19th Century
Materials, Processes, Technologies

Photographic Process ID Webinar #1

Image Permanence Institute
2017-2018

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Resources

Web Resources

- Graphics Atlas
  - www.graphicsatlas.org
- George Eastman Museum Photographic Processes Series
  - YouTube
- Lingua Franca: A Common Language for Conservators of Photographic Materials
  - iTunes App
- The Atlas of Analytical Signatures of Photographic Processes
  - www.getty.edu/conservation/publications_resources/pdf_publications/atlas.html

Print Resources

- *Care and Identification of 19th Century Photographic Prints* by James Reilly
- *Photographs of the Past: Process and Preservation* by Bertrand Lavedrine
- *In the Darkroom: An Illustrated Guide to Photographic Processes Before the Digital Age* by Sarah Kennel

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

What is a Photograph?

- An Image
  - Light Sensitivity of Chemical Compounds
    - Silver Salts
    - Iron Salts
    - Chromium Salts
- A substrate

Salts (Chemistry): an ionic compound which is made up of two groups of oppositely charged ions (positive and negative)

Chromium Salt: Potassium dichromate

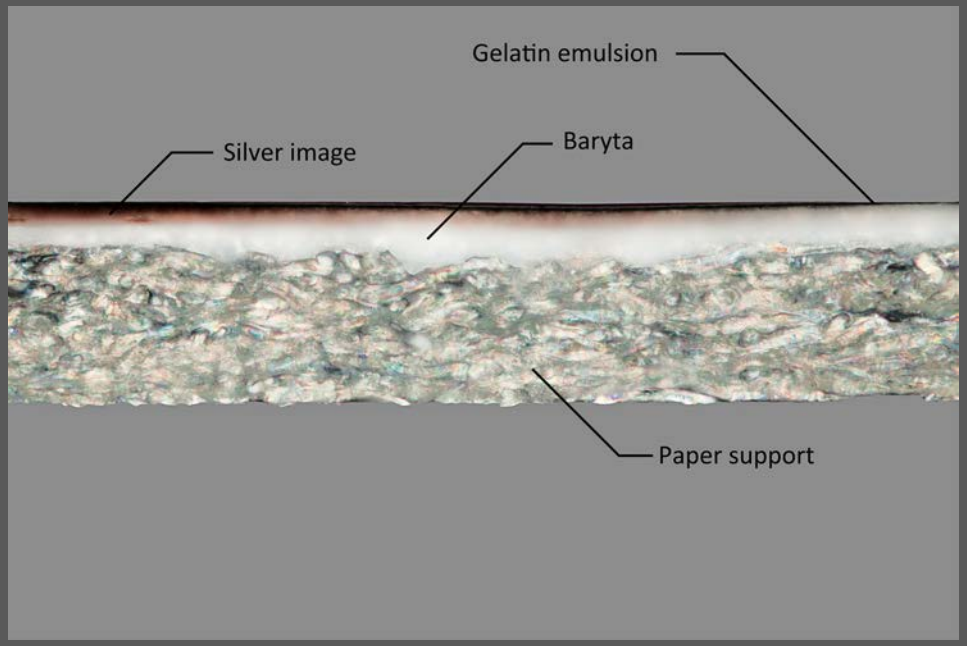
NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Building Blocks of a Photograph

- Image Material
- Support
- Image Binder*
- Support Coating*

*not always present

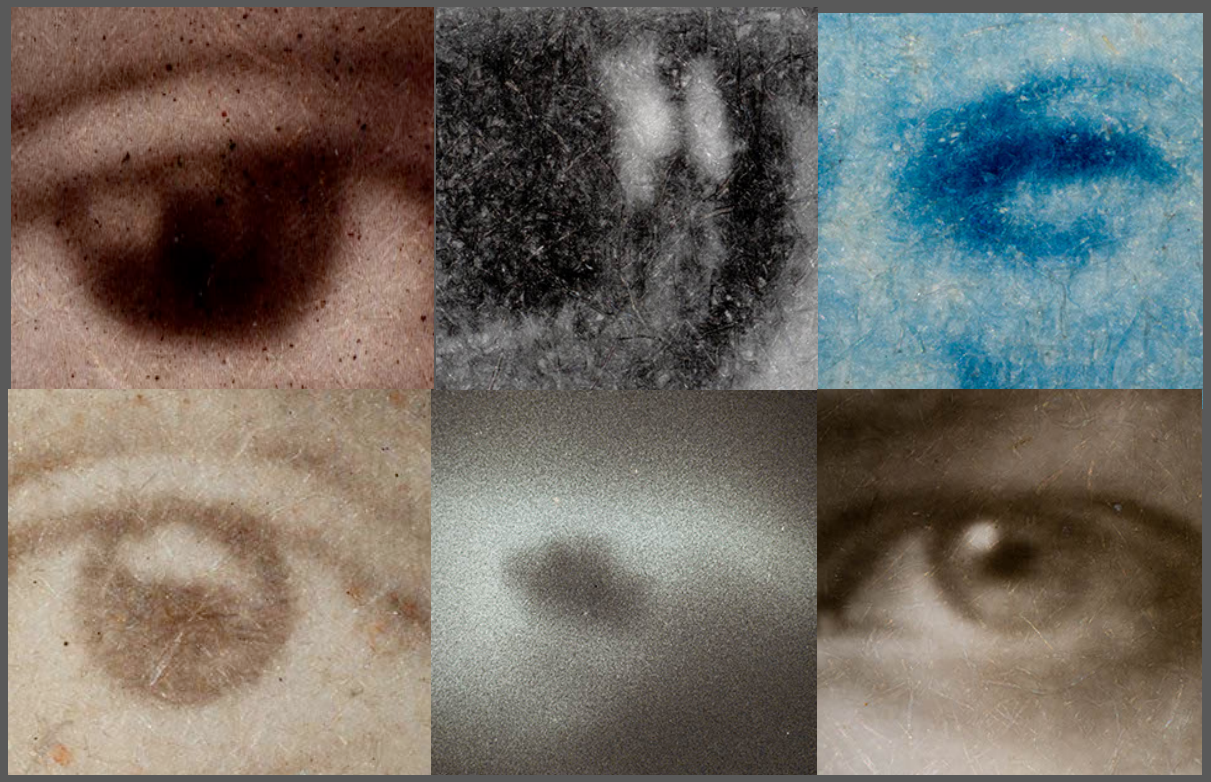


NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Image Material

- Metal
  - Silver
  - Gold
  - Platinum
- Pigment

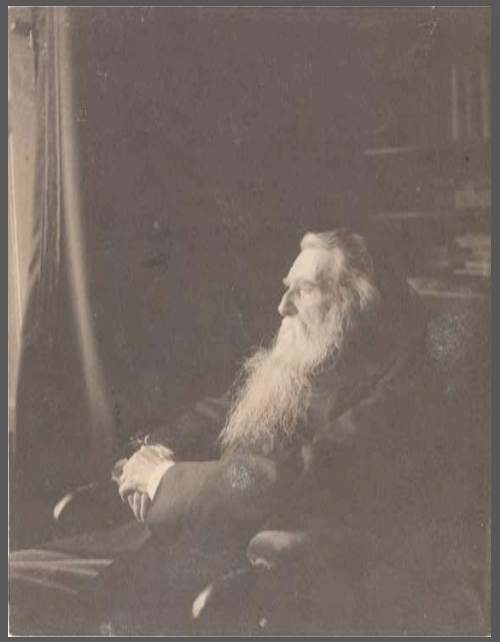


NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Supports

- Common
  - Paper
  - Metal
  - Glass
- Less common
  - Cloth
  - Ceramic
  - Leather



NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Image Binder

- Materials
  - Albumen
  - Collodion
  - Gelatin
- Purpose
  - To hold and suspend the image material above support
  - Sharper image
- Properties
  - Transparent
  - Ideal for suspensions
  - Each binder has specific properties

Albumen print

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Support Coating

Baryta

- Materials
  - Barium sulfate and gelatin
- Purpose
  - Cover paper fibers
    - Smooth surface
    - Reduces light scattering
  - Higher surface sheen
  - Sharper image
  - Higher density in shadows
  - Improve binder adhesion

