To Make Many Pigments

for use in illuminations

THLady Jorhildr Hrafnkelsdottir
(April Parks)

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The contents of this publication is the compilation of my pigment research/projects from 2016 as entered in Gleann Abhann Kingdom A&S and at Gulf Wars. Edits for clarity and pdf presentation have been made.

My pigment research/experimentation continues.
New research and class handouts will be posted to my site at jorhildr.boaredraven.com

THLady Jórhildr Hrafnkelsdóttir, C.S.L., C.O.C., O.S.R., O.O.C.
Kingdom of Gleann Abhann · Shire of Blackwood

jorhildr.boaredraven.com jorhildr@boaredraven.com

In working on an award scroll commission for a 14th century English persona. I decided to make as many of the pigments for the piece as possible. Not all of the pigments presented here were used for that scroll. Instead I present these as a group of pigments that could be found in an illuminator's color box during the SCA time period.

Presented here are blue from Azurite ore, green from Malachite ore, verdigris green from copper, Rose made from brazilwood, eggshell white, and yellows made from weld, turmeric, saffron, unripe buckthorn berries, and buckthorn tree bark. All are crafted using period recipes and techniques as well as some experimentation.

Only the mineral-based pigments, Azurite and Malachite, are extremely colorfast. The pigments obtained from organic materials are considered fugitive; that is they will fade heavily over time or when exposed to light. Verdigris can shift color with exposure to some chemicals. Nevertheless, these colors still had their place in a medieval pallet for illumination.

Each pigment has process pages with material information to follow.

Materials:

- Brazilwood shavings (*De Arte Illuminandi,* 8) - from Griffin Dyeworks
- Cochineal (reasonable substitute for Kermes lice or dyers grain) (*De Arte Illuminandi*, 8)
- Azurite ore (Morocco; purchased through Etsy)
- Malachite ore (Congo; purchased through Ebay)
- Ground Turmeric Root (*De Arte Illuminandi,* 3) - purchased from Monterey Bay Spice Company
- Weld (*De Arte Illuminandi,* 3) - purchased from Griffin Dyeworks
- Saffron (*De Arte Illuminandi,* 3) - "My Spice Sage" brand
- Unripe Persian Berries (aka Buckthorn berries) - given to me by Baroness Jac
- Buckthorn bark - purchased from Monterey Bay Spice Company
- Copper plates & copper pipe fittings
- Alum (*De Arte Illuminandi,* 8)
- Powdered Gum Arabic (*De Arte Illuminandi*, 13-14)
- Potash (potassium carbonate) (*De Arte Illuminandi,* 8) - from Kremer Pigments
- Marble Dust (*De Arte Illuminandi,* 8) - from Kremer Pigments
- Glair (*De Arte Illuminandi*, 13) - Made by whipping egg whites stiff, then collecting the clear liquid that weeps out the next day.
- Sea Shells
- Distilled Water
- White Vinegar (*A Booke of Secrets*, 9)
- Apple Cider Vinegar
- Kosher Salt
- Clove oil (preservative)
- Vellum for showing swatches
- Verdigris pigment (for mixing) - purchased from the Limner's Guild
- Eggshells (chicken)

Tools:

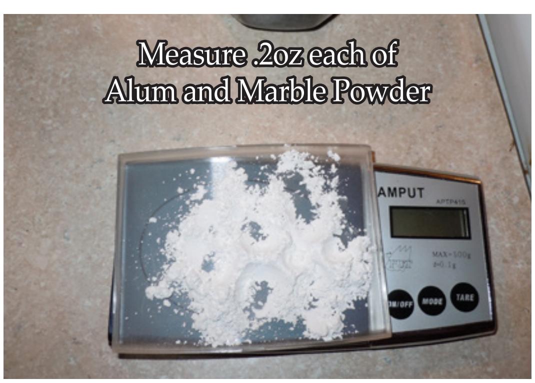
- Glass plate, granite plate & glass muller
- Mortar and Pestle (Brass & porcelain)
- Pyrex dish
- Linen fabric (*De Arte Illuminandi,* 8)
- Wooden skewers and wooden spoons (for stirring
- Knife for scraping the copper
- Glass jars
- Variety of containers for levigation (glass, ceramic, plastic)
- Wire mesh/sieve
- Unglazed ceramic dishes for drying pigment

Reasons for non-period substitutions:

- I used a Pyrex dish as this is my non-food pyrex dish for making pigments.
- Plastic cups were used for some of the levigation for ease of photography

Sample illumination using some of the Rose pigment on animal velum.

To Make Rose Paint
from brazil wood for use in illuminations



Brazil wood is part of the organic red lake family of period pigments. I had expected madder (Thompson, 121) to be chief among this group, but neither *De Arte Illuminadi* or *A Booke of Secrets* mention madder. Both listed recipes using brazil wood to make red or rose color pigments.

Brazil is wood from a tree of the Caesalpinia family. Multiple varieties exist in the Middle East and in South America for which the country of Brazil was named (Thompson, 116,117). The wood contains a chemical that produces a lake pigment when mixed with a mordant. In this case, the mordant is alum. Like all lake pigments, the result is not colorfast and will fade or shift color over time.

This color uses variations of a 14th century recipe, a 16th century recipe, and some experimentation. **Note**: The sample illumination (page 4) uses recipe #2a and #3 for the dark rose areas. Process photos are for Recipe #1 with and without cochineal.

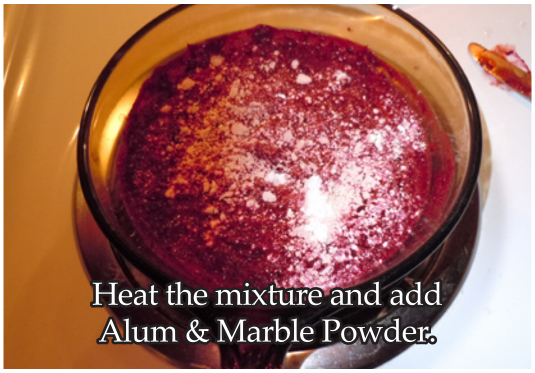
Methods:

Recipe #1a and #1b from De Arte Illuminadi (page 8)**:**

> *"The body-color pink is made in this way. Take some of the best brazil wood...and with a knife or a piece of glass, scrape off as much of this wood as you want. And put it into a lye made from the wood of vines or oaks.... And put this into a glazed dish which will stand the heat: and have the lye cover this brazil, so that whatever part of it is extractable may be thoroughly extracted by this lye. And let it stand in this lye for a night or a day to soften. Then put it on the fire, and heat it to the boiling point, but do not let it boil; and stir it often with a stick. Then take account of how much scraped brazil there was, and take the same quantity" of very nice white marble very thoroughly worked up on the porphyry to an impalpable powder, or scraped with a knife, and as much sugar alum or rock alum as there is of the brazil. And grinding them thoroughly, mix them gradually in this dish, always stirring it with a stick, until the froth which it makes subsides, and it is well colored. And then it is strained through a clean linen or hempen cloth into as glazed or unglazed porringer. ... And if anyone wants to make it richer, he may, when he puts in the brazil, put into the lye with it some dyer's grain,if obtainable, to the amount of an eighth or a sixth part of the weight of that brazil. more or less, at will, because it makes a more permanent color and will be more beautiful; and proceed as above. However, it is a more beautiful color with the brazil alone than mixed with the grain. Do whichever you like."*

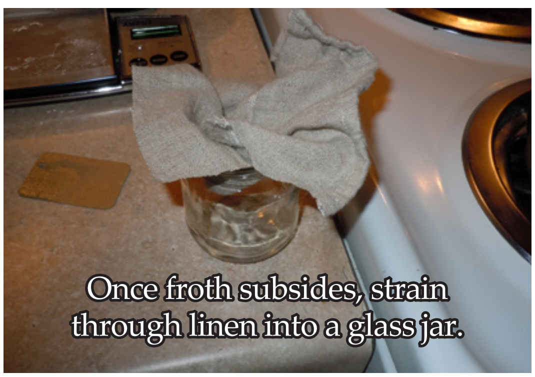
This recipe is very similar to the one described by Cennini (103) except that the white substrate is added when the alum, brazil and lye mixture has cooled.

