Alternative Process Photography and Science meet at the Getty

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As chemical (classical) photography is increasingly replaced by digital photograph technology, there is a danger that this shift will trigger a decrease in knowledge and scientific research in chemical photography. This shift could also result in the loss of crucial information about previous artistic, commercial, and experimental photographic processes and technologies.

To address these concerns, the Getty Conservation Institute (GCI), together with several internal and external collaborators, has embarked on a large-scale, long-term project that indentifies many issues in the preservation of photograph materials heritage: what we now call the era of "chemical" photography.

Since 1826, when Joseph Nicéphore Niépce created the "First Photograph," more than 150 different photographic processes have been invented, used, abandoned and replaced by faster, less expensive and/or more convenient processes. Photographs created using this wide variety of photographic processes can today be found in museums, archives, libraries and private collections around the world. If it's not possible to identify which process was used to create a photograph, however, one cannot develop an appropriate and successful strategy for its long-term preservation, storage, conservation treatment and/or restoration.

The GCI's research project focuses on the development of an objective, scientifically based methodology that would allow curators and conservators to not only identify all of the major photographic processes from the chemical photography era, but also identify minor processes and process variants that are sometimes very difficult to ascertain.

The GCI is a world-class conservation research center providing both scientific and educational support to the fields of art conservation and cultural heritage preservation. An integral component of the Getty Center in Los Angeles, the GCI and its scientists have nearly ideal conditions for undertaking such a demanding and far-reaching project. The J.Paul Getty Museum holds one of the world's most important collections of art photographs and the Getty Research Institute's holdings include several million art-related photographs.

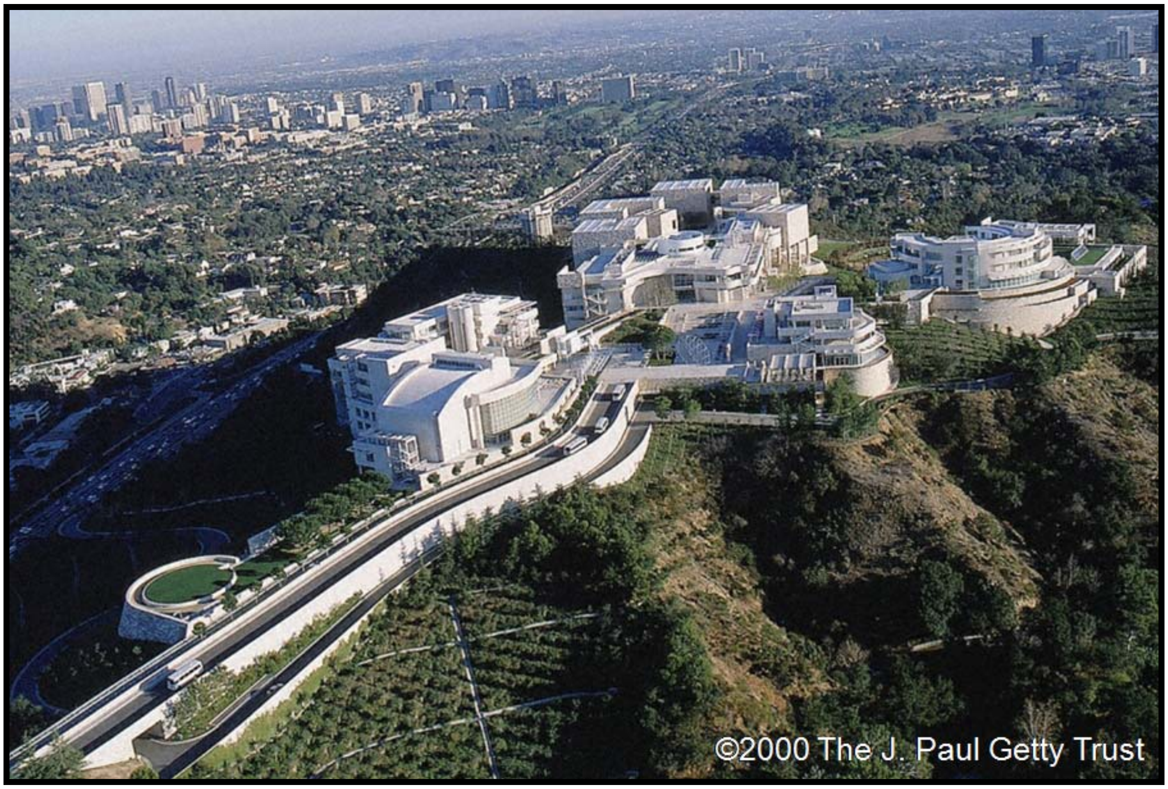

Fig. 1 The Getty Center in Los Angeles

One of the most important components of the GCI's scientific research is its efforts to develop, test and apply new methodologies and instruments to investigate works of art; and provide objective data for studies in the provenancing and authentication of museum objects. By using and modifying previously tested scientific methodologies, GCI scientists over the past nine years have conducted many important investigations that have had a significant impact on research in the conservation and preservation of photographs, in the areas of both analytical techniques and in portable instrumentation.

In June 2002, the world's First Photograph, Joseph Nicéphore Niépce's *View from the Window at Le Gras* (1826), arrived at the GCI for scientific analysis. This unique and important photograph, part of the photographic collection of the Harry Ransom Humanities Research Center at the University of Texas at Austin, is the first known example of a permanent image created by exposing a photosensitive plate in a camera-like device (Fig.2).

Fig. 2 The First Photograph

Although Niépce's process was generally described in his writings, the image itself had never before been scientifically analyzed. The Harry Ransom Center asked the GCI to conduct the first scientific study of the heliograph's material makeup and determine the object's condition. The GCI scientific team used non-invasive analytical techniques, including X-ray fluorescence (XRF), Fourier-transform infrared spectrometry (FTIR), and reflection spectrophotometry to study the image. XRF analysis confirmed the plate to be pewter and composed of tin, lead, copper, nickel and iron. FTIR and microscopic analysis confirmed the image layer to be bitumen, though not a solid layer as presumed but rather a layer of bitumen microdots (Fig. 3).

