Title: **The Light at the End of the Bromine, *The truth is out there.***

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Background

The introduction of chemical accelerators to the coating process, particularly bromine, to the coating process had a revolutionary effect on daguerreotype practice. Suddenly it became possible to take portraits in a matter of few seconds instead of minutes. Capturing the fleeting expressions on the face of a child or the image of a horse or even a cat was now well within the capability of every experienced daguerreotypist.

Paul Beck Goddard and Robert Cornelius introduced bromine into the daguerreotype process in early December of 1839. (1) By May of 1842, Antoine Claudet had added chlorine to the list of accelerating agents. (2) By 1844, the standard method of using three coatings, first iodine, then bromine, and finally iodine once more had been adopted. (3)

During the preparation of daguerreotype plates, it was necessary to use some light in the darkroom to examine the plates during the coating process. Daguerreotypists at first were concerned that too much light would fog the plates. They recommended only the indirect light from a pinhole covered with tissue should be used to examine the plates. (4)

Percy and Shaw reported an extensive investigation of the effects of light exposure after bromine fuming in December of 1844. (5) They found that when an exposed daguerreotype plate was fumed briefly with iodine and/ or bromine “the impression produced by light is destroyed” and the plate was restored “to its original condition; that is its sensitiveness to light is restored”. Even after this cycle of exposure and fuming had been repeated 4 times “its sensitiveness appeared unimpaired”. They stressed that maintaining the proper ratio of bromine to iodine during this fuming was necessary or “the sensitiveness of the plate was diminished”. Since multiple sensitizing of daguerreotype plates was typically done under conditions of subdued light, it is most probable that the plates of Percy and Shaw had already been exposed to some light during the first fuming cycle. It is therefore unlikely that they would have observed any increases in the sensitiveness of their plates during subsequent exposure and fuming cycles. One could conclude from their work that the first two sensitizing steps could be carried out under bright light but that the final iodizing step had to be done under non-actinic light.

Introduction

The modern daguerreians Nelson [6] and Schreiner [7] have emphasized that multiple fuming with iodine and bromine is the most important factor contributing to the light capturing ability of the daguerreotype plate. While these articles discuss the general effects of bromine-sensitizing, no quantitative effects are given.

It is generally thought that the total speed increase is due to bromine alone. Increasing effective plate speed by exposing the plate after the bromine fuming with subdued white light is a new wrinkle. Barger and White postulated that exposing the plate to subdued light after the bromine fuming produced random photolytic silver atoms in silver halide coating thereby doing some of the work that would have been done by the camera exposure. [9] The image exposure also produces silver atoms. Their number at any point in the image is roughly proportional to the light intensity distribution of the image on the plate during the camera exposure. During development, mercury combines the silver atoms from the two sources: (1) subdued light exposure after the bromine fuming, and (2) image exposure in the camera. This yields larger image particles than would be the case if the plate were not exposed under a subdued light source.

Purpose

Anyone who has made daguerreotypes knows that fuming an iodized plate with bromine substantially increases plate sensitivity over that obtained with plates sensitized only with iodine. Does light exposure, during the bromine fuming process, also increase the speed of the daguerreotype? I set out to test the hypothesis that light, falling on the surface of the daguerreotype plate during the sensitization process, leaves behind a beneficial residue of photolytic silver in the halide matrix. According to Barger's hypothesis, random photolytic silver atoms imbedded in the silver halide coating act by combining with the latent image silver atoms to create a more visible image on the surface of the daguerreotype plate. [9] Assuming that the image density of the daguerreotype plate is indeed influenced by the exposure of the plate to light during the coating process, it should be possible to demonstrate this influence by varying the intensity of light exposure after the bromine-sensitizing step on a single plate.

The purpose of my research project was to determine if exposure of a daguerreotype plate to subdued light during the sensitizing process leaves behind a visible record in the image of the plate. If such a visible record exists, can measurements of image density of the daguerreotype be used to estimate the effect of subdued light exposure on the photographic speed of the plate? Finally, what is the effect of the ratio of bromine to iodine on photographic speed and what impact does it have on the effect of subdued light exposure after the bromine-sensitizing step on the speed enhancement of the daguerreotype plate?

WHAT WAS DONE

Step 1 A series of daguerreotype plates was sensitized by fuming over bromine and/or iodine for times that varied from 5 seconds up to 40 seconds. The bromine sensitizing was conducted under a safelight so as not to expose the surface to actinic light as is usually done during this procedure.

Step 2 The plates, covered with a photographic step tablet, were exposed to white light. The step tablet modulated the light reaching the plate to produce stepped exposures ranging from 2 to 120 foot-candle-seconds.

Step 3 The plates were then given a second iodine sensitizing of 5 seconds.

Step 4 Light sensitivity of each plate was subsequently determined by giving them a second (i.e.,” camera”) exposure to white light through the photographic step tablet.

Step 5 Each plate was developed over room temperature mercury then fixed dried and gilded.

Step 6 Image densities of selected areas of each plate were measured both before and again after the images were gilded.

Step 7 Image densities were plotted versus the final or “camera” exposure as D-Log E curves for selected areas on each plate.

Step 8. Relative plate speed was determined from the horizontal distances between the curves, usually at the point where the curves crossed the 0.5 density line. The exposure index (ISO speed) was calculated from the camera exposure value (Hm) that produced a 0.10 increase over baseline image density. Plate contrast was calculated from the slope of the D-Log E curve.

Step 9. Image densities were correlated with the camera exposure, the ratio of bromine/iodine used, and the amount of light exposure during the bromine-sensitizing stage of the coating process.

Step 10. Image contrasts were correlated with the ratio of bromine/iodine used, and the amount of light exposure during the bromine-sensitizing stage of the coating process.

EXPERIMENTAL RESULTS

BROMINE / IODINE RATIO OF 2 / 1

The daguerreotype in Plate 1 was fumed for 15 seconds over iodine and 30 seconds over bromine. The ratio of bromine/iodine (i.e., 2/1) was higher than that typically used by daguerreians. This plate was approximately one full stop slower than the average speed of the next two plates. Based upon the ungilded densities in Figure 1a, this plate showed no significant dependency on light exposure after the bromine-sensitizing step. However, the gilded densities in Figure 1b, indicate that the plate gained about one-half stop in speed. The exposure indices in Figure 1c increased from 0.042 to 0.077 when it was exposed to more than 7.5 fcs of light after the bromine-sensitizing step.

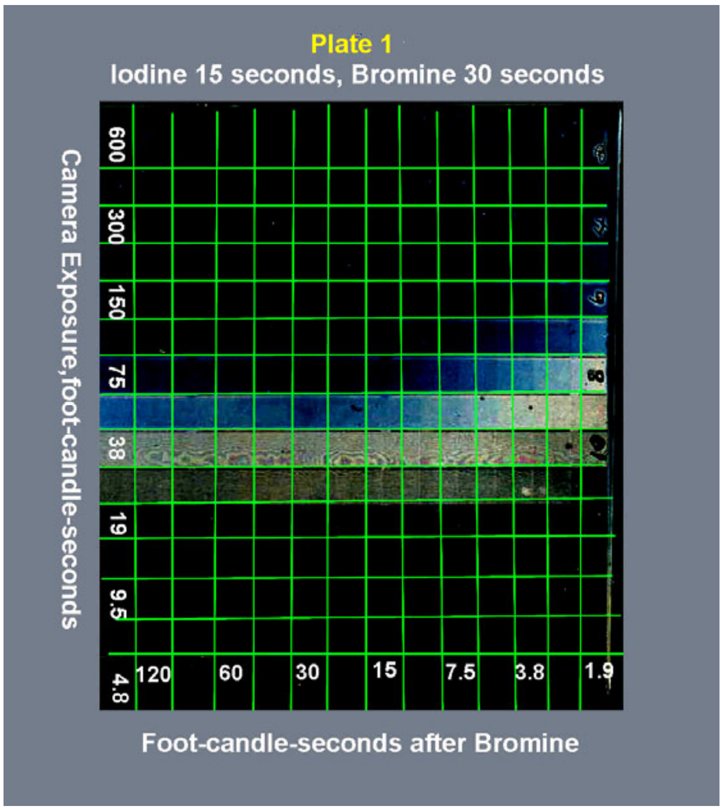


Figure 1a
D-Log E of Ungilded Plate with Bromine / Iodine Ratio of 2:1
No change when light after Bromine was increased

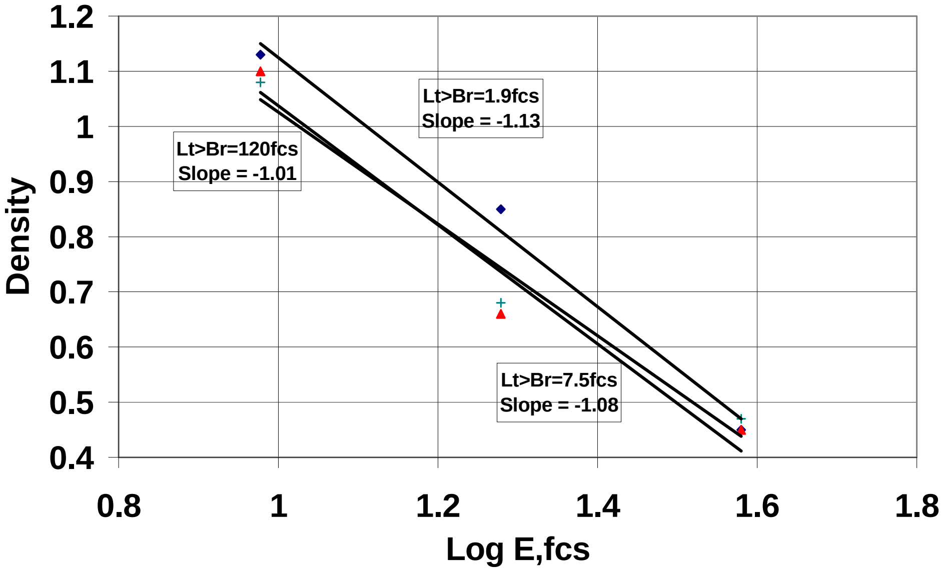
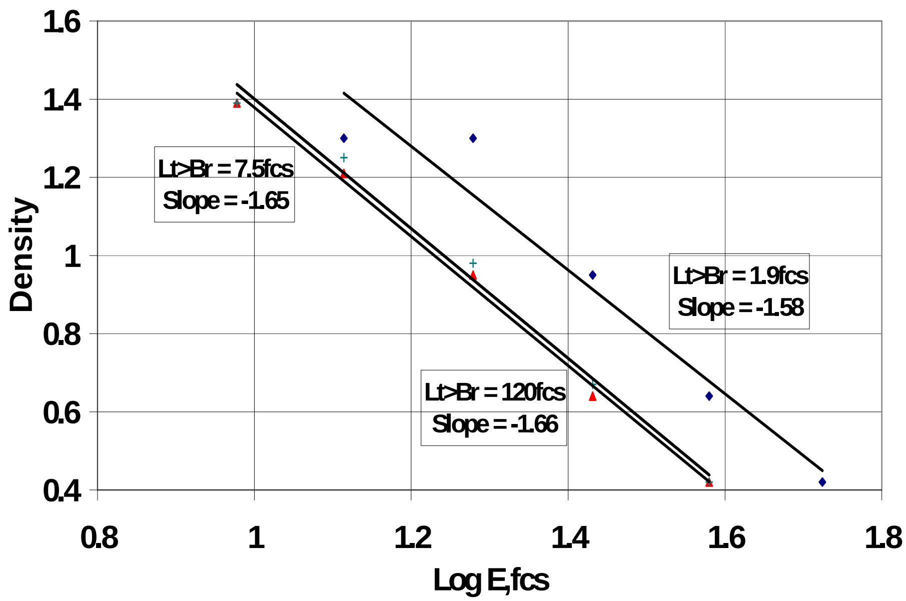
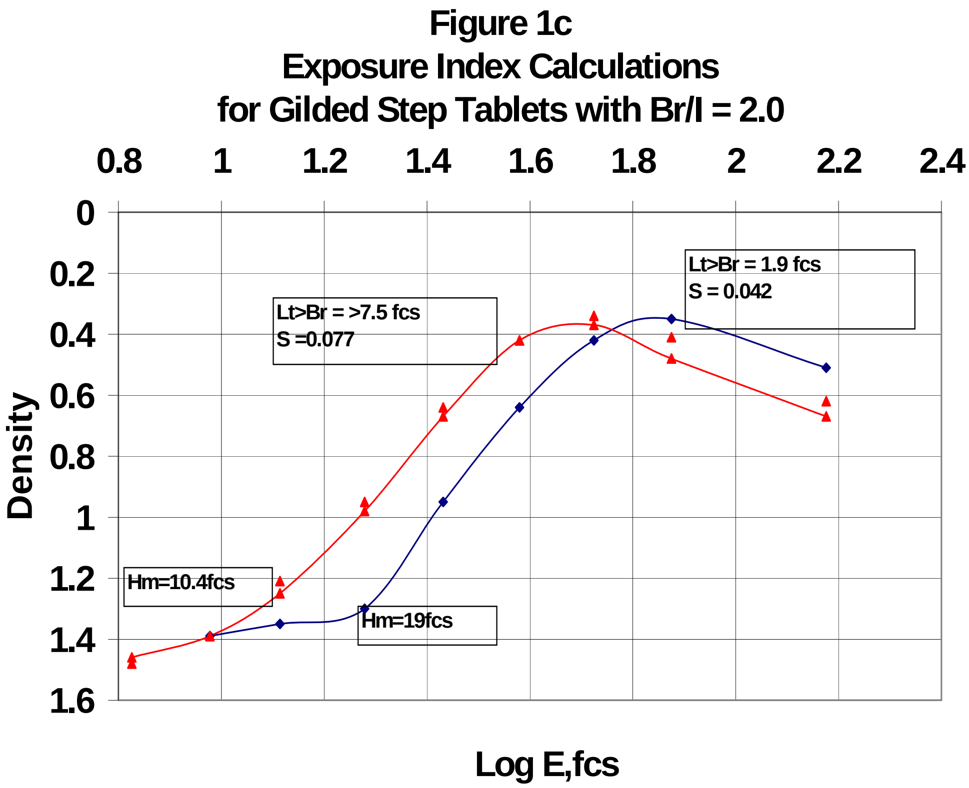


