

Making Kallitype Prints: A Fresh Look at a Beautiful Printing Process

制作铁银法印相：

从一个全新的角度来理解这个精美的印相流程

作者： **Sandy King**

翻译： **战平**

古典摄影中文杂志

***重要提示：此工艺中所使用的部分化学药品有毒，使用时请慎重小心。**

What is a Kallitype? And a Little History.

什么是铁银法印相？以及一点儿历史。

Kallitype is one of a number of printing processes in the iron-silver family, along with, among others, Vandyke brown and argyrotype. There are some similarities among these three, but in kallitype the light-sensitive element is ferric oxalate; in Vandyke and argyrotype it is ferric ammonium citrate. The ferric oxalate makes a superior process in several important ways: it permits darker shadows, i.e. more Dmax, with kallitype than with either Vandyke or argyrotype. The difference is not huge, but well-made comparison prints side by side show more richness in the shadows of a kallitype than in a Vandyke or argyrotype. Another advantage of kallitype is greater control of contrast, making it possible to print negatives with a wider range of densities than the other two iron-silver processes. Another advantage is that kallitype is a developing-out process, which generally translates into greater depth in the shadows than POP processes such as Vandyke or Argyrotype. Shadows in these processes often appear murky because they are fully exposed before the highlights have a chance to print in.



铁银法印相（Kallitype）是一种属于以铁盐和银盐来印相的工艺。类似的工艺还有，范戴克法（Vandyke）、阿盖洛法（Argyrotype）。这三种工艺有其相似之处。但是，铁银法印相的感光剂是草酸铁，其他两种工艺的感光剂为柠檬酸铁铵。草酸铁为铁银法印相带来了巨大的优势：1、使阴影（黑位）部分更深。虽然差别并不十分巨大。但是把印好的这三种工艺的照片放在一起，会看出铁银法印相的暗部细节更加丰富。2、另一个好处是，铁银法印相更容易控制反差。使印制影调范围较大的照片成为可能。3、由于铁银法印相是“显影出来”的照片，这与直接显影的另外两种工艺的区别在于，影调可以通过显影的控制而变得不同。而另外两种工艺，在曝光的时候，感光剂已经反应完毕，显影只是把为反应的部分去掉。

The basic theory of kallitype printing is found in Sir John Herschel's paper of 1842, "On the Action of the Rays of the Solar Spectrum on Vegetable Colours, and on Some New Photographic Processes." However, it was not until 1889 that W. W. J. Nicol patented the first iron-silver process and he is widely considered to be its inventor. In Nicol's original patent, the print was developed in a silver nitrate bath. He patented several revisions in the early 1890s and in one of the formulas recommends making silver nitrate part of the sensitizing bath rather than adding it to the developer. This last revision is the method used by most contemporary kallitype printers.

铁银法印相的基本理论最早出现在 John Herschel 爵士 1842 年的论文（“On the Action of the Rays of the Solar Spectrum on Vegetable Colours, and on Some New Photographic Processes.”）中。直到 1889 年，W. W. J. Nicol 第一个申请了铁银法工艺的专利，他并认为是这种工艺的发明者。在他最早的专利中，照片是在硝酸银溶液中显影。1890 年早期，他对他的专利进行了多次修改和补充，其中一个配方是把硝酸银作为感光剂的一部分。而这一个配方，被大多数与其同时代的铁银法印相师所使用。

Overview of the Process

工艺概述

In kallitype printing, a suitable paper is coated with a solution of ferric oxalate and silver nitrate, using either rod or brush. When dry, the sensitized paper is exposed to a negative under an ultraviolet light source. Since kallitype is a contact-printing process, exposure requires a same-size negative and some means of making the "sandwich" -- a printing frame or vacuum frame, or even simply two sheets of heavy plate glass. After exposure, the paper is developed, cleared, toned, fixed, washed and dried.

铁银法印相基本流程：把草酸铁和硝酸银的溶液涂在合适的纸上，涂抹过程可以使用玻璃（橡胶）棒，或者刷子。待干透之后，把底片压在感光的纸上，放在紫外线（灯箱或阳光）下曝光。由于铁银法印相是一种接触印相工艺，所以需要与影像相同大小的底片。相同大小的意思是，需要使用“三明治法”。一个简易的印相框或真空印相框，也可以简单的使用两块玻璃，夹住底片和纸。曝光之后，相纸要经过显影、清洗、调色、定影、水洗和干燥这些过程。



The Chatooga River near Bull Sluice

The kallitype turns out to be a very close cousin of platinotype. Both processes are based on ferric oxalate as the light-sensitive element, and processing for both is almost identical. In fact, the developers and clearing agents used for platinum can be used for kallitype. Finally, a well-made kallitype, when toned with platinum or palladium, is for all practical purposes identical in tonal range and color to a true platinum or palladium print. In fact it would be impossible for even an expert to distinguish between well-made kallitype and platinum prints made from the same negative.

铁银法印相和铂金印相很接近，这两种方法都基于草酸铁感光剂，整个过程也很接近。其实，显影剂和清洗剂可以通用。一张制作精良的铁银法印相照片，经过铂、钯盐溶液调色之后，色调和影调几乎和铂金印相一致。事实上，即使是专家也很难区分同一张底片制作出来的铁银法印相和铂金印相作品。

In other words, the kallitype process allows us to make platinum or palladium toned prints that look like real Pt/Pd prints and are just as permanent, but at much less cost. And that is no small

thing, because the cost of printing Pt/Pd can be very high. Of course, if we are going to tone our prints, as I strongly recommend, we will spend some money on gold, platinum or palladium, but full toning of a kallitype requires only about 1/4 as much chemistry as a Pt/Pd print, so there is still considerable saving. Savings may be even greater because kallitype toning is done after development and clearing, when it is fairly obvious if the print is a keeper or not. Thus we don't waste our precious metal on an inferior print. Since platinum/palladium prints incorporate the metal in the sensitizer, the metal from a failed print cannot be saved. (Of course cost differential will vary according to whether we buy the metals in small or large quantities.)