Fig. 3 Dusan Stulik (GCI) investigating the First Photograph using digital microscopy

Analyzing hundreds of 20th century photographs, GCI scientists noticed that photographs printed on different kinds of black and white photographic papers differ in the details of their chemical composition. An extensive examination of historic photographic paper samples using XRF spectroscopy was conducted at the GCI (2002-2007).

Among common elements detected were barium and strontium (from the baryta layer), calcium (paper base), and often chromium (present as a gelatin-hardening agent). The quantitative analysis of these elements, especially when compared to the base line of papers of known provenance, can provide clues into the origins of prints, possibly identifying the manufacturer, brand, and date.

Results of the GCI's investigation were recently used in (to date) the largest and most comprehensive analytical investigation of photographs by a single photographer ever conducted. Working in close collaboration with the Henri Cartier-Bresson Foundation, the Atelier de restauration et de conservation des Photographies (ACRP) in Paris and several important museums, GCI scientists concentrated their analytical research on photographs by the iconic French photographer Henri Cartier-Bresson. Among their many successes, they were able to provide dates for some photographs that were, until then, of unknown age (Fig. 4).


Fig. 4 Art Kaplan (GCI) at the Société Française de Photographie (SFP) in Paris analyzing a series of Henri Cartier-Bresson photographs.

The National Media Museum (NMeM) in Bradford (UK) is a special place for many collaborators involved with the GCI project. Each spring, GCI scientists travel to England to study its unparalled collection of historical photographs, including the prestigious Royal Photographic Society collection. From each visit their research inevitably produces new discoveries which often change or modify existing beliefs in the history of photography. Their research also generates so much experimental information that it takes an entire year between visits to process and interpret all of the collected data and to explain the results.

One of the first photographs the NMeM's curators ever challenged the project team with was a copy of an architectural plan (1885-94) from the NMeM collection described as "Smallwood Manor by Willis". The photographically produced copy had a note written in pencil on its back, "The first platinum print by Willis". XRF analysis of the dark purple lines of the copy (Fig. 5), however, did not show the presence of platinum or any other typical imaging metal used in 19th century photography. The only inorganic element found in the copy of the architectural plan was chromium.

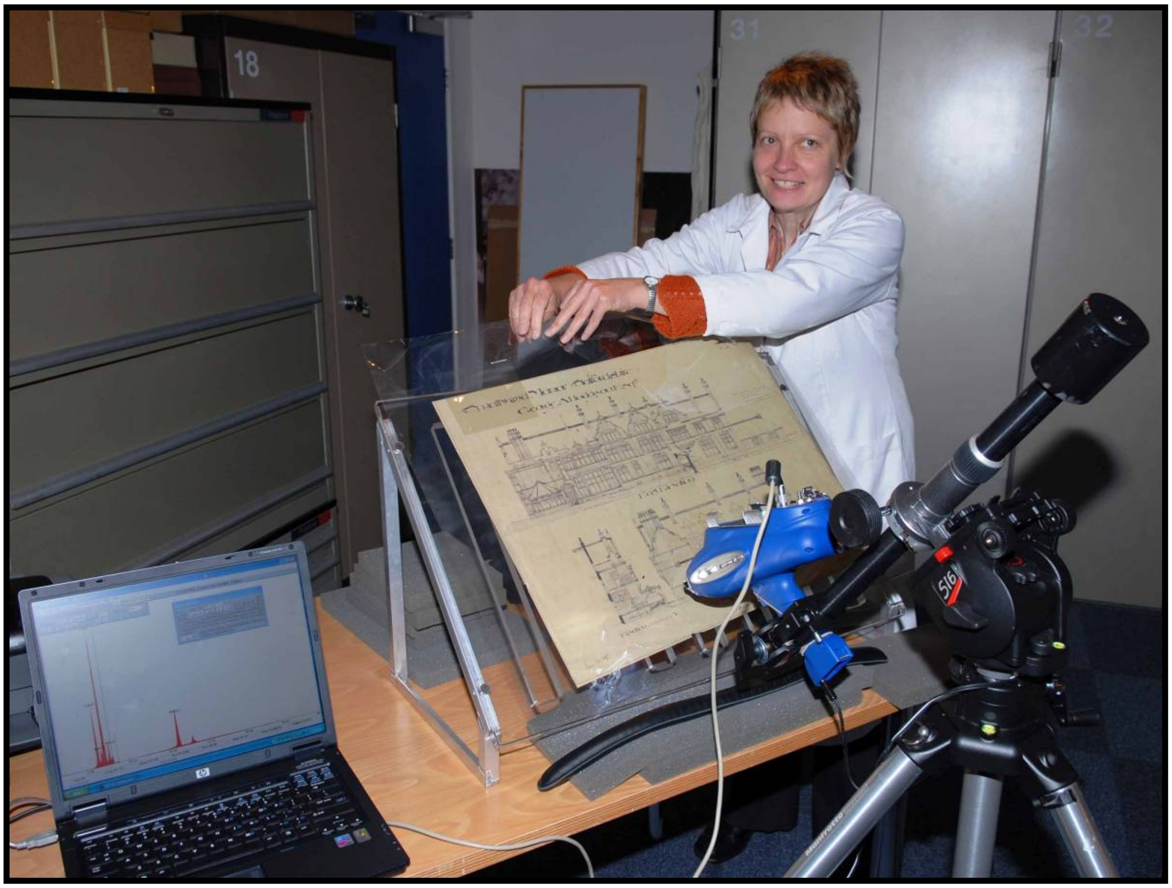

Fig. 5 Photograph conservator Susie Clark with the Willis print "Smallwood Manor"

The presence of chromium together with the tonality of the lines of the plan viewed under a microscope provided enough information for a very different interpretation of the print than how it was described on the back. We still do not know if the copy of the architectural print was made by William Willis or by his father of the same name. What we do know is that the print was not made using the platinotype process, but by an aniline process invented and patented by the elder William Willis in 1864.

