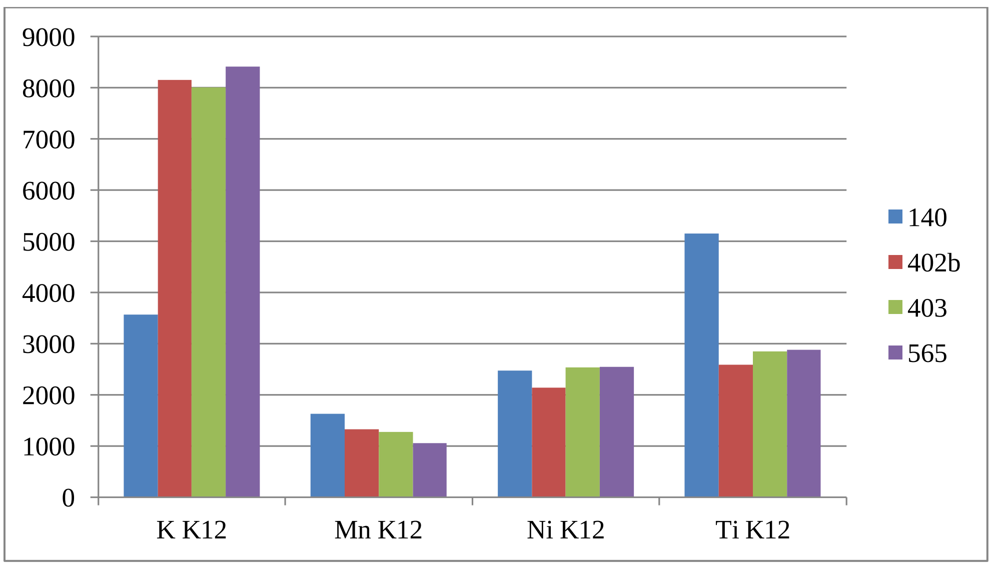


Figure 18. XRF analysis of Potassium (K), Manganese (Mn), Nickel (Ni), and Titanium (Ti)

Figure 19 shows a graph of the four negatives from Table 9 and the elemental counts for aluminum, chromium, and sulfur. While the graph appears to show discernable differences in aluminum and sulfur, statistically the difference in counts are not significant enough to be counted.

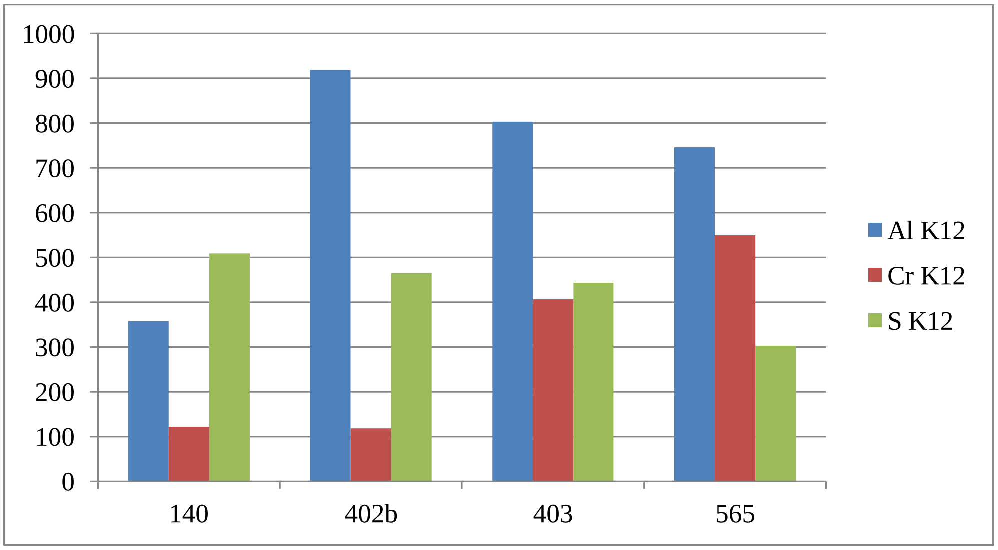


Figure 19. XRF analysis of Aluminum (Al), Chromium (Cr), and Sulfur (S)

Figure 20's graphical representation of calcium and silicon indicate almost identical amounts for the four plates from Table 9.

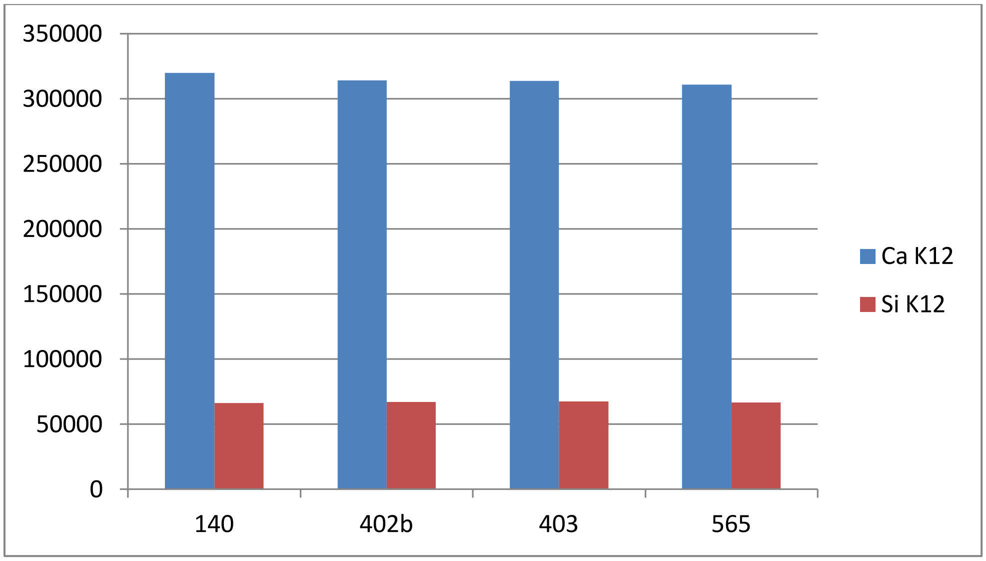


Figure 20. XRF analysis of Calcium (Ca) and Silicon (Si)

The elements copper and zinc in Figure 21 are virtually identical in count for all four plates from Table 9.

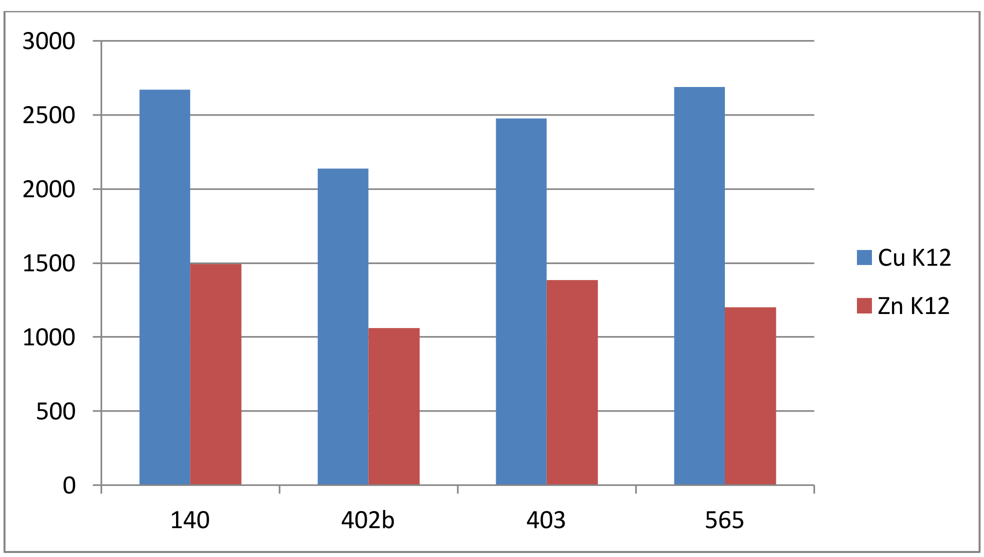


Figure 21. XRF analysis of Copper (Cu) and Zinc (Zn)

Cross-section Measurement

Using the photographs taken of the cross section of the negatives when UV analysis was performed, the image was imported into Photoshop. Figure 22 is a photograph of the cross-section of negative number 42892. The glass support is the black band in the center. The emulsion is the bright line at the bottom of the image.

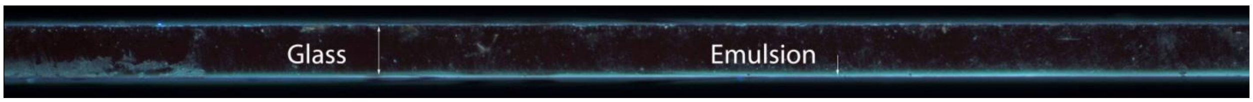


Figure 22. UV-A image of plate 42892 showing cross-section of glass and emulsion

Using three different points, the thickness of the glass and the thickness of the gelatin layer was measured for 54 negatives. The numbers were averaged and plates were ranked by size of glass and size of gelatin. The data was then analyzed to determine if the groups correspond to specific manufacturers' boxes.

Table 11 shows the averaged results of the four 5”x7” negatives from Table 9. The first column is the negative identification number. The second column is the average glass thickness in millimeters for each of the negatives. The third column is the average emulsion thickness in millimeters for each of the negatives. The results of the glass measurements for the fifty 8”x10” negatives can be found in Appendix 6. The results of the gelatin measurements for the fifty 8”x10” negatives can be found in Appendix 7.

Table 11. Glass and emulsion thickness (millimeters-mm)

Negative Number	Glass (mm)	Emulsion (mm)
31140	3.04	0.24
30402	3.68	0.27
30403	2.93	0.27
30565	4.14	0.25

Developing Methods

To determine if the brand of plate used by Beach influenced the methods he used to develop his negatives, the archives were searched for any information on the chemicals or processes he used. Documentation was digitized and can be found in the following figures. It was then compared to the standard procedures recommended by a particular manufacturer.

Figure 23 is a “recipe” for a developer from Beach’s actual journal. It is for a mixed developer of pyro-hydrochinon. Solution A is the developing agent which combines pyro, potassium bromide, and water to which is added a hydrochinon and water mixture. Solution B is the mixture for the preservative. The solution is made of sodium sulphite and water. The third solution, C, is the alkali, a mixture of potassium carbonate and water. When combined, bromide is added as the restrainer. There are two different formulas at the bottom, one for a weak developer and one for a strong developer. The only difference is the amount of solutions mixed.