Gelatin POP

Building Blocks of Photographic Prints

One layer

Two layers

Three layers

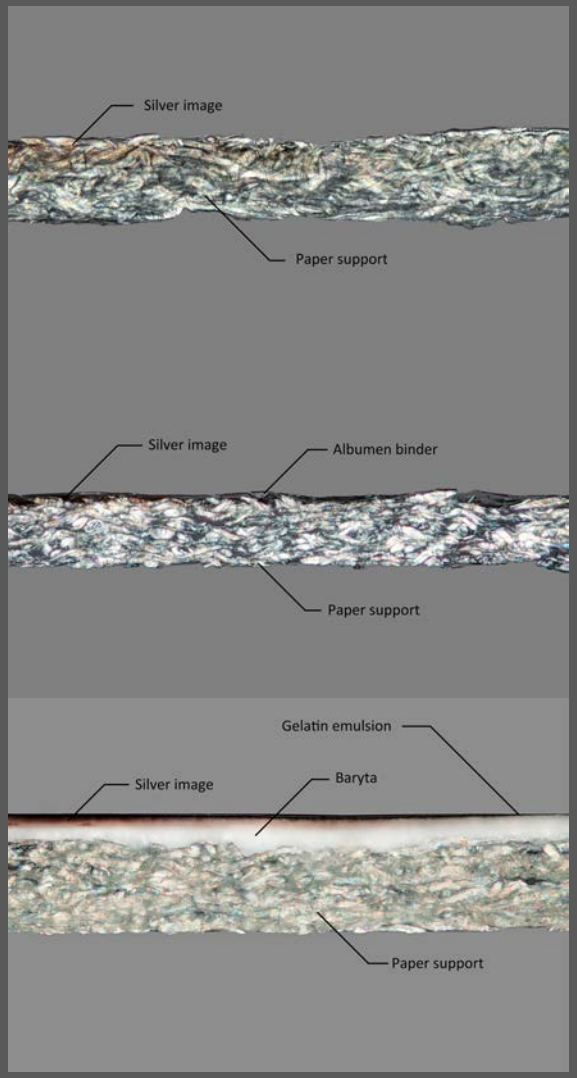


Image material
Support

Image material in Binder
Support

Image material in Binder
Baryta
Support

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Types of Photographs

- Negative
- Print
- Positive Transparency
- Direct Positive

NATIONAL ENDOWMENT FOR THE HUMANITIES

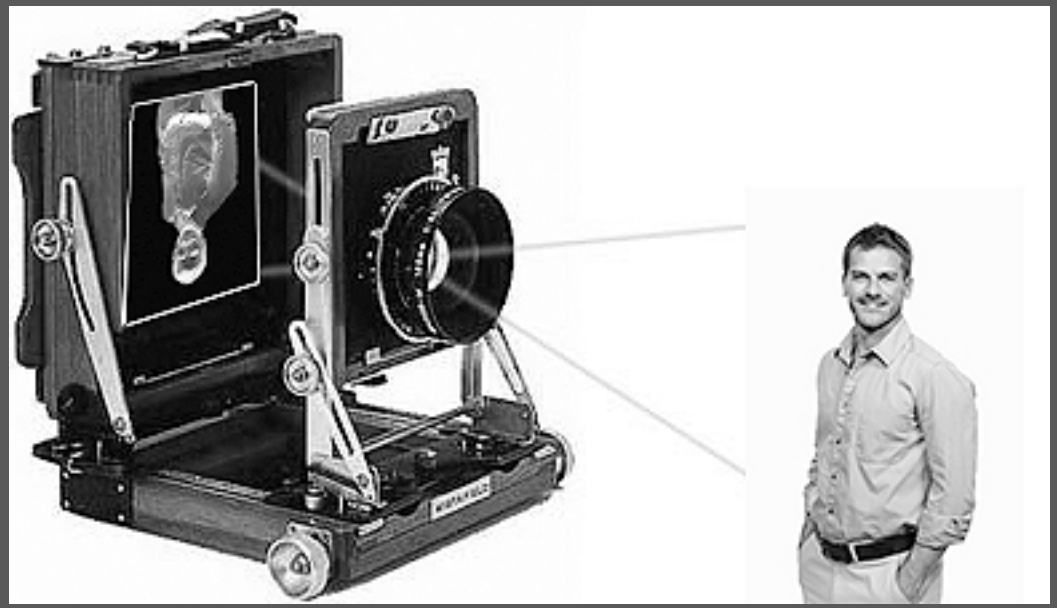
IPI IMAGE PERMANENCE INSTITUTE

Negative

A tonally reversed image on a transparent support.

Negative

All light sensitive materials exposed to light through a camera produce a negative image.



More light is reflecting off the light surfaces like the man's shirt exposing the light sensitive material creating darker hues.

Less light is reflecting off the dark surfaces, like the man's hair. Little to no material is exposed creating light hues.

NATIONAL ENDOWMENT FOR THE Humanities

IPI IMAGE PERMANENCE INSTITUTE

Print

A positive image on an opaque support

Positive Transparency

A positive image on a transparent support

Direct Positive

A positive images made directly in the camera.

- "Direct positive" images are technically negatives.

- Daguerreotypes
- Ambrotypes
- Tintypes

NATIONAL ENDOWMENT FOR THE HUMANITIES

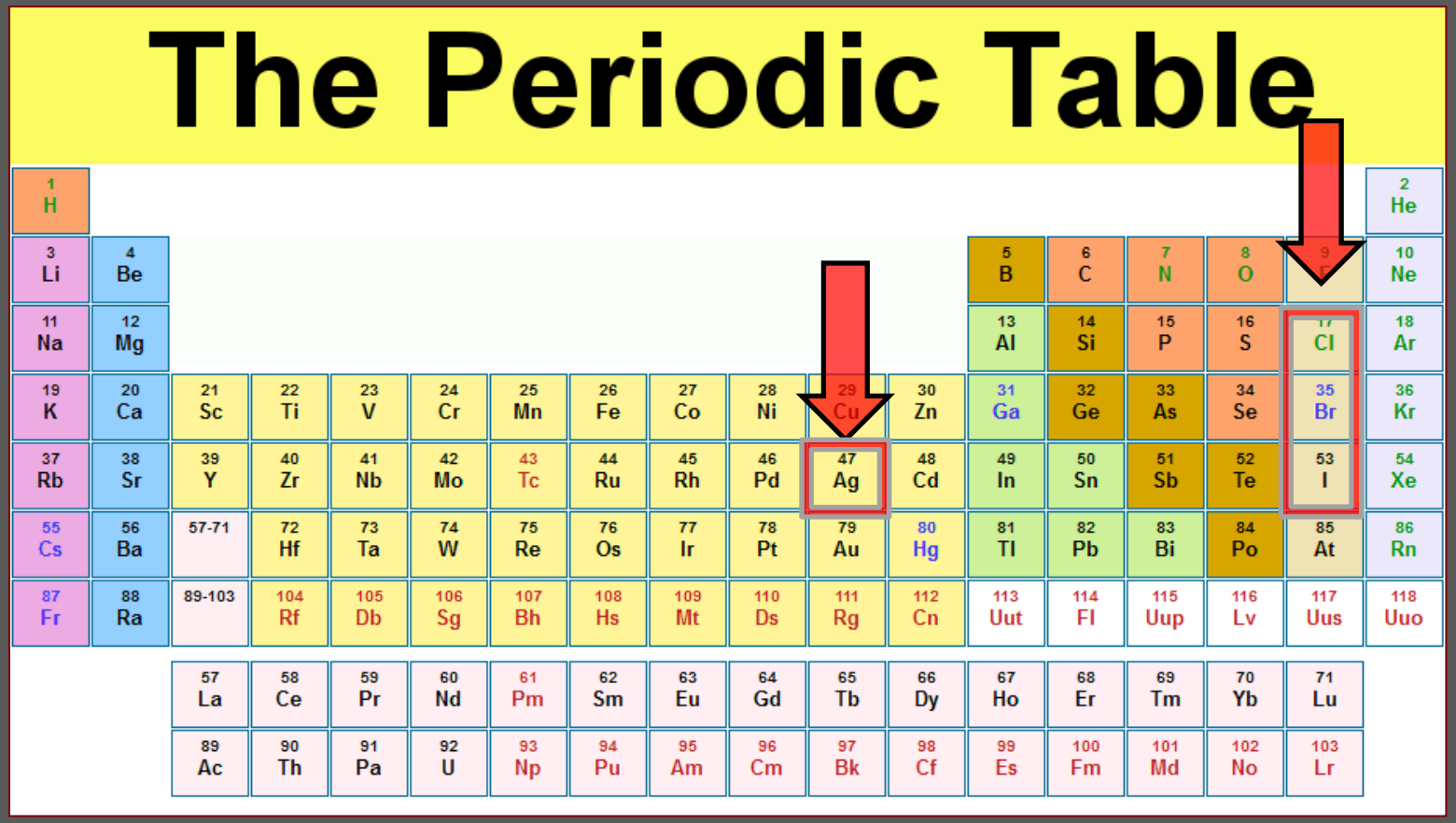
IPI IMAGE PERMANENCE INSTITUTE

The Chemistry

Silver Halide Chemistry

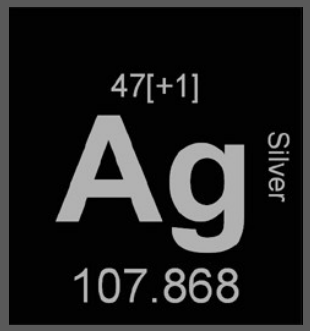
- Developing Out
  - Negatives
  - Some Direct Positives
- Printing Out
  - Prints

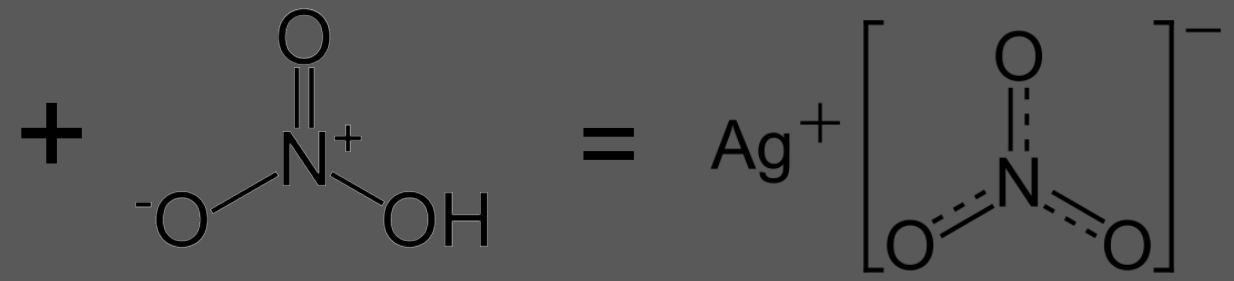
Chemistry: Silver



$Ag^{+} + Cl^{-}, Br^{-}, I^{-} = AgCl, AgBr, AgI$

Chemistry: Silver





NATIONAL ENDOWMENT FOR THE Humanities

IPI IMAGE PERMANENCE INSTITUTE

Chemistry: Silver

$$Ag^{+}\left[\begin{array}{c} O \\ \| \\ O=N-O \end{array}\right]^{-}_{(aq)} + [Na]^{+}\,[Cl]^{-}_{(aq)} = AgCl_{(s)}$$