换一句话说，经过经过铂、钯盐溶液调色的铁银法印相照片看起来和真正的铂金印相照片非常接近，然而成本却比后者大大降低。这可不是什么小事情。因为，铂钯的价格很高。如果要为铁银法照片调色（我强烈建议对这样做），我们会花一些钱在金、铂和钯上，但是调色过程所需要的化学药剂只相当于相同大小铂金印相照片的四分之一。另外调色使用的是经过显影和清洗的铁银法照片，这样的话，可以更清楚的知道那张照片需要保留。这样就不会有浪费的现象，进而会更加节省昂贵的金属。

There is another important factor in weighing relative costs.. Since the actual cost of making a platinum print is significant, when we add in the number of wasted prints, the cost to print in platinum can be very great. And this cost can cause our creativity to suffer. Carmen Lizardo in her recent article on kallitype in Post-Factory Photography puts it this way: "Since printing kallitype is so much cheaper than printing platinum . . . it allows me to feel free, experiment, have fun, and make BIG beautiful prints." Judy Seigel quotes Man Ray to the effect that an artist must have "contempt" for his materials, which it's harder to do with platinum/palladium. In sum, kallitype frees us to be creative and to fully experiment with our materials.

另外，还有一个很重要的因素来权衡相关的费用。制作铂金印相的成本本身就非常高，当我们再加上一些废弃的照片，他的成本就更加巨大。这种高成本会使我们感到煎熬。摄影师 Carmen Lizardo 在她最近的关于铁银法印相的文章中这样说：“因为铁银法照片比铂金印相要便宜得多，这使我没有顾虑，做试验，制作漂亮的大照片，并从中得到乐趣。”。Judy Seigel 引用 Man Ray 的话，说：“摄影师必须做到对其使用的材料无所顾忌。”，这对于制作铂金印相很难做到。总之，铁银法印相让我们从材料中解脱出来，使我们无所顾忌的做实验与创作。

Notes on Image Permanence

照片的持久性

As noted, kallitype is based on ferric oxalate, which contains ferric iron, Fe (3+) and oxalate. On exposure to ultraviolet light, ferric iron is reduced to ferrous iron, Fe (2+). To make a permanent print, ferrous iron must be further reacted with something else. In kallitype printing, the something else is the noble metal silver.

铁银法印相是基于草酸铁的印相工艺。草酸铁包含三价铁离子和草酸根。经过紫外线曝光之后，三价铁离子转变为二价铁离子，为了得到固定的影像，二价铁离子需要与其他的物质发生反应。这个“其他的物质”就是贵金属银。

The major danger to long-term permanence of a kallitype image is residual ferrous iron, Fe(2+). If left in the paper, even very small quantities of residual ferrous iron will eventually oxidize the silver, and the image will fade. The key to maximum archival quality with kallitype is direct toning in which the image silver is replaced with another noble metal that is resistant to oxidation by residual ferrous iron. The metals commonly used to tone kallitypes are gold, palladium and platinum. A kallitype processed for maximum archival stability, and toned with gold, palladium or platinum, will have great permanence. We could go even further: a kallitype print toned with palladium or platinum is in every way an exact equivalent, both visually and in terms of image permanence, of a Pt/Pd print. Selenium can also be used, but it tends to stain the print if toning is done before fixing.

主要影响铁银法照片保存的因素是残留的二价铁离子。如果有二价铁离子残留在纸张中，即使是极少量的，也会使银氧化，并使影像逐渐消失。最大程度上保存铁银法照片的关键在于，用另外一种不会被二价铁离子氧化的贵金属来替换银。这种贵金属通常是金，铂和钯。经过金，铂或钯调色的铁银法照片具有极好的持久性。这种做法还有另外一个优点：经过铂或钯调色的铁银法照片，无论从色调和影调，以及持久性等任何角度讲都极其接近，甚至一样。硒也可以作为调色剂，但如果在定影之前调色，会使照片污浊。

Maximum permanence also requires removing all residual ferrous iron from the paper, fixing to remove unused silver, and removal of all residual hypo via an adequate wash.

使铁银法照片获得最大限度的持久性还需要去除所有的二价铁离子，定影以去掉未反应的银，并通过充分的水洗去除所有的海波。



The Beach at Kiawah Island

About My Method

我的方法

One of the things that has turned people off on kallitype is its seeming complexity. Virtually every text on kallitype lists numerous developer formulas, each capable of providing a different color or tone, with an infinite number of variations in processing: time of development, time of clearing, strength and length of fixing, etc, which can be very confusing for the beginner. If you really want to know how complicated kallitype printing can become, have a look at Dick Stevens' book, *Making Kallitypes: A Definitive Guide*.

使人们对铁银法印相望而却步的原因之一是它看起来非常复杂。事实上，几乎所有的关于铁银法印相的文章都列举出了一系列的显影剂配方。每一种配方都可以产生一种不同的影调和颜色。印相过程中的各种参数：显影时间，清洗时间，定影的强度和长度，等等。这对初学者来说非常困惑。如果你真的想了解铁银法印相到底能复杂到什么程度，可以看看 Dick Steven 所写的一本书，*Making Kallitypes: A Definitive Guide*（制作铁银法照片：一本权威的指导书）。

My method is based on a limited number of working options and is rooted in two principles: less is more and the print should be processed for maximum permanence. Thus, instead of the dozens of developers recommended in some texts, I recommend just one. But, as with any process based on silver salts, the ultimate stability and permanence of the image depends on careful processing. For maximum image stability, all kallitypes should be toned. This article provides instructions for toning with gold, palladium or platinum, which are toned before fixing, and selenium, which is toned after fixing.