Figure 1b
D-Log E of Gilded Plate with Bromine / Iodine Ratio of 2:1
Speed increased after 7.5 fcs of light after Bromine





BROMINE / IODINE RATIO OF 1 / 1

The daguerreotype in Plate 2 was fumed for 20 seconds over iodine and 20 seconds over bromine. The ratio of bromine to iodine (i.e., 1/1) was the maximum typically used by daguerreians. Portions of this plate became up to a half stop more sensitive to ”camera” exposure when they were exposed 15 fcs of light exposure after the bromine-sensitizing step. Exposure indices increased from 0.077 to 0.108. Other portions of this same plate became a half stop less sensitive to camera exposure (S = 0.077) if they received more than 60 fcs of light exposure after the bromine-sensitizing step. Judging by the slopes of the D-Log E curves, the contrast of the image also increased and then subsequently decreased again in proportion to the sensitivity of the plate. Contrast also increased after gilding.

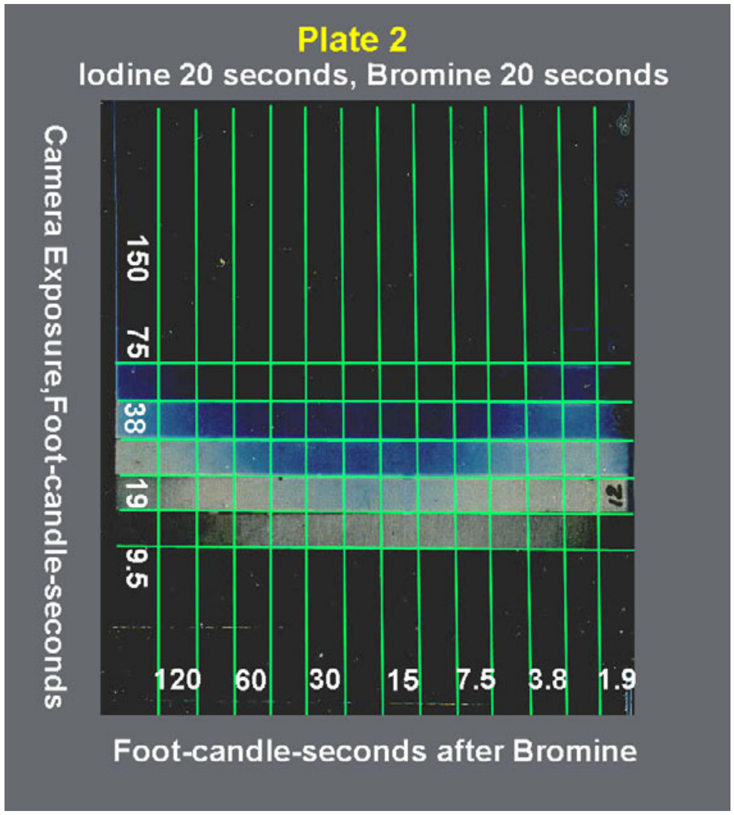


Figure 2a
Ungilded Plate with Bromine / Iodine Ratio of 1:1
Plate gained 1/2 Stop after 15 fcs
Then lost 1/2 stop after 60 fcs

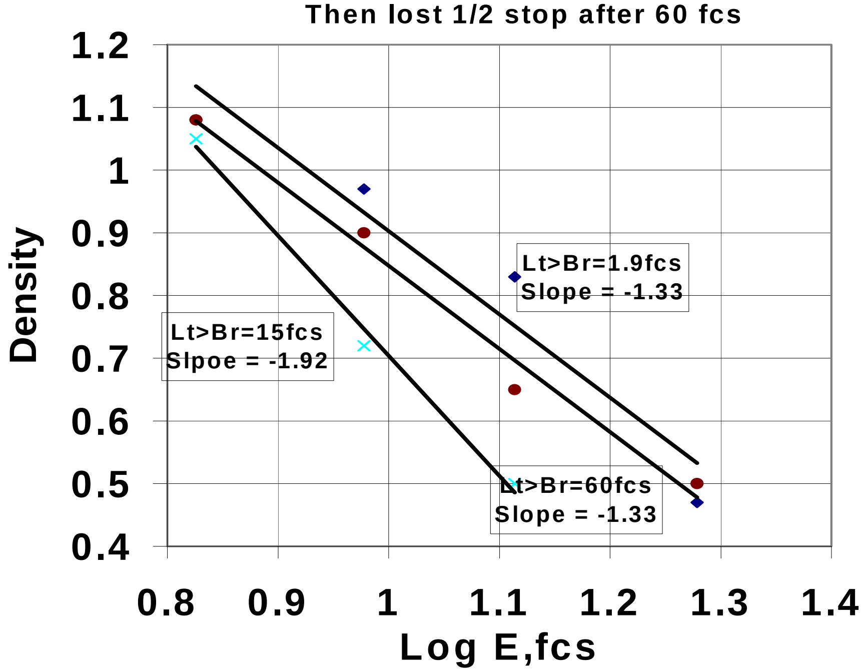


Figure 2b
Gilded Plate with a Bromine / Iodine Ratio of 1:1
All Areas of Plate gained Contrast after Gilding

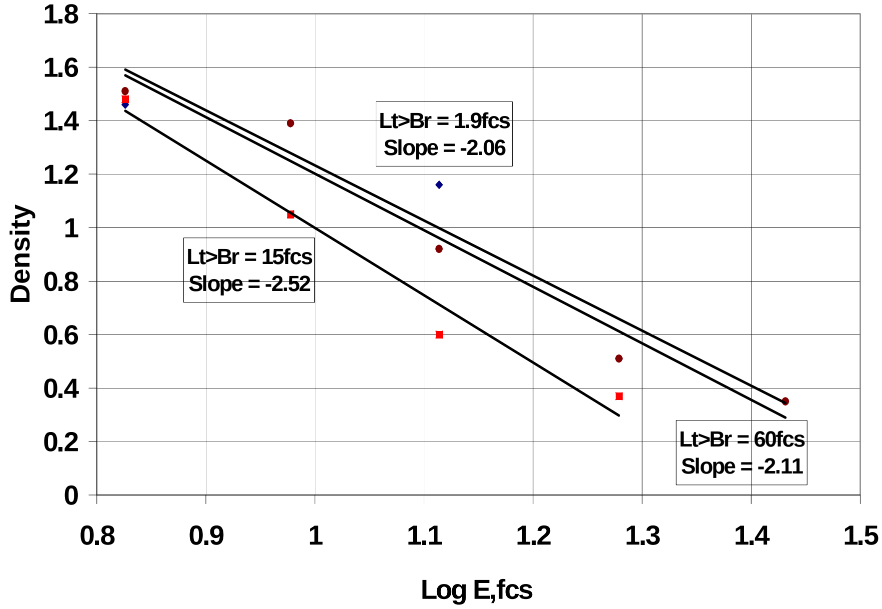
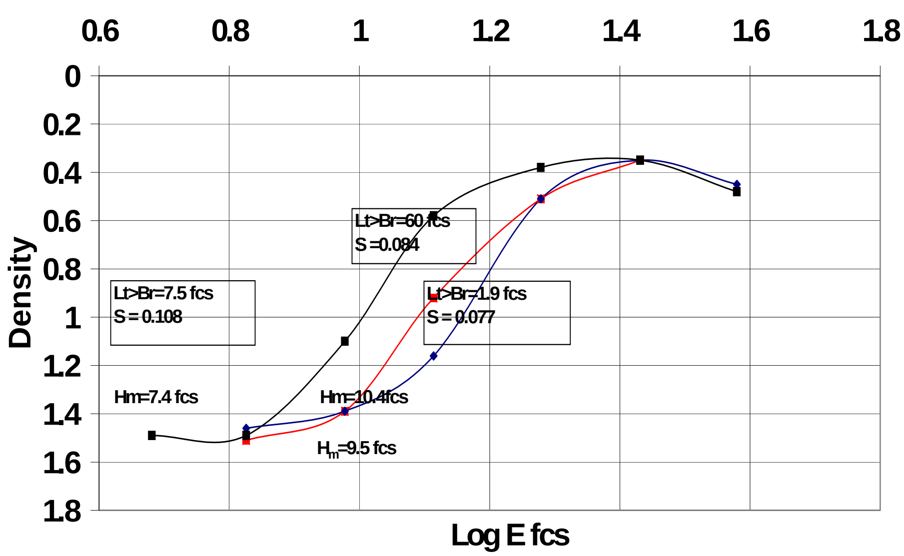


Figure 2c
Exposure Index Calculations
for Gilded Step Tablets with Br/I = 1.0



BROMINE / IODINE RATIO OF 1 / 3

The daguerreotype in Plate 3 was fumed for 30 seconds over iodine and 10 seconds over bromine. The ratio of bromine to Iodine (i.e., 1/3) was within the range normally used by daguerreians. Portions of this plate became up to a half stop more sensitive to ”camera” exposure when they were exposed 7.5 to 30 fcs of light after the bromine-sensitizing step. The corresponding exposure indices increased from 0.064 to 0.114 . Other portions of this same plate became a half stop less sensitive when they were exposed to 120 fcs of light after the bromine-sensitizing step. Judging by the slope of the D-Log E curves, the contrast of the image increased and then subsequently decreased again in proportion to the sensitivity of the plate. Contrast also increased after gilding.