Chemistry: Silver

NATIONAL ENDOWMENT FOR THE HUMANITIES

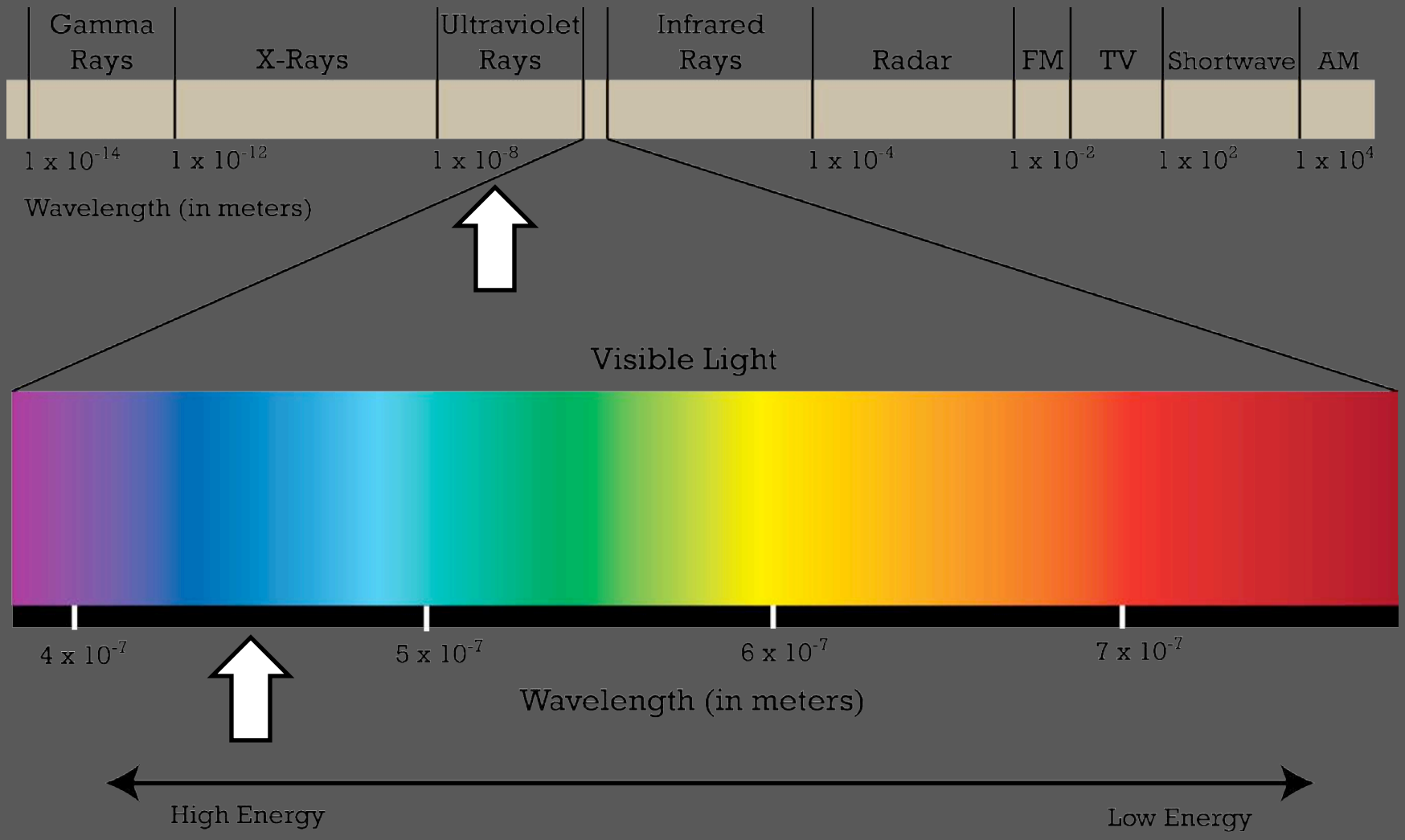
IPI IMAGE PERMANENCE INSTITUTE

Chemistry: Silver

Silver Iodide Silver Bromide Silver Chloride

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE



The Electromagnetic Spectrum

NATIONAL ENDOWMENT FOR THE Humanities
IPI IMAGE PERMANENCE INSTITUTE

Silver DOP

Developing Out (DOP)

- Negatives and some Direct Positives 1839-1880s
- Excess of halide
- Short exposure
- Latent image is formed (invisible)
- Reduced by chemical reaction to metal
- Produces large particles
- Creamy white highlights, black or brown shadows/midtones

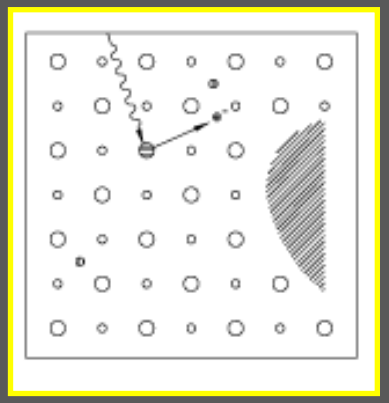
NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Silver Halide Crystal

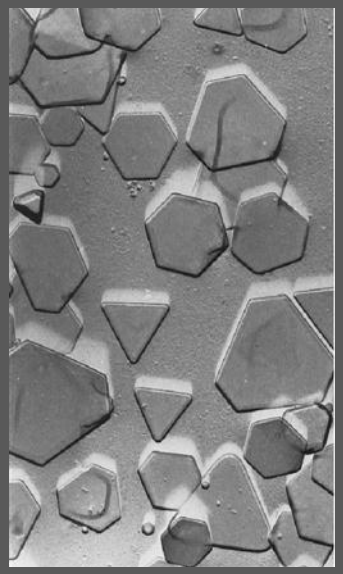
3D Model of AgBr

=



2D Model of AgBr

=



Actual AgBr crystals

=

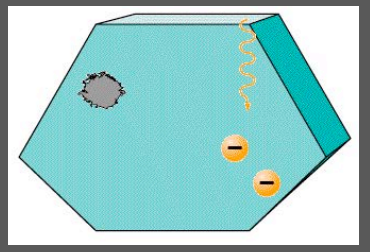
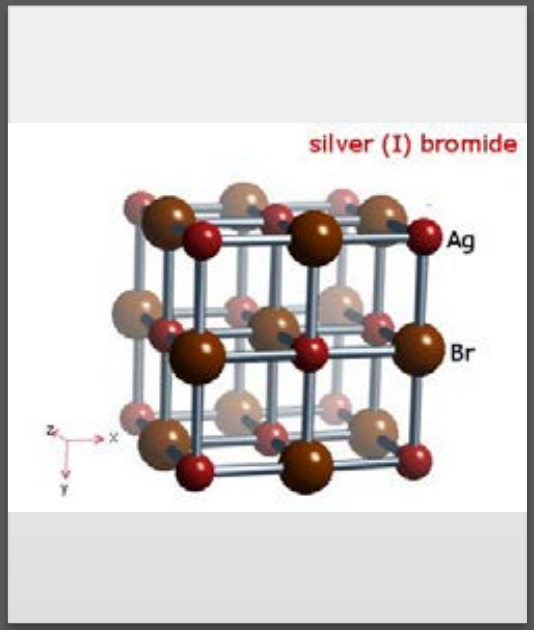


Illustration of AgBr crystals

Silver DOP

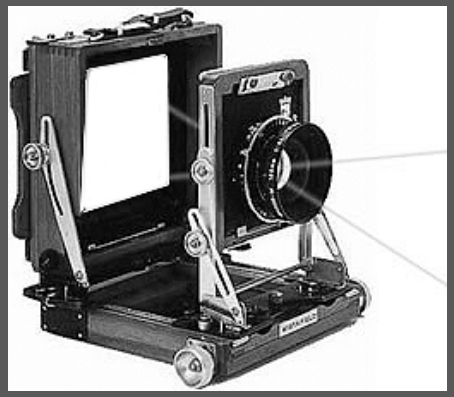
Light sensitive silver salts are coated onto the substrate



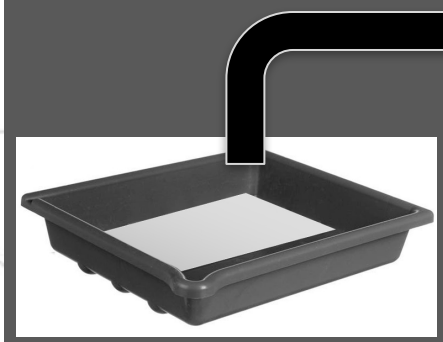
2AgBr (s)

Silver Bromide

Silver DOP



Exposure

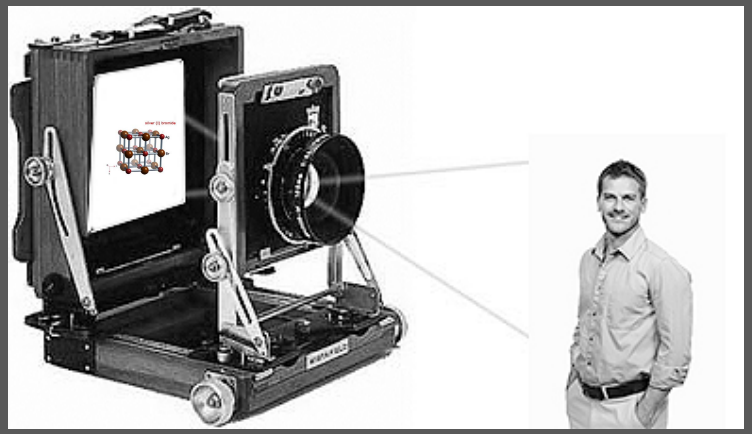


Development

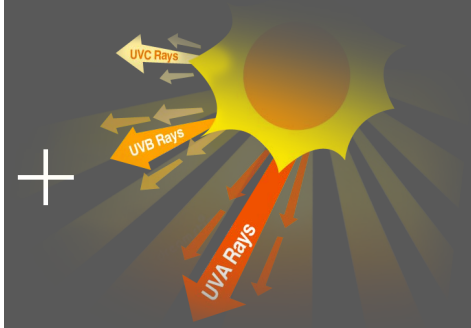
Fix

Wash

Silver DOP



+



=

2AgBr (s)

Silver Bromide

Light

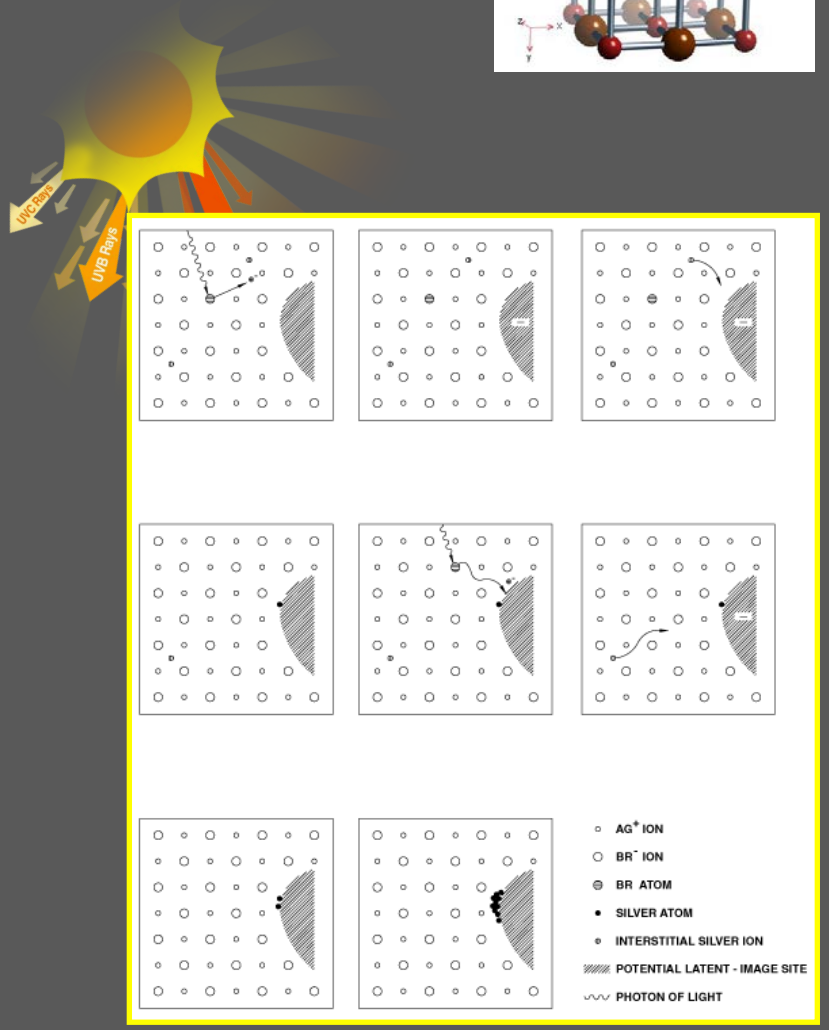
Latent image

NATIONAL ENDOWMENT FOR THE Humanities

IPI IMAGE PERMANENCE INSTITUTE

Latent Image

- Light photons (energy) excite electrons, kicking them out of orbit.
- Electrons get trapped in a defect in the crystal lattice
- Free silver ions are attracted to the electrons and reduced to silver metal atoms. Four or more silver atoms create a latent image center.