我的方法基于有限的选择以及两个准则：越少越好，照片需达到最大限度的持久性。所以，我只推荐一种显影剂配方，而不是像其他文章中推荐数十种配方。但是，由于整个过程基于银盐，照片的稳定性和持久性都依赖于小心的处理过程。为了达到最好的稳定性和持久性，所有的铁银法照片都需要经过调色。金、铂或钯的调色需要在定影前进行，而硒调色需要在定影之后进行。

There are many reasons to tone before fixing: shadow depth is increased, bleaching during fixing is minimized, and the change in tone is much more dramatic. I always tone before fixing, except with selenium, in which case it is better procedure to tone after fixing.

金、铂或钯的调色需要在定影前进行有很多原因：阴影部分的深度加深，定影过程的漂白作用最小；影调的变化更加剧烈和有戏剧化。我大部分情况下都会在定影之前调色，除了硒调色。

Necessary Materials

必要的材料

| The Basic Chemicals | 基础化学药剂 |
|--|-------------|
| Silver nitrate | 硝酸银 |
| Ferric oxalate powder | 草酸铁粉末 |
| Sodium thiosulfate crystals | 硫代硫酸钠 |
| Sodium carbonate | 碳酸钠 |
| Sodium sulfite | 亚硫酸钠 |
| Citric acid | 柠檬酸 |
| Potassium Chloroplatinite 20% solution | 氯亚铂酸钾 20%溶液 |
| Sodium Chloropalladite 20% solution | 氯亚钯酸钠 20%溶液 |
| Gold chloride 5% Solution | 氯化金 5%溶液 |

Kallitype requires six different solutions: 1) sensitizer, 2) developer, 3) clearing agent, 4) toner, 5) fixer, and 6) hypo-clear.

铁银法印相需要 6 种不同的药液：

- 1、感光剂 2、显影剂 3、清洁辅助剂 4、调色剂 5、定影液 6、海波清洗剂



1) Sensitizer 感光剂

The sensitizer is prepared as two separate stock solutions, solution A and solution B, which are mixed in equal parts just before use.

感光剂需要分别准备两种溶液，A 和 B，这两种溶液在使用前等量混合。

Solution A 10% silver nitrate

Mix 10g silver nitrate in 70 ml distilled water. Allow to dissolve and then add water to make a total of 100ml of solution.

溶液 A：10%硝酸银溶液。将 10 克硝酸银溶解于 70 毫升的蒸馏水中。然后把溶液加到 100 毫升（一共为 100 毫升）。

Solution B 20% ferric oxalate

Mix 20g ferric oxalate powder in 75ml distilled water. Allow to dissolve and then add water to make a total of 100 ml of solution. Ferric oxalate takes a long time to go into solution and should be mixed about 24 hours before use. In powder form it lasts indefinitely, but once mixed with water will slowly degrade, with a resulting increase in print fog. To avoid this fogging, mix no more solution than you expect to use in two to three months.

溶液 B：20%草酸铁溶液。

将 20 克草酸铁粉末溶解于 75 毫升蒸馏水中，然后把溶液加到 100 毫升（一共为 100 毫升）。草酸铁需要很长的时间来溶解，并需要静置 24 小时之后才可以使使用。草酸铁粉末可以存放很长很长时间，一旦溶解到水中，它会缓慢的分解，从而使照片起雾。为了避免这种现象发生，每次都需要少量配置溶液，并在 2 到 3 个月之内用完。

2) Developer 显影剂

My preferred developer is a 20% solution of sodium citrate. Add 200g of sodium citrate to 750ml distilled water, stir until completely dissolved, then add water to 1000ml.

我比较喜欢的显影剂是 20%的柠檬酸钠。把 200 克柠檬酸钠溶解到 750 毫升的蒸馏水中，待溶解完成，把溶液加到 1000 毫升。

3) Clearing Agent 清洁辅助剂

The recommended clearing agent for my method of kallitype is a 3% solution of citric acid. To prepare, add 30g citric acid to 750ml water, stir until completely dissolved, then add water to 1000ml.

我推荐的清洁辅助剂是 3%的柠檬酸。30 克柠檬酸溶解到 750 毫升水中，然后溶液加到 1000 毫升。

4) Toner 调色剂

See the section at the end of this article for various toner formulas.

请参照文章最后面的配方。

5) Fixer 定影

Add 50g sodium thiosulfate, 10g sodium carbonate and 2g sodium sulfite to 750ml water. Stir. When dissolved, add water to 1000ml. You can also prepare the fixer as a concentrated solution at 4X the strength above and dilute 1:3 for a working solution.

750 毫升水中加入 50 克硫代硫酸钠和 10 克碳酸钠，以及 2 克亚硫酸钠。溶解后把溶液加到 1000 毫升。你也可以配置浓缩液，只需要把上述药品重量乘 4，使用时 1: 3（水为 3）稀释。

6) Hypo Clear 海波清洗剂

The hypo clear is a simple 1% sodium sulfite solution. To prepare, add 10g sodium sulfite to 1000ml water and stir until completely dissolved. This solution should be mixed just before use and discarded after about an hour or so, or after use.

海波清洗剂就是 1%的亚硫酸钠溶液。

Paper 纸

Choosing a suitable paper is one of the most important factors in making kallitypes. Papers that will not clear completely in about 4-5 minutes should not be used. Most of the papers that work well with pt/pd printing also work well for kallitype. I have had good success in kallitype with Crane's stationery AS 8111, Platine, Bristol 2-ply Rising, Stonehenge Rising and Fabriano Artistico. Of these, my personal preference is Stonehenge Rising. It has a nice pebbly surface, gives good image detail, and clears easily.

