A method of consolidating delaminated autochrome plates from the photograph collection of the Albertina Museum in Vienna

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Abstract

A collection of about 2,100 autochromes belonging to the Albertina Museum was surveyed. This collection was formerly part of the Collection Eder at the Höhere Graphische Bundeslehr- und Versuchsanstalt (Training and Research Institute for Photography and Reproduction Processes), Vienna, Austria. Based on their condition, the autochromes were classified into several groups. The most severe damage identified was partial or complete delamination of the photographic emulsion from the glass support. A method for readhering the delaminated emulsion to the glass was developed. It involved the local application of xylene to the glass support, which softened the emulsion and allowed it to readhere to the glass. The image quality was not impaired by this treatment, and the physical stability of the photographs was significantly enhanced. The treatment was tested on original photographs, and preventive conservation measures developed for the rest of the collection.

The autochrome process

The autochrome process is not only one of the earliest colour processes but also the first successful commercial process. It is a direct-positive, transparent colour process on glass, and the resulting autochromes can be viewed by transmitted light or projection. In 1904 the first autochrome plate, created by the Société Anonyme des Plaques et Papiers Photographiques A. Lumière et ses Fils, was presented to the public. Three

years later they became commercially available when autochrome plates made by the brothers Auguste Lumière (1862–1954) and Louis Lumière (1864–1948) of Lyon, France appeared on the market. The autochrome process was used commercially between 1907 and 1937.

The production method is described by Hübl (1908), Lavédrine (1992) and Mebes (1911). Figure 1 shows a cross-section of the structure of an autochrome plate. First the glass support is coated with a layer of varnish. This is a mixture of latex and dammar resin, dissolved in ethyl acetate and toluene. Then a mixture of red, green and blue-dyed potato starch grains (the screen layer) is dusted onto the varnished glass support. These dyed starch grains form the colour component of the image after processing. The size of the grains is between 0.011 and 0.015 mm. Voids between the grains are filled with black charcoal powder. This is necessary to avoid the penetration of interfering white light. A second layer of varnish, which is a mixture of dammar resin and cellulose nitrate dissolved in ethyl acetate with castor oil, protects the screen from water. Finally the autochrome plate is coated with a panchromatic gelatin bromide emulsion. In their instructions, the Lumière brothers recommended the application of a final varnish as a protection layer. Usually a solution of dammar resin in benzene was applied.

The collection

The collection of autochromes that was surveyed is part of the collection of the Höhere Graphische Bundeslehr- und Versuchsanstalt (HGBLV), Vienna. This institute was founded in 1888 and gained an international reputation due to the work of Joseph Maria Eder (1855–1944) (Lechner

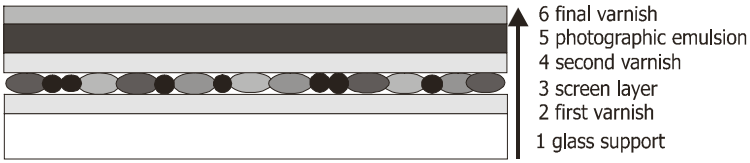

Figure 1. Structure of an autochrome plate. The arrow indicates the direction of exposure and viewing.

2003). The photographers at the HGBLV were Arthur Freiherr von Hübl (1853–1932), Karl Prokop, Josef Rheden (1873–1946) and Georg Winter. With the exception of Karl Prokop, the photographers were scientists and their photographs had a scientific purpose. Hübl, Rheden and Winter published numerous essays, articles and books about the autochrome process and other colour screen processes. In the *Photographische Korrespondenz* of 1907 (Photographie in natürlichen farben 1907) it was mentioned that the Lumière brothers had sent some plates to the HGBLV for experimental purposes. The photographers experimented with using these plates, resulting in very good flower and portrait photographs. The subject matter is mainly travel impressions from northern and southern Europe – Norway, Spain and Tunisia. In 2000 the whole collection of the HGBLV was transferred to the Albertina Museum as a permanent loan.

The survey

During transportation of the collection to the Albertina and preparation of the new inventory it was noticed that many of the autochrome plates were severely damaged. The survey gave an exact overview of the type and frequency of the damages. Altogether 2,135 autochrome plates were examined. The survey took a total of 51 hours working time.