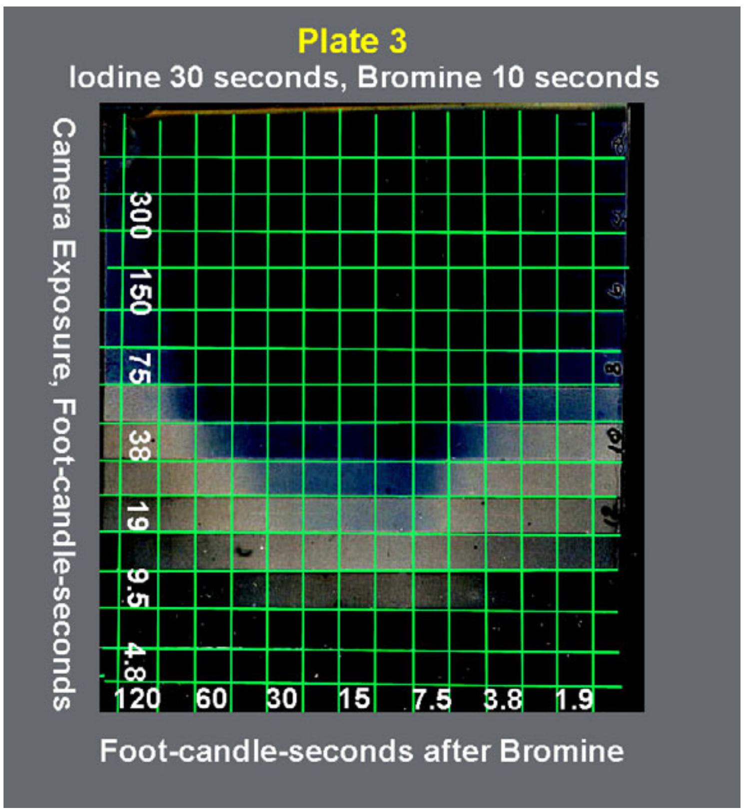


Figure 3a
Ungilded Plate with a Bromine / Iodine Ratio of 1:3
Plate gained 1/2 stop after 7.5 fcs
Then lost 1 stop after 120 fcs

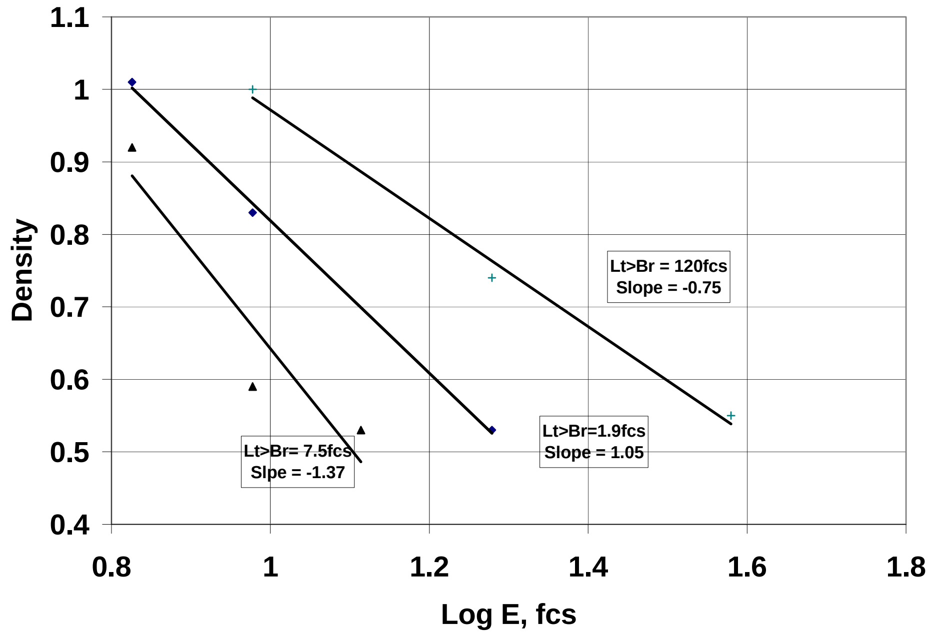


Figure 3b
Gilded Plate with a Bromine / Iodine Ratio of 1:3
Plate gained Contrast after Gilding

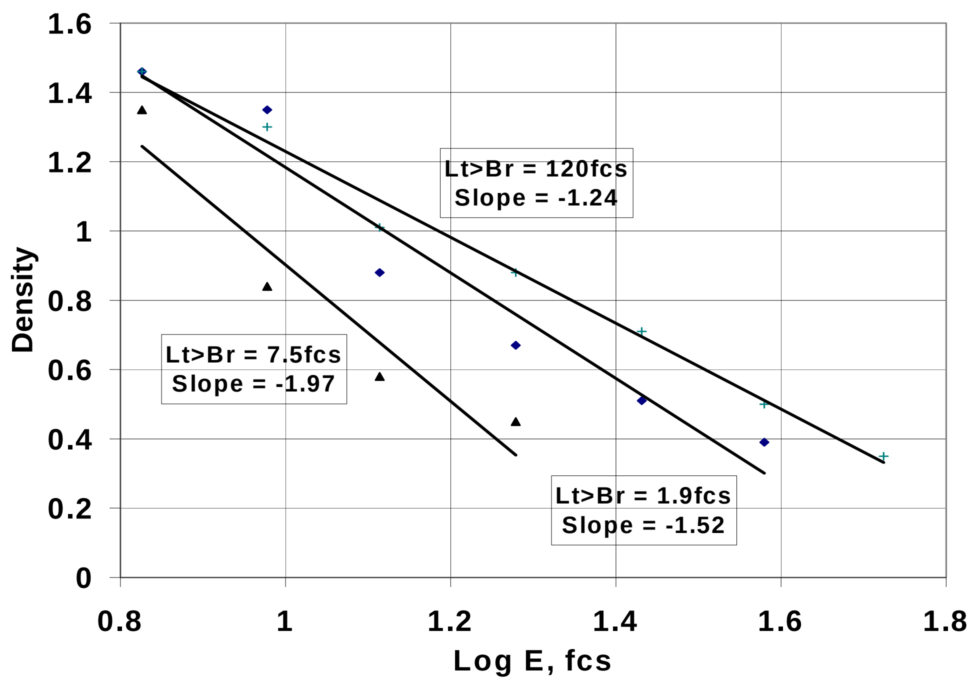
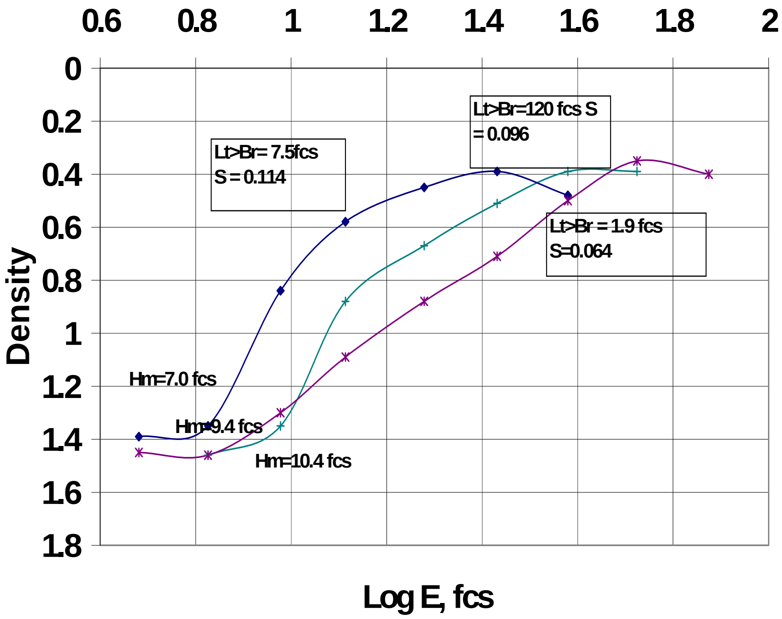


Figure 3c
Exposure Index for Gilded Imperial plates
where the Br/ I ratio was 0.33



BROMINE / IODINE RATIO OF 1 / 8

The daguerreotype in Plate 4 was fumed for 40 seconds over iodine and only 5 seconds over bromine. The bromine/Iodine ratio (i.e., 1/8) was less than that normally used by daguerreians. The most sensitive portions of this plate were those that had been exposed to only 1.9 fcs of light after bromine sensitizing step. The plate became 1 full stop less sensitive after exposure to 30 to 120 fcs of light following the bromine-sensitizing step. The corresponding exposure indices decreased from 0.078 to 0.041. Judging from the slope of the D-Log E curves, the contrast of the image decreased in proportion to the sensitivity of the plate. The contrast of the plate increased after gilding.

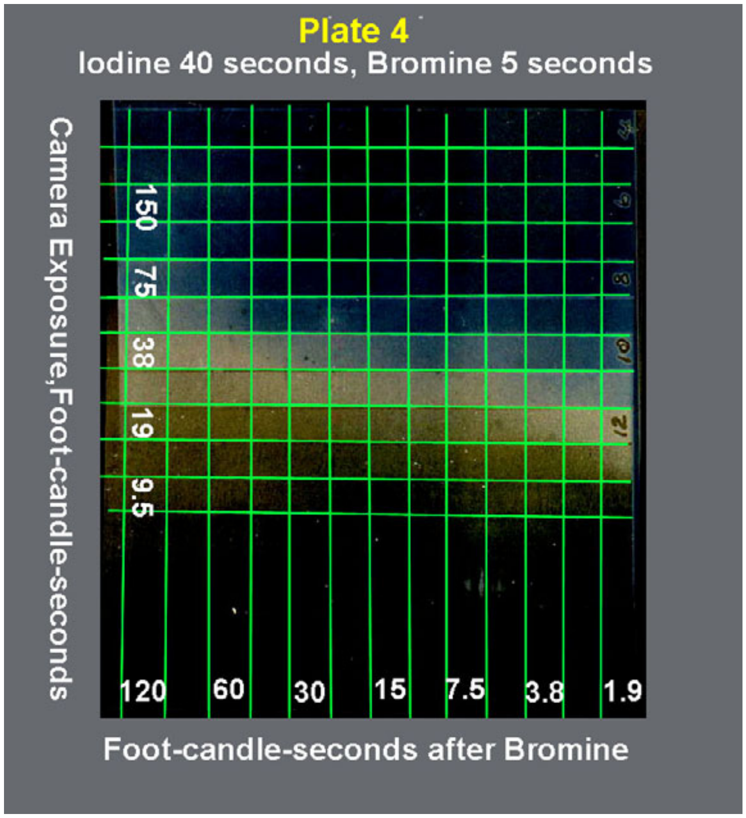


Figure 4a
Ungilded Plate with a Bromine / Iodine Ratio of 1:8
Plate lost 1 Stop after 120 fcs
of light after Bromine

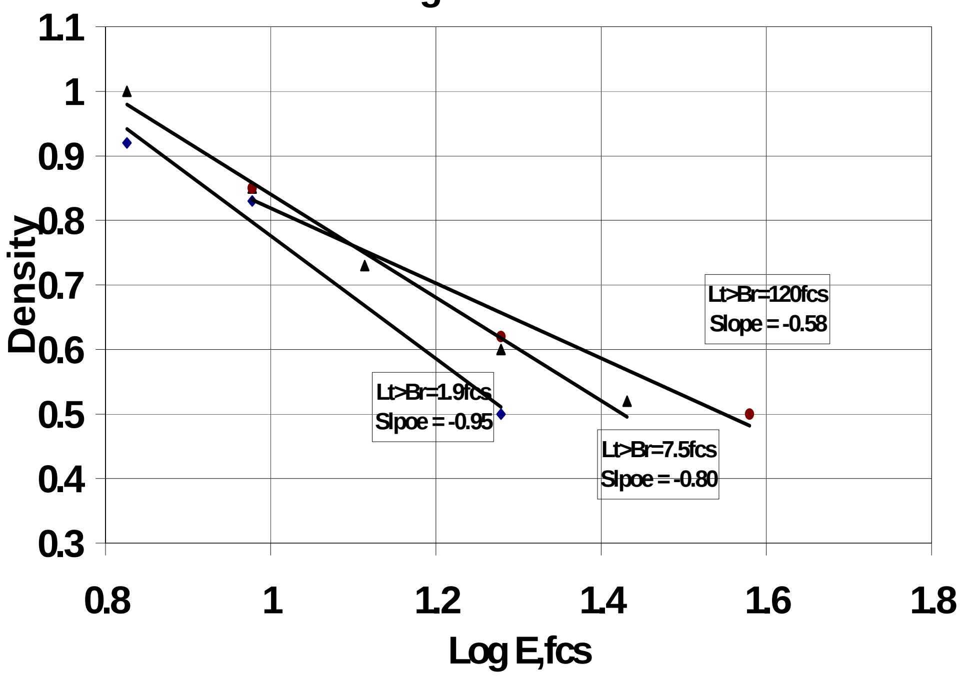


Figure 4b
Gilded Plate with a Bromine / Iodine Ratio of 1:8
Plate Gained Contrast after Gilding