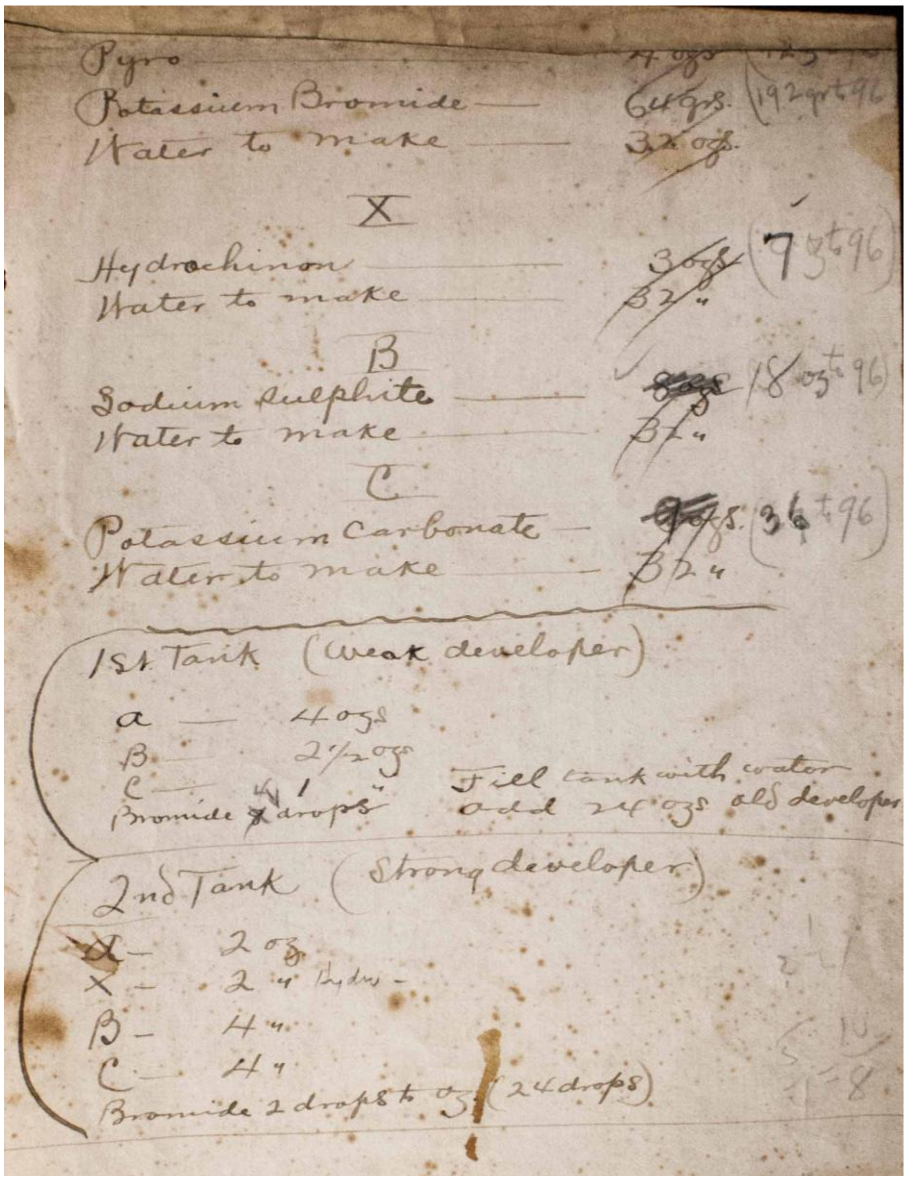

Pyro
Potassium Bromide — 64 grs. (192 grs ÷ 96)
Water to make — 32 ozs.
X
Hydrochinon — 3 ozs (7 3 ÷ 96)
Water to make — 32 "
B
Sodium Sulphite — (18 ozs ÷ 96)
Water to make — 32 "
C
Potassium Carbonate — ozs. (36 ÷ 96)
Water to make — 32 "
1st Tank (Weak developer)
a — 4 ozs
B — 2½ ozs
C — 4 "
Bromide drops
Fill tank with water add 24 ozs old developer
2nd Tank (Strong developer)
X — 2 ozs
X — 2 " hydro —
B — 4 "
C — 4 "
Bromide 2 drops to oz (24 drops)

Figure 23. Developers from Beach journal (Beach n.d.)
Source: Wiedemer – digital image of Beach Collection
Courtesy of the Giallombardo family, Buffalo, N.Y., used with permission

Figure 24 gives the "recipe" for Beach's metol-hydrochinone developer. The metol and hydrochinone are first dissolved in water. Sulphite soda solution is then added. Finally a solution of carbonate soda completes the formula. Alternative combinations are shown for various types of plates – negatives, lantern slides, under exposed negatives.

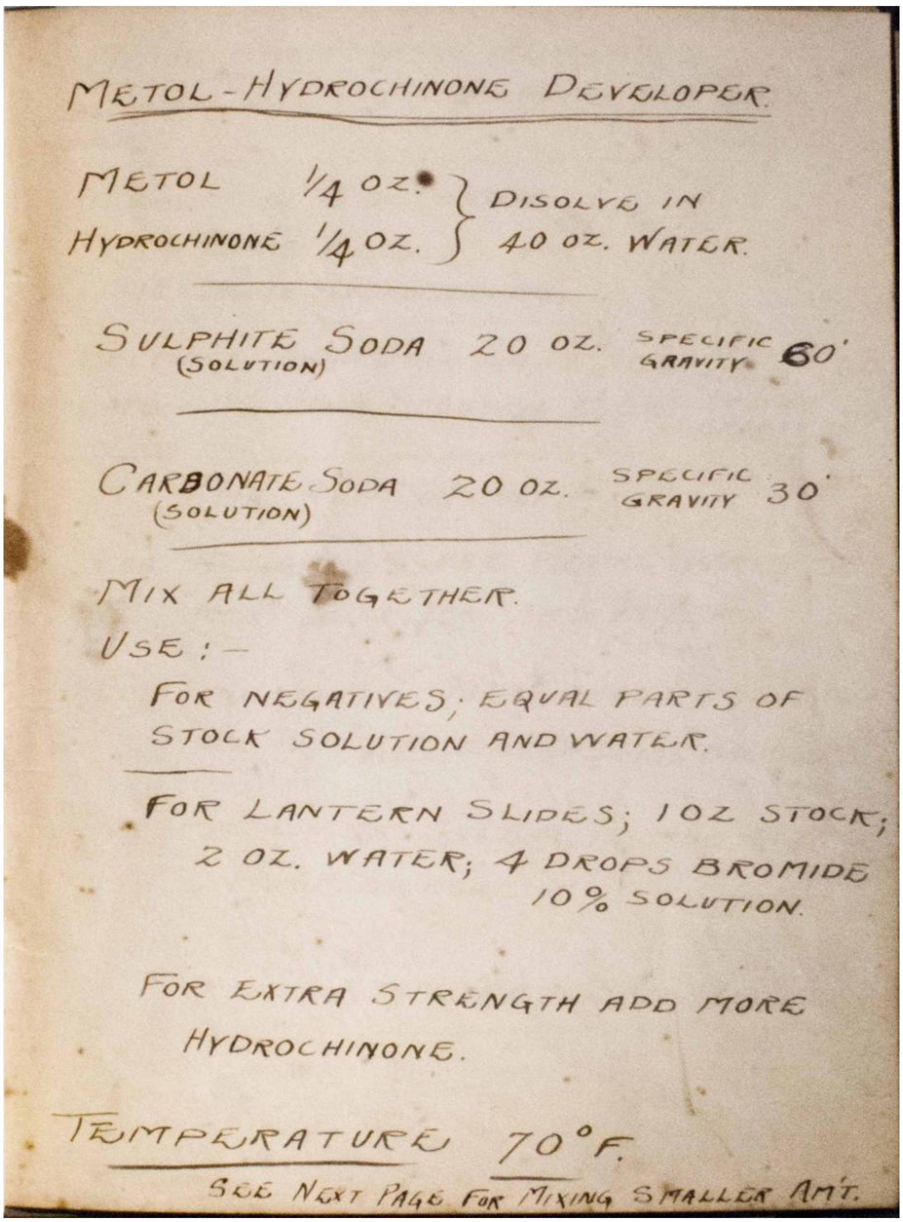


Figure 24. Metol-hydrochinone developer from Beach journal (Beach n.d.)
Source: Wiedemer – digital image of Beach Collection
Courtesy of the Giallombardo family, Buffalo, N.Y., used with permission

Figure 25 is the same developer as Figure 24, but is for a smaller stock solution.

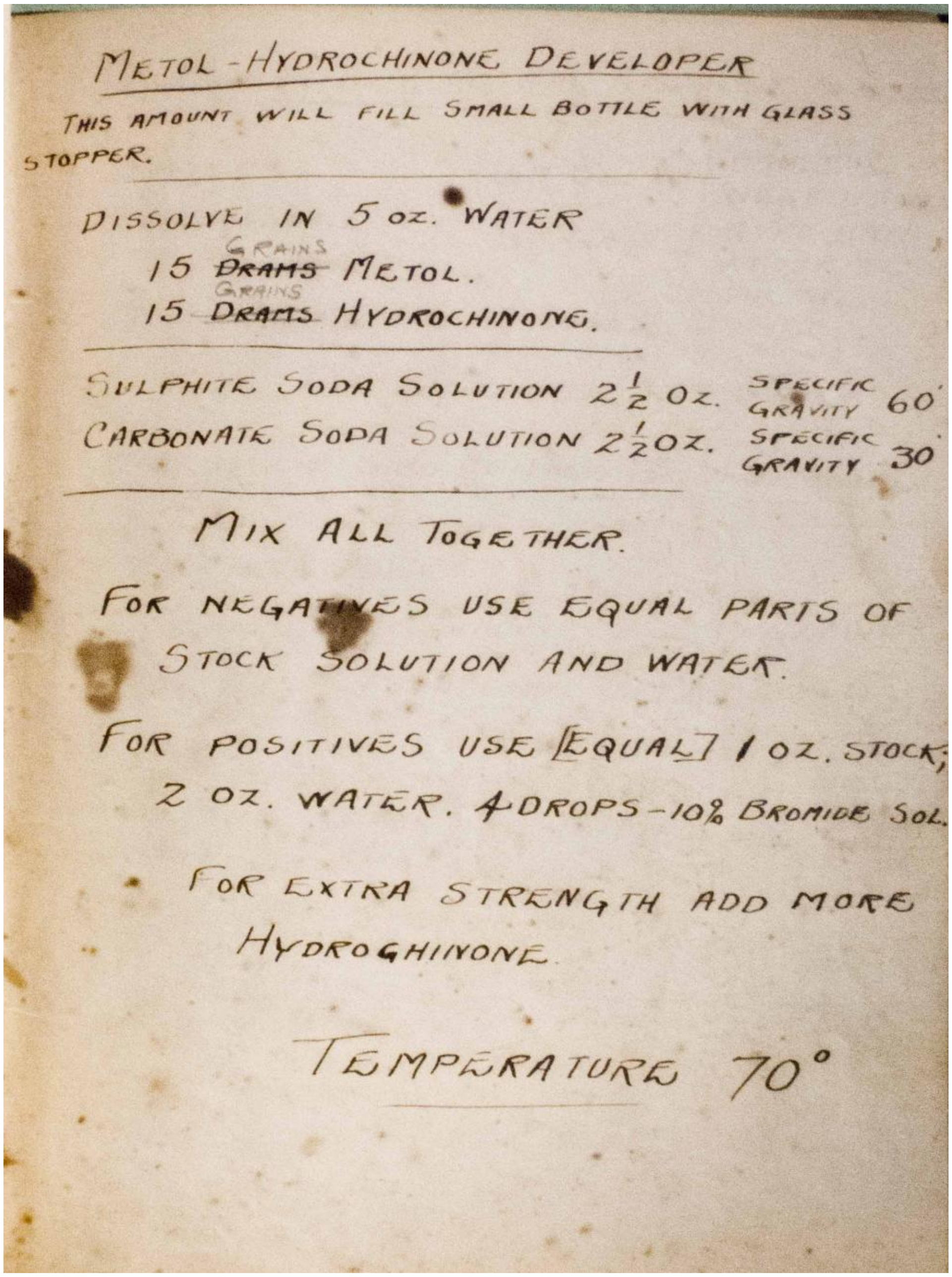
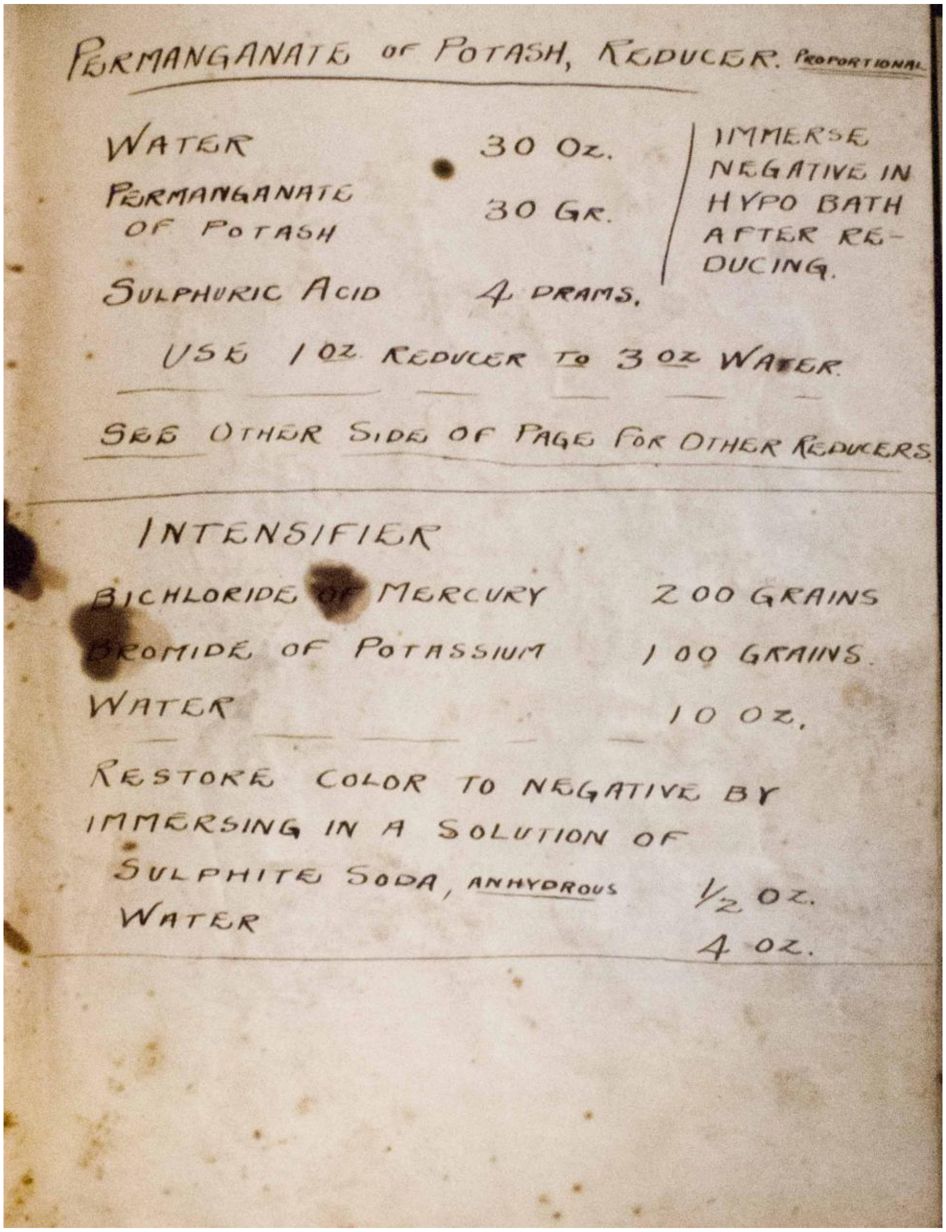