选择合适的纸张对于铁银法印相很重要。在 4 到 5 分钟内不能清洗干净的纸则不能使用。大部分适合铂金印相的纸都可以用于铁银法印相。我用过得比较好用的纸有：Crane's stationery AS 8111, Platine, Bristol 2-ply Rising, Stonehenge Rising and Fabriano Artistico。其中，Stonehenge Rising 效果最好，不但细节好，而且很容易清洁。

Light Source 光源

Printing requires a light source high in ultraviolet light, of which there are a variety: the sun, a bank of black-light fluorescent tubes, mercury vapor and metal halide HID lamps, as well as commercial plateburners such as the Nuarc 26-1K. More information on light systems can be found in my article [Ultraviolet Light Sources for Printing with the Alternative Processes](#).

曝光需要紫外线比较强的光源。符合这种要求的光源有很多：太阳，紫外线灯管（晒版用），晒版灯等等。要求是光线频率在 300 纳米到 400 纳米之间，峰值为 365 纳米。也可以参考这篇文章 [Ultraviolet Light Sources for Printing with the Alternative Processes](#)。



The Rooster Store

The Negative 底片

Although considerable contrast control is available in kallitype, it's advisable to start with a good negative and then apply corrective controls later. The best negative for kallitype has a density range of about log 1.8. This is a very contrasty negative that will not print well even on a grade #0 or #1 paper. If you are making in-camera negatives with sheet film, this density range can be achieved by developing the film about 50% longer than normal for silver gelatin #2 paper.

尽管在铁银法印相中可以控制相当大范围的反差，但是还是建议开始就是用一张较好的底片，然后加以少量的修正处理。铁银法印相比较适用的底片密度在 log 1.8。这种底片的反差很大，以至于很难在 0 号和 1 号纸上得到很好的影像。如果你使用的是大画幅相机，可以通过加长显影时间 50% 来得到这样的底片。

Excellent enlarged negatives for kallitype can also be made digitally from 35mm roll film and sheet film originals. The original negative or transparency is scanned, worked on in Photoshop to give the best possible print on screen, and then printed on overhead transparency film on one of the modern inkjet printers. I make my digital negatives with an Epson 2000P, but numerous other printers can be used. The one great advantage to digital negatives over original camera negatives is that they all have close to the same density and contrast range, so that exposure time and contrast will be virtually identical. A detailed account of making negatives digitally is beyond the scope of this article, but for working details, consult Dan Burkholder's excellent book, *Making Digital Negatives for Contact Printing*. There is also a good paper on making digital negatives by David Fokos on the Bostick and Sullivan website. Unfortunately, Fokos' paper is now several years old and has not been updated to reflect the current generation of inkjet printers. For a really recent study on making negatives with inkjet printers see Judy Seigel's article on making digital negatives in *Post-Factory Photography Issue #8*.

也可以使用通过胶片或者数字文件制作的放大的底片，或者叫中间底。可以用 Photoshop 修改，然后用打印机制作底片。我只用 Epson 2000P 打印机来制作底片，当然也可以使用其他打印机。用打印机制作底片的优势在于可以得到质量稳定的底片，无论是底片的密度还是反差范围，因此曝光时间可以一致。关于制作数字底片的方法不是本文的主题，但关于这个话题可以参考 Dan Burkholder 的书《*Making Digital Negatives for Contact Printing*》。另外还有 David Fokos 在 Bostick and Sullivan 上的文章，遗憾的是，Fokos 的文章写于很多年前，文中没有更新关于现代喷墨打印机制作中间片的内容。要想看最近的研究结果，可以 Judy Seigel 的文章《*making digital negatives*》，在 *Post-Factory Photography* 第 8 期可以找到。

It is certainly possible to make good enlarged negatives for contact printing with traditional film, but frankly I have found the advantages of working with digital negatives so great that I cannot recommend going back to wet processing.

要制作出用于接触印相得漂亮的放大底片是完全可以的，但是说实话，我发现用数字技术制作底片的优势之后，我不建议再回到传统的方式来制作底片。

Contact Printing Frame or Vacuum Frame.

接触印相框或真空印相框

For sharp prints good contact between the negative and sensitized paper is critical. Lacking good contact, the print will have an overall soft look with localized blurry areas. A contact printing frame is adequate for prints up to about 8X10 inches, but for larger sizes best results require a vacuum frame.

为了得到锐利的照片，胶片 and 相纸之间做到很好的接触很重要。如果接触不好，照片会变得模糊。接触印相框对于 8x10 英寸以下的照片来说已经足够了，但是要是印制大于这个尺寸的照片，最好使用真空印相框。



Working Procedures

制作流程

To avoid spreading trays all over my darkroom, I recommend carrying out all processing in just one tray, with a good water rinse between steps.

为了避免暗房里到处都是显影盘，我建议所有的过程都只用一个显影片，并在做下一步之前清洗显影盘。

1) Mix the sensitizer 混合感光剂

Prepare the sensitizer by mixing equal parts of Solution A (10% silver nitrate) and Solution B (20% ferric oxalate). About 2ml of combined solution is adequate for an 8X10 print, or the equivalent.

等量混合溶液 A 和溶液 B。8X10 英寸大小的照片只需要大约 2 毫升药液。

2) Coat the Paper 涂抹感光剂

Begin the coating operation by placing several sheets of newspaper on a flat, level surface, and then tape the paper you will be printing on to the newspaper. This will prevent it from moving around when you brush on the sensitizer. Measure out the required amount of sensitizer and gently pour it over the center of the paper. Using a good-quality hake brush or a good quality artists' brush like the Richeson, quickly spread the sensitizer over the printing area of the paper, stroking lightly across the paper from left to right, then from bottom to top, and finally on the diagonal. Continue with light brushing until there is no more pooling of the sensitizer, at which point stop.