For the survey, and the conservation and restoration treatments resulting from it, three condition classes were defined: I good, II moderate and III bad. Table 1 shows the characteristic features of these three classes. The condition of the support, the cover glass – if existing – and the image layer were described. The image layer is composed of the varnish layers, the screen layer and the emulsion. Each object was classified into one of the three condition classes. It can also be assumed that in the aging process the dyes of the autochromes at least partly suffer from changes in hue.

For the survey an Excel™ spreadsheet was created. All objects of the condition classes II moderate and III bad were registered in this spreadsheet – altogether 816 autochrome plates or about 38% of the whole autochrome collection. The following information was also entered into the database: inventory number, size, date, technique, damage to support and cover glass and damage to the image layer. Restoration and

conservation treatment requirements were noted. All objects which were not registered in the table have the condition class I good.

The size of the objects varies from 4.5×4.5 cm to 18×24 cm. Most of the autochromes are in a 9×12 cm format. Dates were very difficult to evaluate because inscriptions on the plates or on the boxes are rare. Approximate dating was possible by using the best-before date on the original Lumière plate boxes. This procedure is necessarily inaccurate because the plates might be stored for some time and the photographer could even have used an out-of-date charge. Approximately two-thirds of

Table 1. Condition classes

Condition class	*Description*	*Treatment required*
I good	Minor damage to support, cover glass and image layer: soiling, minor silver mirroring at edges.	Cleaning.
II moderate	Medium mechanical and chemical damage to the support, cover glass and image layer: soiling, broken cover glass, glass corrosion of cover glass, medium silver mirroring, minor delamination at the edges, minor formation of tears and cracks. Legibility and use are impaired.	Cleaning, and conservation and restoration treatments: stabilising the broken cover glass, replacing the cover glass, stabilising and/or repairing the delaminated layer.
III bad	Considerable mechanical and chemical damage to support, cover glass and/or image layer: soiling, broken support and cover glass, glass corrosion of the support, strong silver mirroring, medium to strong delamination, strong formation of tears and cracks. Legibility and use are strongly impaired.	Cleaning, conservation and restoration treatments: safeguarding the broken glass, replacing the cover glass, consolidation of delaminated layers.

the objects have a cover glass, which is fixed with a black paper mounting tape to the support. Only a few objects have a final varnish.

Damage to support and cover glass

The most frequent types of damage to the support are fingerprints and soiling. These are due to careless handling and considerable dust contamination in the storage location that was used until 1999. The next most frequent type of damage is broken glass and chipped or missing corners – also caused through improper use and storage. Glass corrosion was only identified on a few objects, either as little droplets or as crystalline deposits on the support glass.

The damage to the cover glass is similar. Soiling, dust and fingerprints were frequently noted. In many cases the black mounting tape has detached. Glass corrosion can be noticed relatively often on the cover glass. Broken glass and missing parts are the next most frequent types of damage.

Damage to image layer

Because of aging, climate fluctuation, unsuitable storage conditions and careless use at the previous storage location there were also various types of damage to the image layer. Delamination of the image layer from the support is common, with severity ranging from local to complete delamination. This affects autochrome plates both with and without a cover glass. In total 33% of the whole collection (i.e. 665 objects) show this damage. The image layer lifts off the support from the edges, in the form of smaller and bigger flakes. Delaminated ares can be recognized by their lighter colour (see Figure 2).

This delamination has occurred for several reasons. One is the complex structure of the image layer. The interrelation between the hydrophobic varnish layers and the hydrophilic emulsion layer plays an important role in explaining why adhesion problems between glass support and image layer arise. Through different swelling behaviour due to water absorption by the hygroscopic layer (gelatin emulsion) and the hydrophobic varnish layers, considerable tension arises. This may lead to delamination. The sensitivity of autochromes to humidity and temperature fluctuation was noted several times during the survey. Another reason for the delamination could be the absence of a final varnish (Waldthausen and Lavédrine 2002).