Figure 25. Metol-hydrochinone developer small amount from Beach journal (Beach n.d.)
Source: Wiedemer – digital image of Beach Collection
Courtesy of the Giallombardo family, Buffalo, N.Y., used with permission

Figure 26 gives Beach's formula for permanganate of potash reducer and a bichloride of mercury-bromide of potassium intensifier. A reducer is commonly used to decrease the contrast of a negative (*Kodakery* 1920, 12). An intensifier brings out details in the shadows (Lock 1903, 194-195).



PERMANGANATE OF POTASH, REDUCER. PROPORTIONAL

WATER 30 OZ.
PERMANGANATE OF POTASH 30 GR.
SULPHURIC ACID 4 DRAMS.

IMMERSE NEGATIVE IN HYPO BATH AFTER REDUCING.

USE 1 OZ REDUCER TO 3 OZ WATER

SEE OTHER SIDE OF PAGE FOR OTHER REDUCERS

INTENSIFIER

BICHLORIDE OF MERCURY 200 GRAINS
BROMIDE OF POTASSIUM 100 GRAINS.
WATER 10 OZ.

RESTORE COLOR TO NEGATIVE BY IMMERSING IN A SOLUTION OF
SULPHITE SODA, ANHYDROUS 1/2 OZ.
WATER 4 OZ.

Figure 26. Permanganate of potash reducer from Beach journal (Beach n.d.)
Source: Wiedemer – digital image of Beach Collection
Courtesy of the Giallombardo family, Buffalo, N.Y., used with permission

Figure 27 gives a formula for a soft developer. A mixture of Elon (a metol developer from Kodak), sulphite, carbonate of potash, bromide of potash, and water.

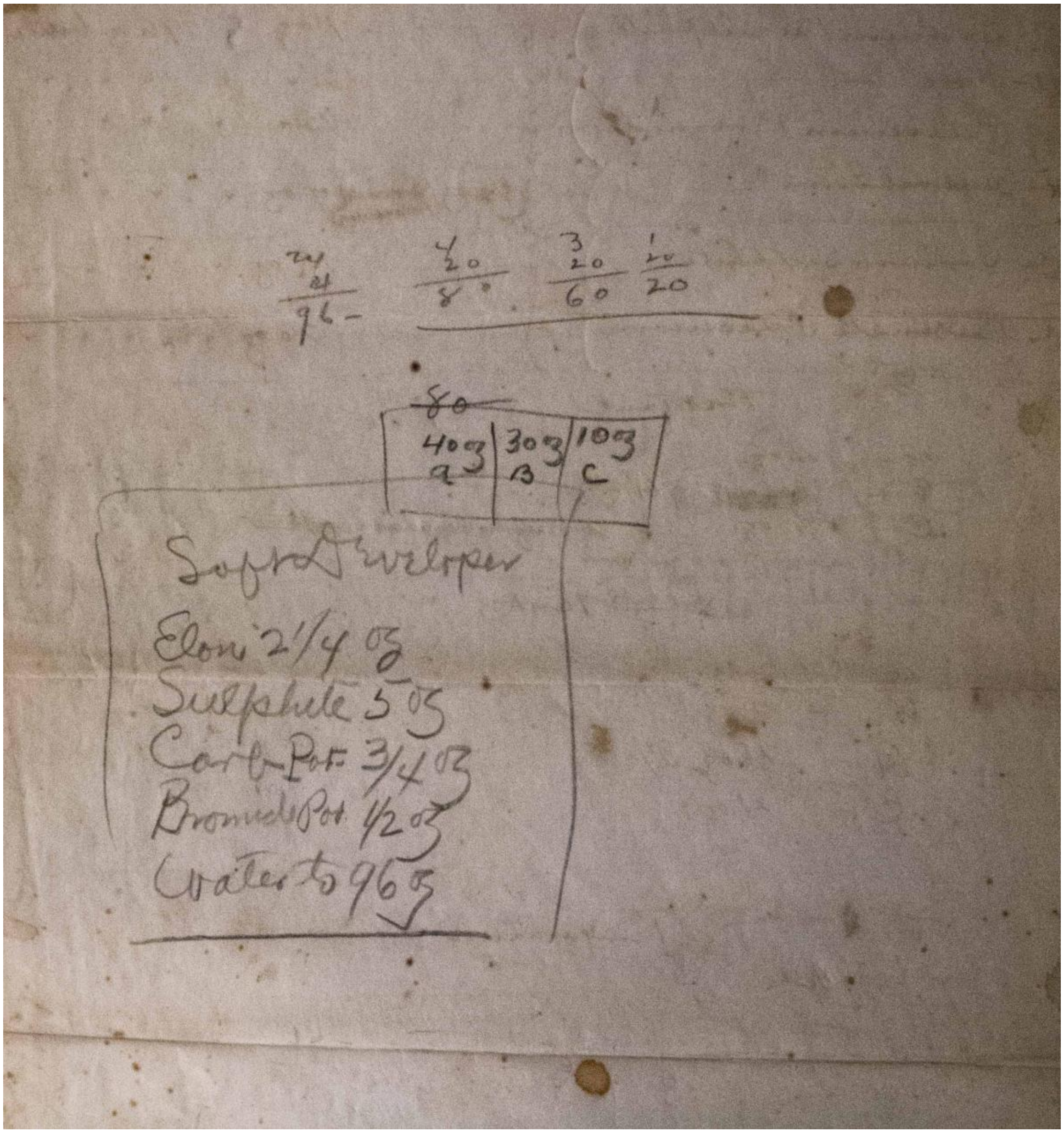

Soft Developer
Elon 2 1/4 oz
Sulphite 5 oz
Carb Pot. 3/4 oz
Bromide Pot. 1/2 oz
Water to 96 oz

Figure 27. Soft developer from Beach journal (Beach n.d.)
Source: Wiedemer – digital image of Beach Collection
Courtesy of the Giallombardo family, Buffalo, N.Y., used with permission

Figure 28 is the formula from Beach's journal for a hypo bath which is used to stop the action of the developer.