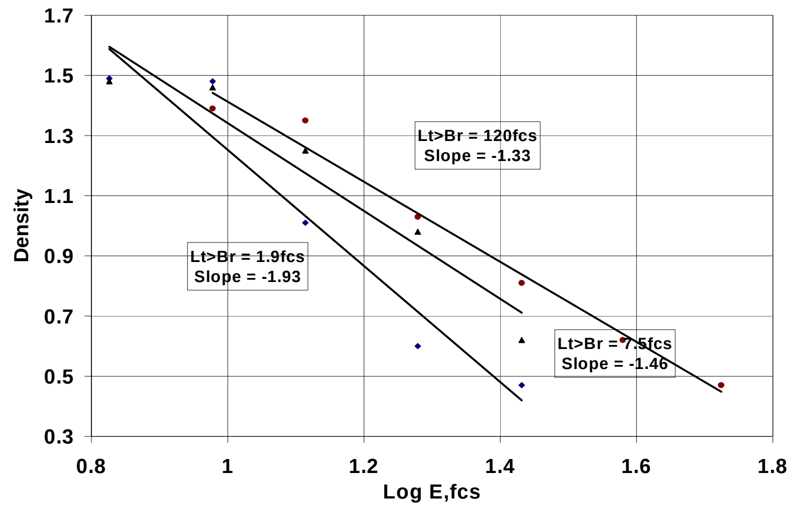
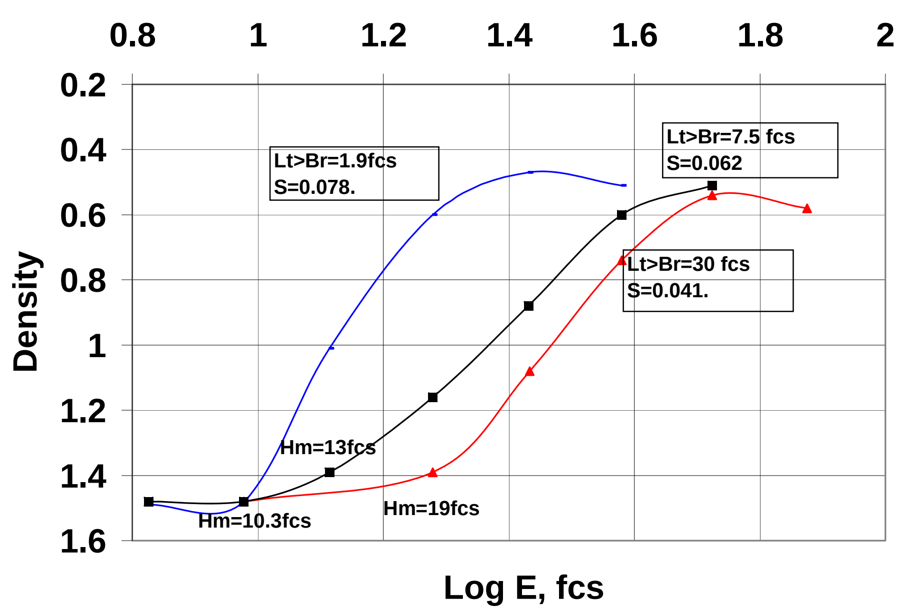


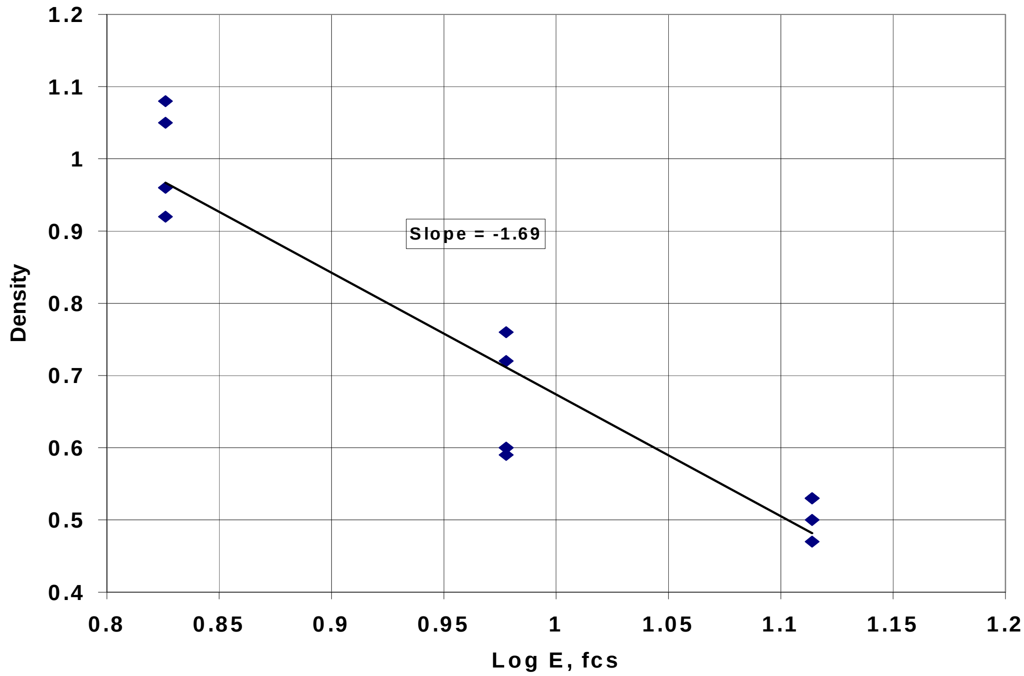
Figure 4c
Exposure Index for Gilded Imperial plates
where the Br/I ratio was 0.125



DUPLICATION OF RESULTS

Multiply fumed daguerreotype plates showed significant evidence of variations in coating sensitivity, which could be attributed to the amount of bromine and also to light exposure during and after the bromine fuming process. Despite these variations, the light sensitivity of duplicate daguerreotype plates produced under similar conditions showed a remarkably high degree of reproducibility.

Figure 5
Average D-Log E Curve of 6 Results
on 2 Plates with Br/I Ratios of 0.33 & 1.0
in 3 areas receiving 7.5, 15, & 30 fcs of Lt >Br



THE EFFECTS OF LIGHT AND BROMINE

TABLE I
SUMMARY OF CONTRAST AND SENSITIVITY MEASURMENTS FOR PLATES 1-4

Light after Bromine FCS	**Br/I=2.0**			**Br/I=1.0**			**Br/I=0.33**			**Br/I=0.125**		
	SLOPES (contrast)		ISO Spd	SLOPES (contrast)		ISO Spd	SLOPES (contrast)		ISO Spd	SLOPES (contrast)		ISO Spd
	UG	GLD		UG	GLD		UG	GLD		UG	GLD	
1.9	1.1	1.6	.042	1.3	2.1	.077	1.1	1.5	.064	1.0	1.9	.078
7.5	1.1	1.7	.077			.108	1.4	2.0	.114	.80	1.5	.062
15				1.9	2.5							
60						.084						
120	1.0	1.7	.077	1.3	2.1		0.8	1.2	.096	0.6	1.3	.041

The effect of light exposure after bromine sensitizing was seen to depend of the amount of bromine fuming that the plate had received in the following ways:

1. Plates that had received minimal bromine (i.e., Br/I=0.125) were found to be extremely sensitive to light exposure after the bromine sensitizing step. They lost approximately one stop in speed and became lower in contrast if they were exposed to more than 1.9 fcs of light after the bromine-sensitizing step.
2. Plates that had received normal levels of bromine (i.e., Br/I= 0.33 to 1.0) gained a half stop in speed and increased in contrast if they were exposed to 7.5 to 30 fcs of light after the bromine-sensitizing step. They also lost both speed and contrast if they were exposed to more than 60 fcs of light after the bromine-sensitizing step.
3. Plates that had received excess bromine fuming (i.e., Br/I=2.0) were lower in contrast and half a stop slower. They gained contrast and a half stop in speed if they were exposed to 7.5 fcs of light after the bromine sensitizing step. However, they did not lose any contrast or speed if they were exposed to more light after the bromine-sensitizing step.

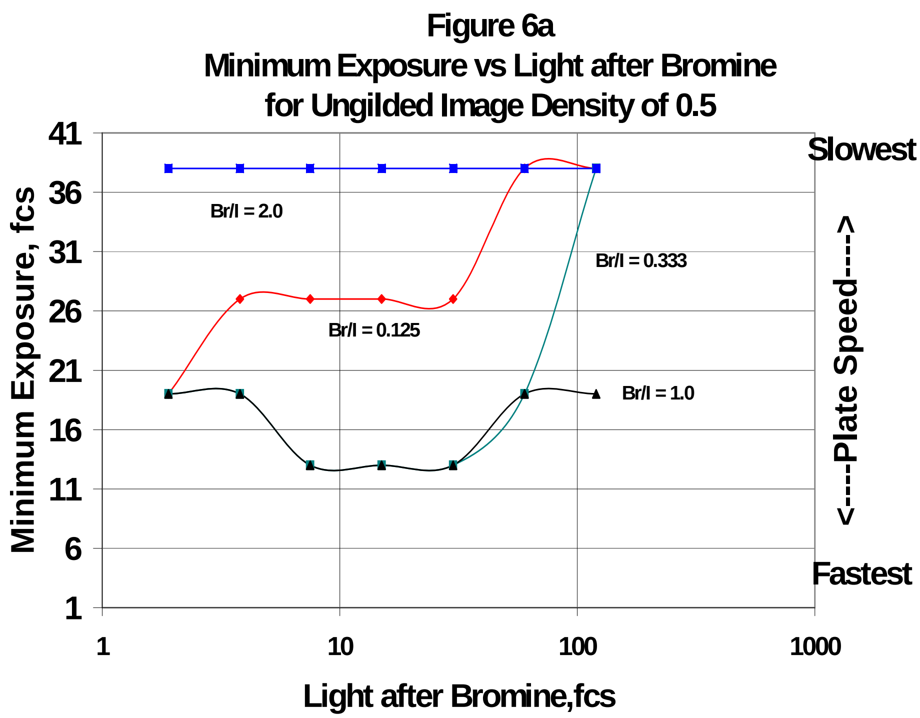


Figure 6a
Minimum Exposure vs Light after Bromine
for Ungilded Image Density of 0.5
Minimum Exposure, fcs
41
36
31
26
21
16
11
6
1
Br/I = 2.0
Br/I = 0.333
Br/I = 0.125
Br/I = 1.0
Slowest
<----Plate Speed---->
Fastest
1
10
100
1000
Light after Bromine,fcs