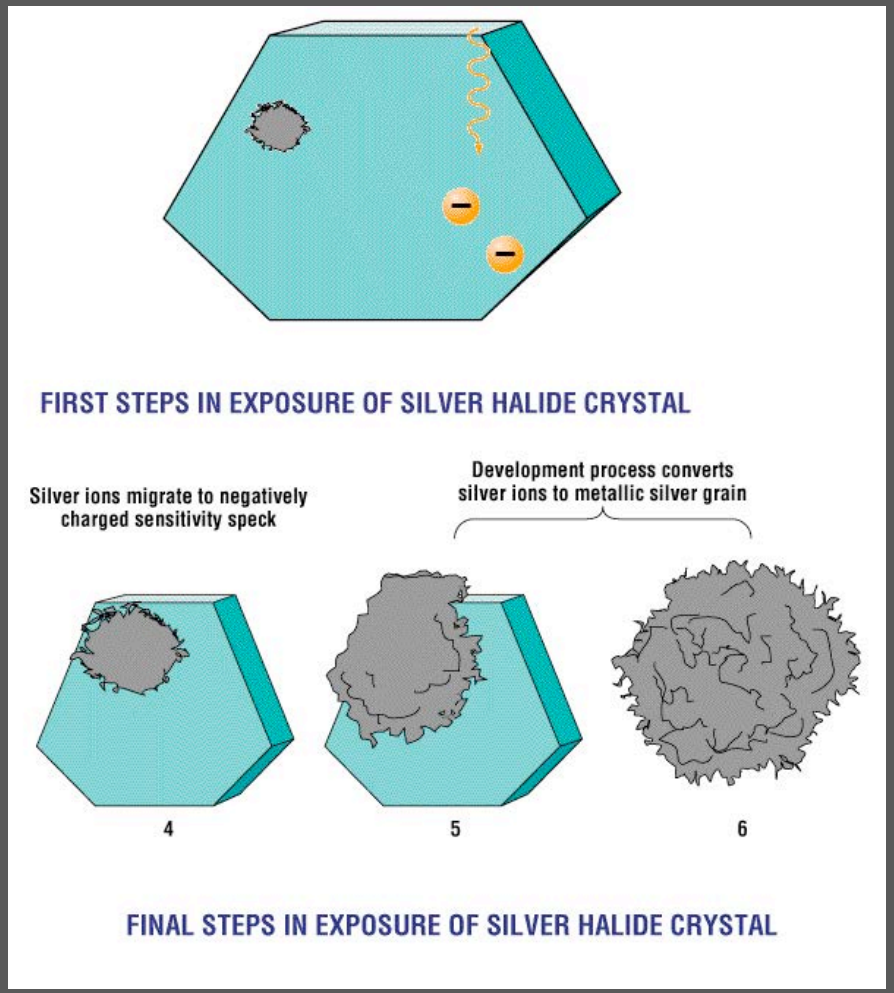
NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Silver Image Development

- Developer is an electron source
- It provides the electrons needed to complete the reaction
- Silver ion reduces to metallic silver image grain.

e^-



Silver Image Development

During development, the exposed silver halide is chemically reduced to silver

Silver DOP

Processes
- Calotype
- Paper negative

Type
- Negative

Image
- Silver

Support
- Paper

Paper negative, 1840-1865

Edouard Denis Baldus
Orange (Vaucluse) - Face sud, arc de triomphe en 1851
Paper Negative
Musee D'Orsay

Silver DOP

Process
- Wet plate collodion

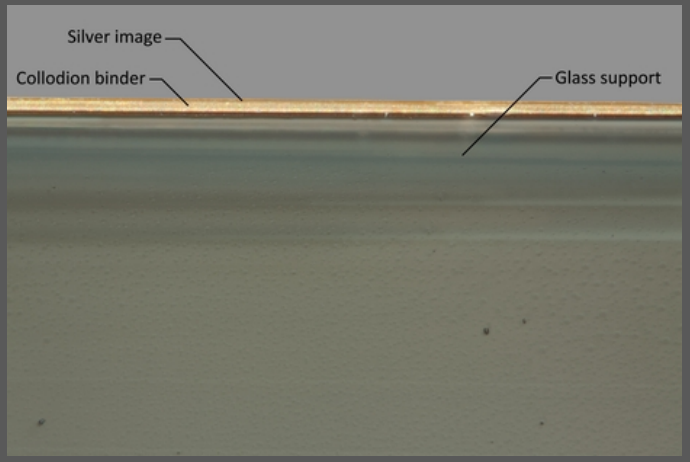
Type
- Negative
- Positive Transparency

Image
- Silver

Supports
- Glass

Binder
- Collodion

Wet Plate Collodion 1851-1885



NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Silver DOP

Processes
- Ambrotype, tintype

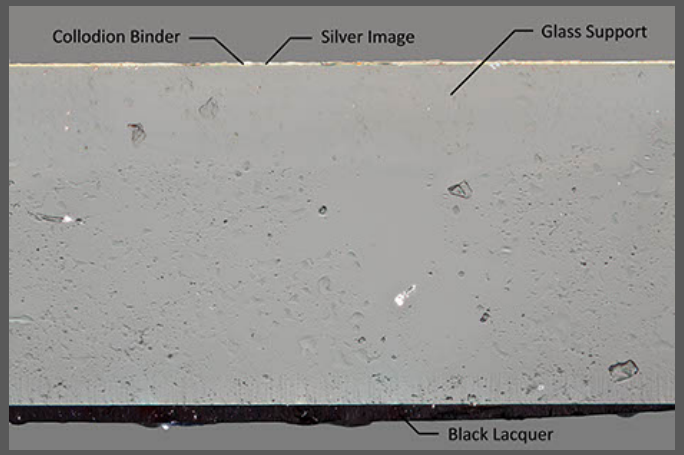
Type
- Direct Positive

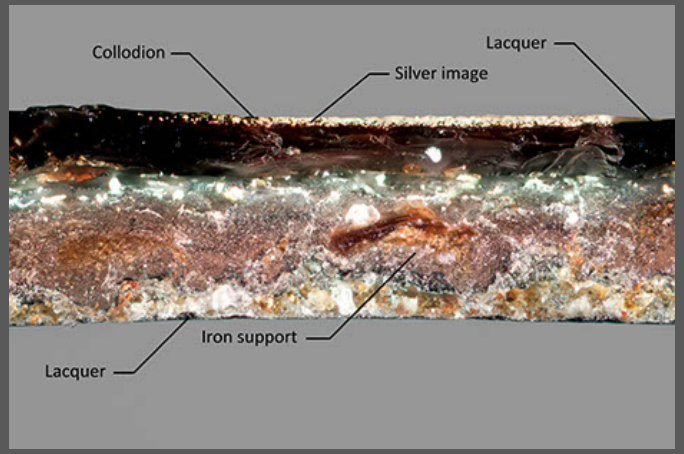
Image
- Silver

Supports
- Glass
- Metal

Binder
- Collodion

Ambrotype, 1854-1865





Tintype 1856-1920

Silver DOP

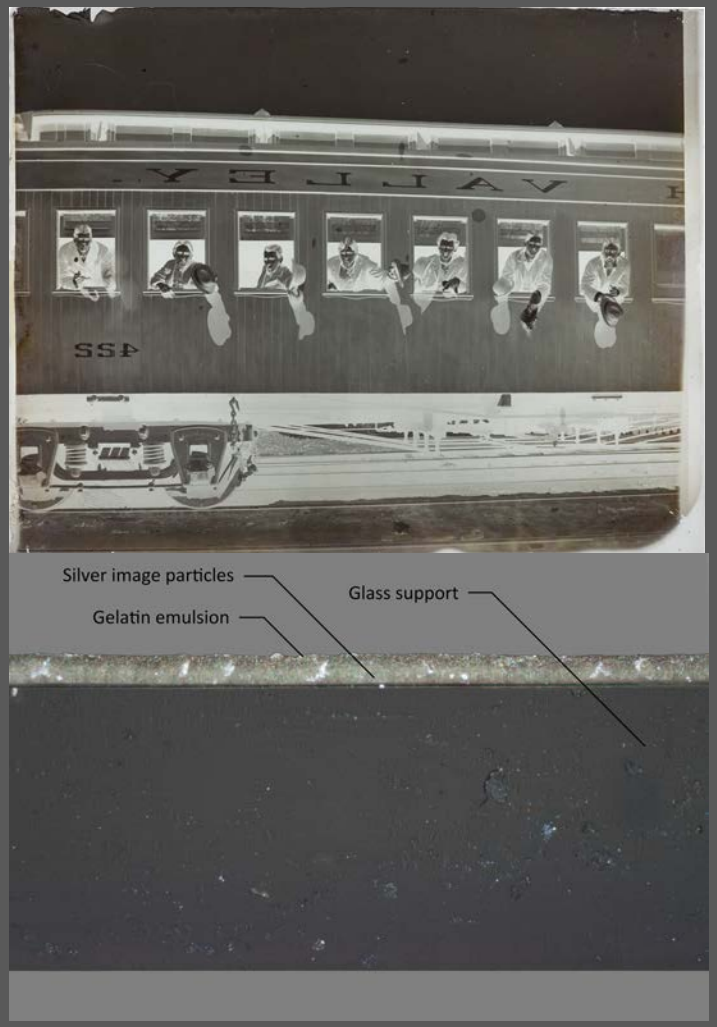
Process
- Gelatin dry plate

Type
- Negative
- Positive transparency

Image
- Silver

Support
- Glass

Binder
- Gelatin



Gelatin Dry Plate, 1880-1925

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Daguerreotype

Sensitize: Ag + Br, I = AgCl, AgBr, AgI

Develop: Mercury (Hg)

Daguerreotype

Type
- Direct Positive

Image
- Silver
- Gold
- Mercury

Support
- Metal

Daguerreotype, 1840-1860

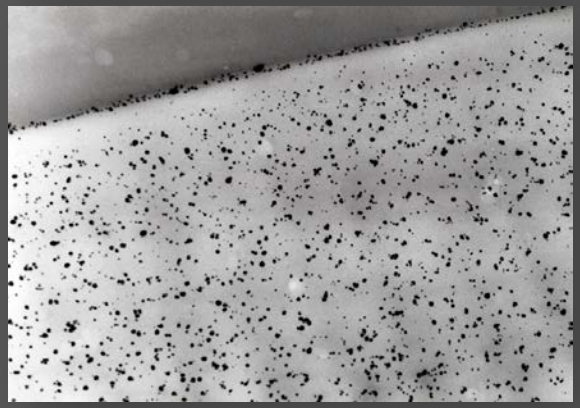
NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Print

A positive image on an opaque support

Silver POP



Printing Out (POP)

- Prints only, 1839-1900
- Excess of silver
- Silver salt reduced to silver by light alone
- Long exposure
- Small, round particles
- Toned with gold and/or platinum
- Warm image tone: Purple/Red

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Silver POP

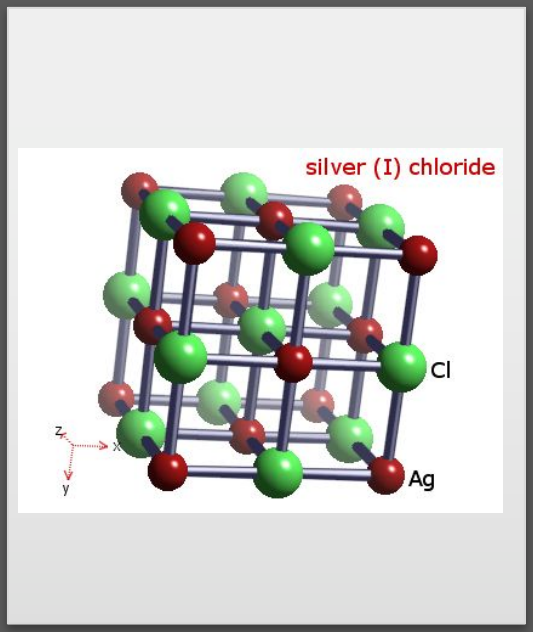
- Salted paper, 1840-1855
- Albumen, 1860-1895
- Collodion POP, 1885-1910
- Gelatin POP, 1885-1910
- Matte Collodion, 1895-1910

NATIONAL ENDOWMENT FOR THE Humanities

IPI IMAGE PERMANENCE INSTITUTE

Silver POP

The paper is exposed to light. The exposed silver salts are reduced to silver by the action of sun (UV) light alone producing an image.