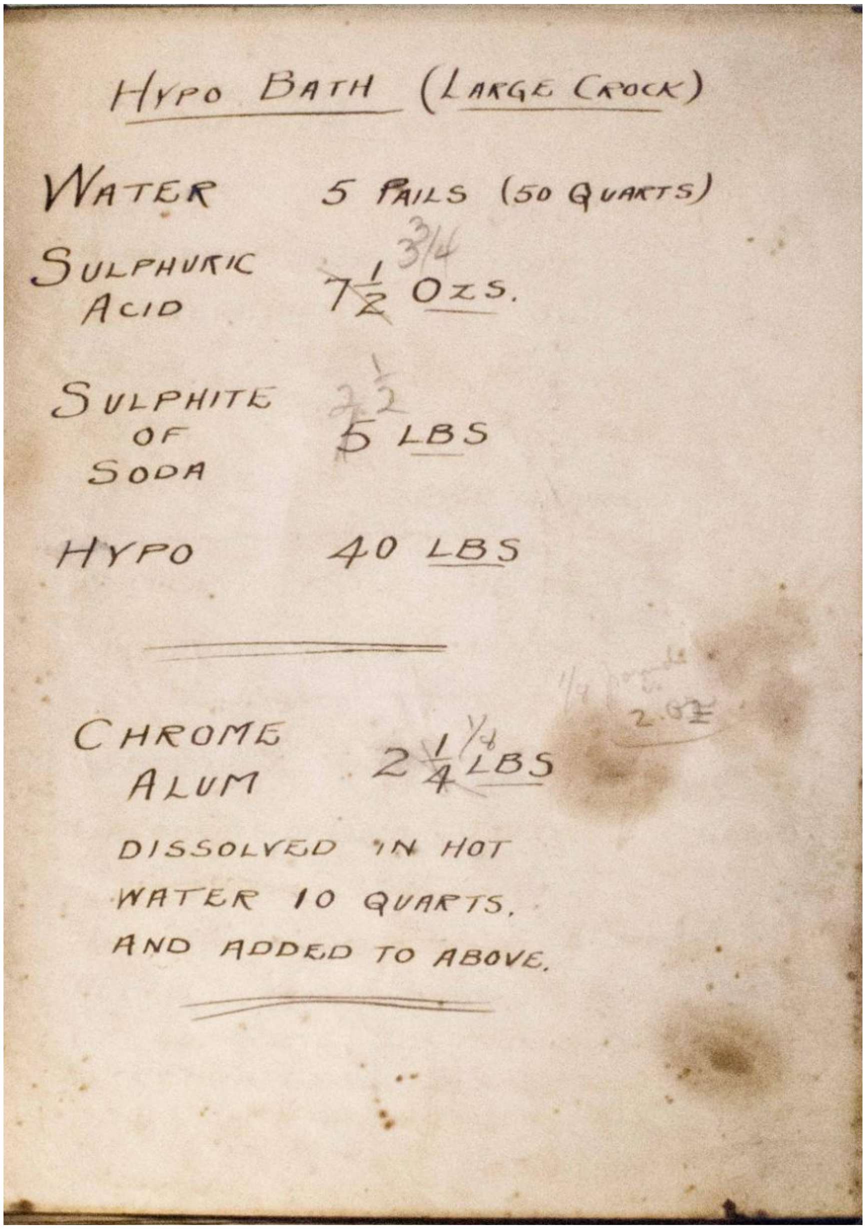
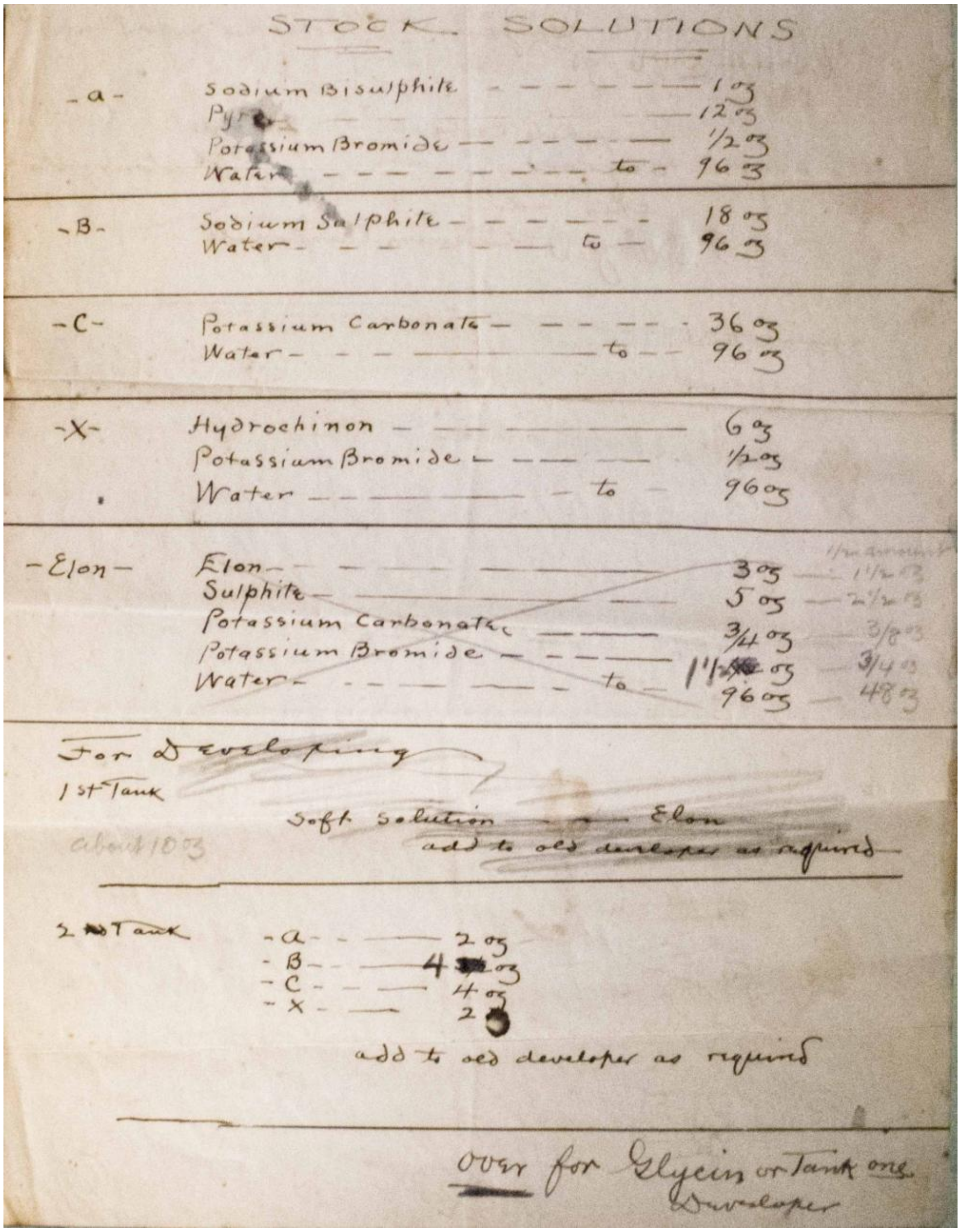


Figure 28. Hypo bath from Beach journal (Beach n.d.)
Source: Wiedemer – digital image of Beach Collection
Courtesy of the Giallombardo family, Buffalo, N.Y., used with permission

Figure 29 gives the recipe for an Elon-hydrochinon developer. This developer is mixed using four separate solutions.



STOCK SOLUTIONS

-a-	Sodium Bisulphite		1 oz
	Pyro		12 oz
	Potassium Bromide		1/2 oz
	Water	to	96 oz
-B-	Sodium Sulphite		18 oz
	Water	to	96 oz
-C-	Potassium Carbonate		36 oz
	Water	to	96 oz
-X-	Hydrochinon		6 oz
	Potassium Bromide		1/2 oz
	Water	to	96 oz

				1/2 amount
-Elon-	Elon		3 oz	1 1/2 oz
	Sulphite		5 oz	2 1/2 oz
	Potassium Carbonate		3/4 oz	3/8 oz
	Potassium Bromide		1 1/2 oz	3/4 oz
	Water	to	96 oz	48 oz

For Developing

1st Tank

Soft solution — Elon

about 10 oz

add to old developer as required

2nd Tank

-a- 2 oz

-B- 4 oz

-C- 4 oz

-X- 2 oz

add to old developer as required

Over for Glycin or Tank one Developer

Figure 29. Stock solutions for Elon-hydrochinon developer from Beach's journal (Beach n.d.)
Source: Wiedemer – digital image of Beach Collection
Courtesy of the Giallombardo family, Buffalo, N.Y., used with permission

Limitations of Study

Although most of the glass plates are housed in original manufacturer boxes, it cannot be assumed that after exposure and processing, they were returned to the same box. Many of the boxes have the box top from one manufacturer and the box bottom from another. Noticeable differences during visual examination, such as thickness of the glass support and thickness of the emulsion layer, of the negatives from the same box suggest that each box does not contain a homogeneous group of negatives.

The UV and XRF analysis was limited to qualitative analysis because there are no certified reference standards (CRS) available. Many of the manufacturers kept their recipes top secret; consequently, there are no records to compare elemental analysis or glass manufacturers.

Because the negatives are considered a cultural heritage material, there are limitations to the types of analyses that can be conducted on the samples. While certain analytical methods may be better than others for obtaining the desired information, any type of destructive analysis must be eliminated.

Finally, because the research was conducted by an unpaid intern at a museum with limited research funds, analyses were limited to methods that could be provided at no cost by the SUNY Buffalo State's Art Conservation Department.

CHAPTER 5: CONCLUSION

This paper serves to explore the results of the pilot study of the Beach Collection. The survey of the original manufacturer's boxes reveals the preferred brand of plates used by the Beach Studio. Various physical and chemical properties of the gelatin dry plate negatives were compared with anecdotal and often contradictory evidence from the literature to determine if they conform to the "standards" and if they can be identified by certain manufacturers' characteristics. By combing through Beach's studio journal for evidence of his preferred chemical solutions when developing the negatives, ample clues that lead to an understanding of Beach's photographic working methods were provided. A wealth of data was discovered and used to compare to the industry standards.

Answers to numerous questions are sought in conducting the research necessary to grasp a somewhat complex and often contradictory story. What brands of dry plates did Beach use for his portraits? Do they have different characteristics? Can the characteristics mentioned in the literature be measured with any degree of accuracy? Can the characteristics be used to identify a specific manufacturer? Why may Beach have preferred one brand over another? How did it affect his working methods?

Survey of Manufacturer Boxes

Which was the manufacturer of dry plates preferred by the Beach Studio?

The survey of 765 or 2.5% of the total number of original manufacturer boxes indicates there are six manufacturers represented in the collection: Cramer Dry Plate Company, Eastman Dry Plate Company, Hammer Dry Plate Company, M.A. Seed Dry Plate Company, Stanley Dry Plate Company, and Wratten & Wainwright Dry Plate Company. Of the six manufacturers represented, the survey establishes that Beach overwhelmingly preferred negatives from the Hammer Dry Plate Company or an estimated 79% of the collection, followed by Cramer at 14% and M.A. Seed at 7%. The tallies for Eastman, Stanley, and Wratten & Wainwright were negligible since they were less than 1% of the total surveyed boxes. The manufacturer of one box of negatives could not be determined since the top was Hammer and the bottom was M.A. Seed and is labeled “unknown”.

When the data is sorted further by size, 5” x 7” versus 8” x 10”, the tally yields almost identical results to the total number surveyed. Of the total 765 boxes surveyed, 725 were 5” x 7” and 40 boxes were 8” x 10”. The Hammer Dry Plates are the negative of choice for both the 5” x 7” and 8” x 10” plates. Only three manufacturers were represented in the 5” x 7” tally, Cramer, Hammer, and M.A. Seed, and were of the same ratio as above – 79% Hammer, 14% Cramer, and 7% Seed. Five manufacturers were found in the 8” x10” tally with the following percents in order of most favored to least favored: 83% Hammer, 8% Cramer, 5% Stanley, and a tie of 3% for Eastman and Wratten & Wainwright respectively. It can be concluded that the Beach Studio preferred to use the Hammer dry plates regardless of the size of the negative.

Which brand of negatives was preferred by the Beach Studio?

Surveying 2.5% of the boxes in the collection provided the answer to the question of which was the preferred brand of negative. Brands represented in the survey are as follows:

Table 12: Brands in the collection by percent total

Manufacturer	**Brand**	**% of Total**
Cramer	Crown	11%
Cramer	Hi Speed	<1%
Cramer	Isochromatic	<1%
Eastman	Panchromatic	<1%
Hammer	Slow	1%
Hammer	Special	57%
M.A. Seed	26	2%
Wratten & Wainwright	Panchromatic	<1%
Unknown	Unknown	28%

The survey indicates that the majority of original manufacturer boxes were for the Hammer "Special" brand. The 28% of boxes of unknown manufacturer and brand were either too damaged from deterioration or had lost the label which would have confirmed the brand. Breaking out the data for the 5" x 7" and 8" x 10" negatives, Hammer "Special" again had the most number of boxes with 56% and 83% respectively. It can be concluded from the data that Hammer "Special" was the preferred brand overall.

What are the characteristics of the brand chosen by Beach and why might he have chosen that particular brand? Was cost a factor in his choice?

Beach's favorite plate seems to be the Hammer "Special" brand. According to the literature, it is an exceptionally rapid plate with a fine grain, especially useful in low light situations with subjects that are prone to movement (Schriever 1909, 295). While the terms "rapid plate" and "fine grain" appear to be contradictory, it is possible it can be attributed to simple advertising by the company in order to draw more customers. "Fine grain" also suggests that the grain was "fine enough" for portrait work and was not necessarily a comparison of actual grain size. Beach was a portrait photographer who mainly used his studio for his sittings. The city of Buffalo is not known for its numerous days of continuous sunshine, especially in the winter months. Even with electric lighting to illuminate the sitter, an extremely light sensitive plate with a large grain would have been necessary in order to capture the enough details in both the highlights and the shadows.