“

Figure 6b
Contour Plot of Minimum Camera Exposure for Ungilded Plates

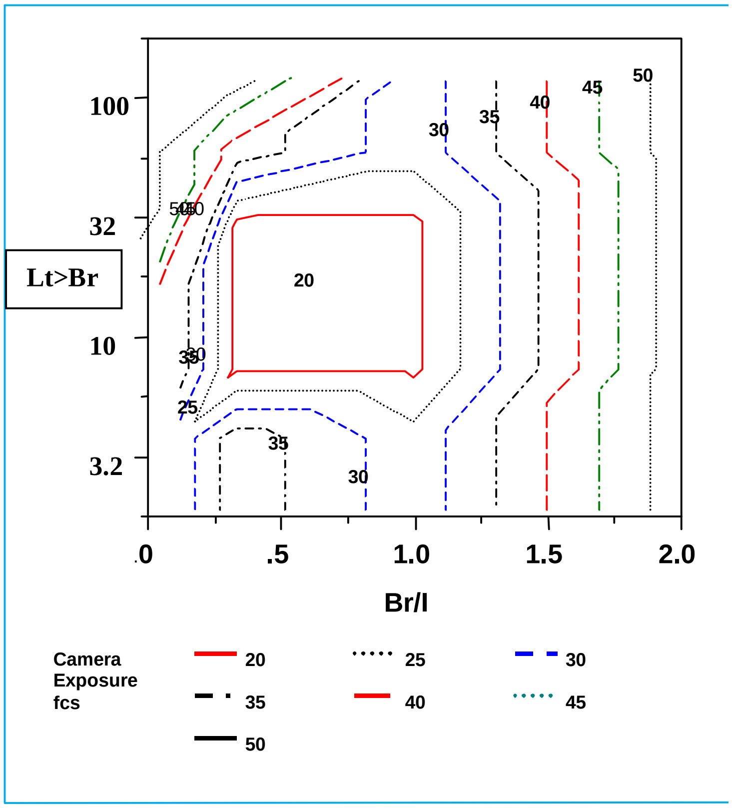


Figure 6c
Contour Plot of Contrast Levels for Ungilded Plates

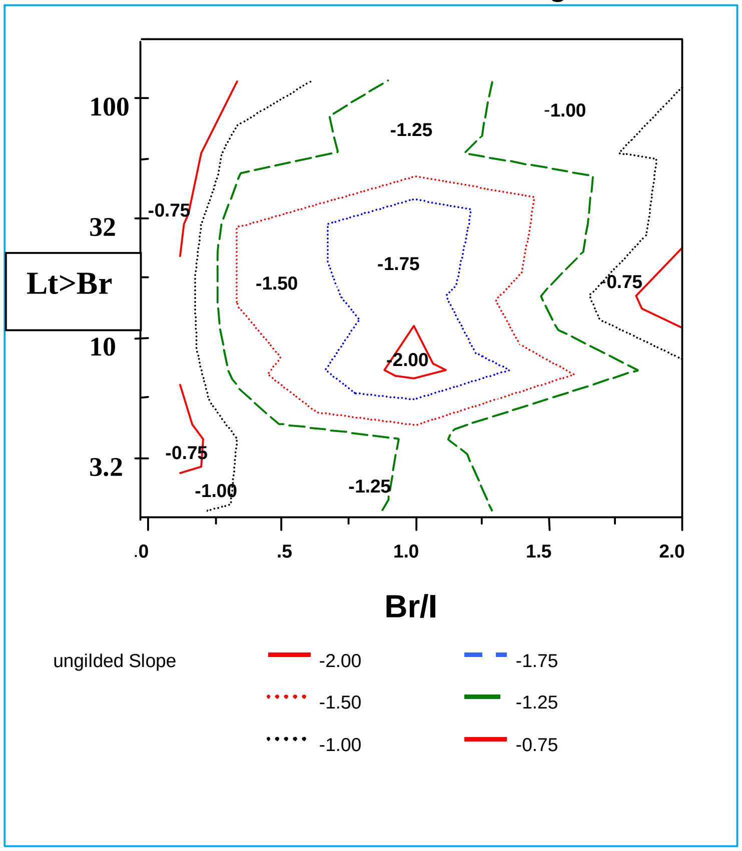
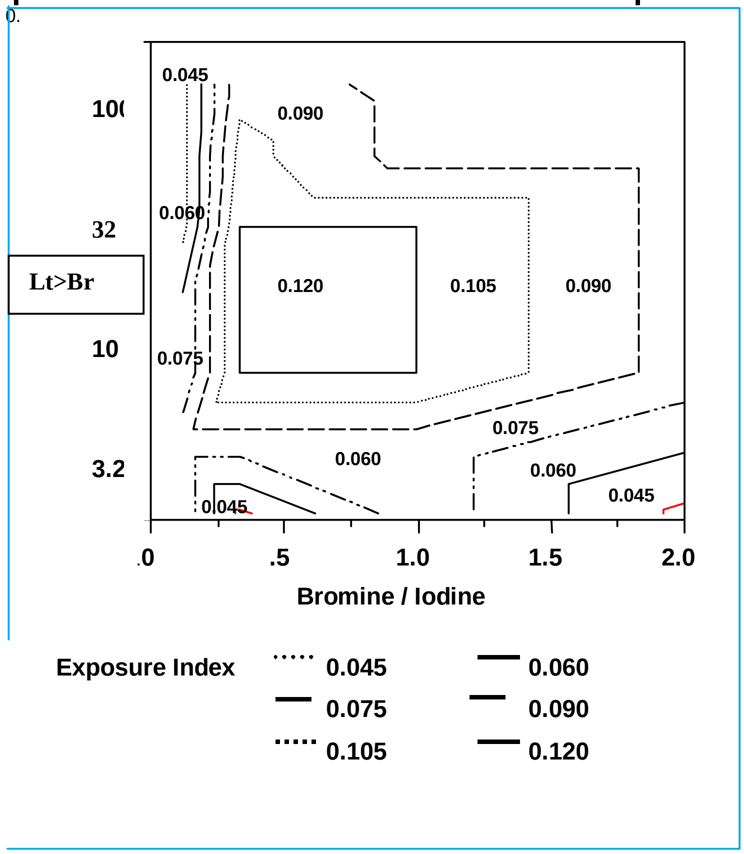


Figure 6d
Exposure Index Contour Plot for Gilded Step Tablets



LIES, DAMM LIES, AND STATISTICS

The effects observed above appeared to be reproducible. Version 3.1 of the JMP [R] statistical discovery computer software package was used to test the significance of the apparent correlation. Image density data was fitted to a statistical parametric model of the experimental variables. The resulting model explained over 88% of the variability of the density data. The likelihood that the density variations, which the model attributed to the parameters, were due strictly to random variations ("Prob.>F") was less than one in ten thousand

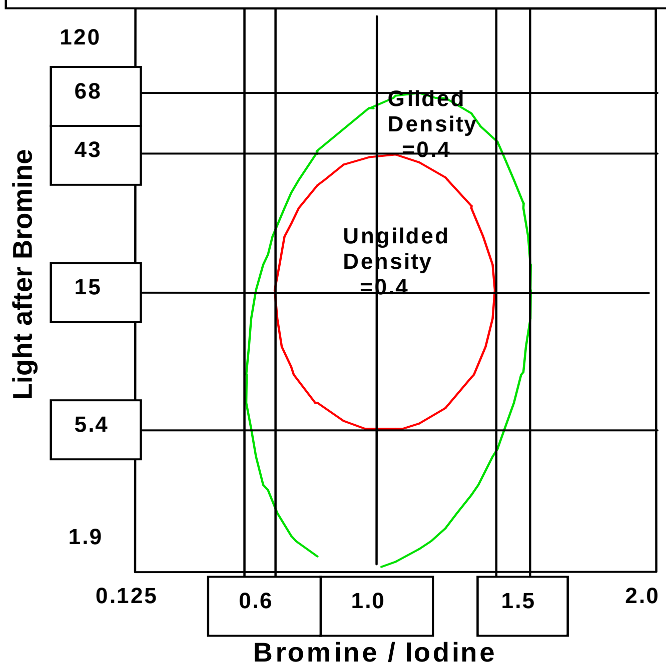
Response: Image Density

Current Estimates

SSE	DFE	MSE	RSquare	RSquare Adj	Cp
0.4950953	93	0.005324	0.8939	0.8848	10.03233

Parameter	Estimate	"F Ratio"	"Prob>F"
Intercept	2.74849256	0.000	1.0000
Br/I	0.15962891	32.364	0.0000
Br/I*Br/I	0.15291977	48.624	0.0000
Log Light>Br	-0.2187656	8.468	0.0000
Log Light>Br*Log Light>Br	0.10962141	21.357	0.0000
Log Camera Exposure	-2.7808294	256.925	0.0000
Log Camera Exposure*Log Camera Exposure	0.91377955	40.299	0.0000
Br/I*Log Light>Br	-0.0290519	2.815	0.0967
Br/I*Log Camera Exposure	-0.3070441	44.114	0.0000

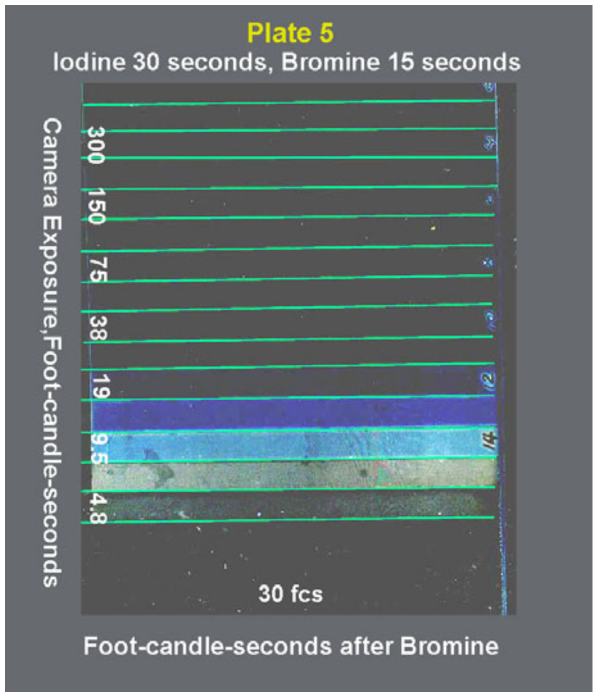
Figure 7
Contour plots showing conditions under which the daguerreotype plates exhibited maximum sensitivity.

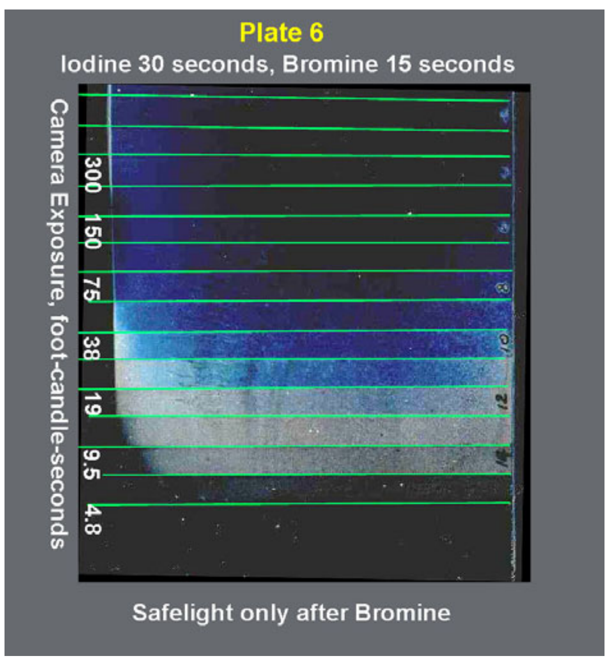


The statistical model was use to construct the above graphical prediction of the conditions under which the daguerreotype plate has maximum sensitivity.

LIGHT vs. NO LIGHT

The daguerreotypes in Plates 5 and 6 were fumed over iodine for 30 seconds and then fumed over bromine for 15 seconds. The Daguerreotype in Plate 5 was exposed to 30 fcs of subdued light after bromine fuming. The Daguerreotype in Plate 6 was fumed over bromine in total darkness. The daguerreotype in Plate 5 was one half stop faster than the daguerreotype in Plate 6. The slope of the D-Log E curve for the plate exposed to light after the bromine fuming step was higher , indicating that the contrast increased.





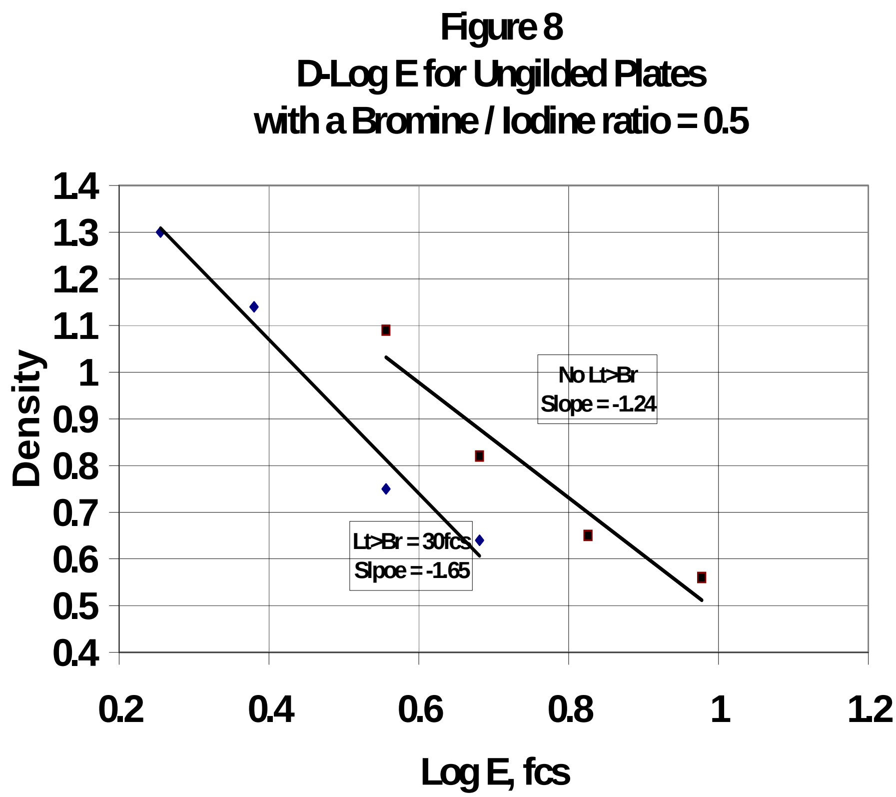


Figure 8
D-Log E for Ungilded Plates
with a Bromine / Iodine ratio = 0.5
Density
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
No Lt>Br
Slope = -1.24
Lt>Br = 30fcs
Slpoe = -1.65
0.2
0.4
0.6
0.8
1
1.2
Log E, fcs

BROMINE VS NO BROMINE

The daguerreotype in Plate 7 was fumed only over iodine for 45 seconds under the light of a red safelight. Plate number 7 was 4 stops slower than the daguerreotype in Plate 6. The combined effect of light and bromine on plate speed (i.e., 60X) was approximately twelve times greater than Barger and White's figure of 2(2.5X) for the effect of light and bromine on daguerreotype sensitivity. (9)

f Judging from the slope of the D-Log E curves, the contrast ratios of the two plates were the same.