现在桌面上铺上几张报纸，铺平水彩纸，并把水彩纸用胶带粘到报纸上。这样可以防止水彩纸在刷感光剂时移动。量出所需的感光剂，轻轻的倒在纸的中间。使用质量较好的毛刷迅速地把感光剂涂抹开，涂抹的范围尽量在图像范围之内。先左右刷，在上下刷，最后在对角线方向刷，一直刷到没有明显的水迹为止。



3) Dry the Sensitized Paper 晾干

Leave the paper taped to the paper for about five minutes after completion of coating, then hang to dry. Drying will take about 15-30 minutes, depending on temperature and humidity. A fan may be used to accelerate drying, but DO NOT force dry with heat, which may cause fogging.

涂了感光剂的纸静止五分钟，不用去掉胶带。然后再把直挂起来晾干 15-30 分钟。晾干的时间取决于温度和湿度。风扇可以加快干燥速度。但千万不要用热吹干，这会使照片起雾。

5) Expose the Sensitized Paper 曝光

Place the emulsion side of the negative in contact with the sensitized paper, with the base of the negative facing the light, and place the sandwich in a contact printing frame, vacuum frame, or between two heavy sheets of glass, and expose to UV light.

把胶片的药膜面贴到纸上，然后把他们放到印相框（或者是真空印相框）中，用紫外线光源曝光。曝光时间需要经过测试，从而得到相对适宜的时间。

6) Development 显影

After exposure, place the print in the tray face up; pour the developer (20% sodium citrate) over it as quickly as possible, and develop 5-10 minutes. Development is visually complete in about 15-30 seconds, but a development time of 5-10 minutes is important for archival purposes: much of the residual ferric iron, which if left in the print could cause loss of permanence, is removed at this stage. Development can be ended when most of the stain on the sensitized but unexposed areas of the print, i.e. those areas that were masked during exposure, has been removed.

曝光之后，把纸正面朝上放在显影盘中。倒入显影液（20%柠檬酸钠），显影 5 到 10 分钟。显

影过程看上去应该在 15 到 30 秒内结束，但是为了得到稳定的影像，5 到 10 分钟的显影时间是必要的。



The Chattooga River from the Old Iron Bridge

Contrast can be controlled by the addition to the developer of a few ml of a 5% potassium dichromate solution. The practical limit ranges from as little as 1 ml per liter of developer up to about 16 ml per liter. This allows the use of negatives from a DR as low as about 1.2 to a maximum of about 2.2. If too much dichromate is added, printing times will increase considerably and the image will take on a granular look.

反差可以通过加入一点儿 5% 的重铬酸钾溶液来控制。具体加入的浓度可以从 1 毫升每升到 16 毫升每升显影剂不等。可以通过这样的方法，使其可以制作底片密度从 1.2 到 2.2 的照片。如果加入过多的重铬酸钾，显影时间需要适当增加，并且会得到有颗粒感的图像。

The developer can be reused, but should be replenished. I recommend replenishment at the rate of about 200 ml of developer per every 500 square inches of print surface developed. To replenish, decant the developer from the top of the bottle and discard the solution on the bottom: if the developer is not replenished, the accumulation of ferrous iron will make it increasingly difficult to clear the print during processing. This will not only result in an unpleasant stain in the masked areas of the print, but may also decrease permanence, because the stain consists in large part of residual ferrous iron.

显影剂可以被重复使用，但是需要添加补充液。我建议每显影 500 平方英寸（大约 6 张 8X10 照片的面积）的照片，需要替换 200 毫升显影剂（倒掉 200 毫升，并补充 200 毫升）。具体操作方法是，把使用过的显影剂缓慢倒出到另外一个容器，把最后底部的 200 毫升药液废弃。如果不补充显影剂，照片清洗变得很困难，同时也会产生污点，并且会影响照片的稳定性。

After development in sodium citrate, the print will have a rather unpleasant brown color, but do not despair. Subsequent processing will change final image color quite dramatically.

显影之后，照片会呈现出不太好看的棕色，但是不要失望，接下来的步骤会大幅度改变最终的影像颜色。

7) First Rinse 第一次水洗

After development, rinse the print for 1-2 minutes in running water. It is very important that this first rinse be done in water that is either neutral or slightly acidic. If the first rinse is alkaline, ferrous hydroxide compounds may be formed in the paper, making complete clearing difficult or impossible.

显影之后，把照片置于流水中水洗 1 到 2 分钟。第一次水洗用中性的水或略带酸性的水很重要。如果是碱性的话，可能会产生氢氧化亚铁，并残留在纸中，这样会是清洁变得很困难甚至不可能。

8) Clearing 清洁

Clear the print until there is absolutely no stain left in the sensitized but unexposed areas of the print. The time for the paper to completely clear will vary with different papers, and sometimes even with the same paper manufactured at different times. However, if the paper takes more than about four minutes to clear, I would consider it unsuitable for kallitype and look for a better one. Renew citric acid bath frequently, as this chemical is very inexpensive and proper clearing is absolutely vital to print stability. The image will lighten considerably during clearing, but don't worry because all the lost density will return during toning and fixing.

用清洁剂清洁照片，直到未感光的部分一点污渍都没有为止。清洁时间可能因纸而异，甚至不同批次生产的纸都有所不同。然而，如果某种纸需要超过 4 分钟以上时间来清洁，说明这种纸不适合铁银法印相工艺，需要寻找其他更适合的纸。要勤更换柠檬酸清洗剂，因为药品很便宜，而且这个过程对照片质量至关重要。这个过程会使影像变淡，但不必担心，因为所有的影像密度会在调色和定影过程恢复。

9) Second Rinse 第二次水洗

After clearing, rinse the print for 30-60 seconds in running water.