In the elder Willis' method, designed to make copies of plans or maps, a paper sensitized with bichromate of potassium is exposed to light under the original plan or other tracing. Light reduces the chromium salts and only areas shielded by the dark lines of the drawing have still unreduced chromium salts. When the light-exposed copy paper is exposed to vapors of aniline, an insoluble dark purple organic dye is formed in areas containing unreduced chromium salts, and a rather permanent copy print is formed. The aniline process was used until about the 1880's when it was slowly replaced by the well known "blueprint" cyanotype process.

Most contemporary alternative process photographers who use the platinotype process are aware that the George Eastman House (GEH) in Rochester has, among thousands of other important photographs, the first platinotype photograph ever made in the US.

The photograph was made in New York in 1877 during the younger Willis' visit to the

U.S. to demonstrate his new photographic process. The GCI team had a chance to analyze the GEH platinotype and determined that Willis had made this particular photograph still using his original platinotype formula patented in 1873 (Fig. 6).

Fig. 6 Dusan Stulik and GCI photo conservator Tram Vo analyzing the first US platinotype

Willis' improved and "silverless" platinotype process was patented in 1878. It is theorized that he was already working with the new formula in 1877 but had not yet obtained good or consistent results, and so he opted to use his original and well-tested formula for his New York demonstration.

These are just some of the examples of the GCI's exciting work and of its collaborative projects with museums, conservation laboratories and collections of photographs around the world. Many of the already mentioned 150+ different photographic processes dating from the chemical photography era are already in museum collections, but because their chemical nature is not obvious, they are often described in registrar databases as just photographs, or according to their subject matter.

Such unusual photographs are virtually "lost" to our research, which is why the GCI is reaching out to museums and important photograph collections which may have some technical information relating to photographs in their collections (e.g., archives of photographers describing their darkroom techniques, books of samples and recipes of photochemical material manufacturers or collections of photographic patents, etc.). The GCI has also solicited help from photography lovers and enthusiasts to share some interesting examples of different but well documented photographs and photographic materials in their own collections that might be important information to have in the preservation of materials heritage from the chemical photography era.

Additional information about this appeal to the museum-going public can be found at the website below:

http://www.getty.edu/conservation/science/photocon/photocon_wanted.html

In early 2009, the GCI established connections with active members of the alternative photographic processes community located through the Alternative Photography website (www.alternativephotograpy.com). We invited this community to join us in its quest to preserve the material heritage of chemical photography; and in building and maintaining an important depository of well-described and scientifically studied samples of alternative process photographs. Both of these objectives are necessary for the in-depth education of future generations of photograph conservators, museum curators, conservation scientists and photography enthusiasts.

To make this proposed collaboration mutually beneficial, we at the GCI have promised to share all our scientific and analytical findings with all project participants; and inform the group of our progress and important findings via periodic project updates including preparing and sharing some project-related articles with the alternative photography community.

In past project updates we communicated different facets of the project directly with those members of the alternative photography community who expressed their interest in joining our research efforts. We feel now is the right time to share some our findings and the excitement of our collaborative work with all of the visitors to this important website. We expect that our work with alternative process photographers would be interesting to all of you and that our project, in the long run, will generate scientific data and knowledge needed for a deeper understanding of chemical photography.

We are very happy to report that the positive reactions from the alternative processes community greatly exceeded our expectations, and we have already accumulated some interesting and sometimes unexpected findings. There is a wealth of new information that may be interesting not only for our research in photographic processes but of particular interest to you as well.

We expect that the majority of alternative process photographers, regardless what photographic process they use now, have at least tried to produce beautiful blue cyanotypes. Out of the many processes you have sent us for analysis and scientific investigation, cyanotype photographs, process variants as well as toning and coating modified cyanotype images were the most frequent submissions to our project. The cyanotypes were also both the largest and smallest photographs we have ever analyzed. The largest cyanotype was hand delivered from Argentina from the studio of Juan Manuel Ipiña (Fig. 7).

Fig. 7 Juan Manuel Ipiña's "Photogram" cyanotype (44x67 inches, 1.1x1.7m) arriving at the GCI from Argentina.

Fig. 8 Photograph conservator Tram Vo performing XRF analysis of the cyanotype photogram

Elemental analysis of this cyanotype showed the presence of small amounts of manganese, which is not usually found in cyanotype photographs. The analysis of the uncoated and unprocessed paper substrate showed that manganese, together with iron, is responsible for the dark brown color of the paper substrate. When analyzing old paintings, the detection of manganese together with iron usually indicates the presence of an umber pigment. Was the brown paper used for Juan Manuel's cyanotype made using umber pigments or was it made using a mixture of iron and manganese oxide pigments? This is still a question we are working on using other analytical techniques at our disposal in our laboratories.

The smallest cyanotype we have analyzed in our project was only 26x23 mm, almost 3200x smaller then Juan Manuel's large cyanotype. This little postage stamp was made in what is today South Africa during the Boer War in 1900. Only a very limited number of these stamps were created using the cyanotype photographic process making these stamps rather expensive and highly coveted by stamp collectors.

As we know so well when observing dealers of fake Gucci or Louis Vuitton handbags in the streets of Florence or other European cities, any monetary value sooner or later attracts the attention of forgers who try to sell their illegal creations as originals. The authentic 1d "Mafeking blue" stamp is shown below in (Fig. 9).

Fig. 9 The infrared analysis of the Mafeking blue

The analysis of the stamp was not only a very interesting venture into the colorful history of the cyanotype process but also provided us with in-depth knowledge of its chemical composition. Our museum does not have a collection of stamps but it is good to know that if we ever encountered a fake Mafeking blue stamp, we would be able to identify it as a forgery.