For both #1 and #2 for this recipe, I did a batch with grain and one without. As dyer's grain is unavailable and Kermes lice are extremely expensive, I have used cochineal as a reasonable substitute for dyers grain in this recipe.



Heat the mixture and add Alum & Marble Powder.

Stir frequently as it froths like crazy!



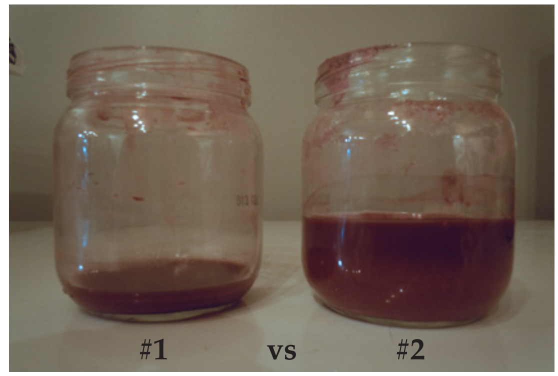
Once froth subsides, strain through linen into a glass jar.

Jar of filtered wet pigment & straining cloth.

Not much pigment after it's all dried.

Next I ground the pigment with a mortar & pestle.

I dissolved a small amount of potash (pea-sized) into distilled water and then covered .2 of an ounce of Brazil wood with the potash water. The water almost instantly turned right red. For the second version, I added .025 ounces of crushed cochineal. Both were allowed to soak overnight. The mixture was heated to near-boiling and then .2 ounces Alum and .2 ounces marble dust were slowly added. The mixture quickly frothed. Once everything seemed well dissolved, I strained the mixture through linen clothing into glass containers. The resulting liquid, after resting for a day, separated out a small quantity of dark pink pigment at the bottom. I carefully drained the liquid from above the pigment and let the remainder dry.



Both samples yielded very small amounts of pigment.

Recipe #2a and 2b from De Arte Illuminadi (page 8)**:**

The same as above, but with the follow alteration:

> *"And know that some say that the lye, after it is well colored, should be strained through a cloth into a glazed dish; and after getting it fairly hot, they put in the alum and marble. And it will take up the color immediately; and the water will separate almost clear above it, and you pour it off carefully."*

Rather than add the alum and marble dust directly to the rosewood mixture, I strained the liquid out of the rosewood mixture using linen cloth. I then heated the liquid and added the marble dust and alum as above. This version resulted in more pigment remaining when the "cooked" mixture was poured into a jar to settle. Once dry and ground with the mortar and pestle, the results were several times more usable pigment than the process in #1.

Grind with water to form a thick paste, then add gum arabic.

Recipe #3 from A Booke of Secrets (page 9)**:**

> *"Take strong vinegar, or wine, and put pouder of alum therin, when the alum is dissolved, then make a strong and thicke lee with quickelime, and take foure times as much Brasill as your alum waieth, put in a clout, and hang it in the lee, and let i stand a day and a night, then straine it, and hang the Brasill again in the lee, and let it stand as long as it did the first time, which doe in like manner three or foure times, when you have done so, let it stand and drie, and it is perfect."*

My redaction:

Soak .2oz of Alum in white vinegar. Dissolve potash in the mixture. Tie up .8oz Brazil wood in linen and hang in the alum/vinegar/potash mixture. Wait 24 hours and strain the liquid through linen. Hang the Brazil wood back in the liquid. Repeat 2 more times.

After dissolving the alum in vinegar, I found out the hard way that the chemical reaction between vinegar and potash is similar to vinegar and baking soda. A frantic Google search indicated the products of the reaction are similar and non-toxic. I am unamused at the lack of warning in the original text.

After the third round of straining, I was concerned this recipe would be a complete waste of brazil wood. I added a drop of clove oil to prevent mold and set the mixture out to dry. This was done on the first of December, 2015. As of today, January 13th, the mixture has not completed dried out, but is still a thick slurry. I scraped some of the dry crystals from the upper part of the jar to grind and test the color.

I mixed up a batch of test paint of each pigment using a muller & glass plate along with gum arabic. Samples were painted onto goat vellum for comparison.

Of the first two recipes, the second process produces a greater quantity of pigment. I can see no major difference in the color between the batches with cochineal added and brazil wood only. There is a slight difference between the color of the powder of #1 verses #2. This is likely due to a difference in ph of the mixture when the pigment was made. (Thompson, 118).

The recipe from *A Booke of Secrets* (#3) does not create a lot of pigment for the amount of brazil used. However, the dark but translucent result is excellent for glazing to shade other colors.

I made additional swatches by mixing 2b with white lead and ultramarine (Cennini, 39) separately. White lead results in a soft pink and ultramarine gives a violet color.

Subsequent batches of Rose have produced slightly different colors. The batch from Gulf Wars is a dark purplish rose, and the batch from Bellwether is much darker than the others. This is likely due to the low volume of marble dust used versus how much dyestuff I was processing.