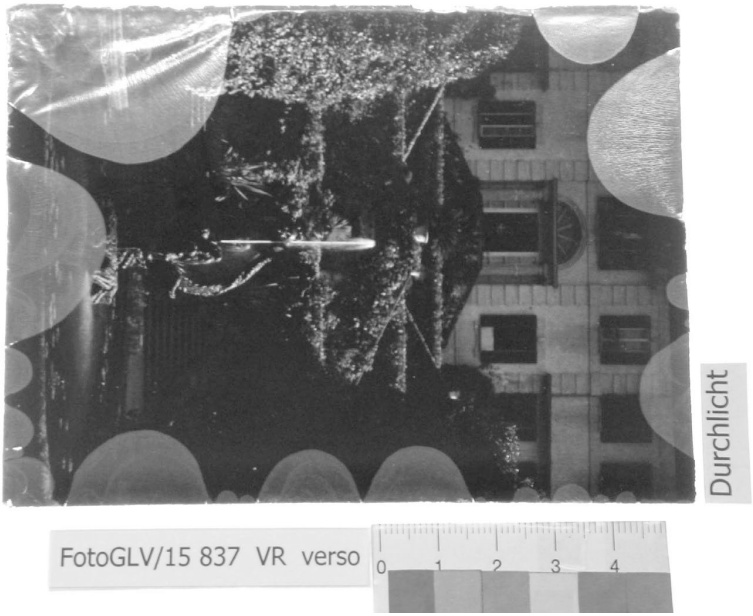

Figure 2. Delamination of the image layer from the glass support of an unglazed autochrome plate, condition class II moderate, transmitted light. GLV/15 837, © Albertina Museum

Loss of emulsion is interrelated with delamination of the image layer. Another frequent type of damage is the formation of tears and cracks in the image layer. Overall these types of damage indicate that the delaminated image layer is very brittle and fragile. 76.5% of the objects in condition classes II and III also have silver mirroring, mainly at the edges. Scratches, soiling and fingerprints on the image layer are not common.

Developing a treatment method

For the autochrome plates with delaminated image layers consolidation is recommended because in the present state use carries the risk of damaging the objects. The delaminated layer is very sensitive in the face of climate fluctuation and transportation. There is the danger that parts of the layer

could break off and image information could be lost. There are also aesthetic reasons for consolidation: the air between the delaminated areas and the glass support refracts the light differently than the well-adhered areas. The photographer's intention often cannot really be perceived and the original impression is impaired.

In the Centre de Recherches sur la Conservation des Documents Graphiques (CRCDG), Paris, Clara von Waldthausen and Bertrand Lavédrine have conducted research on consolidation of delaminated image layers of autochromes (2002). Their results suggest that solvents should be used for readhering. These should regenerate the first varnish layer and restore the adhesion to the glass support. Waldthausen and Lavédrine tested directly applied solvents and solvent vapour. The solvents were judged relating to how much they solubilised the dyes and the varnish components. Xylene and toluene were selected because they had the best test results. They do not dissolve the dyes, but in direct application some components of the varnish were dissolved. Therefore they were used in a gaseous form. A Whatman filter-paper soaked with 3 ml toluene was put into a test tube. This created a solvent vapour chamber which was placed on a part of the delaminated areas for 5 minutes. The consolidated areas were then carefully pressed down with silicon-coated polyester film and a Teflon spatula.

Trials were made to determine whether this method could be transferred to the objects in the autochrome collection. For the tests objects from the collection were made available. Because of the composition of the first varnish layer – dammar resin and latex and toluene – possible solvents are xylene and toluene. Both solvents are aromatics. For the tests xylene was chosen, because it is less toxic than toluene.[1]

The autochrome plates treated by Waldthausen had higher colour saturation in the consolidated areas after treatment with solvent vapour.

1 The threshold limit value of xylene is 100 ml/m³, the threshold limit value of toluene is 50 ml/m³ (Merck material safety data sheets for xylene (item nr. 108688) and toluene (item nr. 108323), 2002). In the safety sheets from 2004 there are no changes to the threshold limit value. Merck KGaA, D-64271 Darmstadt; Tel. +49-61 51 720; www.chemdat.de

Therefore the complete plate was put into a solvent chamber. The solvent vapour was used in a tent of Escal® foil with a volume of 6.8 litres. A tent from this material was first used and recommended in Ritter and Pataki (2004) for the complete solvent vaporisation of silk-screen prints. The foil is transparent, welded together at three sides and has a ceramic inner layer. This layer is a barrier against the escape of the solvents. Three bowls each containing a cotton-wool swab soaked with 13 ml xylene were put into the tent. Then the objects were exposed completely to the vapour. The open side of the tent was closed with clips.