+

=

$2AgCl\ (s)$

Silver Chloride

Light

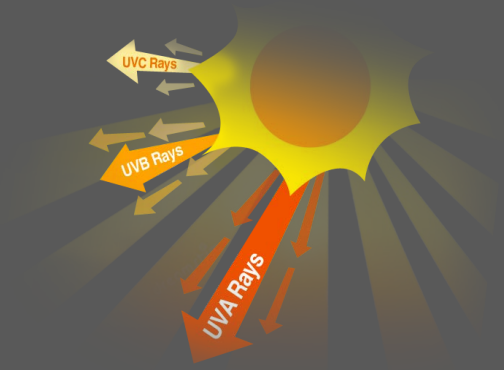
$2Ag\ (s) + Cl_2\ (g)$

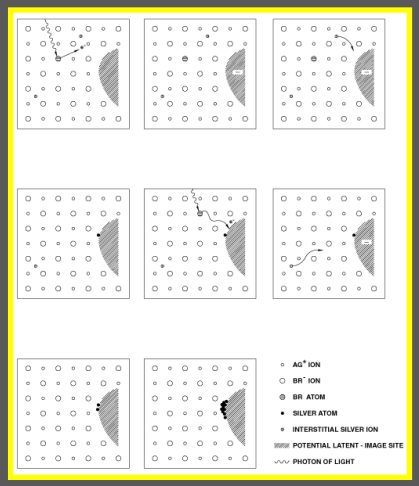
Silver Chlorine

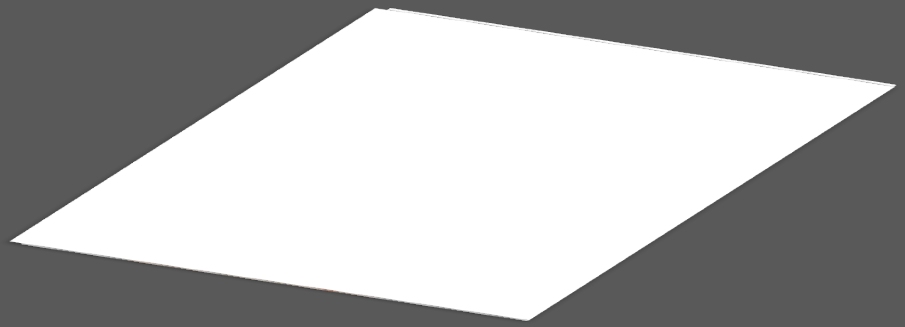
NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Silver POP

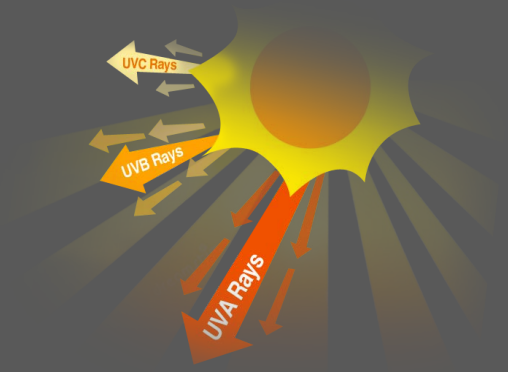


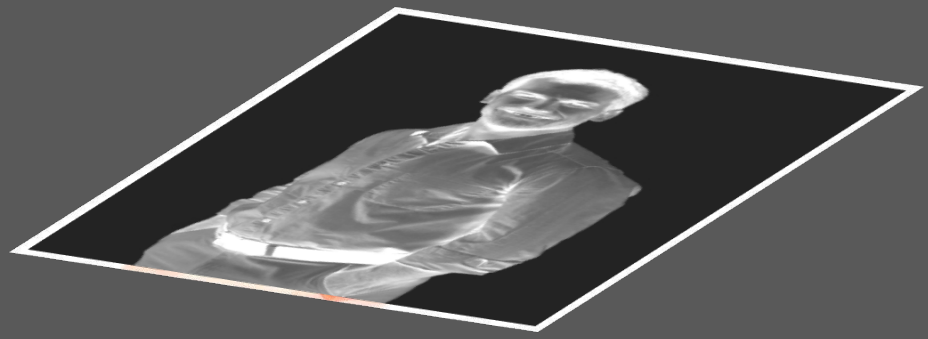




Contact Printed: negative is placed in direct contact with the sensitized paper

Silver POP

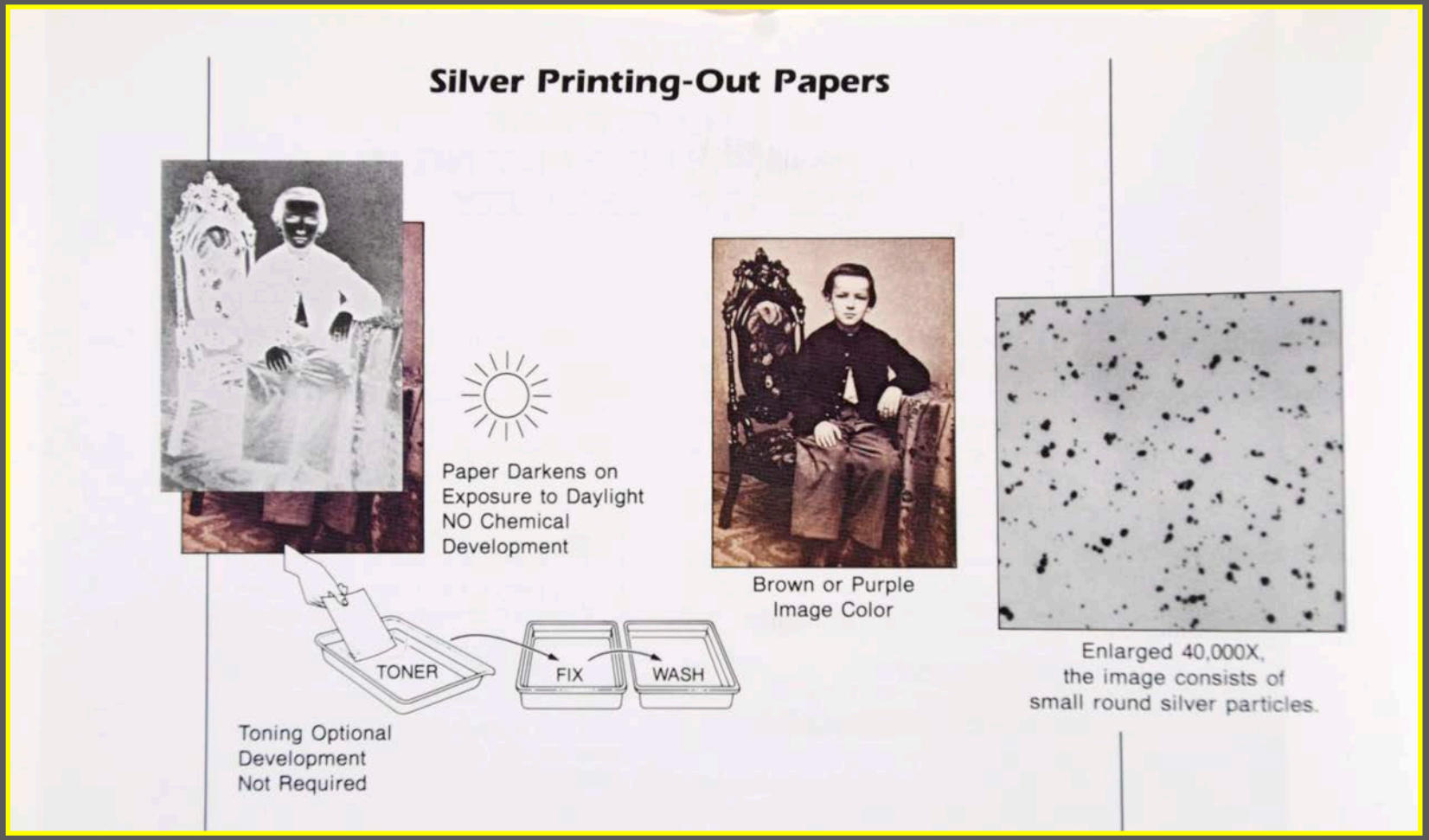




NATIONAL ENDOWMENT FOR THE Humanities

IPI IMAGE PERMANENCE INSTITUTE

Silver POP



Silver POP

Gold toning

- Gold replaces some of the silver
- Image tone depends on the length and strength of gold toning.
- Images range from red-purple to near neutral purple-black.