Monitoring various online alternative process discussion groups clearly shows that the quality and consistency of papers used for printing is one of the most critical issues for most alternative photography artists. Any change in paper chemistry or in the paper manufacturing process seems to have a great and often a very negative effect on an artist's work. Many papermaking companies have experienced changes of ownership and sometimes economical factors can be responsible for often unannounced and unexpected changes in paper chemistry which is later responsible for a lot of anger and frustration on the part of alternative process practitioners.

Performing analyses on a large number of paper substrates used within the alternative process community, we didn't anticipate any unusual findings. The infrared analysis of paper should detect "rag"- based cellulose, the main component of all quality papers. If a paper is not surface-sized, the analytical signature of the paper should be very similar to the analytical signature of pure cotton fibers. XRF (elemental) analysis should detect only small amounts of calcium from paper fillers or buffers and some, if any, other inorganic impurities.

After conducting hundreds of analyses of different papers from our collection and your paper safes we know that there is more "there" then we expected. Some papers contain different fillers (calcium carbonate, white clay, titanium dioxide etc.). There seem to be enough differences in the chemistry of different paper samples that our instruments can often identify which company manufactured them. Much more needs to be done to prove that this is more than just a coincidence and for us to be able to turn these findings into a working methodology for the identification and maybe for the provenancing of different papers (Fig.10).

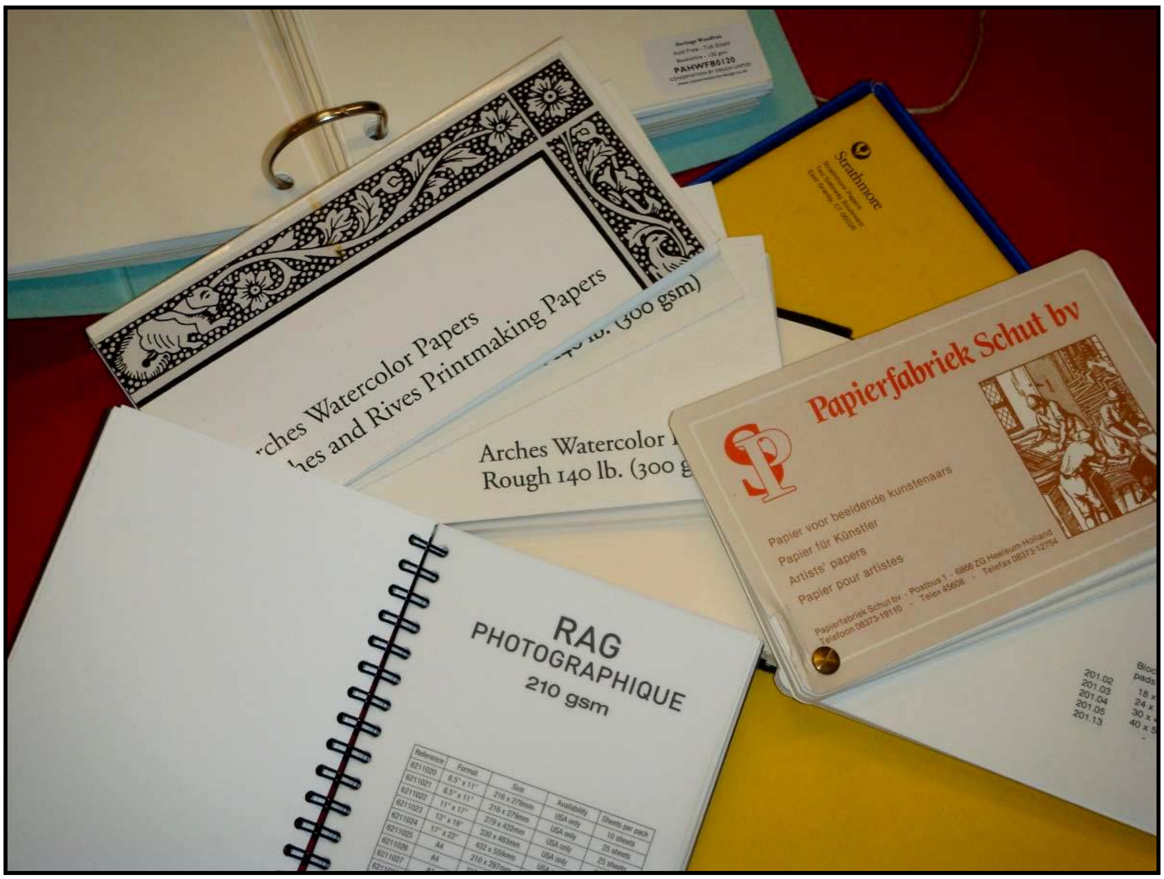

Fig.10 Samples of different papers for alternative processes at the GCI Reference Collection of art materials.

Besides having the potential for developing a new scientific methodology for provenancing papers, our analysis can also assess the purity and chemical consistency of papers.

It is very beneficial that the alternative process community has started to collect samples of different papers used by practitioners around the globe. We feel that such an effort is closely related to our project and that the collection of papers representing different paper types, different manufacturers and different periods will be a very important research resource for future generations of researchers in alternative process photography.

California photographer Steven Lewis sent us several process variants of his Kallitype process. Elemental analysis of these palladium-toned Kallitypes has given us a chance to relate concentrations of both silver and palladium in the final print to his processing chemistry and working procedures.

Analyzing a large number of both historical and modern iron-based alternative process photographs has allowed us to assess different types of developing and clearing procedures. We have experienced platinum prints with dark red highlights due to now fully oxidized residual iron from insufficiently cleared or washed platinum prints. Our analysis of modern iron process prints provides the artist with some insight into their working technique and helps to predict potential changes of print tonality due to aging. To date we haven't found any iron-based prints that do not contain some residual iron even after very good processing, but our analysis of Steven's prints showed that his prints will be very stable with minimum chance of tonality changes due to iron residue.