经过清洗过程，用流水水洗 30 到 60 秒。

10) Toning 调色

Tone for the time necessary, which can vary from 5-20 minutes depending on the strength and amount of toner. With most toners, toning begins first in the highlights, proceeds to the

midtones, and ends with the shadows. The print is fully toned when the shadows have taken on the color that is characteristic of the toning metal. With the toner used full strength, the print should be fully toned in about six to eight minutes.

调色的时间很重要，这个过程会因为调色剂的多少和浓度而不同，大约是 5 到 20 分钟。大多数的调色剂会先作用于高光部分，然后是中间调，最后是暗部。当暗部的颜色变成这种调色剂的标志性颜色时，调色可以停止。使用新的调色剂时，调色过程基本上需要 6 到 8 分钟，使用旧药时，这个过程会更长。

11) Third Rinse 第三次水洗

After toning, rinse the print in running water for 60 seconds.

调色后，流水水洗 60 秒。

12) Fix 定影。

Fix for four minutes. For maximum archival quality, use two separate fixing baths and fix for two minutes in each, with a 30-second rinse in running water between. The second bath should always be fresh fixer.

定影 4 分钟。为了得到最好的稳定性，最好是用两次定影，每次 2 分钟，中间 30 秒钟的流水水洗。第二次定影应该使用新的定影液。

13) Fourth Rinse 第四次水洗

After fixing, rinse in running water for one minute.

流水水洗 60 秒。

14) Hypo Clear 海波清洗

After the fourth rinse, place the print in a 1% solution of sodium sulfite for two minutes. Or Kodak Hypo-Clear can be used.

第四次水洗之后，把照片浸入到 1% 的亚硫酸钠溶液中，2 分钟。或者使用柯达海波清洗剂。

15. Final rinse 最后水洗

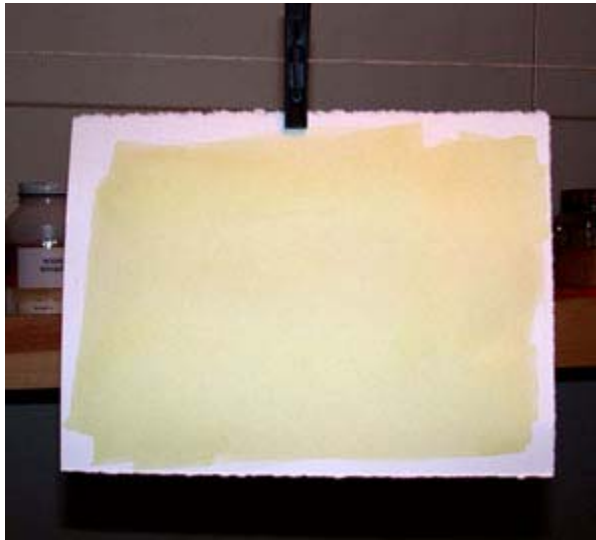
Rinse the print in running water for 20-30 minutes. If you omit the hypo clear bath, final wash time should be an hour.

流水水洗 20 到 30 分钟。如果没有经过海波清洗（第 14 步），则需要水洗 1 小时。

16. Dry 干燥

Hang the print to dry, or place on a drying rack.

把照片挂起晾干，或使用干燥架。



Refinements to the Process 流程微调

As you begin to work with kallitype you will learn that there are literally dozens and dozens of variations of the process, ranging from developer formulations capable of rendering a wide range of colors and tone, to sensitizer additives which can alter color and tonal range. For the most part, I would recommend sticking with the sodium citrate developer until you become very familiar with the process. In fact, there is really no reason to use any other developer unless you want an unusual color that cannot be rendered through toning with gold, platinum or palladium. However, as noted earlier, the permanence of kallitype prints in which silver has not been replaced by toning with one of the more noble metals is highly suspect and I recommend that for maximum permanence you always tone.

作为一个初学者，你会发现有许多许多不定因素影响整个流程。从不同颜色的显影剂配方，到感光剂添加剂对颜色和影到范围的影响等。但最重要的是，我建议你一直使用柠檬酸钠显影剂配方，直到你完全掌握了整个流程。事实上，我们没有理由使用其他配方，除非你需要的颜色不能通过金，铂或钯调色达到。然而，正如我前文所说的，照片中的银不会被分子量低于它的金属所替换，这样会影响照片的稳定性。

Metal Additives 金属添加剂

The addition of small amounts of certain metallic salts to the working sensitizer can modify the color and tonal range of the final image and also, in combination with double toning, produce interesting split tones in the image. The metals most commonly used are gold, platinum, palladium, and mercury. The effects obtained by adding the metallic salt directly to the sensitizer are different from toning.

往感光剂中添加一定数量的金属盐，会改变最终影响的颜色和影调。如果与调色结合，会产生分色效果。最常用的金属是金，铂，钯和汞。这种方法会产生于调色不同的色调。

Gold Additive — Prepare a gold chloride working solution by mixing 5ml of a 1% gold chloride solution with 20ml distilled water. Add the working solution to the sensitizer at about 1 part gold working solution to 9 parts sensitizer. The addition of gold will give a warm brown-olive tone to the final print.

金添加剂：准备氯化金工作液，混合 5 毫升 1% 的氯化金溶液和 20 毫升蒸馏水。把氯化金工作液以 1 比 9 的比例与感光剂混合。金添加剂会使照片呈现一种暖调的棕绿色。

Platinum or Palladium Additive — Prepare a platinum or palladium working solution by mixing 5ml of potassium chloroplatinite 20% solution or sodium chloropalladite 20% solution with 20ml of distilled water. Add the working solution at the same ratio as gold, one part working palladium or platinum solution to 9 parts sensitizer. The addition of platinum or palladium will give a neutral black or a warm black, depending on which metal is used.