Beach's clients were primarily adults, children, and sometimes animals, many of whom are subject to sudden or unexpected movement. Consequently, he would have needed a plate that would almost quickly capture the sitter and freeze their image. A rapid plate that could shorten the exposure time and record the image almost instantaneously would be a huge benefit to the photographer.

The cost of the plates appears to have been immaterial in Beach's choice of brands since all of the manufacturers made an agreement to sell their products at the same price (Taylor 1883, 308). This suggests that the numerous other choices and considerations, such as plate speed, developing speed, and silver grain, were the deciding factors when presented to the professional photographer who was operating a portrait studio. Consequently, the Hammer "Special" brand appears to be an ideal selection to capture the images of the Beach Studio's clientele.

Visual Examination

Can different manufacturers of gelatin dry plates be distinguished from one another using visual analysis?

Visual examination of the plate during cleaning and re-housing showed two distinct variations. The first was a difference in the plate thickness. The plate was determined to be either thick (Hammer, Seed) or thin (Cramer) when compared to the other three plates. There is no literature that indicates the thickness of a manufacturer's plate that combines the glass support and the emulsion. In addition, the sample size was extremely small being only four samples. Consequently, the data was inconclusive for determining manufacturers based on relative thickness.

The second difference was noted on the edges of the negative. Two plates were plain (Hammer and one Cramer), one had red edges on all four sides (the other Cramer), and one had red on the bottom edge (Seed). Additional analysis, tabulated in Appendix3 and Appendix 4, presents similar results. There does not appear to be a direct correspondence between the color of the edges and a certain manufacturer or brand. There is nothing in the literature review that indicates the manufacturer painted or added a red color to the edges of the plates. However, the red color appears to be the same paint used by the photographer to mask sections of the face of the plate. Therefore, it was determined that the red edges cannot be used as a characteristic to distinguish differences in the manufacturers. Overall, visual examination was inconclusive for determining differences in manufacturer characteristics. Research into why the photographer may have added the paint can be conducted in future work.

Scientific Analysis

Can scientific analysis be used to determine different characteristics in the dry plates?

Ultraviolet Radiation Induced Visible Fluorescence

Ultraviolet (UV) radiation induced visible fluorescence was used to examine the glass support of the negatives. The glass may fluoresce differently if there is a significant elemental difference in the composition of the glass. Four 5” x 7” negatives and fifty 8” x 10” negatives were selected for analysis. Of the fifty-four negatives, only negative 31140 showed a slight pale yellow fluorescence. The other fifty-three negatives do not show significant fluorescence at all when irradiated with UV-A. All the negatives show a similar orange fluorescence under UV-C. The range of orange tones is not significant enough to conclude confidently that they are different in composition.

Based on this data, several conclusions can be postulated. Either all of the glass is identical in composition except for negative 31140, or the elements that are unique to each glass sample do not fluoresce differently. It is also possible that plate 31140 was contaminated or the negative was not cleaned enough and the remaining contaminant fluoresces a different color. Any coating added by the photographer, such as the red edges seen under visual examination, may also affect the final fluorescent result.

At this time, ultraviolet analysis of the glass support of the negatives appears to be inconclusive when used as the sole analysis for determining a unique characteristic for a specific manufacturer.

X-ray Fluorescence Analysis

X-ray fluorescence (XRF) analysis was used to examine the elemental composition of the glass support for the four 5” x 7” negatives examined under ultraviolet analysis. Of the four negatives, three showed similar elemental composition while negative 31140 showed a lower count for aluminum (Al) and potassium (K) and a higher count for titanium (Ti) than the other three.

While the data may appear to present a conclusive elemental difference in negative 31140, there is a difference of opinion between two experts in the data interpretation. The first expert argues that the difference in the counts is significant enough to be recognized as a legitimate difference. The second expert counter argues that the difference in counts is not significant enough to be treated as such.

Several conclusions can be made when weighing the opinions of the experts. If the elemental counts are significantly different, the XRF analysis supports the UV findings in that negative 31140 appears to have a different glass support than the other three. If the XRF counts are not significantly different, then XRF would not be a good analytical method in defining a measurable characteristic of a specific manufacturer. Consequently, the XRF results for these four samples are inconclusive at this time.

Cross-section Analysis

The cross-section images recorded under UV analysis were used to measure the average thickness of the negative’s glass support and emulsion layer. Literature suggests that Hammer plates have a thinner emulsion coating and Cramer plates have a much thicker coating with Seed somewhere in between. Glass plates should be approximately 2 mm thick with the emulsion about 1/10th or 0.2 mm.

Examination of the data for the four 5” x 7” negatives analyzed under UV and XRF all have a thicker glass support ranging from 2.93 mm to 4.14 mm. The emulsion thickness ranges from 0.24 mm to 0.27 mm which is slightly less than 1/10th of the glass layer. Looking at the emulsion layer by manufacturer, the two Cramer plates have the thinnest (0.24 mm) and the thickest (0.27 mm) emulsion. Hammer also has one of the thickest (0.27 mm) emulsions. This data does not conform to the literature review.

Further examination of the data for the 8” x 10” negatives found in Appendix 4 and Appendix 5 presents a rather significant range of 2.43 mm to 4.03 mm for the glass support and 0.05 mm to 0.79 mm for the emulsion layer. Comparison of data for a specific manufacturer suggests that there is no discernible correlation between the thickness of the glass support and manufacturer nor is there a discernible correlation between emulsion thickness and manufacturer.

Several conclusions can be reached for this data. If the manufacturer changed glass manufacturers and the new supplier provided a plate of different thickness, then the thickness of the glass support cannot be used as an identifying characteristic for a specific manufacturer. The range of thickness of the emulsion layer may indicate a difference in coating the plate, however, if the identification of a negative’s manufacturer is based on the original box and the box does not contain a homogeneous group of negatives from the same manufacturer, the emulsion will be attributed to a manufacturer erroneously. While there is a measureable difference in both the glass support and the emulsion layer of the dry plates, no concrete correlation can be made at this time.

Overall there are measureable differences using scientific analysis. However, correlation between these differences and specific manufacturers is inconclusive. Therefore, these analyses cannot be used to identify the individual manufacturers at this time. Suggestions for further research can be found in the future work section below.

Review of Beach's Journal for Developer Recipes

Did Beach have a preferred developer and how does it compare to the recommendations from the manufacturer of the dry plate?

Beach's journal has recipes for four different developers: pyro-hydrochinone, metol-hydrochinone, Elon (metol), and pyro-hydrochinone-Elon (metol). As these four were written down out of the hundreds of choices available, it can be theorized that these were his developers of choice since the journal gave him ready access to the formulas.

The Elon or metol developer (Elon was Kodak's trade name for metol) is a very fast developer. It gives good density to the negative, can be used multiple times without rapidly losing its effectiveness, but is a known health hazard since the photographer often develops dermatitis from the chemical coming in contact with the hands (Leiblinger 1905, 169). The ability to use a solution over and over for the development of multiple plates and process them quickly would be a very attractive choice for a busy studio that was processing an average of five plates a day, including the sitting itself and the printing of the final photograph (Appendix 8).

Metol-hydrochinone is a common mixed developer. The metol brings out the detail in the negative first before the density, while the hydrochinone brings the density first and the detail afterward. The combination of the two chemicals results in a well-detailed, moderately dense negative with a relatively short development time (Jones 1912, 170). The emphasis again appears to be on the development time of the chemical suggesting this may have played a significant role in Beach's choice of developers.

The pyro-hydrochinone developer is an unusual mixture. Both chemicals place emphasis on the density of the negative before the detail. The journal notes formulas for a "weak developer" – more pyro, less hydrochinone, sodium sulphite, potassium carbonate, and bromide – and a "strong developer" – equal parts pyro and hydrochinone, and more sodium sulphite, potassium carbonate, and bromide. Weak developers tend toward finer detail and tonal gradation while strong developers give greater density and high contrast. Depending on the subject matter being photographed (portraits versus copy work), being able to use the same chemicals on hand and produce very different outcomes in the final image without having to keep a different set of chemicals in house would have been very beneficial.

Finally, the pyro-hydrochinone-Elon developer may be Beach's own formula. His familiarity with chemistry can be seen in the various reference books in the collection. The 1888 *Pharmaceutical Chemistry* by F.P. Vandenbergh is one of several references in the collection. The pyro-hydrochinone-Elon developer appears to be an identical solution to the pyro-hydrochinone developer with the addition of Elon. It would most likely produce similar results to the metol-hydrochinone developer above with the added benefit of easily creating a weak or strong developer. Again, this seems to be a very good choice of developers for a busy professional studio.

When comparing Beach's preferred developers with the ones recommended by Hammer and Cramer, they do not align with the suggested chemicals. Hammer advises using a pyro-soda developer while Cramer suggest pyro-acetone, pyro, or edinol. It can be posed that artistic license and probably a great deal of experimentation led to the developers of choice for the Beach Studio.

Summary of Contributions Thesis has Made

The research conducted for this paper has been invaluable in the exploration and understanding of Beach's photographic working methods and that of his studio. The collection, when examined in its entirety, proves to be extremely rare. Most collections of a similar nature have the dry plate negatives and perhaps, based on labeling of the enclosures or other similar documentation, the owner may have an indication of the person in the image. Very seldom does a collection include a complete card catalog, business records, yearly ledgers spanning the business' operation, and correspondence with clients, suppliers, and other professionals.

The importance of Beach's contribution to the history of the Buffalo area is undeniable. As a premier portrait photographer, Beach captured images of the elite, the movers and shakers of Buffalo's hey day at the turn of the 20th century. Beach had connections throughout the country through the professional photography organizations of which he was a member (Fraprie 1914, 252; *Photographers' Association News* 1920, 67). As an entrepreneur his contribution to the technical aspects of photography are represented by his mastery of the function of the lens and the light. By examining his choice of materials and his preferences when creating his craft, this research begins the initial exploration of the man and his technical work.

The survey of manufacturers used by the studio helps to broaden the understanding that Eastman and therefore Kodak was not the only player in the gelatin dry plate game. Propelling the information about these other manufacturers into the forefront of the discussion of this collection fills in a gap that only seems to be widening as time and distance intervene. The research presents an alternative history of photography that expands knowledge of the key players. By Establishing Beach's preferences firmly cements Hammer, Cramer, and Seed in the annals of photographic dry plate history.

Analyzing the physical and chemical characteristics of the different brands of dry plates begins to establish a basis for a set of standards for future reference. Lack of existing standards is a detriment to establishing a complete history of dry plates. Testing existing plates and probing the literature for references is an exhausting but worthwhile endeavor.

Finally, exploring the supporting documents in the collection promotes an understanding of numerous aspects related to a professional photography studio. Developing solutions, negative suppliers, and the photographer's varied and vast experience all lead to painting a vivid and enlightening picture of a man in pursuit of a dynamic career at a prolific time in photographic history.

Prospect of Future Work

The examination of the Beach collection is still firmly planted in its infancy. Much work needs to be done in organizing the supporting documentation for easier access for future research. The continuation of the tally of manufacturers represented in the collection and further exploration of the data would be a worthwhile endeavor. Sorting the manufacturers by date and comparing the results with a timeline of world events may reveal issues with suppliers of the raw material based on wars or tariffs. It may also show a changing preference throughout the history of the studio as new products came on the market. Including additional plate sizes in the tally may suggest the preference for a different brand of plates for different types of work, portrait versus copy work for example.