Steven also sent us a wax-coated Kallitype. We analyzed a number of varnished platinotypes including Paul Strand's photographs from the Getty Museum, and the mercury-toned and beeswax-coated portrait of Alvin Langdon Coburn in the collection of the NMeM. Using infrared analysis we were able to identify that the photograph was wax-coated, and when interpreting our recorded spectra we were also able to determine the type of wax used (Fig. 11).

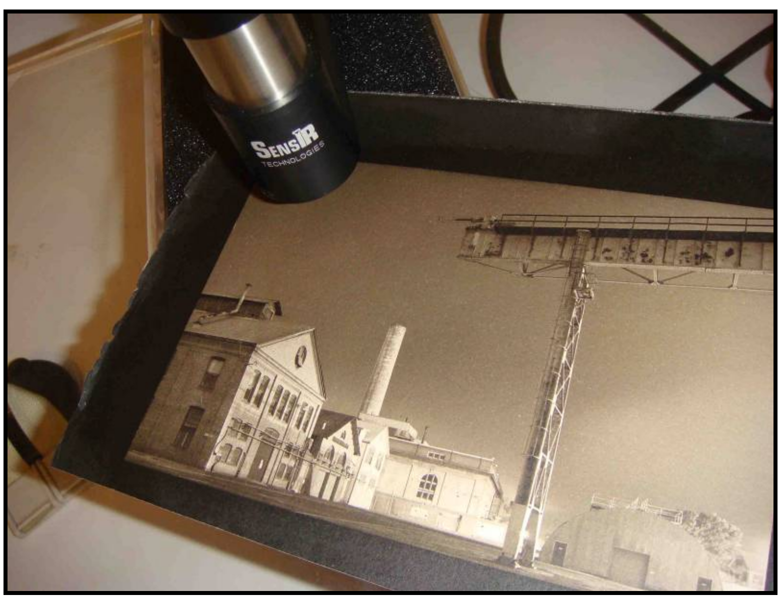

Fig.11 FTIR detection of the beeswax coating on the Kallitype photograph.

We were very pleased when New York platinotypist Bruce Beck sent us his project entry containing several platinum/palladium photographs printed with different but well defined and recorded proportions of platinum and palladium sensitizing solutions. We are planning to do a more in-depth analytical investigation of Bruce's photographs, and we hope that we will be able to learn more about the relation between the proportion of both metals (Pt and Pd) in the sensitizing solution as compared to the proportions of both metals in the final photographs.

Bruce's entry also provided us with some new insight into the chemistry of paper available to today's photographers. Bruce's photographs were printed using the same type of paper (Crane's Platinotype Natural White paper) but the papers were purchased on different dates: 1995, 1998 and 2001 (Fig. 12a and 12b). Our analysis of these photographs showed that the 1995 print did not contain any titanium dioxide, the 1998 photograph had a small amount, and the 2001 print contained a substantially higher concentration.

We assume that titanium dioxide was added to the paper mass during the manufacturing process to improve the optical properties of the paper. We doubt that the addition of a small amount of titanium dioxide would change the working properties of the paper all that much, but different amounts of titanium give us and all future investigators an important clue for "dating" papers, or at least the capability to sort them according to a pre- and post-1995 category.

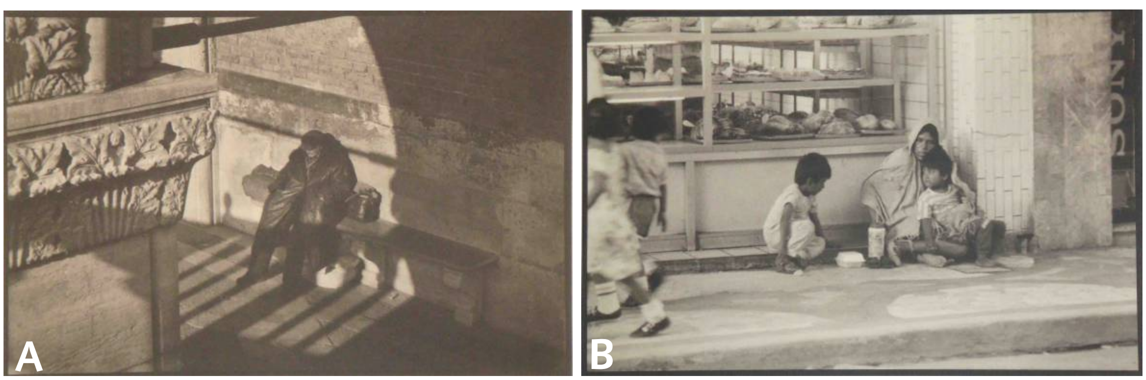

Fig.12 (a, b) Only chemical analysis can fully differentiate between Bruce Beck's 1995 and 2001 platinotypes.

We have learned a lot working with emulsion lift Polaroid photographs submitted to the project by Ivy Bigbee. Ivy not only described all of the details of her working technique when making her images but she also shared with us results of her research and observations processing both Polaroid 690 and Polaroid 669 film. It was very interesting to us to analyze the complex chemical makeup of Polaroid images, but the most interesting part of Ivy's emulsion lift photographs was their detailed study using a digital stereomicroscope. Images that look perfectly smooth under visual inspection reveal a very interesting microstructure under 40x magnification. It seems that the lift process is not completely uniform across the entire photograph. We can also see that some of the observed "cell structure" artifacts visible under a microscope are somehow related to the optical density of the image (Fig. 13a and 13b).