铂，钯添加剂：准备铂，钯工作液，把 5 毫升氯亚铂酸钾或氯亚钯酸钾的 20% 溶液与 20 毫升蒸馏水混合。把工作液以 1 比 9 的比例与感光剂混合。铂，钯添加剂会使照片呈现出中性黑或暖调黑。

Mercury Additive- — Prepare a concentrated mercury solution by mixing 1g of mercuric chloride with 30ml distilled water. Add the working solution to the sensitizer at the ratio of about 1 part working solution to 20 parts sensitizer. Expect a warm olive tone, but results can be somewhat unpredictable. Handle this solution with maximum care because mercuric chloride is a hazardous substance.

汞添加剂：准备汞浓缩液，把 1 克氯化汞溶解到 30 毫升蒸馏水中。把氯化汞溶液按照 1 比 20 的比例与感光剂混合。照片将会产生暖橄榄色，但是有时最终效果并不可预测，具有随机性。需要注意的是，氯化汞有剧毒，请小心操作。

Unfortunately the employment of metal has one important negative effect. The image is more likely to stain and the print will be much more difficult to clear. Stevens suggests that use of nitrates of gold, palladium and platinum instead of the chlorides will eliminate staining, but those compounds are not readily available.

遗憾的是，这种添加剂方法会产生一个很重要的负面效应。图像会更容易产生污渍，并且很难被洗净。

Toning 调色

Many people like the native color of kallotype prints and do not tone them. In my opinion, this is a mistake, because toning provides much greater image permanence. In fact, I am convinced that all untoned kallotype images will eventually fade, as it is impossible to remove all residual ferrous iron from the paper, and if any at all remains it will eventually cause the silver to oxidize, ultimately leading to fading. This may take several decades but is, I believe, almost certain to happen.

许多人喜欢铁银法印相原本的颜色，而不对其调色。在我看来，这是一个错误。因为调色会使照片更具稳定性。事实上，我相信所有未经调色的铁银法照片最终都会退色，因为要完全去掉残留在纸中的铁盐几乎是不可能的事情，即使只有那么一点点残留，也会导致银被氧化，最终导致退色。这个过程也许需要数十年，但是几乎是必定会发生的。

Although the major reason we tone kallotypes is for permanence, toning has other benefits. One of the primary benefits is that images toned before fixing with gold, platinum or palladium will not fade in the fixing bath. The major reason for fading, or image recession during fixing, is bleaching of the silver. An image toned with one of the more noble metals will not fade or recede in fixing because the silver has been replaced with metals that do not bleach.

尽管给铁银法照片调色的主要原因是稳定性和保存性，调色还有另外一个好处。其中一个主要的原因是，在定影之前用金，铂或钯调色，影响不会在定影的过程中退色。退色的主要原因是，定影液对银的漂白作用。而经过调色之后，银被更稳定的金属所置换，所以不会被漂白。

Still another reason to tone is that it eliminates the effects of solarization. In heavily exposed areas we frequently see tone reversal in untoned kallotypes, that is, with increasing exposure the shadow areas actually get lighter. This look can be very unpleasant. Toning with gold, platinum or palladium counteracts tone reversal and restores normal tonal values to the heavily exposed shadow areas.

另外一个原因是，调色可以消除日晒负感作用。我们经常会看到，在曝光充足的暗部区域影调会出现反向的现象，也就是说，增加曝光的暗部区域颜色反而会变淡。这看起来并不好。调色会抵消这种反应。

Finally, through double toning, in which more than one metal is used to tone the print, it is possible to produce a variety of tones and colors in the Print, an effect which can be both intriguing and aesthetically pleasing.

最后，通过使用量种或以上的金属进行双重或多重调色，有可能产生多重色调和颜色。这种现象既有趣又美妙。

Note that the toning formula in this article are based on mixing 1-liter amounts. However, for

maximum consistency I suggest that you tone as a one-shot solution, using the minimum amount of fresh solution possible, and then discard after use. You will need approximately 20ml of solution to fully tone a 5X7" image, or the equivalent for larger images. However, using such small quantities of toning solution requires a flat tray with no ribs or grooves.

要注意的是，本文的调色配方都是基于混合 1 升的药液。然而，为了达到最大的可重复性，我建议每次只使用尽可能少的药液，使用后便丢弃。调色 5X7 英寸大小的照片，大概只需要 20 毫升的药液，大幅照片可以按照比例增加。然而，使用如此少的药液，需要一个底部平整、没有突起和沟槽的显影盘。

Gold Toners 金调色剂

Both of the gold toners following give a very attractive purple/brown/blue tone. Image contrast is increased by about a step through loss of density in the high values, but Dmax values (shadows) are changed little if at all.

这两个金调色剂配方都会产生非常吸引人的紫色/棕色/蓝色的色调。影像的反差会加大一级，高光区域会变淡，但是暗部区域几乎不变。

Gold Toner #1 金调色剂 1 号

| | |
|-----------------------------------|-----|
| Citric acid 柠檬酸 | 5g |
| 5% gold chloride sol. 5%氯化金溶液 | 5ml |
| distilled water to make 蒸馏水配置 1 升 | |

This toner does not keep particularly well so it is best to mix it in small quantities just before it is needed, and of course discard after use.