Continuing the scientific analysis of the glass plates would be a tremendous help in establishing a set of standards from a known and well documented collection. Expanding the assay to include a much larger subset of the collection, utilizing additional chemical and physical resources at Buffalo State College, and broadening the scope to include the organic components in the gelatin using non-destructive analysis would be a huge step forward in differentiating the various manufacturers' processes.

Examining and comparing the various working methods of the four different photographers in the studio and placing them and their choices contextually in a timeline of world events would be invaluable in understanding some of the seemingly contradictory or non-intuitive decisions. Any of these projects would promote a better understanding of both the collection and gelatin dry plates as a whole.

The intention of this paper was to begin to establish an understanding of Beach's working methods and those of his studio. Attempting to contextualize Beach's decisions in this regard and grasp how his choices may have been influenced by world events as well as how he influenced his choices helps researchers comprehend Beach as a craftsman, an artist, and a commercial photographer.

REFERENCES

Ackerman, Carl W. 1930. *George Eastman: Founder of Kodak and the Photography Business*. Washington, DC: Beard Books.

Adams, W. I. Lincoln, and Clarence L. Usher, eds. 1910. Obituary: E. F. Hall. *The Photographic Times* 42 (January): 196.

Averill, Bruce, and Patricia Eldredge. 2007. Atomic Spectra and Models of the Atom. *General Chemistry: Principles, Patterns, and Applications*. Upper Saddle River, NJ: Prentice Hall, Inc.

Bannon, Anthony. 1981. *The Photo-Pictorialists of Buffalo*. Buffalo, N.Y.: Media Study.

Barnes, Julius H. 1924. America's Industrial Production Methods. *The American Economic Review* 14, no. 1 (March).

Bartlett, Frank V., ed. 1922. The Late Andrew Simson: Buffalo's Oldest Photographer. *Bulletin of Photography* 30 (February 8): 168.

Beach, Frederick Converse, ed. 1904. Photography. *The Encyclopedia Americana* 12. New York, NY: The Americana Company.

Beach, Howard D. n.d. Journal.

Beach, Howard D. 1909. Professional Photographers' Society of New York, Buffalo Section Number Six. *Professional and Amateur Photographer* 14, no. 3 (March).

Bernier, Brenda, and Ross Harvey. 2014. Photographic Materials. *The Preservation Management Handbook: A 21st Century Guide for Libraries, Archives, and Museums*. Ross Harvey and Martha R. Mahard, eds. Washington, DC: Rowman & Littlefield.

Bray, Thomas J. 1897. *Photomicrography: Transactions of the American Microscopical Society*.

Brayer, Elizabeth. 2006. *George Eastman: A Biography*. Rochester, NY: University of Rochester Press.

Carrère, John, and Thomas Hastings. 1910. *The Architectural Record* (January): 352

Chambers, Frank V., ed. 1916. *The Camera* 20. Philadelphia, PA: The Camera Publishing Company.

Chandler, Charles F., ed. 1902. The Success of the Photographic Dry Plate. *The Photographic Times-Bulletin* 34 (January): 42.

Cramer Dry Plate & Film Company. 2013. *Business Profiles*. http://businessprofiles.com/details/the-cramer-dry-plate-film-company/OH-266634. (accessed December 3, 2013).

Cramer Dry Plate Co. 21st Edition. n.d.a. *Cramer's Manual on Negative Making and Formulas, 21st Edition*. St Louis, MO: G. Cramer Dry Plate Co.

Cramer Dry Plate Works 2nd Edition n.d.b. *Cramer's Lightning Gelatine Plates*. St Louis, MO: G. Cramer Dry Plate Works.

Danzing, Rachel. 1999. Obtaining Photographic Grade Gelatin. *Topics in Photographic Preservation*. Washington, DC: American Institute for Conservation of Historic and Artistic Works.

Dawn's Early Light: The First 50 Years of American Photography. 2011. *Cornell University Library*. http://rmc.library.cornell.edu/DawnsEarlyLight/exhibition/processes/collodion_neg.html. (accessed on April 27, 2014).

De La Merced, Michael J. 2012. Eastman Kodak Files for Bankruptcy. *The New York Times*.

Eastman Dry Plate and Film Company. 1886. *Illustrated Catalogue and Price List of the Eastman Dry Plate and Film Company*. Rochester, NY: The Eastman Dry Plate and Film Company.

Eastman Kodak Company. 1921. *Elementary Photographic Chemistry*. Rochester, NY: Eastman Kodak Company.

Eder, J. M. 1881. *Modern Dry Plates; or, Emulsion Photography*. New York, NY: E. &. H. T. Anthony & Co.

Fisk, Catherine. 2009. *Working Knowledge: Employee Innovations and the Rise of Corporate Intellectual Property, 1800-1930.* Chapel Hill, NC: The University of North Carolina Press.

Francis Edgar Stanley. 2005. *infoplease*. http://www.infoplease.com/ipa/A0772568.html. (accessed on December 3, 2013).

Fraprie, Frank Roy, ed. 1914. *American Photography* 8, (January-December).

Frederick Charles Luther Wratten. 2012. *Historic Camera*. http://historiccamera.com/cgi-bin/librarium2/pm.cgi?action=app_display&app=datasheet&app_id=2239&. (accessed on April 27, 2014).

French, Wilfred A., ed. 1912. Our Illustrations. *Photo-Era: The American Journal of Photography* 29, (September).

French, Wilfred A., ed. 1915. Our Illustrations. *Photo-Era: The American Journal of Photography* 34, no.3 (March).

G Cramer Dry Plate Company. 2013. *Business Profiles*. http://businessprofiles.com/details/g-cramer-dry-plate-company/US-MO-00010177. (accessed on December 3, 2013).

George Eastman. n.d. *Kodak*. http://www.kodak.com/ek/US/en/Our_Company/History_of_Kodak/George_Eastman.htm. (accessed April 27, 2014).

Gidley, Mick. 1994. Pictorialist Elements in Edward S. Curtis's Photographic Representation of American Indians. *The Yearbook of English Studies* 24, Ethnicity and Representation in American Literature.

GMIA (Gelatin Manufacturers Institute of America). 2012. *Gelatin Handbook*.

GPO (Government Printing Office). 1922. *Congress,* 2^{D} *Session, Senate Documents, Vol 5, Part 2, Senate Document No 108, Hearings before the Committee on Finance United States Senate on the proposed Tariff Act of 1921 (H.R. 7456)*. Washington, DC: Government Printing Office.

Gustav Cramer (Cramer Dry Plates). 2012. *Historic Camera*. http://historiccamera.com/cgi-bin/librarium2/pm.cgi?action=app_display&app=datasheet&app_id=1645&. (accessed April 29, 2014).

Hammer Dry Plate Co. (n.d.). *Little Book: A Short Talk on Negative Making*. Saint Louis, MO: Hammer Dry Plate Co.

Hammer Dry Plate & Film Company. 2014. *opencorporates*. https://opencorporates.com/companies/us_mo/F00008349.(accessed April 29, 2014).

Hance, George Wallace. 1914. *Commercial Photography of Today*. Cleveland, OH: Geo W Hance & Abel's Publishers.

Handheld XRF: How it works. 2014. *Bruker*. http://www.bruker.com/products/x-ray-diffraction-and-elemental-analysis/handheld-xrf/how-xrf-works.html. (accessed Feb 9, 2014).

Hasluck, Paul N., ed. 1907. *The Book of Photography: Practical, Theoretic and Applied.* London: Cassell and Company, Ltd.

Hiscox, Gardner D. ed. 1922. *Henley's Twentieth Century Book of Recipes, Formulas and Processes.* New York: The Norman W. Henley Publishing Company.

Holland, J. G. 1881. Recent Progress in Photography. *Scribner's Monthly: An Illustrated Magazine for the People* 22 (May-Oct.)

Homans, James E., ed. 1918. Seed, Miles Ainscoe. *The Cyclopaedia of American Biography*. New York, NY: The Press Association Compilers, Inc.

Howard Beach. 2014. *FamilySearch*. https://familysearch.org/search/record/results?count=20&query=%2Bgivenname%3Ahoward~%20%2Bsurname%3Abeach~%20%2Brecord_country%3A%22United%20States%22%20%2Brecord_subcountry%3A%22United%20States%2CNew%20York%22%20%2Bspouse_givenname%3Acatherine~. (accessed April 27, 2014).

Howard D. Beach portraits of American Indians at the Pan American Exposition, 1901. 2012. *Smithsonian Institution Research Information System (SIRIS), Archives, Manuscripts, Photographs Catalog.* http://siris-archives.si.edu/ipac20/ipac.jsp?uri=full=3100001~!360572!0 (accessed April 27, 2014).

Iraci, Joe. 2007. Care of Black-and-White Photographic Glass Plate Negatives. *CCI Notes 16/2*. Canada: Minister of Public Works and Government Services.

Jenkins, Reese V. 1975. Technology and the Market: George Eastman and the Origins of Mass Amateur Photography. *Technology and Culture* 16, no. 1, (Jan.).

Jenkins, Ron, R.W. Gould, and Dale Gedcke. 1995. *Quantitative X-Ray Spectrometry* 2nd Edition. New York, NY: Marcel Dekker, Inc.

Jones, Bernard E., ed. 1912. Developers, mixed or combined. *Cassell's Cyclopaedia of Photography*. New York, NY: Cassell and Company, Ltd.

Kodakery: A Journal for Amateur Photographers 8. 1920. Rochester, NY: Eastman Kodak Company. (September).

Lavédrine, Bertrand. 2009. *Photographs of the Past: Process and Preservation*. Translated by John McElhone. Los Angeles: Getty Conservation Institute.

Leiblinger, Julius. 1905. Notes on Photography. *Meyer Brothers Druggist,* 26, no. 6, (June).

Leonard, John W., ed.1906. *A Biographical Dictionary of Leading Living Men of the City of St. Louis*. St. Louis, MO: The St. Louis Republic.

Leyshon, William E. n.d. *Photographs from the 19th Century: A Process Identification Guide*. Prescott, AZ: Sharlot Hall Museum. On-line book at sharlot.org/archives/photographs/19th/index.html (accessed Dec 13, 2013).

Licata, Elizabeth. 2002. Painterly Photographs. *Buffalo Spree*. Buffalo, NY.

Lock, C. G. Warnford, ed. 1903. *American Library Edition of Workshop Receipts*, 1. New York, NY: Spon & Chamberlain.

Ludwig F. Hammer and Hammer Dry Plate Company. 2012. *Historic Camera*. http://historiccamera.com/cgi-bin/librarium2/pm.cgi?action=app_display&app=datasheet&app_id=2026& (accessed April 29, 2014).

M.A. Seed Dry Plate Company. n.d.a. *The Art of Negative Making*. St Louis, MO: M.A. Seed Dry Plate Company.

M.A. Seed Dry Plate Company. n.d.b. *Seed "From Which Good Pictures Grow".* St. Louis, MO: M.A. Seed Dry Plate Company.

M.A. Seed (Seed Dry Plate Co.). 2012. *Historic Camera*. http://historiccamera.com/cgi-bin/librarium2/pm.cgi?action=app_display&app=datasheet&app_id=2041& (accessed April 27, 2014).

Mauk, James F., compiled. 1956. *Industrial Research Laboratories of the United States*. 10th ed. Washington, DC: National Academy of Sciences – National Research Council.

Mees, C. E. Kenneth. 1948. The Kodak Research Laboratories. *Proceedings of the Royal Society of London. Series B, Biological Sciences*.