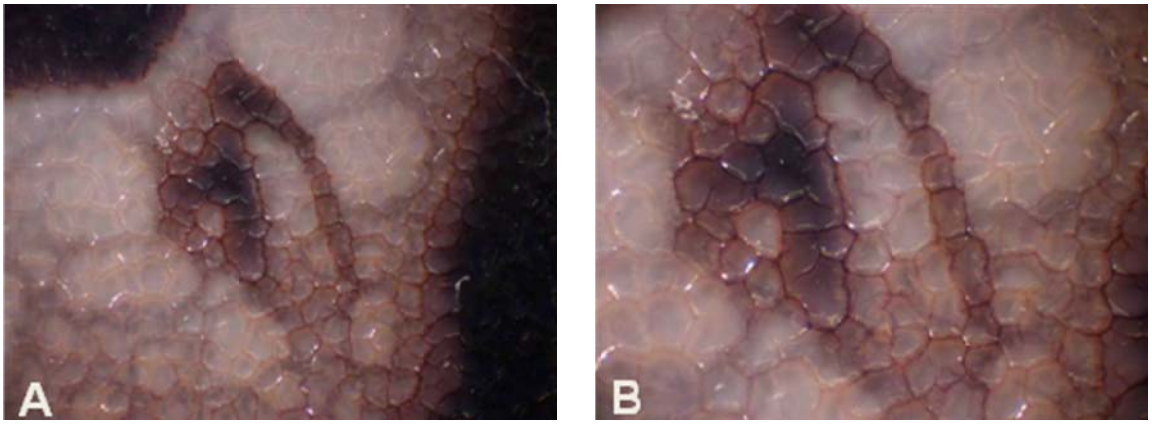

Fig.13 Emulsion lift photographs under 25x(A) and 40x(B) magnification.

You can see this effect in both photomicrographs above. Lighter areas of the photograph exhibit larger "cell" like surface structures in comparison with the much smaller cells that follow the dark parts of the model's eye and her eyebrows. As of now we don't have any good explanation for this phenomenon, but we hope that our future collaboration with other emulsion lift artists and our contacts with Polaroid scientists and technologists will provide us with some answers.

Quinn Jacobson works in different wet collodion photographic processes, and his project entries mirror his photographic interests. When creating his modern ambrotype photograph, he selected as his glass substrate the black glass used by contemporary stained glass window artists (Fig. 14).

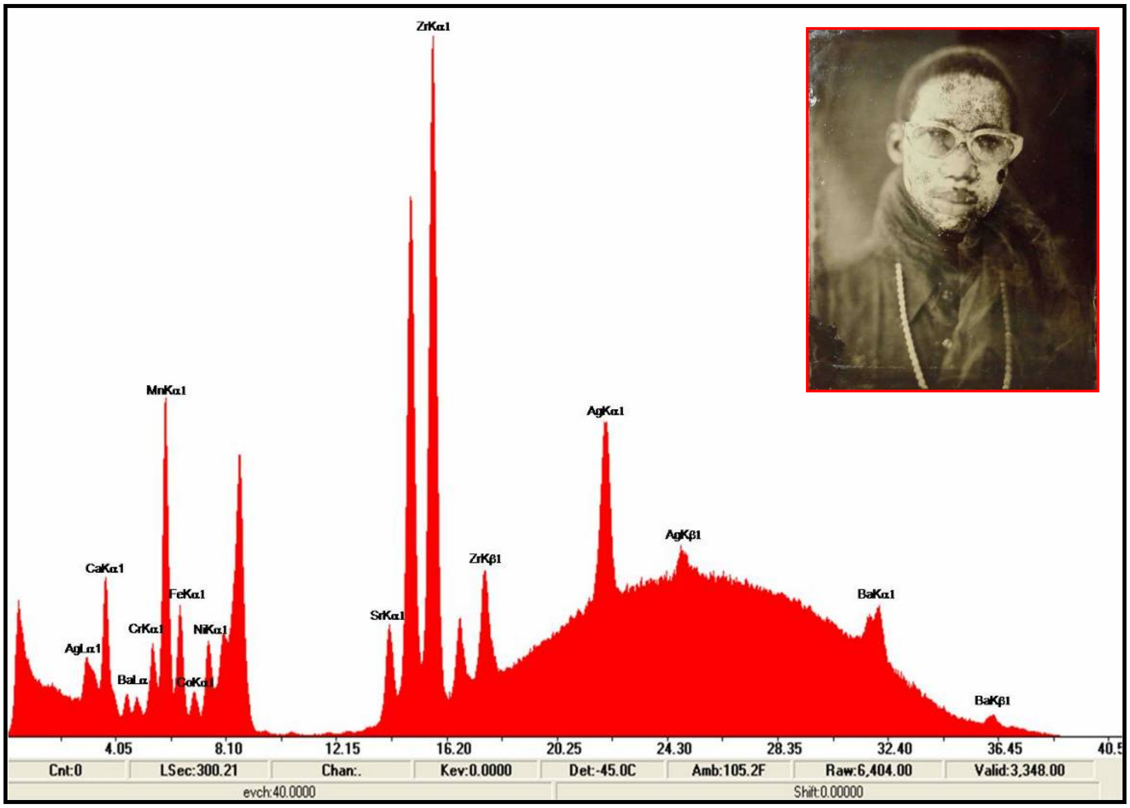

Fig. 14 Black glass ambrotype and its elemental composition

The elemental analysis of Quinn's ambrotype was very interesting. Its XRF spectrum was much more complex than we expected. Besides the glass components such as silicon and calcium, our analysis also detected the presence of chemical elements responsible for the black color of the glass (chromium, manganese, iron and cobalt). To our surprise, we also detected high concentrations of barium, strontium and zirconium. These elements would not be present in 19th century glass.

This is a warning for anybody interested in making forgeries of 19th century black glass ambrotypes. There is a very good chance that we can uncover the evil work of forgers! Well, that is unless they have spent a lot of money searching for genuine 19th century black glass (this is not a very serious statement, as not all science has to be serious!).