这个调色剂很难保存，所以配置少量、现用现配，并且用后丢弃。

Gold Toner #2 金调色剂 2 号

| | |
|-----------------------------------|------|
| 1% thiourea 1%硫脲溶液 | 50ml |
| 1% gold chloride 1%氯化金溶液 | 50ml |
| tartaric acid 酒石酸 | 0.5g |
| distilled water to make 蒸馏水配置 1 升 | |

This toner keeps well and retains its working characteristics even after moderate use. However, I strongly recommend that you use as little solution as possible to tone and then store the used solution in a separate bottle so that the fresh solution does not become contaminated.

这个调色剂很好保存，并且适度使用后也会保存活性。然而，我强烈建议每次尽量少量的使用新鲜的药液，然后把使用过的药液保存到另外的容器内，这样新鲜的药液不会被污染。



Ruins at Montauk

One of the interesting qualities of Gold Toner #2 is that it works on all areas of the print — shadows, midtones and highlights — at about the same time, unlike Gold Toner #1, which works first on the highlights, then progressively on the midtones and shadows.

金调色剂 2 号的一个有趣的现象是，它同时作用于影响的所有区域：暗部、中间调、高光。不像金调色剂 1 号，它先作用于高光，然后再是中间调、暗部。

Platinum and Palladium Toner 铂和钯调色剂

| | |
|--|-----|
| Citric acid 柠檬酸 | 5g |
| potassium chloroplatinite 20% solution 氯亚铂酸钾 20%溶液 或 氯亚钯酸钠 20%溶液 | 5ml |
| distilled water to make 蒸馏水配置 1 升 | |

The platinum and palladium toners keeps well and can be stored fresh in one-liter amounts for up to several months. Even so, for consistent results I recommend that they be used as one-shot solution and discarded after use. Prints toned with platinum will have a very neutral black tone, while those toned with palladium have a brownish/black color. Intermediate tones can be obtained by mixing the two toners. With the Pt/Pd toners, the final density of the print will be somewhat greater than untoned, but contrast will be identical.

铂和钯调色剂很好保存，并且新鲜的药液保存数个月。尽管这样，为了效果稳定和可重复，我建议少量使用，并使用一次便废弃。用铂调色的照片会呈现中性黑。而用钯调色的照片会呈现棕黑色。要得到中间的色调，可以混合这两种调色剂，这样最终的图像会比未调色的深，但反差几乎一样。

Selenium Toners 硒调色剂

In selenium toning, metallic silver is converted to a silver selenide, which is highly resistant to the effects of oxidizing agents. In practice it is extremely difficult to get satisfactory results with selenium when toning is done before fixing, because it reacts with residual silver nitrate in the paper and causes staining. For this reason, I recommend that toning with selenium be done after fixing. This will require an adjustment in exposure time because there is more recession, or bleaching, during fixing of an untoned image.

硒调色中，金属银转化为硒化银，这种物质具有很强的抗氧化作用。实际操作中，我们很难在定影之前通过硒调色得到满意的影调，因为硒调色剂会与残留在纸张中的硝酸银反应，并且形成污渍。因此，我建议硒调色需要在定影之后进行。这需要对曝光时间进行一点儿调整。

Selenium Toner #1 硒调色剂 1 号

To prepare a stock solution, add 100g sodium sulfite to 100ml hot water and allow to dissolve completely. Then add 10g selenium powder.

方法如下：100 毫升热水中加入 100 克亚硫酸钠，完全溶解后，加入 10 克硒粉末。

A working toner is mixed by adding 100ml stock solution to water to make a total of 1000ml, or the equivalent. Stronger solutions give browner prints, weaker solutions, cooler tones.

工作液：100 毫升上述浓缩液加水配置 1 升工作液，或略少。较强的工作液会得到较棕色的照片，较弱的工作液，影调偏冷。

Selenium Toner #2 硒调色剂 2 号

Kodak Rapid-Selenium 柯达硒调色剂浓缩液 10ml

Distilled water to 用水配置 1000ml



Dolmen Pedra da Arca

Double toning is used to produce what is known as split toning, i.e. parts of the image are toned with one metal, with its characteristic color, and other parts are toned with another metal. This kind of toning must begin with the most noble metal, either platinum or palladium, and be completed with the least noble, gold. This is because the most noble metal will always replace the least noble and if toning is done first with gold, and followed to completion with platinum or palladium, the image will look as if it has been toned in just platinum or palladium.

双重调色会产生分色现象。比如说，一部分图像用一种调色剂，另外一部分用其他的调色剂。这种调色方法必须要从最具惰性的金属铂或钯开始，其次是金。这是因为最具惰性的金属会置换次惰性的金属。如果先用金调色，然后再用铂或钯，金会被铂或钯替换，从而影像看起来和铂或钯调色一样。

One way to achieve split tones is to begin toning with platinum or palladium and allow the toning process to continue just until the platinum or palladium has replaced the silver in the highlights and mid-tones. Then, discard the toner, wash the print, and pour in the gold stoning solution. The gold toner cannot replace the palladium or platinum in the highlights and mid-tones, since it is less noble, but it will replace the silver in the shadow areas. The result will be a print with neutral black or warm black highlights but cool purple/black shadows. This can be a very pleasing look.

一种达到分色效果的方法是，先用铂或钯调色，等调色剂完成了对高光和中间调的作用之后，倒掉调色剂，水洗，倒入金调色剂，金调色剂无法置换高光和中间调区域的铂或钯，但是会置换阴影区域的银。结果就是会得到一张高光区域为中性或暖调的黑，而暗部是冷调紫/黑的照片。这种影调可能会很吸引人。

Thus, the key is to begin toning with the most noble metal and tone only until the desired values have been changed, then wash and tone to completion with the least noble metal. Double toning can produce fascinating results and I encourage you to experiment with it.

所以，关键在于先使用最惰性的金属调色，直到达到想要的效果。然后水洗，再用次惰性的金属调色。双重调色可能会达到意想不到的效果，我建议你多做实验进行尝试。