Meldola, Raphael. 1889. *The Chemistry of Photography*. London: MacMillan and Co.

Monro, William L. 1926. *Window Glass in the Making An Art, A Craft, A Business*. Pittsburgh, PA: American Window Glass Company.

National Glass. 1915. *National Glass Budget: Weekly Review of the American Glass Industry* 31, (July).

Needham, F. M. n.d.. *Complete Instructions in Photography*. Chicago, IL: Sears, Roebuck, & Co.

New York Times. 1920. Belgian Glass Industry: Factories Unable to Fill Orders from All Over the World. *New York Times*. (New York, NY).

Ortwein, Andrew. 2013. How Film Speed Affects Exposure and Grain of your Film Photography: ISO Film Speed Photography Guide and Techniques. *Guide to Film Photography*. www.guidetofilmphotography.com/film-photography-speed.html (accessed April 27, 2014).

Osterman, Mark. 2007. Making, Coating and Processing a Simple Gelatin Emulsion. Rochester, NY: George Eastman House.

Palmquist, Peter E., and Thomas R. Kailbourn. 2005. *Pioneer Photographers From the Mississippi to the Continental Divide, A Biographical Dictionary, 1839-1865*. Redwood City, CA: Stanford University Press.

Photo-Era, The American Journal of Photography: An Illustrated Monthly of Photography and Allied Art.1912. Boston, MA: Wilfred A. French.

Photographers' Association News 8, no. 2. 1920. Cleveland, OH: Photographers' Association of America. (March-April).

Richardson, Charles Henry. 1920. *The Glass Sands of Kentucky*. Frankfort, KY: The Kentucky Geological Survey.

Ritzenthaller, Mary Lynn, and Diane Vogt-O'Connor. 2006. *Photographs: Archival Care and Management*. Chicago, IL: The Society of American Archivists.

Sarvas, Risto, and David M. Frohlich. 2011. *From Snapshots to Social Media – The Changing Picture of Domestic Photography*. London: Springer-Verlag.

Schriever, James Boniface. 1909. *Complete Self-instructing Library of Practical Photography* 2. Scranton, PA: American School of Art and Photography.

Sheppard, S. E. 1921. No. 143, Gelatin in the Photographic Process. *Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Company* 21. Rochester, N.Y.: Eastman Kodak Company.

Strong, Mark. 2013. Howard D. Beach. Meibohm Fine Arts, Inc. http://www.meibohmfinearts.com/artists.aspx?ID=71. (accessed May 10, 2014).

Taylor, J. Traill. 1883. *Photographic Times and American Photographer*. New York, NY: Scovill Manufacturing Company.

Taylor, J. Traill. 1884. *Photographic Times and American Photographer* 14, no. 157. (January).

Tisa, Benedict. 1986. Photography: Pictorialists' movement brought new 'reality' to their art. *Chicago Tribune* (Chicago, IL).

Tragni, Claire Buzit. 2005. The Use of Ultraviolet-Induced Visible Fluorescence for Examination of Photographs. *Advanced Residency Program in Photograph Conservation*. Rochester, NY: George Eastman House.

Two Heads are Better than One: The Stanley Brothers. 2014. *Legends of America*. http://www.legendsofamerica.com/jh-stanleybrothers.html. (accessed on April 27, 2014).

Valverde, Maria Fernanda. 2005. *Photographic Negatives: Nature and Evolution of Processes*. Rochester, NY: Image Permanence Institute.

Wallace, Robert James. 1904. American Astronomical Society: The Silver "Grain" in Photography. *Astrophysical Journal*.

Weinstein, Robert A., and Larry Booth. 1977. *Collection, Use, and Care of Historical Photographs*. Nashville, TN: American Association for State and Local History.

Whitman, Katharine. 2007. *The History and Conservation of Glass Supported Photographs*.

Whitten, David O., ed. 1990. *Handbook of American Business History*. Westport, CT: Greenwood Press, Inc.

Wilson, Edward L., ed. 1890. *Photographic Mosaics: An Annual Record of Photographic Progress*.

Wong, Michael. 2011. 1883: Stanley Dry Plate Company. *British Photographic History*. http://britishphotohistory.ning.com/profiles/blogs/1883-stanley-dry-plate-company. (accessed on April 28, 2014).

APPENDICES

Appendix 1

Timeline

The following timeline serves to put some of the significant contributors to the dry plate manufacturing industry in context not only with each other, but with significant world events.

Date	Beach Events	Significant Photography Event	Wars	Events
1834		Ludwig F Hammer (Papa Hammer) born Wurttenberg, Germany (Chandler 1902, 42)		
1838		Gustav Cramer (Papa Cramer) born Eschweg, Germany (Palmquist 2005, 184)		
1840		Frederick Charles Luther Wratten born (Frederick Charles Luther Wratten 2012)		
1843		Miles Ainscoe Seed born Lancashire, England (M.A. Seed 2012)		
1849		Twins Freelan Oscar and Francis Edgar Stanley born (Two Heads are Better 2013)		
1854		George Eastman born in Waterville, NY (George Eastman n.d.)		
1854		Hammer immigrates to US (Chandler 1902, 42)		
1859		Cramer immigrates to US (Gustav Cramer 2012)		
1860		Cramer opens photography studio (Palmquist 2005, 184)		
1867	Beach born	Seed immigrates to US (M.A. Seed 2012)		
1877		Wratten forms partnership with Henry Wainwright (Frederick Charles Luther Wratten 2012)		

Date	Beach Events	Significant Photography Event	Wars	Events
1879		Seed releases dry plate (M.A. Seed 2012)		
1879		Eastman patents plate-coating machine in London (George Eastman n.d.)		
1880		Cramer Dry Plate Company founded (Leonard 1906, 136)		
		Cramer dry plates take top honors at Chicago National Photographers Convention (Palmquist 2005, 184)		
1880		Eastman patents plate-coating machine in US (George Eastman n.d.)		
1881		Eastman Dry Plate Company formed (George Eastman n.d.)		
1883		Seed incorporates as M.A. Seed Dry Plate Company (M.A. Seed 2012)		
1884	Moves to Buffalo, NY	Eastman Dry Plate and Film Company formed (George Eastman n.d.)		
1888		Stanley Brothers Dry Plate Manufacturing Company founded (Two Heads are Better 2014)		
1889		Eastman Company formed (George Eastman n.d.)		
1890		Hammer Dry Plate Company established in St Louis, MO (Chandler 1902, 42)		
1892		Eastman Kodak Company of New York formed (George Eastman n.d.)		
1896	Partners with Simson			
1898			Spanish American War	

Date	Beach Events	Significant Photography Event	Wars	Events
1899	Daughter Margaret born			
1900	Buys out Simson			
1901	Photographs Sioux tribes at Pan-American Expo in Buffalo, NY	Eastman Kodak Company of New Jersey formed (George Eastman n.d.)		
1902		Eastman buys Seed (M.A. Seed 2012)		
1905		Eastman buys Stanley (Wong 2011)		
1908	Buys Hall studio			
1912		Eastman buys Wratten & Wainwright (Frederick Charles Luther Wratten 2012)		
1913		Seed dies (M.A. Seed 2012)		
1914		Cramer dies (Palmquist 2005, 184)	World War I	
1918		Francis Stanley dies (Francis Edgar Stanley 2005)		
1920s	Richardson enters studio records			
1921		Hammer dies (Ludwig F. Hammer 2012)		
1926		Wratten dies (Frederick Charles Luther Wratten 2012)		
1930				Great Depression
1932		Eastman dies (George Eastman n.d.)		
1939			World War II	
1940		Hammer Dry Plate Company dissolved (Hammer Dry Plate 2014)		
1940		Freelan Stanley dies (Francis Edgar Stanley 2005)		
1945				

Date	Beach Events	Significant Photography Event	Wars	Events
1954	Beach dies			
1957		The Cramer Dry Plate & Film Company formed in Ohio (G Cramer Dry Plate 2013)		
1961		Cramer Dry Plate & Film Company dissolved (Cramer Dry Plate 2013)		
2012		Eastman Kodak files for bankruptcy (De La Merced 2012)		

Appendix 2

Terminology

The terms listed below are from *The Book of Photography: Practical, Theoretic and Applied*, edited by Paul N. Hasluck in 1907, unless otherwise noted.

Developer. A solution employed to bring out or render visible the latent image in metallic silver or other sensitive material.

Dry plate. A sensitive gelatine or collodion plate which may be kept and exposed in a dry state.

Eikonogen. A valuable developing agent giving soft, delicate negatives, of good colour. It does not stain, and may be used in conjunction with pyro and other developers.

Emulsion. The sensitive material used in coating a plate.

Fixing. The removal of unacted-on silver salts from a negative … generally by a solution of hyposulphite of soda.

Gelatin(e). A nitrogenous substance obtained from the bones, hoofs, and other parts of animals, by boiling for a long time and purifying the resulting jelly. It has the property of swelling in cold water, but will not dissolve until heated. The melting point varies with the quality of the3 gelatine. When heated and cooled many times, or kept in a fluid state for any length of time, it loses its power of setting. On this account, in making emulsions, only a portion of the gelatine is boiled at first, and the bulk added afterwards. The commoner sorts are very brittle, while the better kinds are hard, and difficult to break. Potassium bichromate, and some other salts, have the effect of rendering gelatin insoluble on exposure to light; a fact which is taken advantage of in many photographic processes. … Gelatine is one of the most useful materials employed in photography. Nearly all the dry-plates now used are coated with a gelatin emulsion, and it forms, besides, the vehicle for the sensitive salts in the bromide, the gelatino-chloride, and other processes.

Glass. A mixture of silicates of the alkali metals and alkaline earths, fused at a high temperature in a furnace. The varieties principally used by photographers are flatted crown, patent plate, and polished sheet.

Hydroquinone, hydrochinone, hydrokinone, quinol, or dihydroxybenzene. A phenol derivative obtained by the dry distillation of resins and wood, and in other ways. One of the most valuable of modern developing agents. It gives blackish negatives, and may be used repeatedly. Its one defect is a tendency to give harsh contrasts, which, however, is a recommendation for some kinds of work, as copying, photomechanical work, etc. A combination of hydroquinone and metol forms an ideal developer, in which each atones for the weak points of the other; the density-giving properties of hydroquinone being united with the detail and rapidity of metol, and the undesirable hardness of the former is effectually counteracted.

Metol or para-methyl-amidophenol-sulphate. One of the most energetic of modern developers. Producing negatives of great softness, it has the peculiarity of first bringing out the detail of the image, and then gradually building up the density. A combination of metol and hydroquinone forms a very satisfactory developer for … plates. It sometimes has an irritating effect on the skin, causing disagreeable sores.

Metol-quinol. A name given to a mixture of metol and hydroquinone, used as a developer. It is very suitable for plates.

Negative. A photographic impression in metallic silver on a glass plate or film, in which the dark portions of the original appear light and the light portions dark. From a negative a positive can be printed, which, by again reversing the light and shade, gives a correct picture.

Plate. A sheet of glass coated with sensitive emulsion, on which a photographic image can be obtained by exposure to light.

Pyrogallic acid, pyrogallol, pyro, or tri-hydroxybenzene. The developer probably most used at the present time. It is fairly rapid in action, gives any amount of density, and enables negatives of good printing quality to be obtained. It allows, perhaps, more power of modification to suit different exposures than any other developer, and for all-round purposes is still unequalled. Pyro may be employed in combination with various other developers to secure different effects, as in pyrol-metol, pyro and eikonogen, etc.

Rapid emulsion. An emulsion possessing extreme sensitiveness to light.