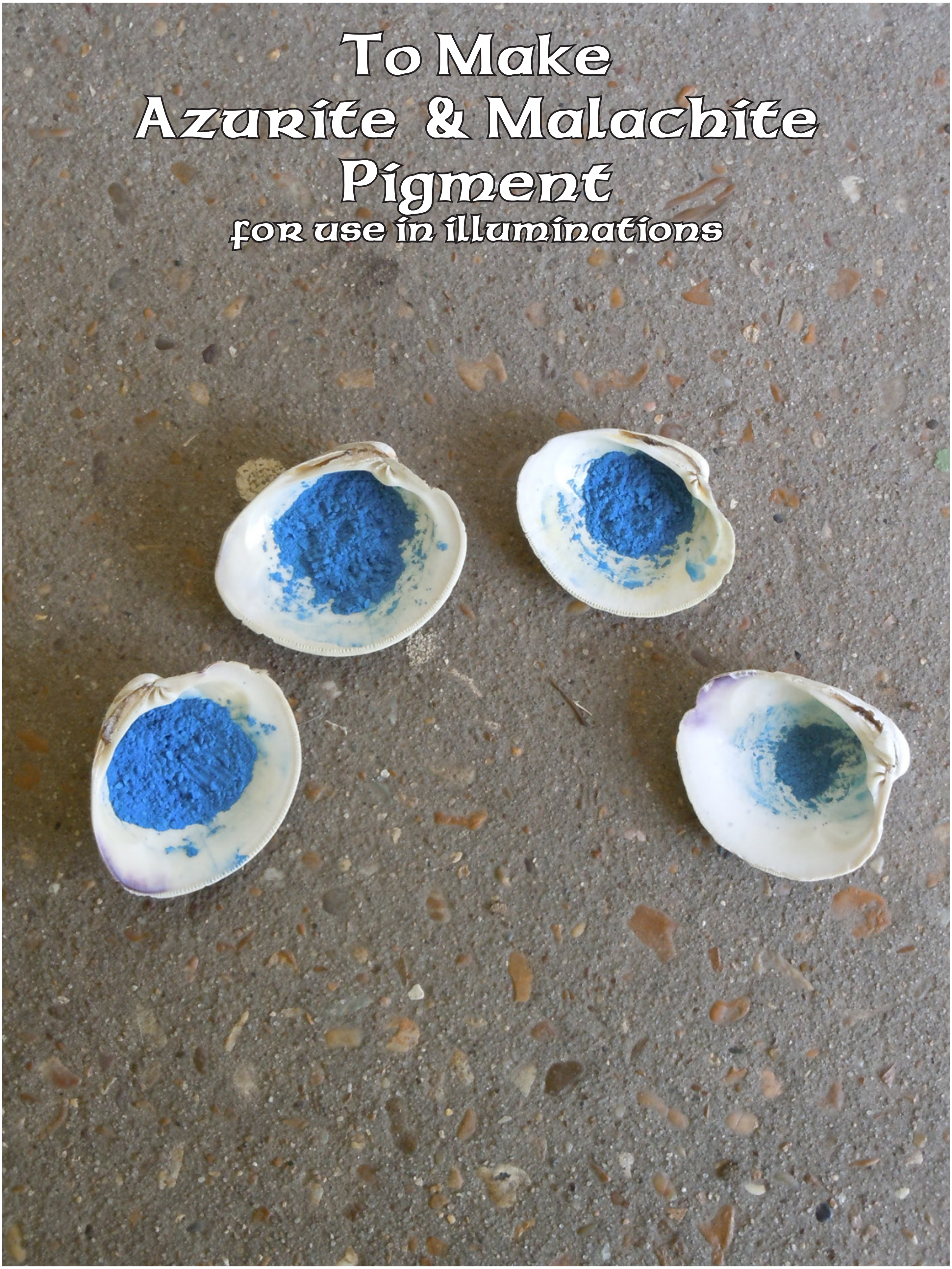
Center: Ground pigment. Left: Paint without cochineal.
Right: Paint with cochineal.

Sample illumination using my own Malachite, Azurite, and Rose pigments on goat velum.

Note: Sample illumination is based on the Gorleston Psalter and consists of real gold gilding, goat vellum, and all hand-made paints which include white & red lead.
Shows use of Malachite Green and Azurite Blue.

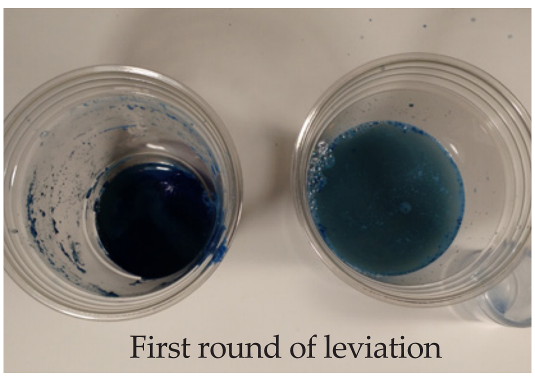
To Make Azurite & Malachite Pigment

for use in illuminations



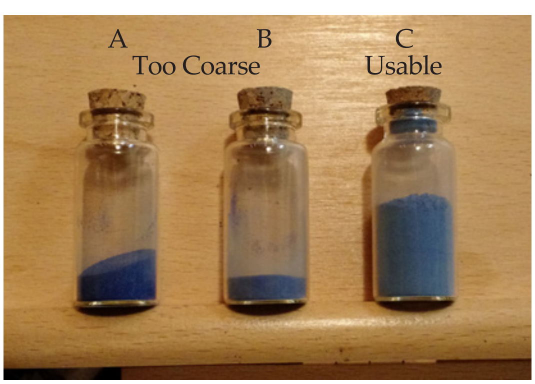
Azurite Stones

Grinding by hand



First round of leviation

Three resulting grades of pigment



Pigment analysis of the Macclesfield Psalter (Panayotova, 342), a 14th century English manuscript, indicates that only Azurite blue, not ultramarine, was used in the illumination. As such, I decided to see if I could make my own pigment from Azurite stones.

The same pigment analysis determined that the green used in the Macclesfield Psalter was not Malachite, but some other copper based pigment. As Malachite was a common green in period (Thomas, 161), and uses the same processing methods as its cousin Azurite, I also decide to make green pigment from the mineral as well.

Azurite and Malachite are copper carbonate minerals. As Azurite can turn into Malachite over time due to weathering, both minerals can be found in the same stone (Thompson, 131). Both must not be ground too fine or the pigment will lose its color (Cennini, 31, 36).

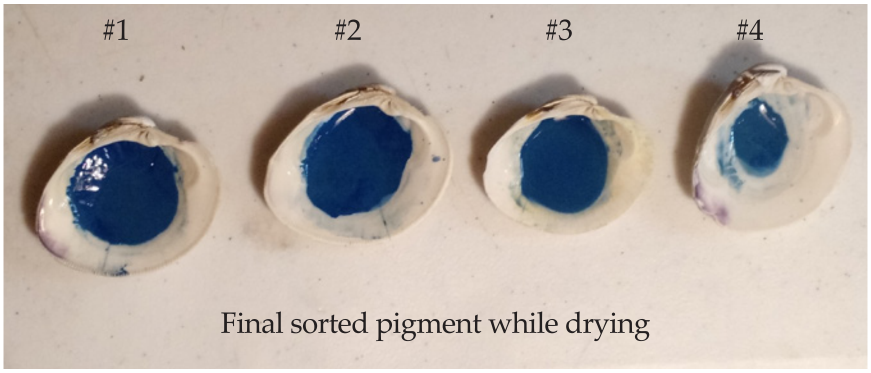
Due to its lower cost, Azurite was more commonly used than Ultramarine, which was produced from the lazurite, the blue mineral found in Lapis Lazuli. In instances where both minerals were relatively free from other minerals, the stones could easily be mistaken for each other. True Lapis is unharmed by heat whereas Azurite turns black (Thompson, 131). These days, good solid blue Azurite is hard to find and expensive when you can locate it.

Methods:

Azurite - Grinding and Levigation:
Unlike other pigments I have experimented with, turning Azurite into pigment is fairly straight-forward, though laborious. The stone must be broken up, then ground down to powder. The powder is washed to remove dirt. (Thomson, 131). The powder is then levigated by stirring with water and allowed to settle. The water is then poured off into another container. If that water is still blue, it is again allowed to settle, and then the water is poured off again. Repeat until the water has no discernible blue (Thompson, 132).

Though Thompson notes that other materials were employed to speed the process, such as gum arabic and lye, I do not have a large enough sample of Azurite at this time to test this process. I have employed plain distilled water and gum arabic at this time (*De Arte Illuminandi,* 16*)*.

Azurite without Malachite contamination is expensive and difficult to find. I located some small but relatively uncontaminated pieces from a seller on etsy. Due to the cost of the stones, it will be some time before I have another sampling of stones to further test pigment refinement techniques with Azurite. I sorted my Azurite stones to exclude those with Malachite spotting.