Quinn also sent us his own variant of the tintype process printed on a factory-made black paint coated aluminum sheet. Following his suggestion we registered his photographs in our registrar records under the name of Alumitype. Just a few days after finishing and sending Quinn's analytical report, we heard from our collaborator in Bulgaria about his discovery of an alternative process photographer there producing the same type of photographs but using a different name. Who knew that we would need a nomenclature commission to deal with some linguistic and nomenclature problems? We will connect both photographers and we hope that they will solve these nomenclature issues over a glass of good Bulgarian red wine!

Photosynthesis and anthotype prints attracted a lot of attention when they arrived at our Institute. They were sent to us by New Zealand photographer Rosemary Horn. Our elemental and organic analysis of her print on an Arum lily leaf did not provide any earth-shattering new findings or any important clues that would help us to differentiate between the green and light brown parts of exposed leaf (Fig. 15).

Fig. 15 Rosemary Horn's Photosynthesis Arum lily leaf print

Several of our colleagues who had seen Rosemary's photographs asked about the light stability of her images, but we couldn't provide any real answers to those questions. We are very lucky that another research group at the Getty researches these types of issues.

Every visitor to the pastel room of the J.P. Getty Museum or the pastel galleries at the Musée d'Orsay in Paris knows that light levels allowed when exhibiting light sensitive artworks are much lower than light levels in galleries that show oil paintings. Recommended light levels are usually based on the scientific research of the light fastness of different art materials. The instrument that is used to conduct these experiments is called a microfadeometer. Having several instruments of this type at the GCI along with experienced scientists who can deal with these issues directly gives us the opportunity to find answers to our own questions and those from our colleagues. During a microfadeometry experiment, a minute beam of light irradiates an art object. The light reflected from its surface is measured by a very sensitive and sophisticated instrument. This instrument can detect not only any changes in the color of the material well before they are visible to our naked eyes, but it can also predict the long-term fading or darkening of the material when exposed to different lighting conditions in museum galleries (Fig. 16a and 16b).

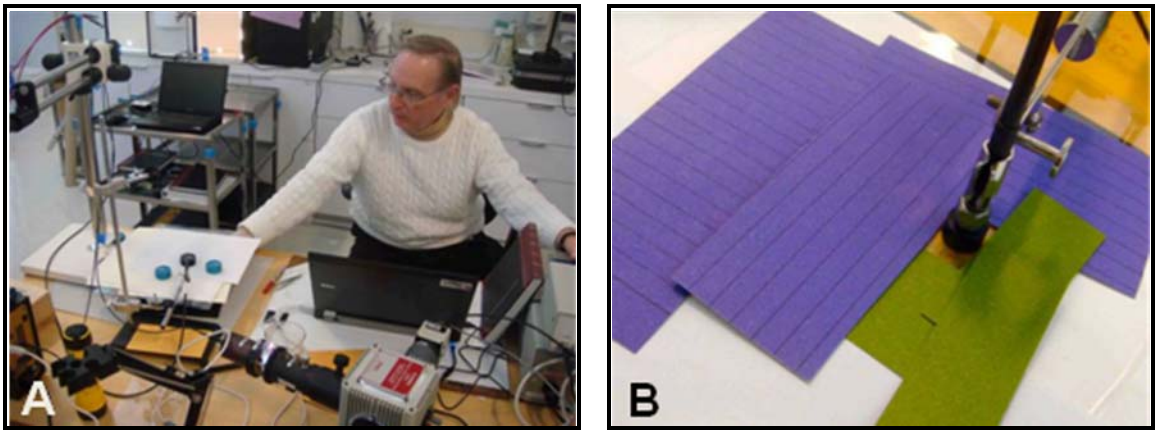

Fig. 16 a-GCI's Jim Druzik and his microfadometry laboratory b-Rosemary's leaf under the glass fiber probe of the microfader (most of the photograph was protected against room light fading during the measurement)

The recommendation of our light scientist regarding Rosemary's photographs was very clear:

"Both prints are light sensitive. The photosynthesis print can be displayed under low light levels for short periods of time. The Anthotype cannot be displayed at all without loss of image density."

This article is not the place for scientific data and mathematical equations, but we have very precise data that can explain and predict the future light stability behavior of both images in the exact language of physics and mathematics (Fig.17).