Silver. The salts of silver, especially the bromide, chloride, and iodide, are invaluable in photography; one or other of the latter forming the sensitive principle of modern dry plates.

Stock solutions. Concentrated developing or other solutions from which baths for toning, fixing, developing, etc., of normal strength can be made up as required.

UV-A. Ultraviolet absorption of radiation with a wavelength of ~320-400 nm (Tragni 2005)

UV-C. Ultraviolet absorption of radiation with a wavelength of ~100-280 nm (Tragni 2005)

XRF. X-ray fluorescence – commonly used to analyze inorganic elements (Handheld 2014)

Appendix 3

Visual examination of 5” x 7” negatives

Neg #	Manufacturer	Edges	Neg #	Manufacturer	Edges
28752	Hammer	no color	32460	Cramer	red edges
28758.1	Hammer	no color	32462	Cramer	no color
28758.2	Hammer	no color	32542	Cramer	red edges
29873	Cramer	no color	32695	Hammer	red edges
29879	Cramer	no color	32696	Hammer	red edges
30113	unknown	no color	32699	Hammer	red edges
30116	unknown	no color	33070	Hammer	no color
30120	unknown	no color	33071	Hammer	no color
30122	unknown	no color	33221	Cramer	no color
30381	Hammer	red on three edges	33430	Hammer	no color
30382	Hammer	no color	33432	Hammer	no color
30400	Cramer	no color	33510	Hammer	no color
30401	Cramer	no color	33510	Hammer	no color
30402	Hammer	no color	33515.1	Hammer	no color
30403	Cramer	no color	33515.2	Hammer	no color
30565	Seed	red bottom edge	33517	Hammer	no color
31080	Hammer	red edges	33519	Hammer	no color
31140	Cramer	red edges	33546	Hammer	no color
31231	Hammer	red edges	33755	Hammer	no color
31234	Hammer	red edges	33771	Hammer	no color
31239	Hammer	no color	33807	Cramer	no color
31241	Hammer	red edges on top and bottom	33940	Cramer	no color
31245	Hammer	no color	33947	Cramer	no color
31246	Hammer	no color	33963	Cramer	no color
31250.1	Cramer	red edges	33964	Cramer	no color
31250.2	Hammer	no color	34870	Hammer	no color
31252	Hammer	no color	34878	Hammer	no color
31254.1	Hammer	no color	34879	Hammer	no color
31254.2	Hammer	no color	35710	Hammer	no color
31311	Hammer	no color	35713	Hammer	no color
31316	Hammer	red edges	35714	Hammer	no color
31728.1	Cramer	red edges	35719	Hammer	no color
31728.2	Cramer	red edges	36923	Hammer	no color
31728.3	Cramer	red edges	37135	Hammer	no color
31728.4	Cramer	red edges	37137	Hammer	no color
31736	Hammer	red edges	37816	Cramer	no color
31933	Hammer	red edges	37830	Hammer	no color
31934	Hammer	red edges	37831	Hammer	no color
32257	Hammer	red edges	38086	Hammer	no color

Neg #	Manufacturer	Edges	Neg #	Manufacturer	Edges
38088.1	Hammer	no color	42324	Hammer	red left and bottom edges
38088.2	Hammer	no color	42580	Hammer	no color
38311	Hammer	no color	42581	Hammer	no color
38950	Hammer	no color	42742	Hammer	no color
38952	Hammer	no color	42758	Hammer	no color
39860	Hammer	no color	42786	Hammer	no color
39894	Hammer	no color	42820	Hammer	no color
39895	Hammer	no color	42825	Hammer	no color
39935	Hammer	no color	42842	Hammer	no color
39936	Hammer	no color	42843	Hammer	no color
39937	Hammer	no color	42853	Hammer	no color
39957	Hammer	no color	42854	Hammer	no color
40194	Hammer	no color	42855	Hammer	no color
40201	Hammer	no color	42875	Hammer	no color
40206	Hammer	no color	42928	Hammer	no color
40271	Hammer	no color	43138	Hammer	no color
41100	Hammer	red bottom edge	43651	Hammer	no color
41111	Hammer	no color	43655	Hammer	no color
41140	Hammer	red left and bottom edges	43791	Hammer	no color
41157	Hammer	no color	43792	Hammer	no color
41225	Hammer	red left edge	43892	Hammer	no color
41239	Hammer	no color	43990	Hammer	no color
41274	Hammer	no color	43993	Hammer	no color
41331	Hammer	no color	43994	Hammer	no color
41333	Hammer	no color	44031	Hammer	no color
41334	Hammer	no color	44032	Hammer	no color
41338	Hammer	no color	44275	Hammer	no color
41339	Hammer	no color	44276	Hammer	no color
41776	Hammer	no color	44279	Hammer	no color
41779	Hammer	no color	44720	Hammer	no color
41866	Hammer	no color	44723	Hammer	no color
41870	Hammer	no color	44762	Hammer	no color
41871	Hammer	no color	45763	Hammer	red bottom edge
42172	Hammer	no color	47890	Hammer	no color
42176	Hammer	no color	47896	Hammer	no color
42320	Hammer	no color	47897	Hammer	red left and bottom edges

Appendix 4

Visual examination of 8” x 10” negatives

Neg #	Manufacturer	Edges
39726	Hammer	no color
39760	Stanley	no color
39765	Stanley	no color
40812	Hammer	no color
41084	Hammer	no color
41085	Hammer	no color
41117	Hammer	no color
41150	Hammer	no color
41158	Hammer	no color
42411	Hammer	no color
42445	Hammer	no color
42458	Hammer	no color
42471	Hammer	no color
42595	Hammer	no color
42619	Hammer	no color
42757.1	Hammer	no color
42757.2	Hammer	no color
42883	Hammer	no color
42892	Hammer	no color
43195	Hammer	no color
43652	Hammer	no color
43760	Cramer	no color
43910	Hammer	no color
43929	Hammer	no color
43940	Hammer	no color
43967	Hammer	no color
43998	Hammer	no color
44627	Hammer	no color
44651	Hammer	no color
45102	Hammer	no color
45139.1	Hammer	no color
45139.2	Hammer	no color
45142	Hammer	no color
45205	Hammer	no color
45238	Hammer	no color
45557	Hammer	no color
45802	Hammer	no color
45821	unknown	no color
45827	unknown	no color
45829	Wratten & Wainwright	no color
45842	unknown	no color
45844	Wratten & Wainwright	no color
45855	Wratten & Wainwright	no color
45899	unknown	no color
45945	Hammer	no color
46059	Hammer	no color
46536	Eastman	no color
47741	Hammer	no color
47889	Hammer	no color
47916	Hammer	no color
47951	Cramer	no color

Appendix 5

Results of Ultraviolet Analysis of 8” x 10” Negatives

NOTES:
NSF = no significant fluorescence

Neg #	Manufacturer	UV-A	UV-C	Neg #	Manufacturer	UV-A	UV-C
39726	Hammer	NSF	orange	43967	Hammer	NSF	orange
39760	Stanley (Eastman)	NSF	orange	43998	Hammer	NSF	orange
39765	Stanley (Eastman)	NSF	orange	44627	Hammer	NSF	orange
40812	Hammer	NSF	orange	44651	Hammer	NSF	orange
41000	Hammer	NSF	orange	45102	Hammer	NSF	orange
41084	Hammer	NSF	orange	45139.1	Hammer	NSF	orange
41117	Hammer	NSF	orange	45139.2	Hammer	NSF	orange
41150	Hammer	NSF	orange	45142	Hammer	NSF	orange
41158	Hammer	NSF	orange	45205	Hammer	NSF	orange
42411	Hammer	NSF	orange	45238	Hammer	NSF	orange
42445	Hammer	NSF	orange	45557	Hammer	NSF	orange
42458	Hammer	NSF	orange	45802	Cramer	NSF	orange
42471	Hammer	NSF	orange	45821	Cramer	NSF	orange
42595	Hammer	NSF	orange	45827	Cramer	NSF	orange
42619	Hammer	NSF	orange	45829	Wratten & Wainwright	NSF	orange
42757.1	Hammer	NSF	orange	45842	Cramer	NSF	orange
42757.2	Hammer	NSF	orange	45844	Wratten & Wainwright	NSF	orange
42883	Hammer	NSF	orange	45855	Wratten & Wainwright	NSF	orange
42892	Hammer	NSF	orange	45899	Cramer	NSF	orange
43195	Hammer	NSF	orange	45945	Hammer	NSF	orange
43652	Hammer	NSF	orange	46059	Hammer	NSF	orange
43760	Cramer	NSF	orange	46536	Eastman	NSF	orange
43910	Hammer	NSF	orange	47741	Hammer	NSF	orange
43929	Hammer	NSF	orange	47889	Hammer	NSF	orange
43940	Hammer	NSF	orange	47916	Hammer	NSF	orange
				47951	Cramer	NSF	orange

Appendix 6

Cross Section Measurements of Glass Support

NOTES:
* Glass and emulsion layers could not be distinguished from each other.
Average thickness of glass layer: 3.27 mm

Negative #	Glass (mm)	Negative #	Glass (mm)
41000	0.00*	43195	3.14
41158	0.00*	46536	3.19
43940	0.00*	45802	3.30
44627	0.00*	45899	3.33
45139.1	0.00*	42595	3.34
45139.2	0.00*	43910	3.35
45142	0.00*	42619	3.38
45821	0.00*	41084	3.39
47916	0.00*	45827	3.39
42471	2.43	42411	3.42
39726	2.60	40812	3.47
43998	2.63	45829	3.48
42445	2.64	43760	3.51
41117	2.68	42757.1	3.52
41150	2.71	47889	3.55
45557	2.79	39760	3.58
45102	2.85	42458	3.59
45855	2.95	45945	3.61
47951	2.99	42883	3.61
45205	3.01	47741	3.61
43967	3.03	39765	3.68
44651	3.07	42892	3.69
42757.2	3.11	45844	3.69
45238	3.12	43929	3.74
46059	3.13	45842	3.86
		43652	4.03

Appendix 7

Cross Section Measurements of Emulsion

NOTES:
* Glass and emulsion layers could not be distinguished from each other.
Average thickness of gelatin layer: 0.25 mm

Negative #	Gelatin (mm)	Negative #	Gelatin (mm)
41000	0.00*	45855	0.15
41158	0.00*	45205	0.15
43940	0.00*	45827	0.16
44627	0.00*	45557	0.19
45139.1	0.00*	46536	0.20
45139.2	0.00*	45802	0.20
45142	0.00*	42458	0.21
45821	0.00*	44651	0.22
47916	0.00*	43998	0.24
42757.1	0.05	45102	0.27
40812	0.05	45844	0.28
39726	0.06	47741	0.28
42883	0.06	43910	0.31
39765	0.06	43195	0.31
41084	0.07	42892	0.32
39760	0.08	43760	0.32
42757.2	0.09	41117	0.33
43929	0.10	43652	0.35
45945	0.11	47889	0.37
45842	0.11	47951	0.38
43967	0.12	45238	0.44
46059	0.13	42411	0.52
42619	0.13	41150	0.58
45899	0.14	42445	0.59
45829	0.14	42595	0.70
		42471	0.79

Appendix 8

Estimation of number of 5” x 7” plates processed in a given year

NOTES:
* Assuming a 5 day work week

Year	Annually	Monthly	Weekly	Daily *
1907	1624	135	31	6
1908	1616	135	31	6
1909	1485	124	29	6
1910	1333	111	26	5
1912	1416	118	27	5
1913	1176	98	23	5
1914	985	82	19	4
1915	1337	111	26	5
1917	1362	114	26	5
1918	1587	132	31	6
avg	1392	116	27	5