Final sorted pigment while drying

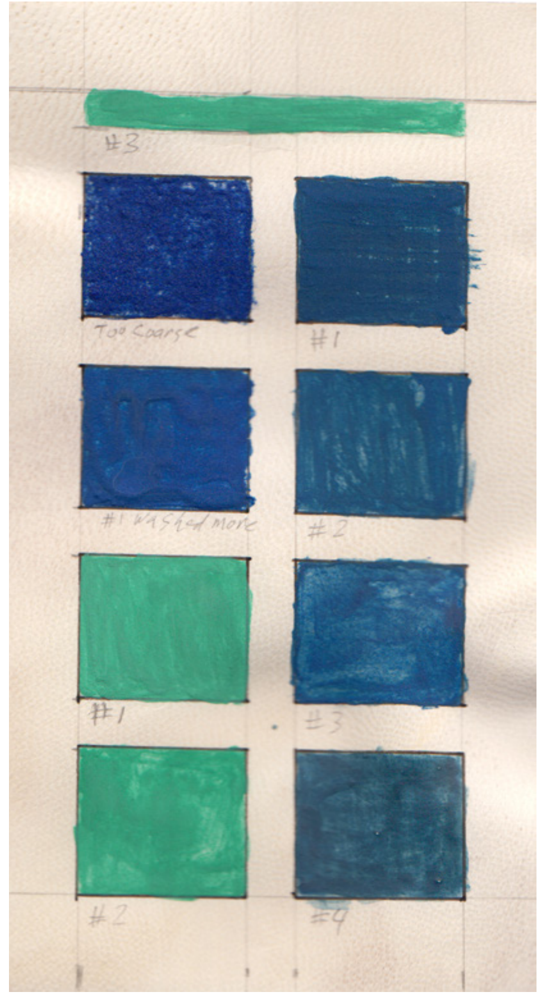
The best stones were then crushed in a porcelain mortar and pestle. To avoid grinding the stone too fine, I attempted to grade my pigment with water with relatively coarse powder. The results indicated I had not ground the powder fine enough for pigment yet. More grinding ensued. The second washing resulted in 3 different grades of pigment. What I thought was the best quality pigment turned out to be too coarse (see A & B below, right). The third, C, turned out to be the right particle sizes for pigment.

At this point I employed fine mesh sieves to help sort the course pigment to help avoid over-grinding as I processed the rest of the stone.

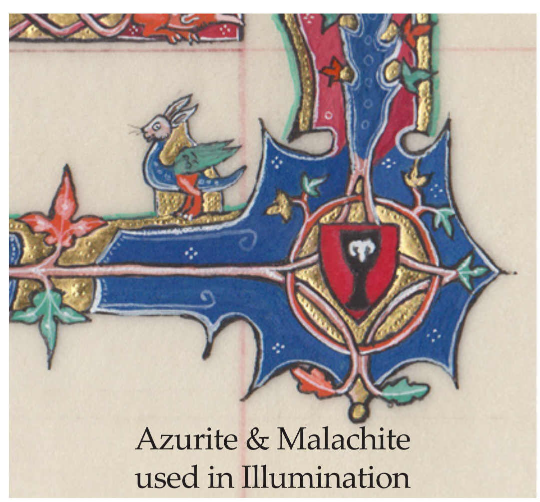
Once enough of my powder was fine enough, I was able to get the 4 grades of Azurite using gum arabic and water for the levigation process. As I was working with a fairly small amount of powder, I opted to use shells for my containers.

The resulting 4 pigments ranged from dark denim blue to a slightly green-grayish blue as shown in the swatches labeled #1 - #4. Per the instruction in De Arte Illuminandi (16), I further washed some of the pigment by filling the shell with water, letting it settle and draining off the water. This method did not disappoint. The #1 quality pigment became a more vibrant blue when cleaned as shown in the swatch labeled #1 washed more. The loss of additional pigment is worth the increase the quality of the color. I've included a swatch of the coarse sample B to show that while a beautiful blue, the pigment is too coarse to lay as paint.


4 grades of Azurite once dry




#1 After being washed more


Azurite & Malachite used in Illumination

Malachite - Grinding and Levigation:
Malachite is processed in the same manner as its blue cousin. At this point I had acquired a nice 4lb brass mortar and pestle to make crushing and grinding easier and faster. I'd started with larger piece of ore, so my first step involved a hammer to break it down into manageable pieces.

Levigation of a small quantity of the less than 25 micron size pigment resulted in 3 grades. However, painting swatches with these 3 grades shows little discernible difference in color as shown in the green swatches numbered 1-3. Seen next page for process photos.

Conclusion:

Overall, this pigment experiment has been a success so far. I've acquired enough usable pigment from the Azurite to value more than what I put into the project. Hopefully I can acquire more stones soon to play with further washing the pigment for better color.

As I have plenty of Malachite left to process, I intent to try using gum arabic and lye to see if I can get a finer sorting of the pigment for more differentiation in the colors. I suspect I didn't let the water settle long enough between pours.

Painting with the Azurite proved interesting as I had to do thin layers to build up the blue. For my sample illumination, I used #1 that was washed for the blue background on the device. #2 washed was used for the surrounding board. The malachite was very easy to paint with despite requiring 2 coats to get a nice solid green.

Section from an award scroll using the Azurite & Malachite pigments produced from these processes.

Malachite processing

1 pound of Malachite

About 1/3 of the ore was broken up with a hammer.

The pieces were pounded and then ground in the bronze mortar over the span of a day.

Soon I went from coarse stone....

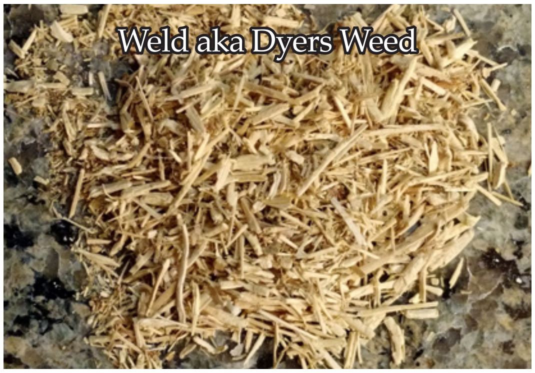
...to a manageable powder.

Unlevigated pigment at top
Shells of paint at bottom

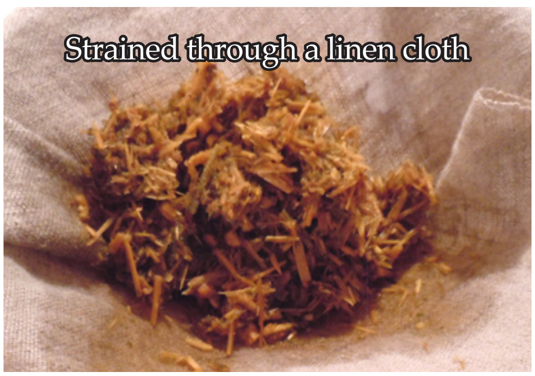
Sample Illumination: Saffron & Glair, Berry Yellow, Verdigris & Saffron, Rose Color, along with white & orange gouache on vellum.