In the tests adhesion of the first varnish layer to the glass support first occurred after 7–7.5 hours, but only at the edges of the delaminated areas. Under the remaining area air was locked in, which formed an air cushion preventing the solvent from penetrating any further. This shows the limitations of this method – only small areas at the edges of an autochrome plate can be consolidated satisfactorily. As three-quarters of the delaminating autochrome plates in the collection had large delaminated areas, this method was not appropriate.

Final consolidation method

For readhering the laminar delaminated image layers onto the glass support, the solvent xylene had to be brought directly between the glass support and the image layer. Altogether 15 objects from the collection were chosen for the consolidation treatment. Before treatment the glass support should be cleaned with a cotton-wool swab and a 50:50 ethanol: water mixture. However the glass parts under the image layer were only partly accessible for cleaning.

All test objects were photographed before and after treatment with a Nikon Coolpix 4500 digital camera using the largest picture size of 2,272 × 1,704 pixels. The emulsion side (recto) and the glass side (verso) were photographed with normal light as well as in transmitted light.

Working procedure

The solvent was introduced between the image layer and the glass support with a brush. For smaller areas a 1 cm wide, short, artificial-hair brush was used (da Vinci Junior Synthetics No. 8). For laminar delaminated

areas a 2.5 cm long, thin, artificial-hair brush was used (da Vinci Nova Synthetics No. 6). Both have a smooth, soft surface, which is necessary for this work.

The brush was soaked with the solvent, but not made too wet. Then the brush was pushed between the layer and support, in order to bring the solvent to the back of most areas. The autochrome was held glass side up, in order to control the areas being consolidated better. The solvent spread over the glass and the image layer lay down immediately.

With laminar delamination it was found to be very important not to use too much solvent. This allowed the consolidation to be done in a controlled way, in several parts. Air bubbles could form if the solvent did not spread over the glass surface completely. However, the solvent takes some time to swell the image layer and during this time small air bubbles could be brushed outwards to the plate edges. Then the layer was pressed down on the glass support with a Bondina® fleece and a Teflon spatula. It was found to be an advantage to also weight the autochrome plates for at least two hours after consolidation with a Bondina®-fleece, two pieces of cardboard and weights. The required working time depended on the size of the areas to be consolidated. For example, the method allows consolidation of completely delaminated image layers, and in this case treatment time would be about 40 minutes.

Figure 3 illustrates the principal working procedure schematically. It begins with the introduction of xylene between the image layer and the glass support. The next step is brushing any air bubbles outwards to the plate edges. After evaporation of the solvent the image layer is completely fixed onto the glass support.

Figure 4 shows an object during consolidation. The already-consolidated smooth area (right arrow) can easily be distinguished from the wavy areas that are still to be consolidated (left arrow).

Figure 5 shows the autochrome plate from Figure 2 after consolidation with xylene.

Preventive conservation measures

In cooperation with the Klug Conservation company, a special design of the NOMI®-Box KS 15 was created for the packing and storage of

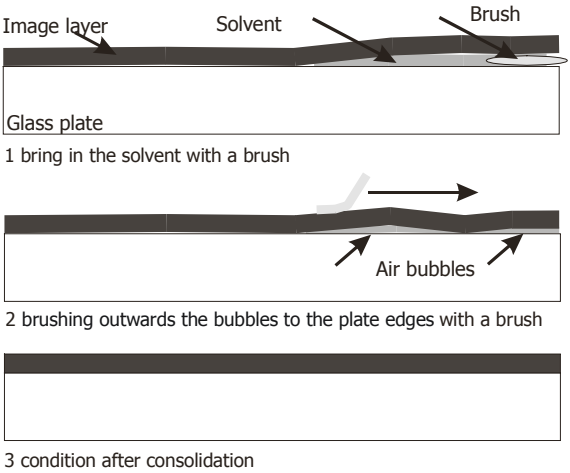

Figure 3. Schematic view of the working procedure for consolidating delaminated image layers with xylene.