Collodion POP

Gelatin POP

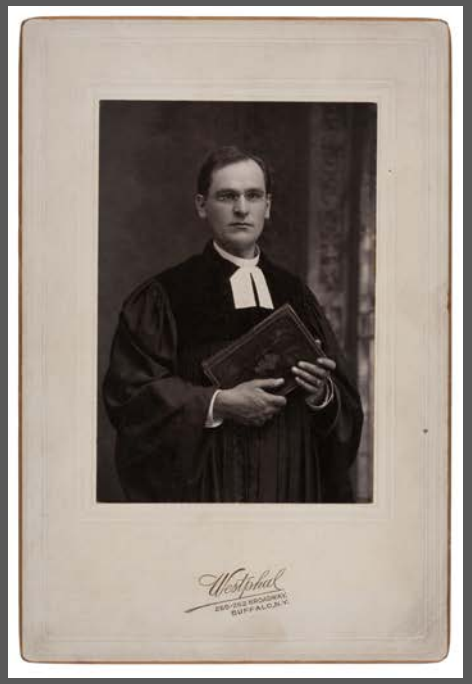
Salted Paper

Albumen

Silver POP

Image Material: gold and platinum toning

- Gold
  - Purplish tones
- Platinum
  - Brown tones
- Gold and platinum
  - Warm black tones



Matte Collodion

Silver POP

Image Deterioration

- Image fading
- Change in image tone
  - brown, yellow, yellow-green

Silver POP

One layer

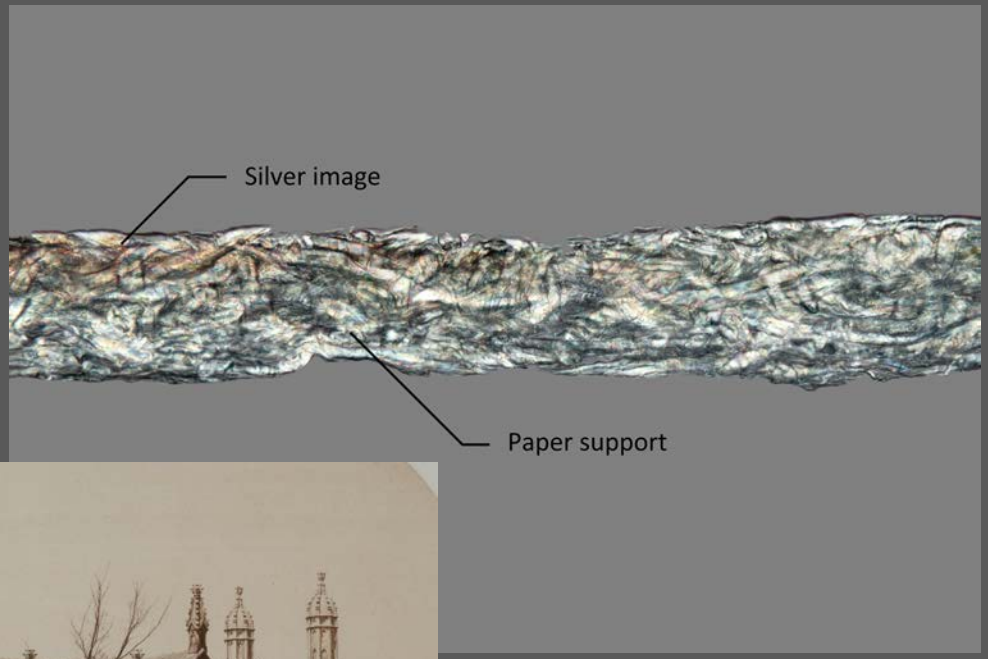


Image material forms directly in paper support

Salted paper print

Silver POP

Two layers

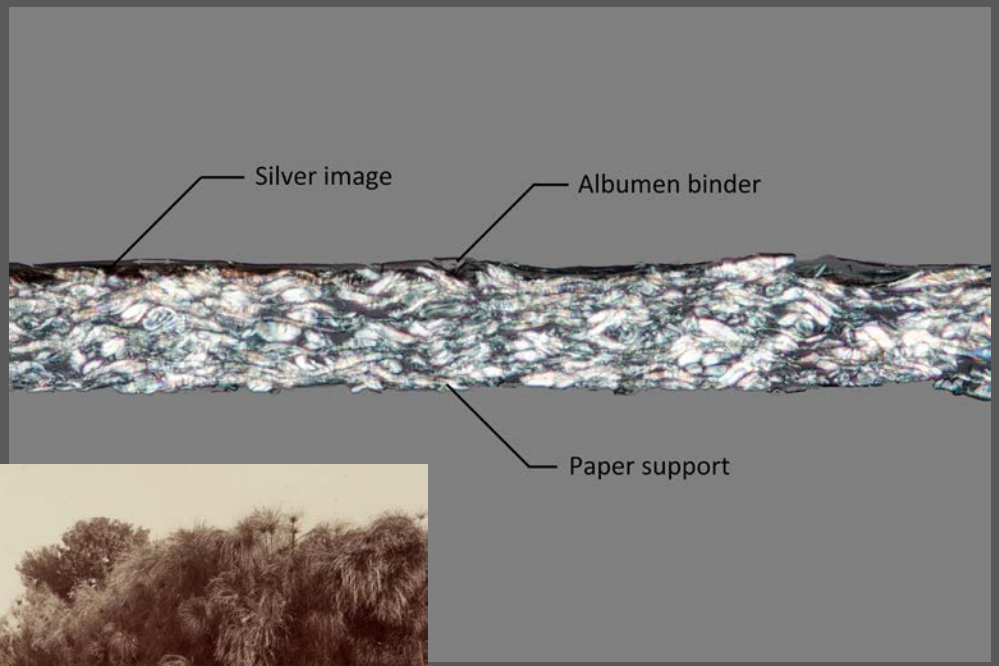


Image material suspended in a binder, binder coated onto paper support

Albumen print

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Silver POP

Three layers

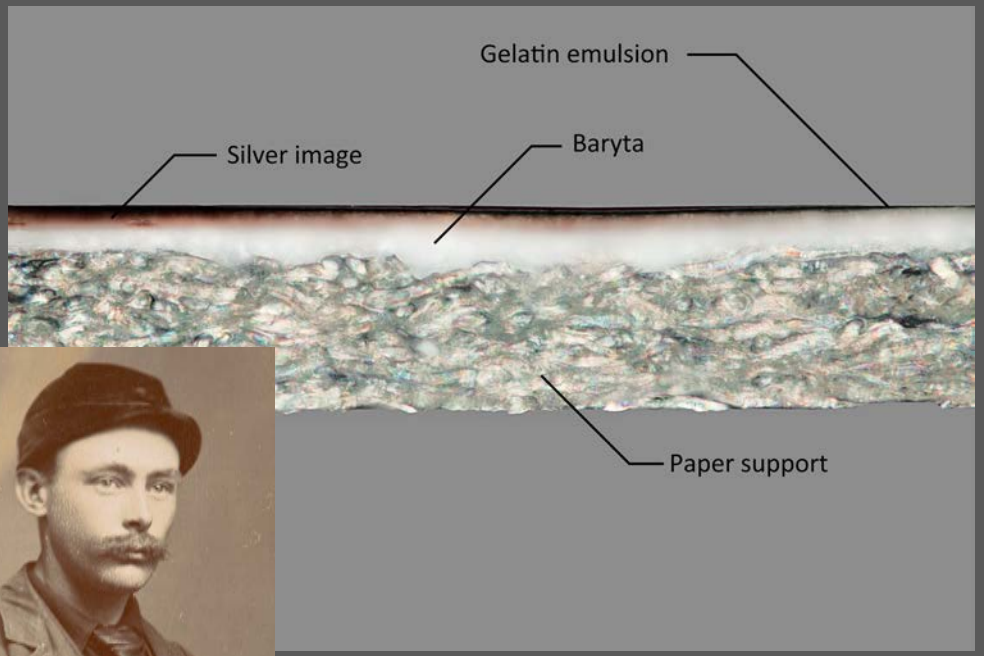


Image material suspended in a binder, binder coated onto baryta, baryta coated onto paper support