To Make Yellow Pigments

from organic materials for use in illuminations


Weld aka Dyers Weed


Weld after soaking overnight


Strained through a linen cloth


Heat the golden liquid


Add marble dust and stir like a mad-man

Or it **will** crawl out of your pot

Weld Yellow

Weld is a kind of *Reseda luteola* which has been used for dying yellow as early as Ancient Rome. All parts of the plant are used to make a yellow dye. Other names for the plant include Dyer’s Weed or Dyer’s Herb.

For use in illumination, weld may be laked upon eggshell white, white lead, chalk, or marble dust (calcium carbonate). Eggshell white is costly to buy and time-consuming to make. I have used marble dust for my experiment as it is less dangerous than toxic white lead (Thompson, 187,188).

I used a 14th century recipe as the basis for making a weld lake.

Weld (Dyers Weed) Yellow Recipe from *De Arte Illuminadi* (pages 3&4)**:**

> *“It is also made in a similar way out of that dyiers’ weed.” Take this and cut it up fine with a knife, and put it into plain water or fairly strong lye,” and have the water or lye stand over the weed in good measure. Boil it hard for a while; then, if there is one handful of the plant, put in an ounce and a half of white lead, well worked up. But, before you put in the white lead, work up one ounce of rock alum thoroughly, and put it into this dish with the decoction of the plant, and get it dissolved. And when it is dissolved, add the white lead gradually, constantly stirring it with a stick until all those things are thoroughly incorporated. And then strain it through a linen cloth into an earthenware porringer, fired but not glazed, and let it settle. And pour off the water, and again put in some clear plain water. And when the substance settles pour off the water; and let it dry, and put it away.”*

I soaked weld overnight in distilled water with potash added. After bringing the mixture to boil, I added about half an ounce of alum to the pot. Having learned my lesson in previous pigment making processes, I strained the mixture through linen to remove the excess plant material before bringing the liquid back to a boil. When the marble dust was added the mixture rapidly bubbled and expanded out of the pot despite furious stirring.

I placed the pigment into a glass jar to let the pigment settle. After draining off the top liquid, I added fresh water to the jar and again let the pigment settle out. After draining off the water one last time, I transferred the wet pigment to a small unglazed bowl to allow the pigment to dry quickly.

My first batch turned out a bit pale, so I repeated the recipe with more weld and a bit less marble dust. The result was a darker yellow.


Dried pigment ready to be ground into powder

Turmeric Yellow

Ground Turmeric

Liquid after soaking and straining

Heat the liquid

Stir in Marble Dust

Pour into unglazed bowl to dry

Turmeric, a spice related to ginger, has a long history as a yellow dye. The root of the plant, which has a pungent odor, appears to be less commonly used for a lake pigment for illumination. I was able to locate one period recipe specifically for making turmeric into a pigment for illumination.

Turmeric Yellow Recipe from *De Arte Illuminadi* (page 3):

> *"It is made in this way: take one ounce of turmeric roots shaved good and thin with a knife, and put them into a half petita of plain water, and add an eighth of an ounce of rock alum in a glazed earthenware dish. And let it soften for a day and a night; and when it is quite yellow, put one ounce of white lead into it, well worked up, and stir it with a stick. And let it stand on the fire for a while, constantly mixing it with the stick to keep it from boiling over. Then strain it through a linen cloth into an earthenware dish, fired but not glazed, and let it aside. And pour off the water carefully, and dry it, and put it aside for your use."*

Note: In all cases calling for white lead to be added with heat, I have substituted marble dust for safety sake.

For the first attempt, I scaled the recipe down by 50%. I soaked half an ounce of powdered turmeric and 1/16th of an ounce of alum in water for 24 hours. I then heated the turmeric and added half an ounce of marble dust, while stirring to try to keep the reaction from crawling out of the pot. I strained the mixture through linen cloth into a glass jar. Very little pigment resulted.

The second attempt, I did not scale the recipe. My experience with making rose pigment from Brazil wood **De Arte Illuminadi** (page 8) has taught me that straining the dye material out before, rather than after, adding marble dust will result in more usable pigment. This did indeed result in a much higher usable pigment load for the turmeric.

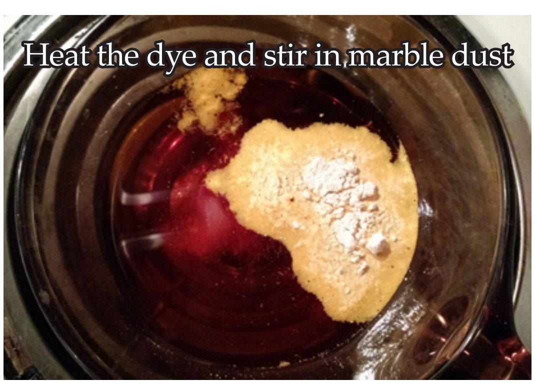
Dried pigment being ground to powder

Saffron Threads

Saffron soaking in water

Strained through linen cloth

Resulting dark orange liquid



Heat the dye and stir in marble dust

Saffron

The dried stigmas of the *Crocus sativus* flower are the source of the historically expensive saffron spice. The red stigmas, numbering only 3 per flower, are refereed to as "threads". These threads are dried and used as a spice and a yellow colorant.

As with the other yellow pigments in this project, saffron is fugitive and works best in a manuscript with limit exposure to sunlight. Even so, the spice was used with some frequency as can be indicated by multiple sources extolling its uses as a source of yellow for illumination. (Thomas, 185-187). As such, I have three different period processes for saffron.

The first is the 14th century recipe from *De Arte Illuminadi* which immediately follows the weld recipe (see page 4).

Saffron Yellow Recipe from *De Arte Illuminadi* (page 4)**:**

> *"White lead can also be stained with saffron in the same way. And know that if it were not well stained, it could be given more color; and if there is too much color in it, put in more white lead."*

I repeated the weld recipe using 1 gram of saffron instead. After soaking 24 hours in distilled water, the saffron was heated, but not boiled. Alum was dissolved in the liquid, which was then strained through a linen cloth. The resulting saffron liquid is a dark golden orange color which resembles commercial yellow food coloring.

The liquid was heated and marble dust was added in place of toxic white lead. After the resulting lake pigment was "washed" and dried, I felt the color was fairly pale. As this qualified as "not well stained", I redyed the majority of the pale yellow with a new batch of saffron. the result was a dark golden yellow.

Stir until the froth is well colored

Dry pigment about to be ground to powder

The next set of instructions come from Thompson.

Saffron Yellow Recipe from *The Materials and Techniques of Medieval Painting* (page 186)**:**

> *"For use in illuminating, the painter had only to put a pinch of dry saffron into a little dish, cover it with glair, and allow it to infuse. The resulting extract or tincture was perfectly transparent, and strongly yellow."*

Painfully simple compared to the previous recipe, I placed 4 dark red threads of saffron in an oyster shell and covered them with 3 drops of glair made from whipped egg-whites. Yellow quickly began to color the glair. Thirty minutes later, the glair was a strong, translucent red-orange color.

The final set of instructions come from Cennini.

Saffron Yellow Recipe from *The Craftman's Handbook "Il Libro dell' Arte* (page 29)

> *"You should put it on a linen cloth, over a hot stone or brick. Then take half a goblet or glass full of good strong lye. Put this saffron in it; work it up on the slab. This makes a fine color for dying linen or cloth. It is good on parchment."*

While not dissimilar to the initial stages of the previous recipe, this version lacks both alum and a binder for the color. Rather than use more saffron, I used part of the liquid from the first recipe to experiment with. Adding a few drops to a single drop of glair resulted in a highly transparent yellow that is inferior to adding threads directly to saffron.