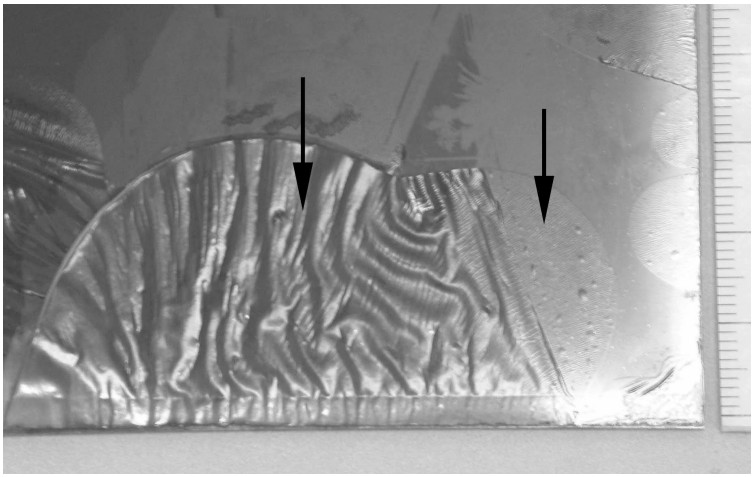

Figure 4. Detailed view of an autochrome plate during consolidation with xylene. The right arrow shows the consolidated area, the left arrow shows the areas still to be consolidated. GLV/15 753, © Albertina Museum

Figure 5. The autochrome plate from Figure 2 after consolidation with xylene, transmitted light. GLV/15 837, © Albertina Museum

the autochromes. The two-piece archival box is made of acid-free and lignin-free, buffered, finely corrugated cardboard. The body remains as a placeholder in the shelves. The insert is subdivided into two compartments. Ten to a maximum of 15 plates can be stored in each box. As additional protection, the objects were also packed in four-flap folders. These were made of acid-free and lignin-free alpha-cellulose paper.

At present the plates are unglazed. For glazing a glass with UV protection, 'UV Denglas' from Denglas Technologies company, was recommended. The recommendation for a tape to join the cover glass and support glass is self-adhesive tape Permacel J-Lar P 910. This consists of a polypropylene support and an acrylic adhesive, and it has passed the Photographic Activity Test. This tape was used for the protection of the

autochrome plates of Heinrich Kühn in the Austrian National Library (Hofmann and Schoegl 2001).

For storage of the autochromes in the photograph collection the following climate conditions were recommended: a temperature of 17°C and a relative humidity of 40%. These conditions are modelled on the climate in the Musée Albert Kahn, Paris, which has a very large collection of autochromes.[2]

Digitisation of the autochrome plates with a touch-free photograph system is also proposed as a conservation measure. The scanning process should be done without a flat-bed scanner. Use of a digital camera and back lighting is preferable.

Conclusion

The consolidation method described makes it possible to readhere partially and completely delaminated autochrome image layers onto the glass support. In the consolidated areas on the autochrome plates that were tested, no colour changes could be seen. On larger areas it is recommended to work in several stages, readhering one part at a time in between pressing down the layers with a spatula. This makes the consolidation process easier to control. In particular, it was found that completely delaminated image layers and layers which are badly torn must be worked in several stages. Only this way can the layer be placed exactly without shifting. Problems with small air bubbles can happen in laminar delaminated areas, but they are controllable. The preventive conservation measures described are suitable for the permanent storage of autochromes.

Acknowledgments

I want to thank Prof. Dr. Gerhard Banik (Academy of Art and Design Stuttgart), Monika Faber (Albertina Museum, photograph collection, Vienna), Mag. Andreas Gruber (photograph conservator, Vienna), Michael Kühner (Klug-Conservation, Immenstadt), Dr. Bertrand Lavédrine (CRCDG, Paris), Mag. Astrid Lechner (Albertina Museum, photograph

2 Musée Albert Kahn, 14, rue du port, F-92100 Boulogne, museealbertkahn@cg92.fr

collection, Vienna), Prof. Dr. Hubert Locher (Academy of Art and Design Stuttgart), Dipl. Ing. Manfred Mayer (University Library, Graz), Elisabeth Thobois (Albertina Museum, restoration workshop, Vienna), Clara von Waldthausen (photograph conservator, Amsterdam) and Dipl. Ing. Günther Wegele (Klug-Conservation, Immenstadt) for numerous information and technical advice, and all employees of the restoration workshop and the photograph collection of the Albertina Museum for their support during the diploma work.

Figures 1–5, Ulrike Müller; Figures 2, 4 and 5 with permission of the photograph collection, Albertina Museum, Vienna, Austria.

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