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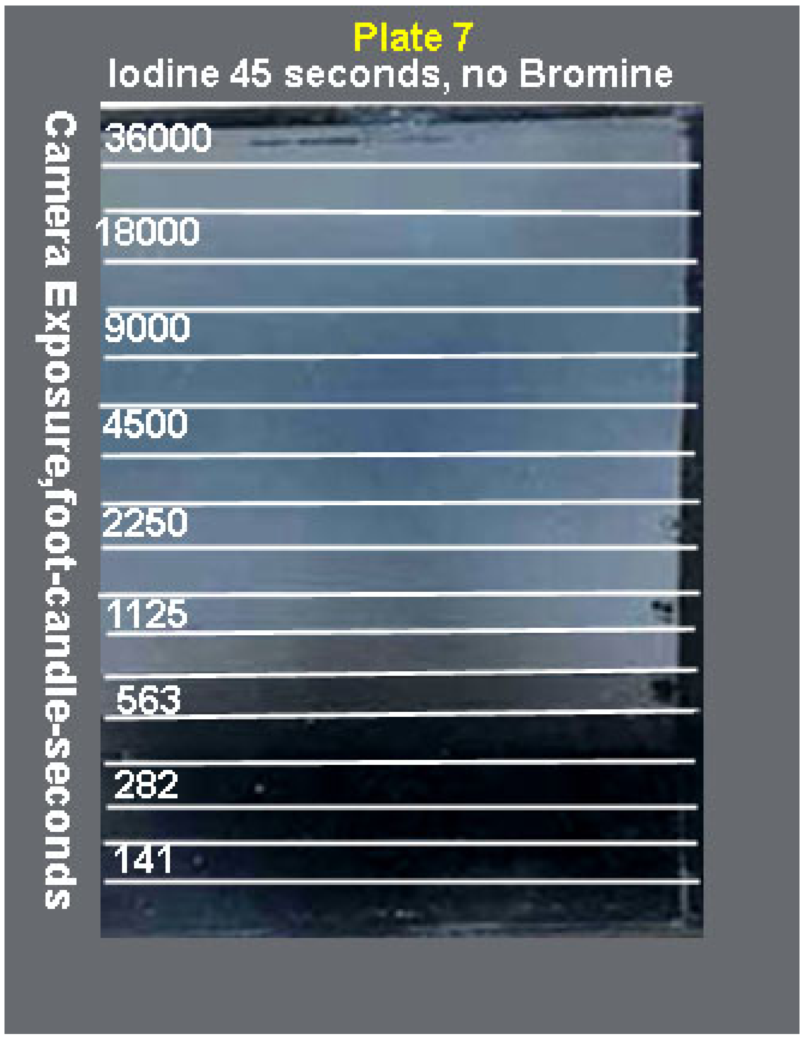
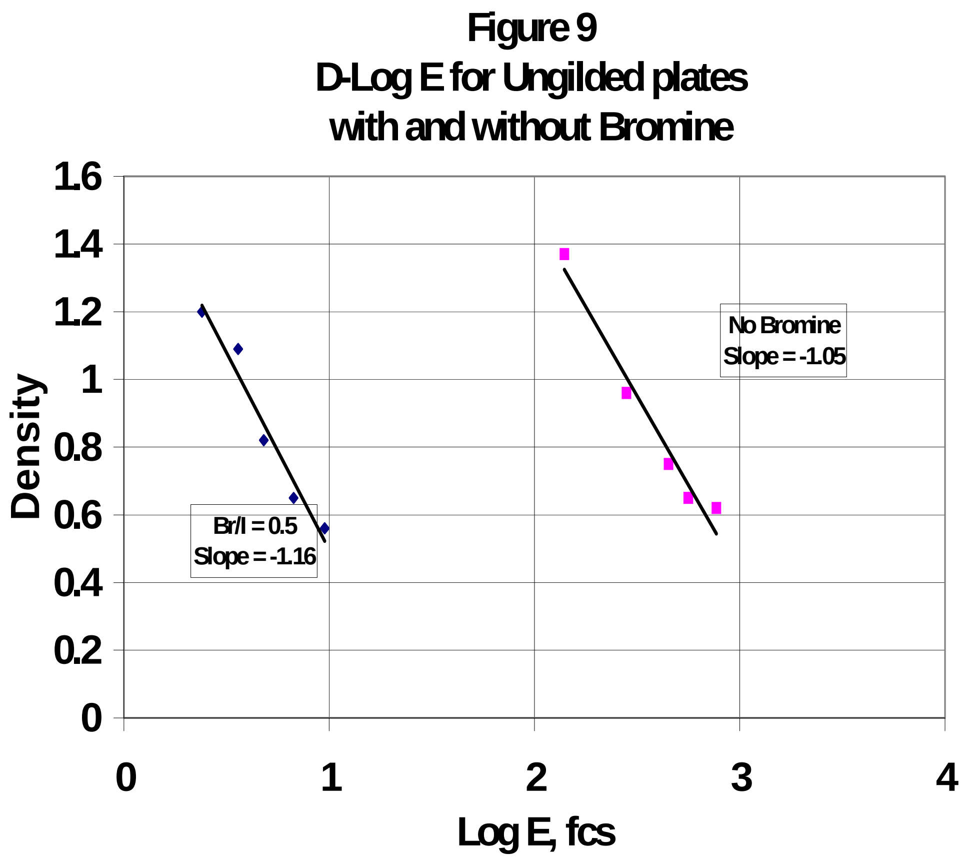




BROMINE VS IODINE: IMAGE EFFECTS

The sensitivity of iodized daguerreotype plates was shown by Pobboravsky [(11)] to vary with the thickness of the coating depending upon the method of development. Both Becquerel and mercury developed plates gave lower contrast images for thick coatings than for thin coatings. The wide discrepancy between the above speed ratio of 60/1 for multiply sensitized versus singly sensitized daguerreotype step tablets may have been partially due to the thickness of the coating on the iodized plate. To test this hypothesis, a second pair of plates was prepared. Plate 8 was multiply sensitized for 35 seconds over iodine, 25 seconds over bromine, and again for 15 seconds over iodine. Plate 9 was singly sensitized for 20 seconds over iodine. Both plates were exposed by contact printing from the same color transparency. The image in Plate 8 received a 12-second exposure to 40 fc of illumination for a total of 480 fcs of light. The image in Plate 9 received 120-second exposure to 240 fc of illumination for a total of 28800 fcs of light. The multiply sensitized daguerreotype plate was at least 60X more sensitive than the singly sensitized iodized plate. The iodized plate produced a higher contrast image than the bromine-sensitized plate. Pobboravsky has reported similar results. [(11)]

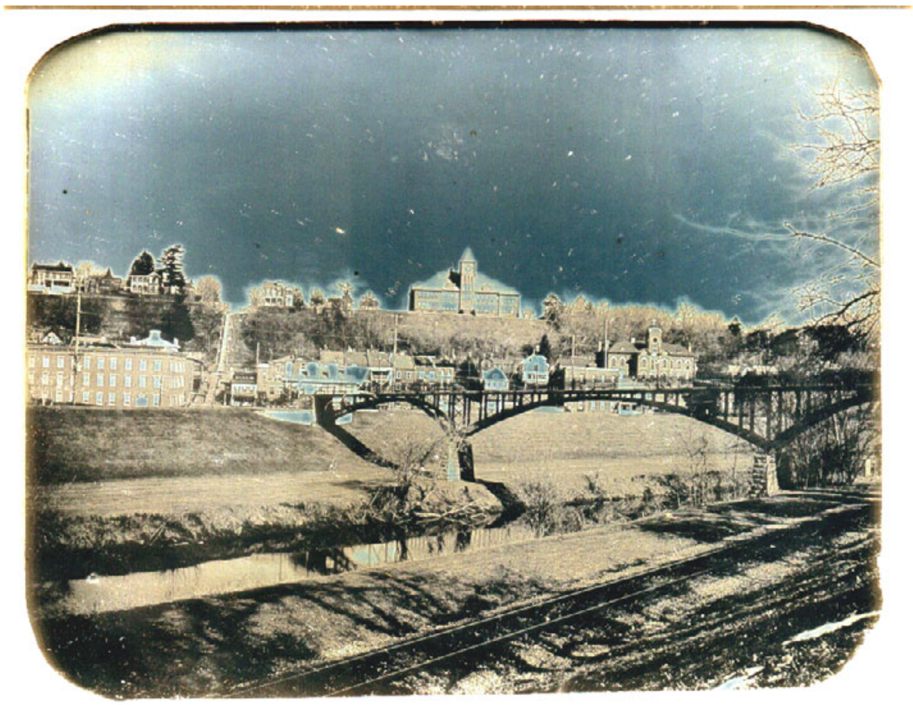


Plate 8
Multiply sensitized 4X5 Daguerreotype plate, Galena Illinois, March 19,1999.

Plate 9
Singly sensitized 4X5 Daguerreotype plate, Galena Illinois, March 19,1999.

Implications for the Daguerreian

Maintaining control of his (or her) process has always been the “Holy Grail” the daguerreotypist. No matter how meticulous the attention to detail, every operator eventually runs into this familiar sequence of events. Things seem to be running smoothly. Getting the best image seems to be only a matter of adjusting the exposure until perfection if achieved. Then, all at once, nothing seems to work the same anymore, especially the bromine. It smells the same. It looks the same. But it sure doesn’t work the same. The only remedy is put a fresh batch of “quick stuff” in the coating box. Then, with luck, the problem will, just as mysteriously, go away.

Image Density

Monitoring the coating process by color comparison under the subdued light of the darkroom is usually a reliable method of maintaining consistent light sensitivity in the daguerreotype plate. Frequent use of the coating box without a rest period interval, fluctuations in darkroom temperature, or an exhausted bromine compound can slow down the bromine fuming process. The fuming times need to be adjusted periodically to bring the color of the coating back within the normal operating range. This usually involves increasing the number of inspections to monitor the coating process. Don’t worry. We’ve always been taught that some light exposure during the coating process is good for our plates. More light must be even better, right? We blithely assume that nothing can go wrong so long as we get the same color on the plate. Or can it?

The results of this study show that a weak bromine coating can actually lose as much as 1 stop in speed if it is exposed to more than 2 fcs of light during the inspection process. Is there a cause for concern here?
Inspecting the plate for more than 2 seconds under very dim light can exceed this limitation. If the bromine is weak and you compensate by extending the fuming time with frequent inspections to see how you are doing, you could easily run into this problem.

The scenario may go something like this. Your bromine is not new, but still working. The fuming time for your first plate is normal. You need two plates so you can bracket the exposure to make sure you get a good image. You are pressed for time so you start fuming the second plate immediately after the first one is done. Your second plate doesn’t seem to have the same color so you put it back in the bromine box once or twice, each time inspecting the color under weak light, until it looks good.

Your first plate was underexposed so you gave the second plate a longer exposure. However, when you develop the second plate you discover that it appears even more underexposed than the first plate. Having learned your lesson, you decide to go back later and fume a third plate. Since the concentration of bromine in the fuming box has had time to return to normal, the plate appears to take on color normally so you have nothing to worry about. Just to make sure you, give that third plate a still longer exposure. When it is done, whoa, it is way overexposed. What may have happened here?

Your first plate received normal bromine fuming with an appropriate light exposure during inspection of 10 to 30 fcs. This combination gave it maximum speed, but you didn't give it quite enough exposure. Your second exposure was appropriately longer but the plate was exposed to too much light during the extra inspection periods. The result was that it lost some of it's potential speed. Your third plate, having received appropriate light exposure during the fuming process, was back up to speed. However you gave it too long an exposure.

If you can't wait for a reasonable length of time between plate preparations, try reducing the level of light in your coating room to avoid the possibility that you are giving your plates too much light during the fuming process.

How much can the loss of half a stop in plate speed affect the image of daguerreotype? The right half of the daguerreotype in Plate 10 was exposed for 15 seconds to 1 fc of subdued light after the bromine-sensitizing step. The left half of the plate was covered during this exposure. After a 5-second re-fuming with iodine, both halves of the plate were covered with a color transparency and given a 12-second exposure to 4 fc of light. After development for 5 hours over cold mercury under a 27-inch vacuum, the right half of the plate that received 15 fcs of light exposure after bromine has a normal image. The left half of the plate, which received no light exposure after bromine, has a very dark image.