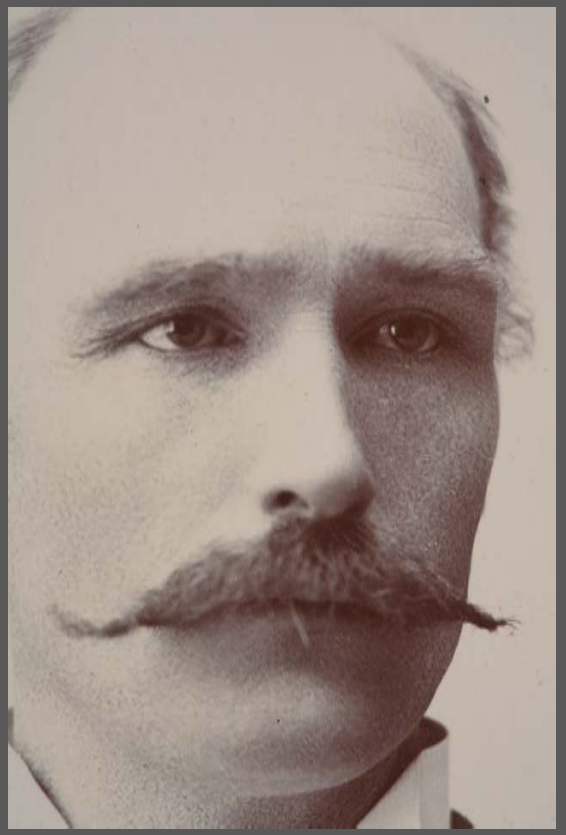
Gelatin POP

Silver POP

Each binder has specific properties

Albumen: yellow highlights

Collodion: iridescence



Gelatin: susceptible to image fade

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Silver POP

One layer

Two layers

Three layers

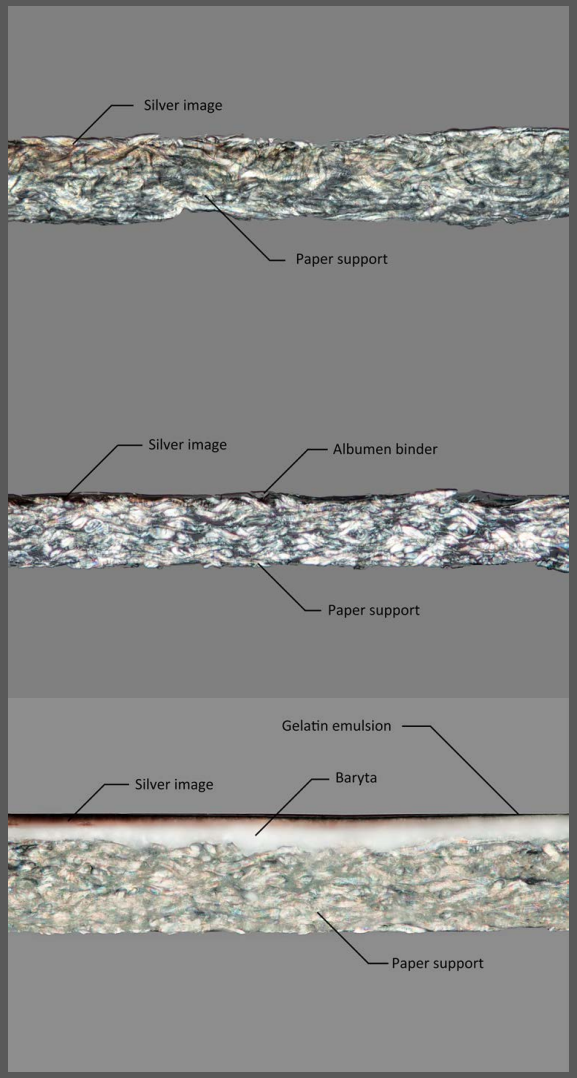


Image material forms directly in paper support

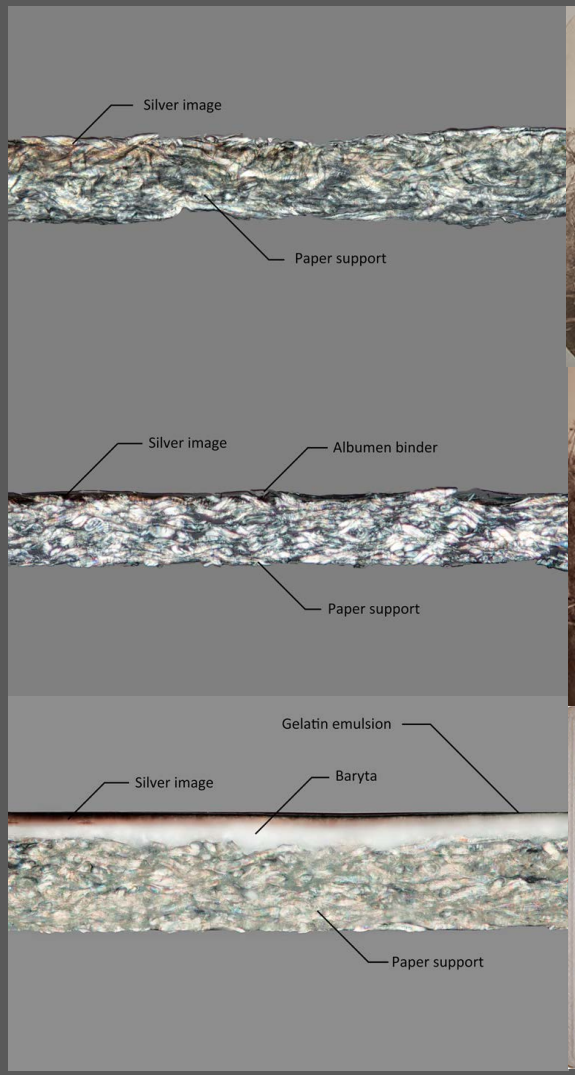
Image material suspended in a binder, binder coated onto paper support

Bartya coated onto paper, image material suspended in binder on top of baryta

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Silver POP

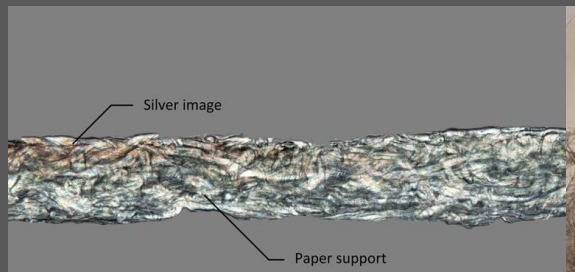


The surface characteristics (texture and sheen) are related to the layer structure of the print.

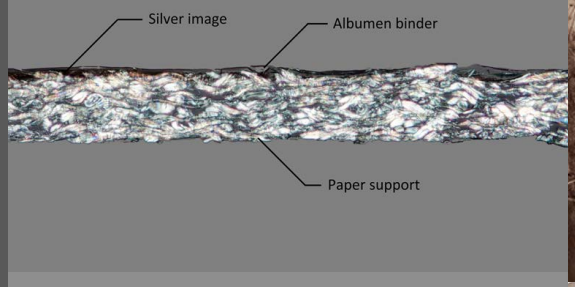
NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

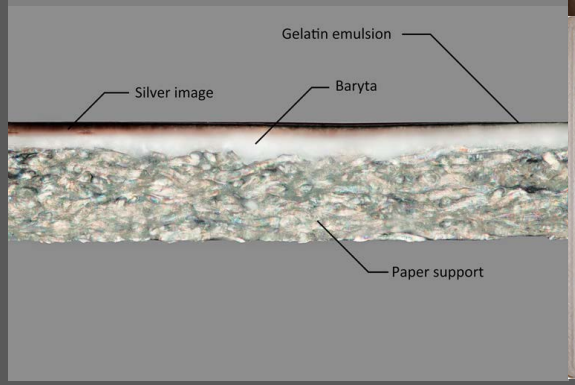
Silver POP



Salted paper



Albumen

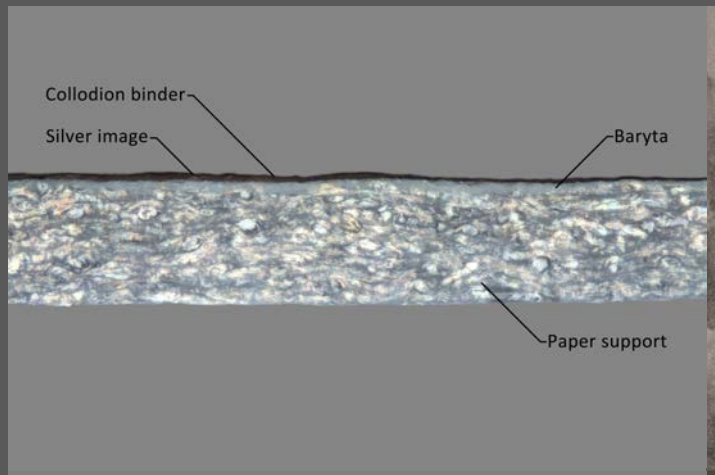


Collodion and Gelatin POP

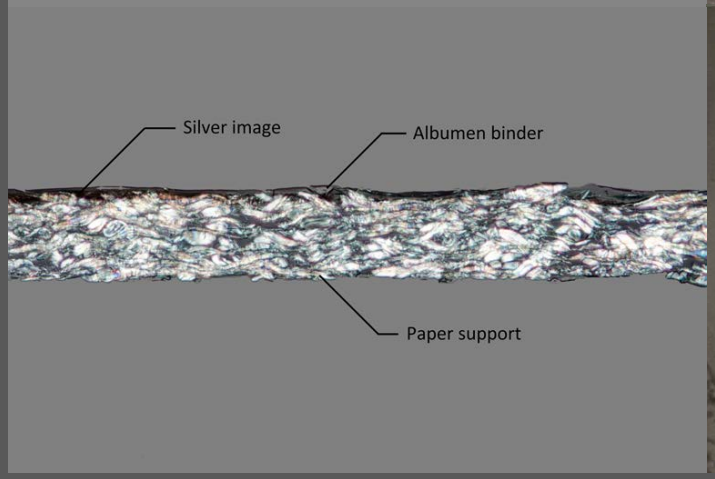
NATIONAL ENDOWMENT FOR THE Humanities

IPI IMAGE PERMANENCE INSTITUTE

Silver POP



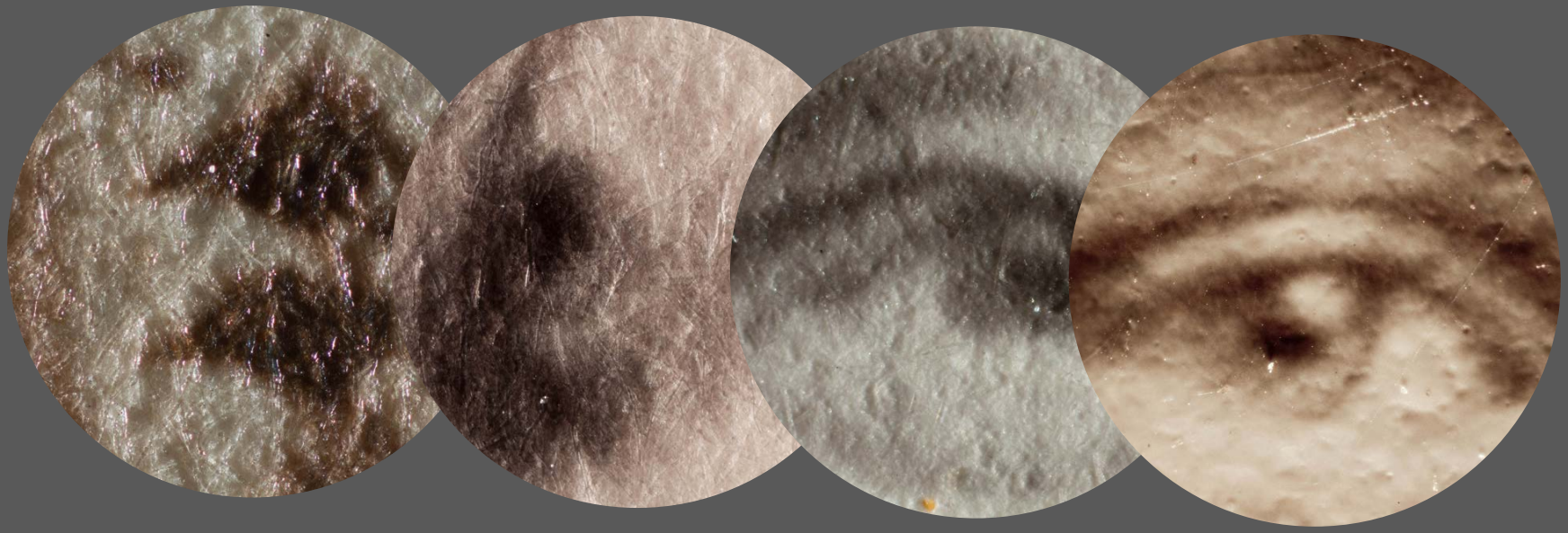
Matte collodion



Albumen

Silver POP

Layer structure influences visibility of paper fibers and where the image rests in relation to the support



Salted paper | Albumen | Matte collodion | Gelatin POP

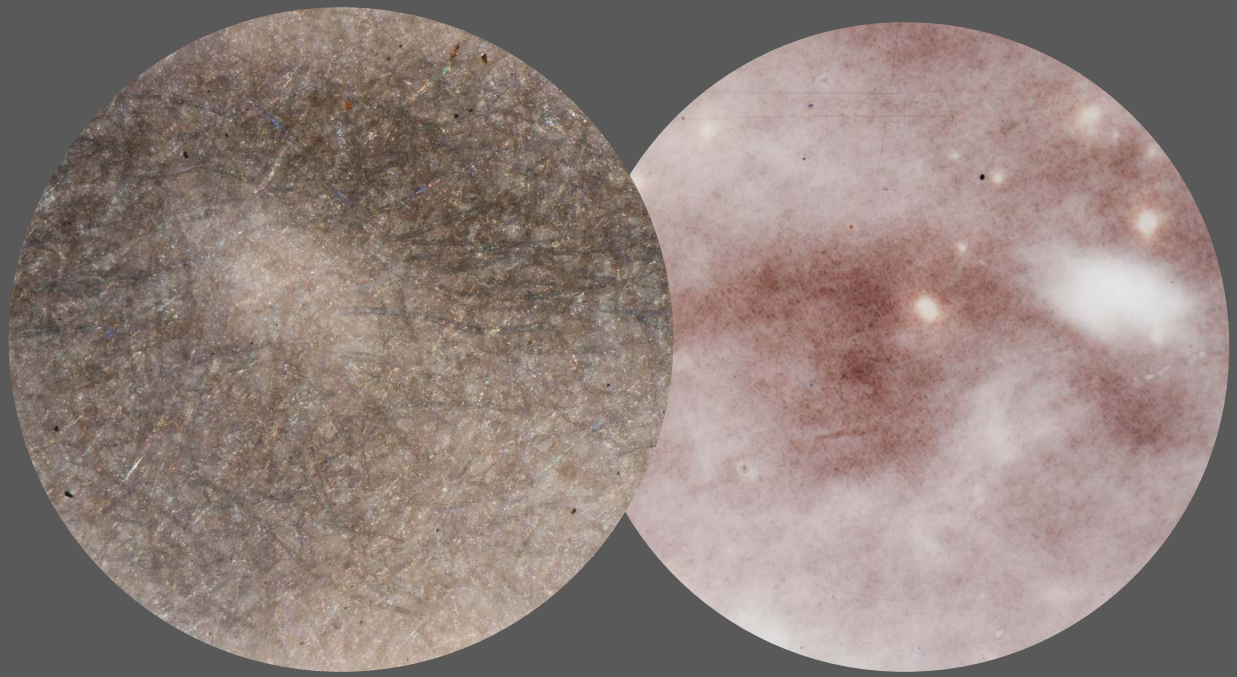
50x magnification, raking light

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Silver POP

Image formation influences image structure



Continuous in tone

50x magnification

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Salted Paper

Characteristics:

- Purple/red image tone
- Matte surface sheen
- Continuous in tone
- Image in paper fibers, paper fibers visible

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Albumen

Characteristics:

- Purple/red image tone
- Semi-matte or glossy surface sheen
- Continuous in tone
- Image above paper fibers in binder, paper fibers visible

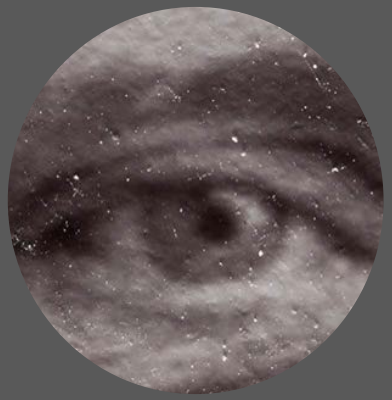
NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Collodion POP

Characteristics:

- Purple/red image tone
- Glossy surface sheen, iridescence (sometimes)
- Continuous in tone
- Image in binder, paper fibers obscured



Gelatin POP

Characteristics:

- Purple/red image tone
- Glossy surface sheen
- Continuous in tone
- Image in binder, paper fibers obscured

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Matte Collodion

Characteristics:

- Purple/red; Brown; Black image tone
- Semi-matte surface sheen
- Continuous in tone
- Image above paper fibers in binder, paper fibers visible

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Chromium

Dichromated Colloid

- Carbon (1868-1940)
- Direct Carbon (1900-1939)
- Gum Dichromate (1894-1930s)

More info:

- www.graphicsatlas.org

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Chromium

- Dichromate ($Cr_2O_7^{2-}$) + organic binder
  - Gelatin or gum arabic
- Contact printed
- The colloid hardens when exposed to light
- Unexposed areas remain soluble and are washed away

Carbon Print

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Chromium

Process

- Carbon

Image Material

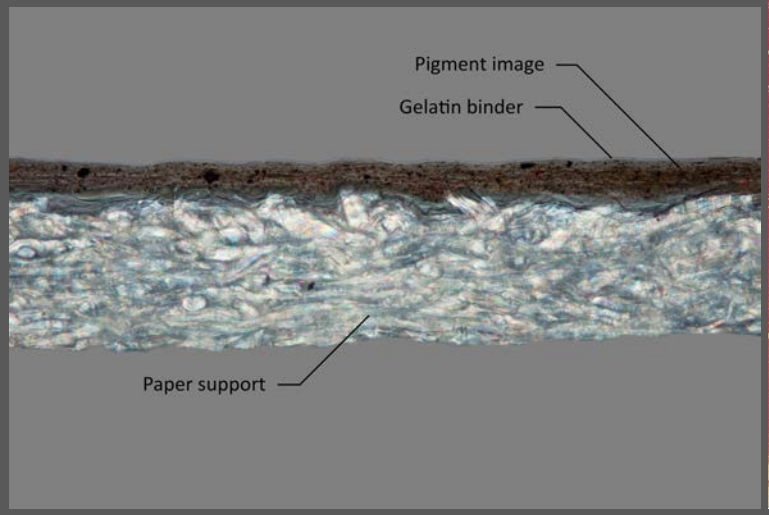
- Pigment

Binder

- Gelatin

Support

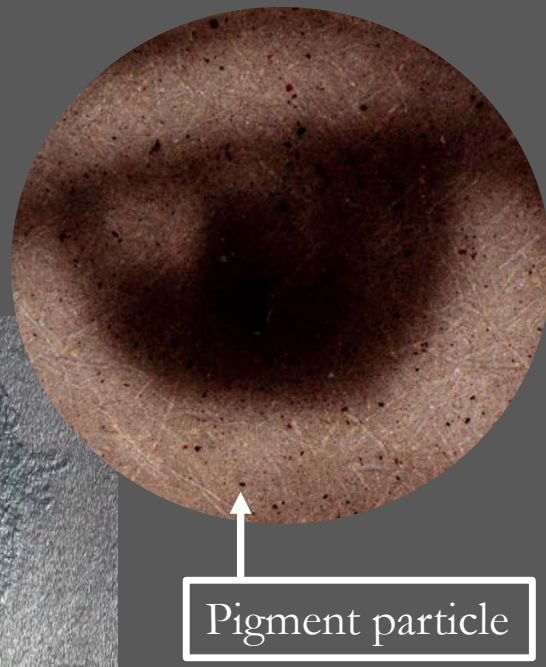
- Paper



Chromium

Carbon Prints

- Differential Gloss
- Pigment particles (continuous in tone)



Carbon Print

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Iron

- Cyanotype, 1842-1950
- Platinum, 1880-1930

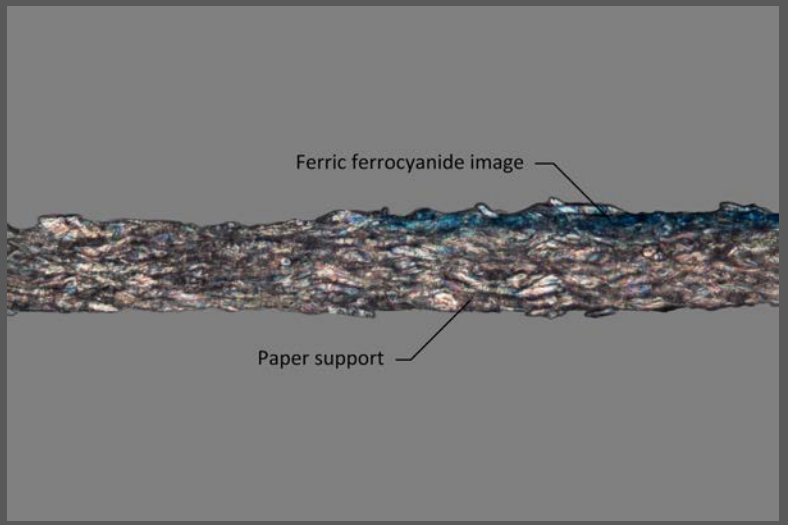
Cyanotype

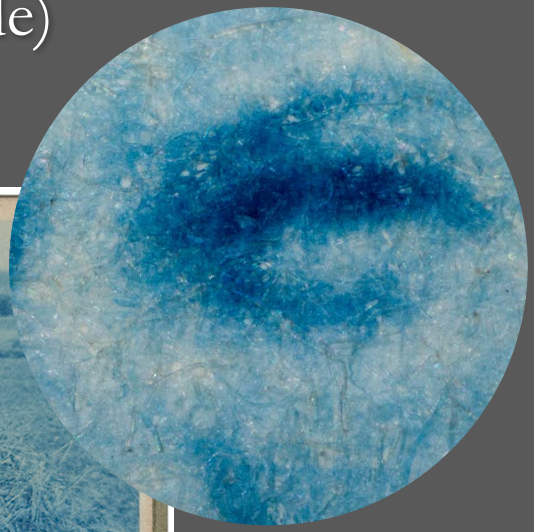
Iron

Process: cyanotype

Support: paper

Image Material: Prussian blue (ferric ferrocyanide)





50x magnification

NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

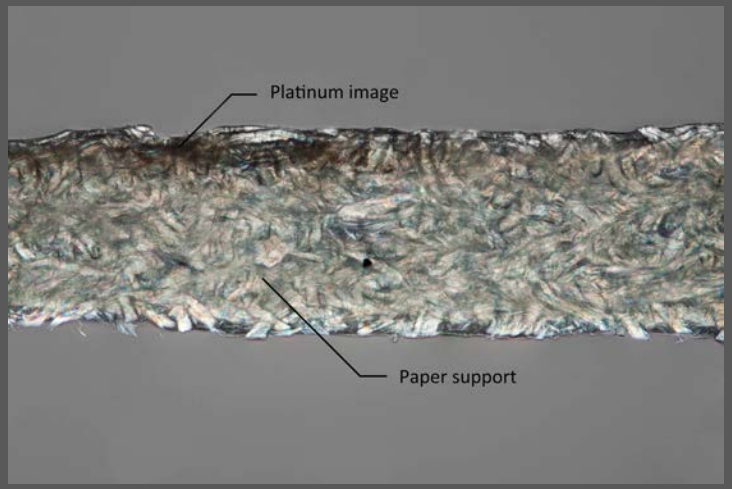
Iron

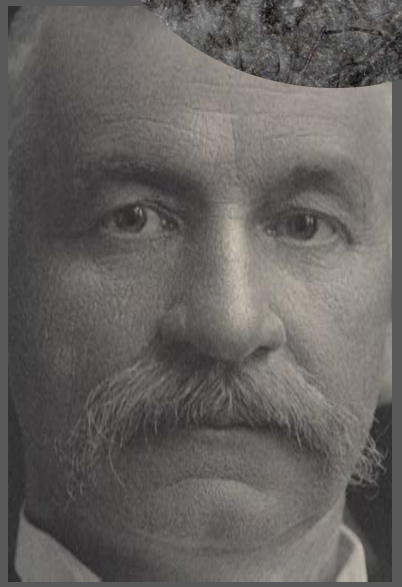
Process: platinum

Support: paper

Image Material: platinum

50x magnification





NATIONAL ENDOWMENT FOR THE HUMANITIES

IPI IMAGE PERMANENCE INSTITUTE

Survey & Thank You

Thank you!

- National Endowment for the Humanities Division of Preservation and Access
- The Andrew W. Mellon Foundation

Next Webinar

- Wednesday, October 11, 2:00pm EDT
- 20th Century Materials and Technologies

Survey!

- A brief survey will appear at the end, please give us feedback!