Buckthorn Berry Yellow

Berry yellow is a pigment extracted from the unripe berries of the Rhamnus bush, also known as buckthorn or Persian berries. The resulting color is not permanent, but is more stable when processed with alum. (Thompson, 187). Ripe buckthorn berries can be used to produce a green pigment called Sap green.

Unable to locate a period recipes specifically for making yellow from buckthorn berries, I had to take Thompson's description of Berry Yellow (page 187) and a 14th century recipe for Sap Green from *De Arte Illuminadi* to redact a recipe.

Berry Yellow in *The Materials and Techniques of Medieval Painting* (187):

> *"The compound of unripe buckthorn berry juice with alum (corresponding to sap green) was not apparently much used; but Valentin Boltz records it as known in sixteenth-century Alsace as Beergal (Beer-geldb), "berry yellow".*

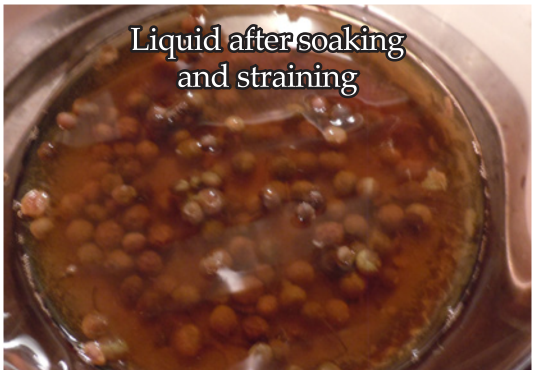
Sap Green from *De Arte Illuminandi* (page 7):

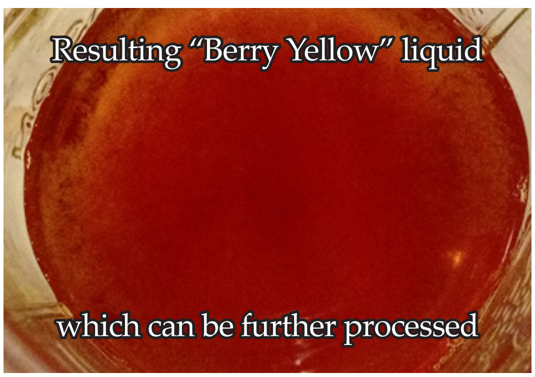
> *"And you do the same thing with those buckthorn berries which are gathered in the vintage season, namely in this fashion. Take the aforesaid seeds or berries, put them in a glazed porringer, and break or crush them well with your fingers. Then dissolve in clear lye, not too strong, as much rock alum as will dissolve on the fire. And pour enough of this lye and alum over the berries in the porringer to cover these berries, crushed as directed. And let them stand so, out of the way, for three days; and then wring them out with your hands in a linen cloth, and strain the juice into another glazed porringer...But otherwise put it into a glass bottle, and keep it by sealing the bottle."*

The dried unripe berries were soaked in distilled water overnight. Alum was added and the mixture was heated slightly to help the alum dissolve. I then strained the mixture using linen cloth. I then stored the berry yellow in a glass dropper bottle with a drop of clove oil as a preservative. The resulting golden liquid produces a brilliant yellow glaze.

Since Thompson (187) states that yellow lakes were made from buckthorn berries in Italy during the 15th century, I used half the berry yellow liquid from the first recipe to make a lake pigment, using similar process as previous pigments, with marble dust.

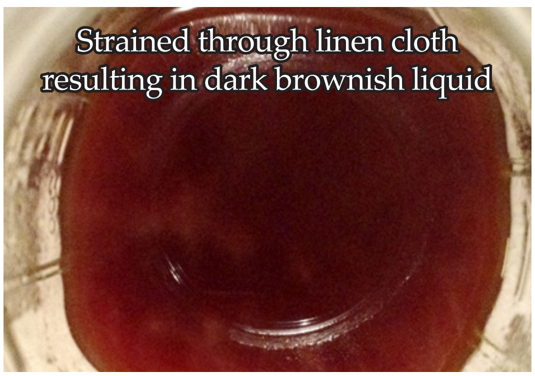
The resulting golden yellow leaves me little doubt as to why some illuminators used the pigment in spite of its lack of colorfastness.





Buckthorn Bark

Soaked overnight, then heated



Strained through linen cloth resulting in dark brownish liquid

Liquid heated & marble dust added

Mixture bubbles and grows

Tree Bark Yellow

This particular yellow started from reading the following vague recipe.

Yellow from Tree Bark Recipe from *A Booke of Secrets* (page 10)**:**

> *"Take the barke of a tree, cut off the outside and throw it away, cut the rest in small peeces, and poure water unto them, let them seeth two or three times, then put powder of alum into it, stirre them well together, and let them seeth againe."*

Among the lesser yellow lake pigments mentioned by Thompson are walnut-tree and apple tree barks (188). Having no easy source for those barks, I decided to try buckthorn (Rhamnus) bark as it was readily available from a herbal supply company.

I soaked the Buckthorne bark overnight in distilled water. After bringing it to a near boil a couple of times, I added a small quantity of alum and let it simmer again for 5 minutes. I then strained the mixture through linen into a glass jar.

The resulting liquid was a dark brownish yellow. The recipe, of course, does not specify if the liquid should be used straight, mixed with gum arabic or glair, or turned into a lake pigment.

I opted to turn the liquid into a lake pigment by adding marble dust to the heated liquid. The resulting powder is a medium yellowish brown color.

Dried pigment ready to be ground to powder

All 5 powdered pigments were ground with gum arabic to produce paint for painting swatches. The Berry Yellow liquid was used without additional gum arabic or glair as the natural stickiness of the berries is enough of a binder. The only glair used was to soak a few bare saffron threads as well as the glair used to mix up verdigris for mixing with saffron and berry yellow.

My resulting turmeric pigment reminds me of a slightly translucent yellow ocher. It is difficult to paint with as the pigment dries quickly and becomes clumpy. I would not willingly use this color unless yellow ocher was simply not available.

The buckthorn bark is included for completeness sake as it is more a slightly yellow brown than a true yellow. As with the turmeric, this one is unpleasant to paint with and prone to clumping.

The results of the weld pigment are much more pleasing. The weld is translucent, but clearly a yellow and far less temperamental when mixed as paint.