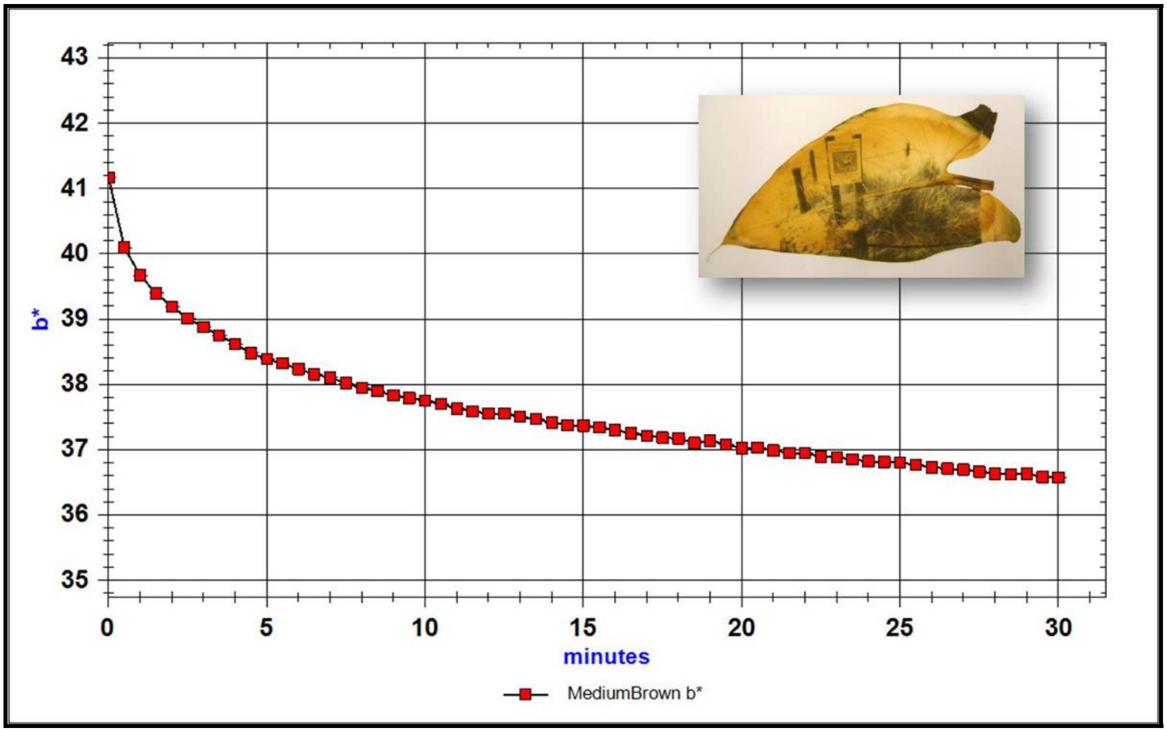

Fig.17 One of many graphs helping to predict the long term light stability of the Photosynthesis print

We are quite positive that in the future these types of experiments and measurements will find many more applications in the research of all chemically and digitally printed photographs.

A longtime supporter and contributor to our research is Texas photographer and photography educator Amy Holmes George. We have previously studied her tungsten-modified Ziatypes and selenium-toned silver gelatin photographs. Her latest contribution to our project is a series of untoned and toned cyanotypes, palladiotypes and various test examples of her gold-toned Van Dyke Brown prints.

One of her photographs is still giving us some sleepless nights because, even after a very thorough investigation, we cannot say that we fully understand it. The image in question is Amy's tea-toned (stained) cyanotype (Fig. 18).

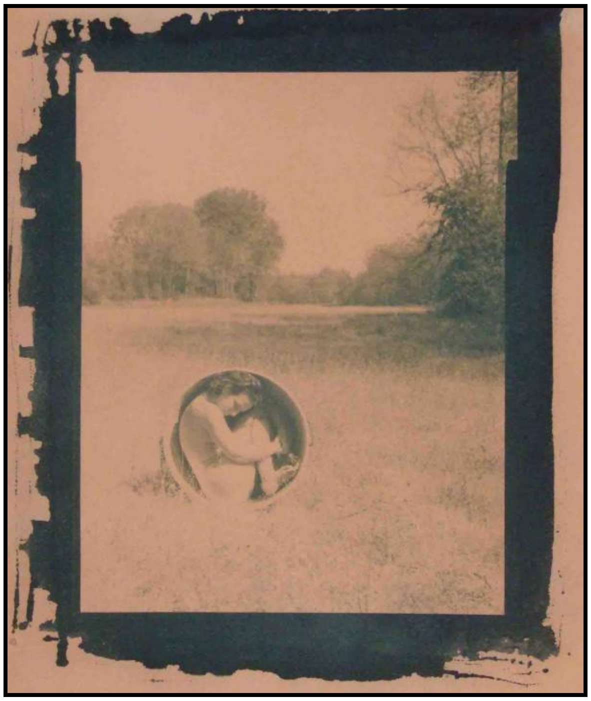

Fig. 18 Mysterious tea toned cyanotype

We have previously seen and analyzed some tea-toned cyanotypes, but this was the first time we detected two chemical elements that we hadn't seen in tea-toned cyanotypes before. These "mystery" elements are manganese (Mn) and rubidium (Rb). Even after analyzing hundreds of historical and modern cyanotypes we have never seen the presence of manganese or rubidium in cyanotypes.

The next step in our quest to understand our findings was to investigate the chemistry of tea leaves. As scientists we also started "cooking" different kinds of teas. It did not take us long to confirm that manganese is consistently a common trace element of tea leaves, and tea-stained paper contains an amount of manganese similar to what we found when analyzing Amy's tea-toned cyanotype (Fig. 19).

Fig. 19 So many tea samples to analyze!

To explain the presence of rubidium is much more difficult. A number of published analytical studies show that both tea and coffee extracts may contain higher concentrations of rubidium. However, our analysis so far of many cups of tea and many samples of tea-stained papers fails to show any detectable presence of rubidium. Well, this is how science works (or doesn't work). There are more tea samples to analyze, and we hope that Amy still has a small amount of the same tea leaves used to tone her cyanotypes.

It is true that researching and solving different mysteries relating to the history of photography causes us to lose some sleep, but these moments are well balanced by the excitement of problem-solving, learning and sharing our findings, as well as by those special moments when, for short periods of time, we are the "only people in the known universe" who know something that might be still a mystery for others.

Our now almost year-long collaboration with the alternative process photography community has been an absolute pleasure and all of us working together can be very proud of our accomplishments. The community contributed a great deal to the advancement of our understanding of many interesting aspects of chemical photography and we have provided many of you with interesting information related to the chemistry of your photographs.

Together we also started to build a very important educational study collection of photographs that is absolutely unique because it contains not only different photographic processes but because each photograph is accompanied by detailed information about its creation, along with samples of different precursors of final photographs along with all of the details of our scientific investigation (Fig.20).

Fig. 20 A section of alternative process photographs of the GCI Study Collection of Photographic Processes

We will conclude our article with a short paragraph included in all of the final reports we have sent to our collaborators upon the conclusion of our research of their samples:

"All photographic material submitted to the project (together with all documentation and analytical results) will be registered as part of the GCI Reference Collection of Photographs and Photographic Materials and will be available as research material to students of photography, students of photograph conservation and students of art history interested in chemical and alternative process photography."

We hope that this year was just the first year of a very successful and exciting and long-lasting collaboration.

October 2010

For more information on the GCI, visit www.getty.edu/conservation.