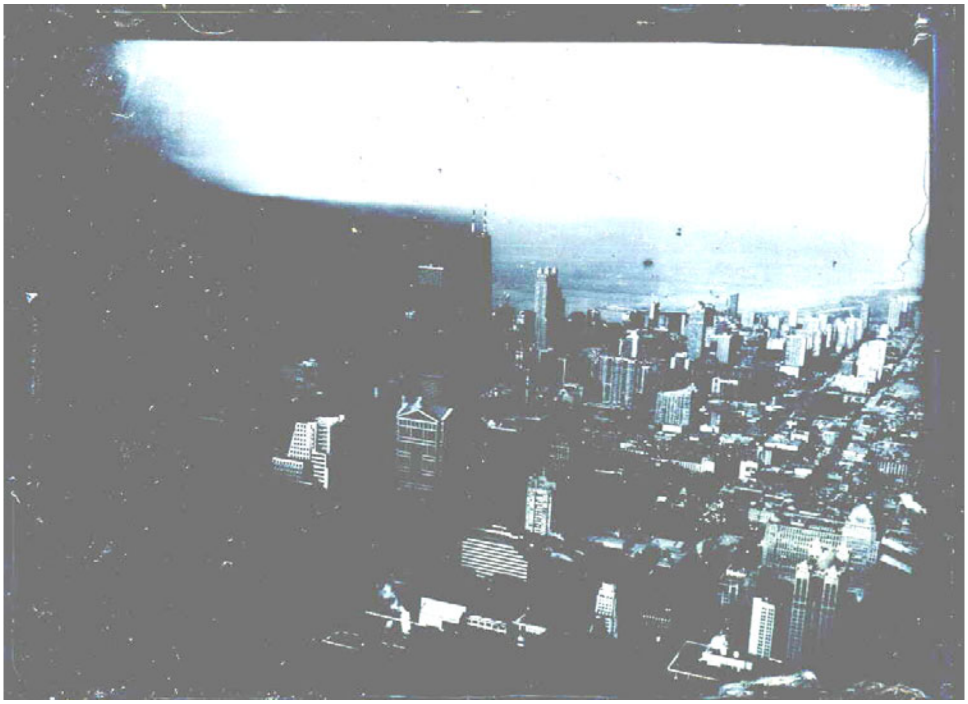


Plate 10
Multiply sensitized Daguerreotype image of Chicago, Ill. December 30, 1998. The right half of the plate which received an exposure of 15 fcs of light after the bromine-sensitizing step recorded more image detail than the left half of the plate which received no light exposure after the bromine-sensitizing step.

How much light can the daguerreotype plate tolerate, after the bromine-sensitizing step, before the image is adversely affected? Plate 11 was fumed over iodine for 30 seconds and then fumed over bromine for 15 seconds. After the bromine-fuming step, the plate was covered with a step tablet and exposed to 960 fcs of light. After a 5-second re-fuming with iodine, both halves of the plate were covered with a color transparency and given an exposure to 20 fcs of light. After development for 5 hours over cold mercury under a 27-inch vacuum, the left half of the plate that received less than 1.9 fcs of light exposure after bromine has a very dark image. The center of the plate that received 1.9 to 120 fcs of light exposure after bromine sensitizing has a normal image. The right half of the plate, which received more than 120fcs of light exposure after bromine sensitizing, also has a very dark image

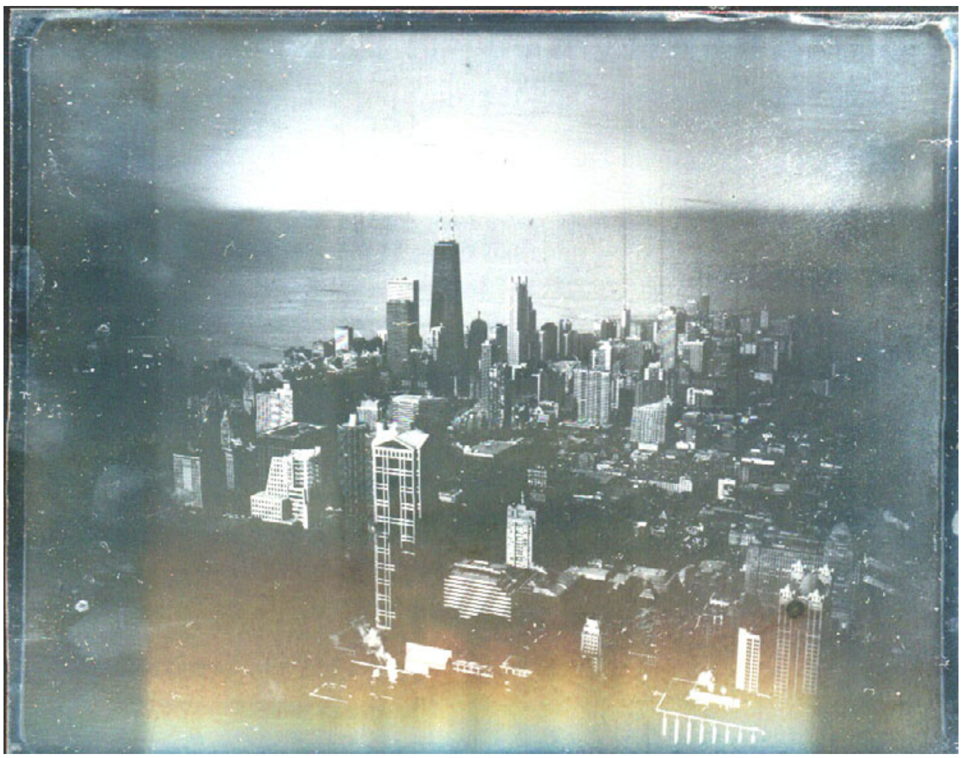


Plate 11

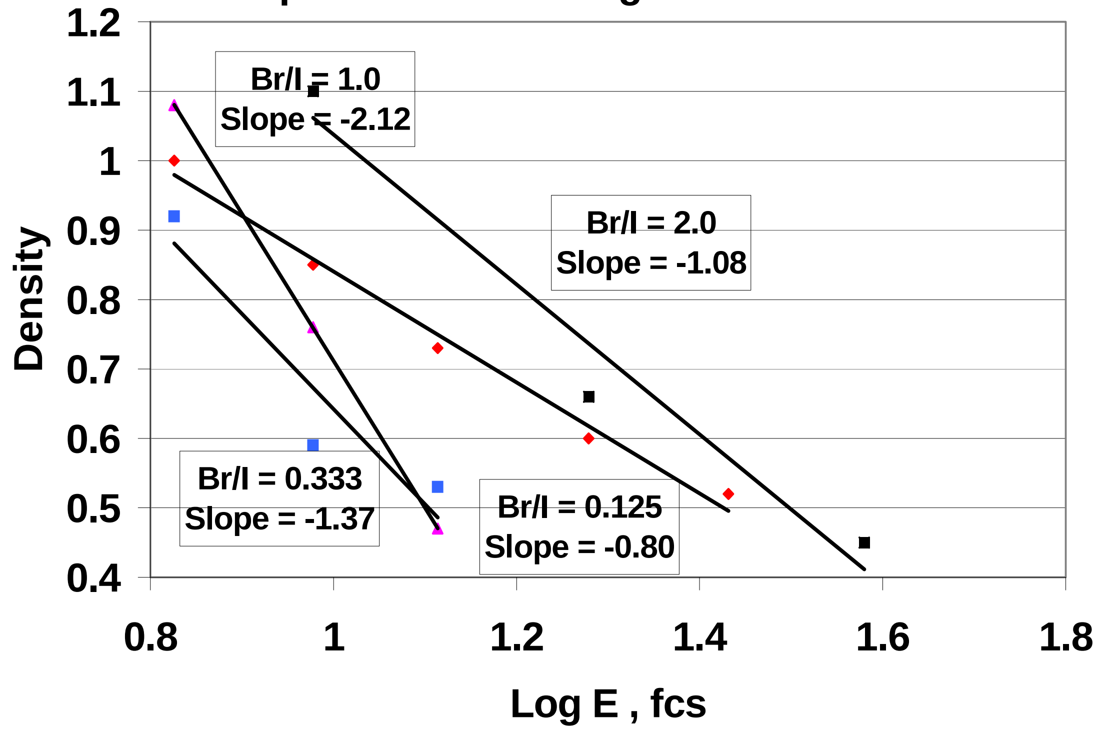
Multiply sensitized Daguerreotype image of Chicago, Ill. December 30, 1998. The center of the plate recorded more image detail than the right side that received more than 120 fcs of light after the bromine-sensitizing step or the left side that received less than 2 fcs of light exposure after the bromine-sensitizing step.

Image Contrast

Image Contrast

Daguerreotypes usually have extremely narrow exposure latitude. Even after the exposure has been optimized to obtain the best overall image density, the contrast ratio between highlight and shadow areas is normally high. Recording image detail in the shadows without solarizing the highlights can sometimes be a Herculean challenge. Fortunately there are a few techniques that the operator can employ to reduce the contrast ratio of the daguerreotype. Foremost among these techniques is increasing the ratio of the second iodine fuming to the first iodine fuming time [6]. Second among these techniques is increasing the bromine fuming time [7]. Both of these measures have a tendency to produce lower contrast images. When used to extreme however, either one may reduce the sensitivity of the coating. [10] Can we also control the contrast of the daguerreotype by adjusting the light exposure after the bromine fuming stage?
This study shows that for plates which have been fumed with typically employed bromine/iodine ratios of 1/3 to 1/1, the contrast, as well as the sensitivity of the plate will reach a maximum after exposure to 7.5 to 30 fcs of light after the bromine fuming stage. With 7.5 fcs of Lt>Br, the lowest contrast ratios were obtained with plates that had been fumed with the least amount of bromine (Slope = -0.80) or the maximum amount of bromine (Slope=-1.08).(See Figure 10. Exposure to 120 fcs of light after bromine will reduce the contrast of the image but it will also reduce the light sensitivity of the coating

Figure 10
D-Log E for Ungilded Step Plate Images
Exposed to 7.5 fcs Light After Bromine



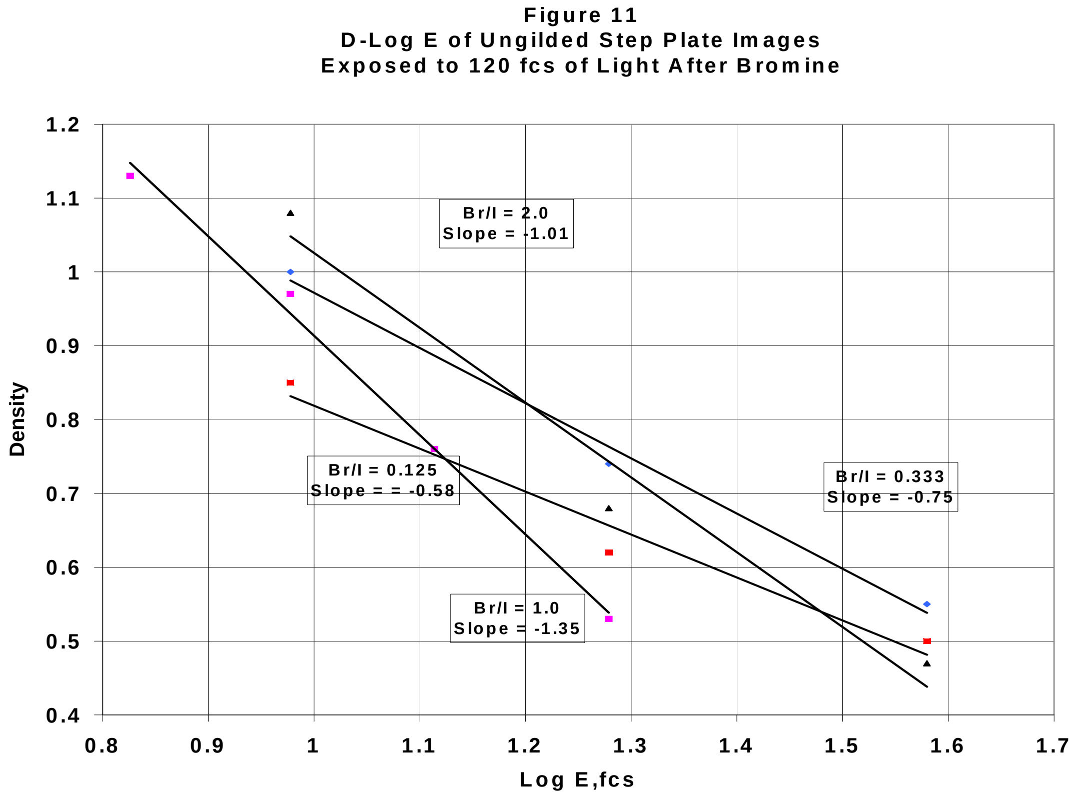


Figure 11
D-Log E of Ungilded Step Plate Images
Exposed to 120 fcs of Light After Bromine
Density
Log E,fcs
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
Br/I = 2.0
Slope = -1.01
Br/I = 0.125
Slope = = -0.58
Br/I = 0.333
Slope = -0.75
Br/I = 1.0
Slope = -1.35

APPENDIX A

Plate Preparation

Daguerreotype plates were obtained from Imperial Plating of Chicago and Theiss Plating of St. Louis. The freshly polished daguerreotype quarter-plates were first preheated using a hair dryer. The warm plates were then fumed over iodine crystals at 15^0 C under subdued light (1 fc). The fuming time was varied from 15 seconds up to 40 seconds. Then, most of the iodized plates were subsequently fumed over a deep orange bromine-lime mixture at 15^0 C under a red safelight. The bromine fuming time was varied from 5 up to 30 seconds. The iodine and bromine fuming times were paired so that the total fuming time for each plate was 40 to 45 seconds. The ratio of bromine/iodine fuming times was thus varied from 2:1 down to 1:8.