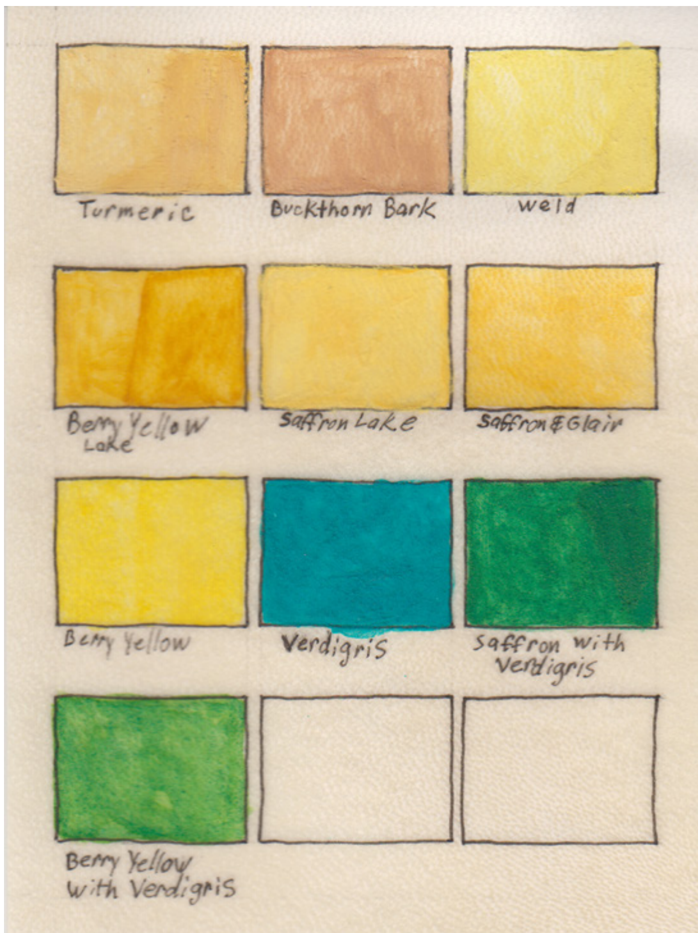
I find the yellows from buckthorn berries to be the prettiest of the lot. The lake pigment is a translucent medium golden yellow. The pure liquid without marble dust produces a vibrant, transparent, light gold glaze. Both paint with relative easy. Sadly the color is fugitive and only in an actual book may the color be useful. This forms a beautiful spring green when mixed with verdigris as indicated by Thompson (187).

The saffron lake pigment is a warmer light yellow than the weld. I feel the saffron shines more with the pigment extraction via soaking in glair. The color is highly transparent, but very effective for glazing other colors. It also produces a lovely grass green when mixed with verdigris (Cennini, 30).

Comparing my swatches, I do not wonder why weld, saffron, and buckthorn berry yellow were among "great medieval yellows" (Thompson, 189). Any illuminator would love to have these colors on her pallet.

I intend to use white lead, once I have an outside setup, to compare the resulting colors on different substrates. I am working on creating enough eggshell white to use that as a white substrate as well.


Turmeric pigment being ground with water and gum arabic

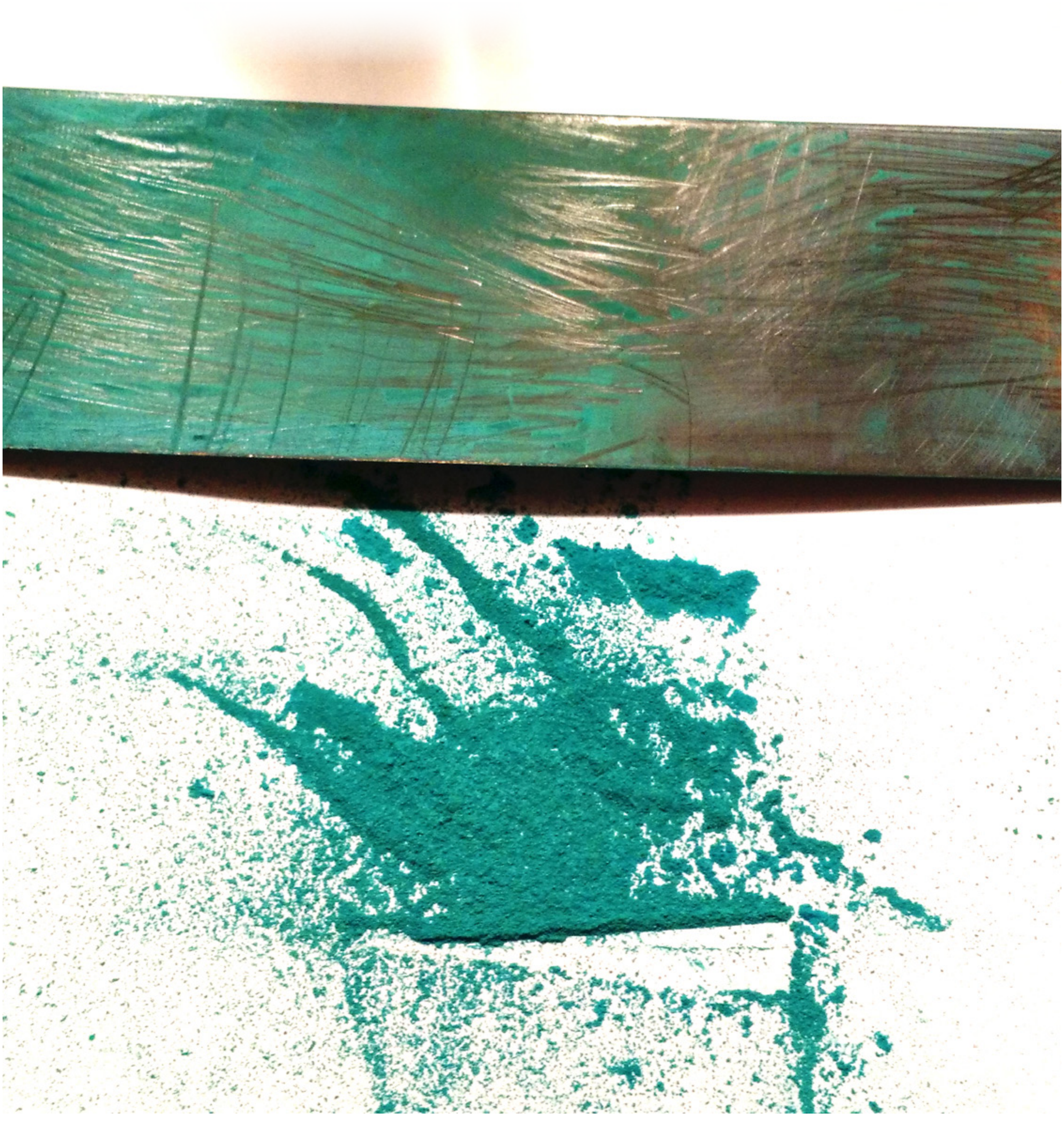

Turmeric
Buckthorn Bark
weld
Berry Yellow Lake
Saffron Lake
Saffron & Glair
Berry Yellow
Verdigris
Saffron with Verdigris
Berry Yellow with Verdigris

Sample Illumination: Spanish Green #1 with Saffron, Spanish Green #1 with Sap Green, Saffron & Glair, Berry Yellow, Rose Color, along with white & orange gouache on vellum.

Please note the sample illumination uses Spanish Green #1 with Saffron for the outside green outline and the leaves have been recolored with Spanish Green #1 with Sap Green.

To Make Verdigris from Copper

for use in illumination work




Copper & Vinegar setup


A Couple Days Growth


Pigment Ready for Harvest


Second batch ready for harvest

Pigment analysis of the Macclesfield Psalter (Panayotova, 342), a 14th century English manuscript, indicates that the green used was copper-based and possibly a form of verdigris. As such, I set out to create some of this pigment for my project.

Verdigris is a copper acetate formed by exposing copper to vinegar. This group of bluish-green pigments were commonly used in period despite being effectively fugative. Over time, the color can shift to brown, or darken completely in the presence of the wrong chemicals (Thompson, 164). In the presence of lead, verdigris will blacken. As such, lead white cannot be mixed to lighten the pigment (Cennini, 33). Eggshell white, bone white, or modern titanium white must be used instead.

Processes:
The first instructions I followed are found in *On Divers Arts* and appears to be the most basic recipe for making green from copper.