Procedure for In-process Light Exposure through a Step Tablet

After the bromine fuming stage, each of the first four plates were covered with steps 2 to 14 of the step tablet and exposed to the light of a blue number 2-photoflood (5600K) at a distance of 18 inches (240 foot-candles) for a period of 1 second. The intensity of the incident light was measured with a Sekonic ™, model L-398M meter equipped with the Lumisphere attachment. The nominal density increment between adjacent steps on the tablet was 0.15. The nominal density increment between two steps (i.e., 2 to 4 of 4 to 6 etc.) was 0.30, which is equal to a factor of 2 in light transmission. Therefore light transmission was cut in half for each increase of 2 in the step tablet. The intensity of the incident light at the surface of the plate varied by a factor of approx. 60X from 2 fc on one side of the plate to the 120 fc on the opposite side of the plate. Total light exposure of the plate ranged from 2 fcs to 120 fcs. See Plate 12b. After the light exposure, each plate was fumed once more over iodine for 5 seconds under a red safelight.

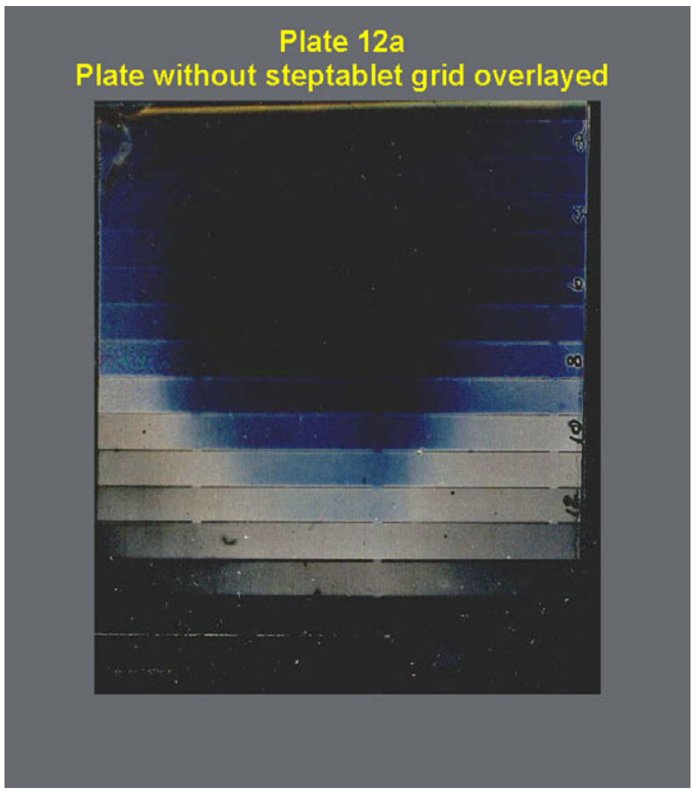
TABLE II

Light Transmission through the Photographic Step Tablet

STEP TABLET NUMBER	STEP TABLET DENSITIES	INCIDENT LIGHT INTENSITY, FC
0	0	240
2	0.10	120
4	0.38	60
6	0.70	30
8	1.00	15
10	1.34	7.5
12	1.61	3.75
14	1.90	1.88
16	2.25	0.94
18	2.58	0.47
20	2.90	0.24
22	3.18	0.12

Procedure for the Final Light Exposure through a Step Tablet

After the second iodine fuming, each plate was again covered with steps 2 to 16 of the tablet, which was positioned at a 90-degree angle from the position used during the first exposure. Then each plate was exposed once more to the light of a blue number 2 photoflood at a distance of 18 inches. This exposure will henceforth be referred to as the "camera" exposure. The intensity of the incident light during the "camera" exposure was thus varied by a factor of approx. 60X from 1.9 fc on one end of the plate to the 120 fc on the opposite end of the plate. Multiply fumed plates were given "camera" exposures of 5 seconds and singly fumed plates were given "camera" exposures of 300 seconds. See Figure 12c. Total "camera" light exposure of the plate ranged from 5 fcs to 150 fcs for multiply fumed plates up to 300 to 36000 fcs for singly fumed plates.



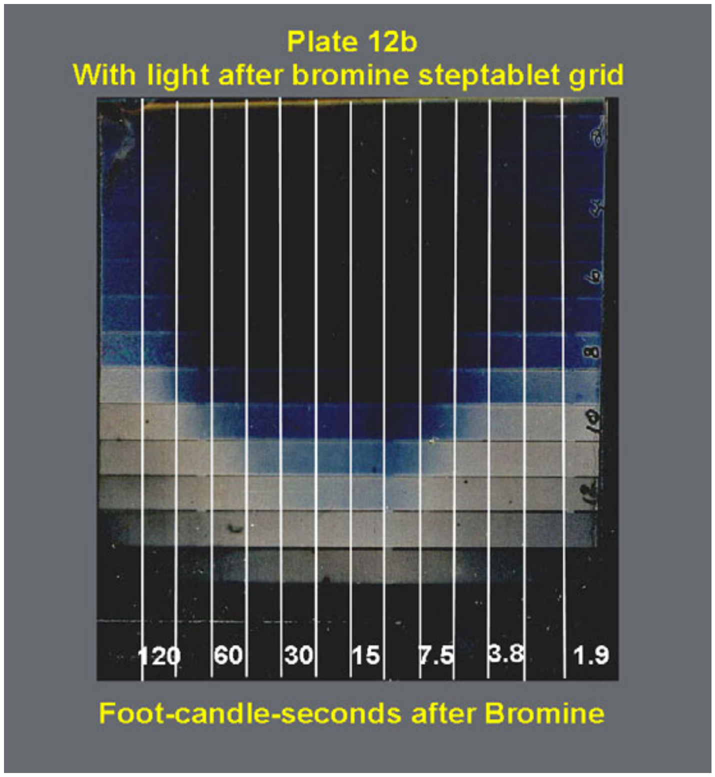


Plate 12b
With light after bromine steptablet grid
120
60
30
15
7.5
3.8
1.9
Foot-candle-seconds after Bromine

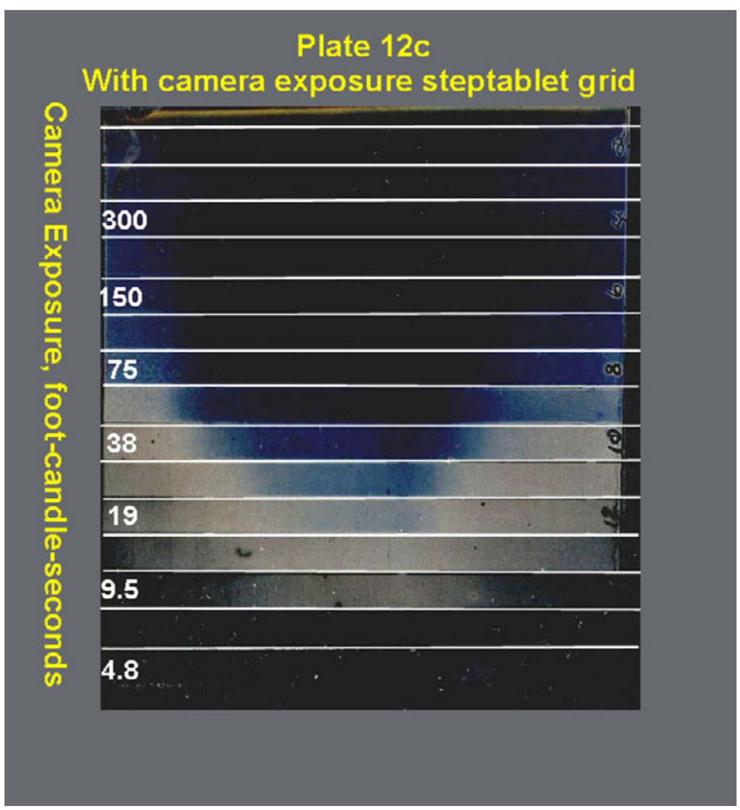


Plate 12c
With camera exposure steptablet grid
Camera Exposure, foot-candle-seconds
300
150
75
38
19
9.5
4.8

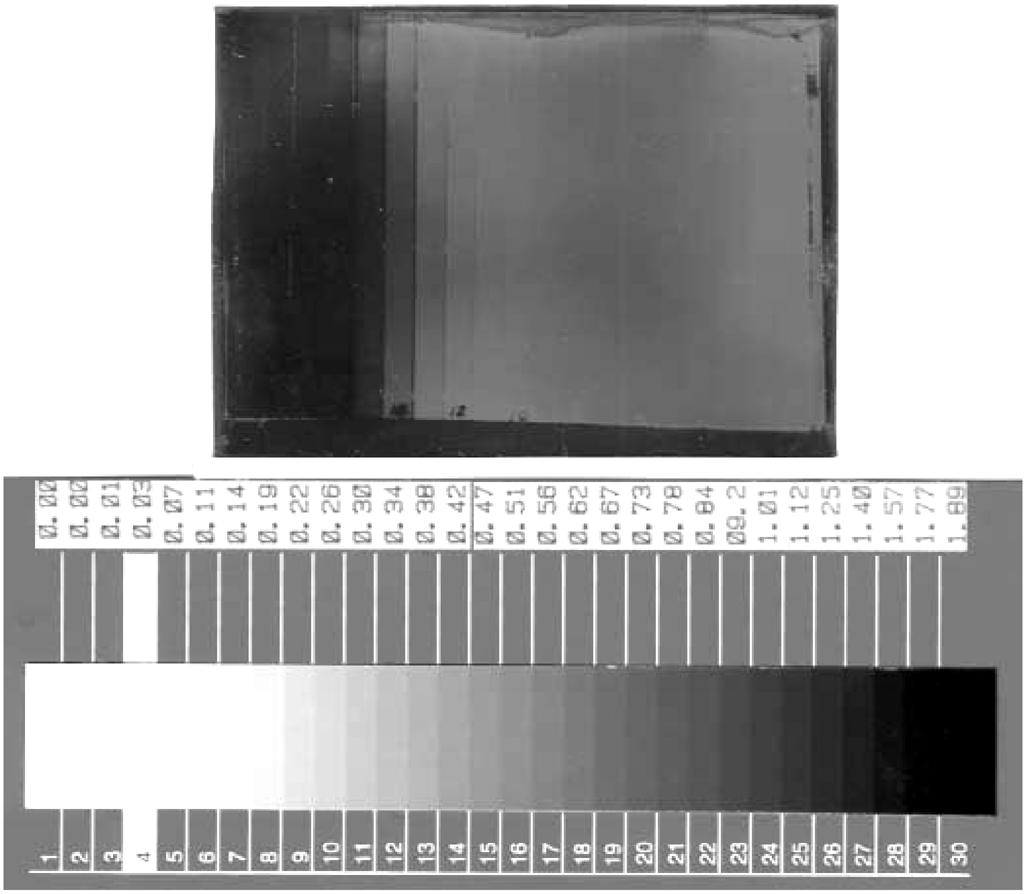


Plate 13

Computer scan of a Daguerreotype step plate with a Rochester Institute of Technology Camera Test Scale for image density measurement.

<u>Step Tablet Development Procedure</u>

After the second exposure each plate was developed over cold mercury at 20C under a 27-inch vacuum for a period of 5 hours. [12] After development, each plate was fixed, dried. The first four plates were also gilded.

<u>Step Tablet Density Measurement Procedure</u>

Each step plate was scanned in a flat bed scanner, along with a calibrated reflection gray scale. See Plate 13. To determine image densities, each section of the step plate was sampled with the eyedropper tool of Adobe ™ PhotoShop Version 4.01. Densities were calculated by matching the sample of the reflected image of the daguerreotype with samples from the calibrated gray scale.

Image density variations were plotted using Microsoft Excel ™. Statistical analysis were made using the JMP ™ program from the SAS institute

ACKNOWLEDGEMENTS

The author would like to thank Irving Pobboravsky for providing his improved method for measurement of image densities on daguerreotype plates. Irv conducted literally hundreds of image density measurements, and this research project could not have been completed without his efforts. Irv's suggestions for additional experiments and for improved diagrams to help the readers understand the work have greatly contributed to the readability of this paper.

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John Hurlock has been a member of the Daguerreian Society since 1996 and is an active daguerreotypist. His first article for the Daguerreian Annual, "Warming up to Cold Mercury" appeared in the 1998 issue. The author received his degree in Chemical Engineering from Northwestern University in 1961. He has recently retired from Nalco Chemical Company after 40 years of conducting research in the field of polymer chemistry.

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