Spanish Green from *Theophilus* (page 41)**:**

> *"Now if you want to make Spanish green, take thinned-out copper plates, scrape them carefully on both sides, moisten them with pure hot vinegar without honey or salt, and lay them together in a small wooden chest in the same way as above. After two weeks inspect and scrape them, and continue doing this until you have enough pigment."*

Similar instructions are found in the ***Booke of Secrets*** on page 14:

> *"To make good greene. Take copper plates, let them lie six months in vinegar in a warme place, then take them out, and drie them in the sun, and the flower you find upon the plates, scrape it of, for that is the colour."*

I've used glass jars in place of wooden boxes as they allow for a tighter seal and are more readily available.

I prepared my copper pipe fittings by washing them and then scrubbing them with fine sandpaper to remove any surface corrosion. For this first batch, I stacked the pipe fittings into the glass jar and poured about 1" of white vinegar into the jar. A green film started forming on the exposed copper the very next day. Approximately 3 weeks later, I removed the copper from the jar and used a butter knife to scrape the verdigris away. The result was a lovely blue-green colored powder.

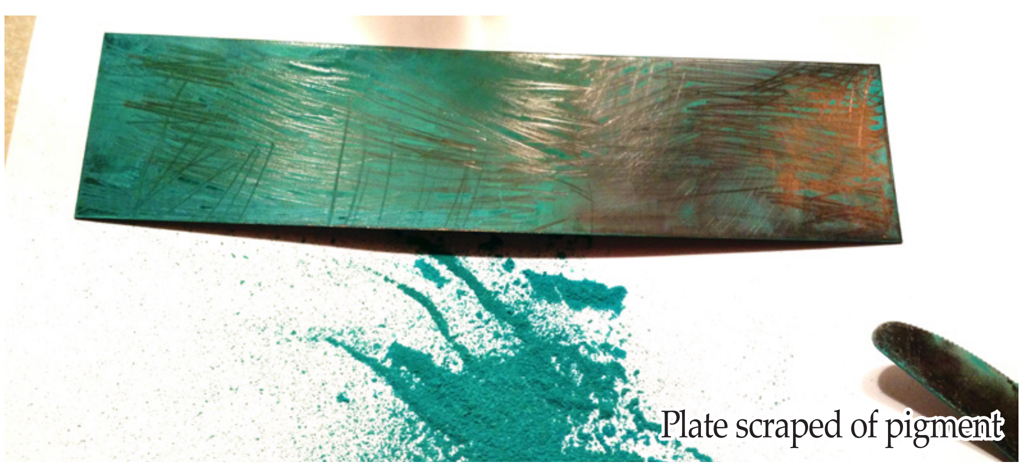


Plate scraped of pigment

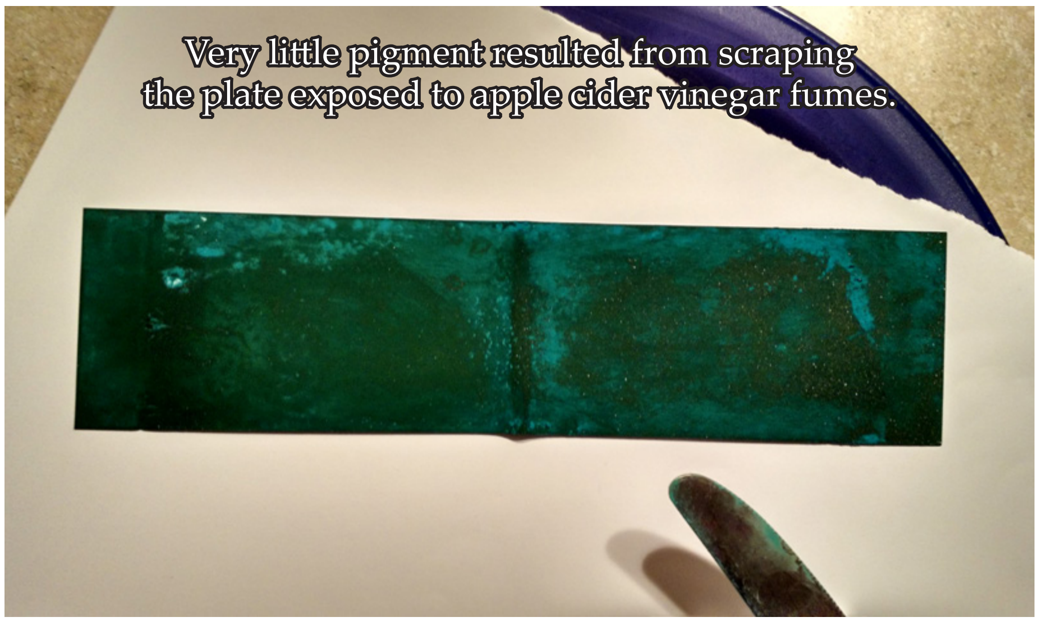
Spanish Green
Verdigris Pigment

This first batch resulted in a very small quantity of pigment. For a second batch, I used two copper sheets 2”x8” in size along with a half-gallon glass jar and a smaller jar to keep the copper out of the vinegar. In less than two weeks time, these two plates produced four times as much powder as the copper caps.

Thompson (164) mentions that in England, Apple cider vinegar was almost certainly used to create verdigris. In order to see what difference this would make over white vinegar, I set a cleaned sheet of copper into a small jar inside a half-gallon jar with a fair quantity of apple cider vinegar. The plate began turning green very quickly.

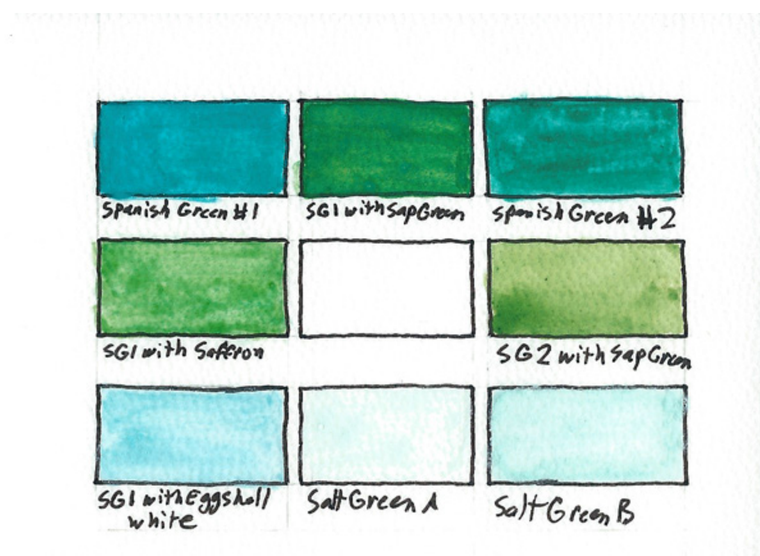
After almost 3 weeks, I attempted to scrape the copper sheet. Despite an extra week’s growth time than the white vinegar batch, only a small amount of pigment could be scrapped from the plate. The resulting powder appears slightly more blue than the white vinegar batch. I will need to produce more pigment to have an easier time comparing the two versions.

Copper with Apple Cider
vinegar



Very little pigment resulted from scraping
the plate exposed to apple cider vinegar fumes.

Two weeks of growth



Salt Green from *Theophilus* (page 41)**:**

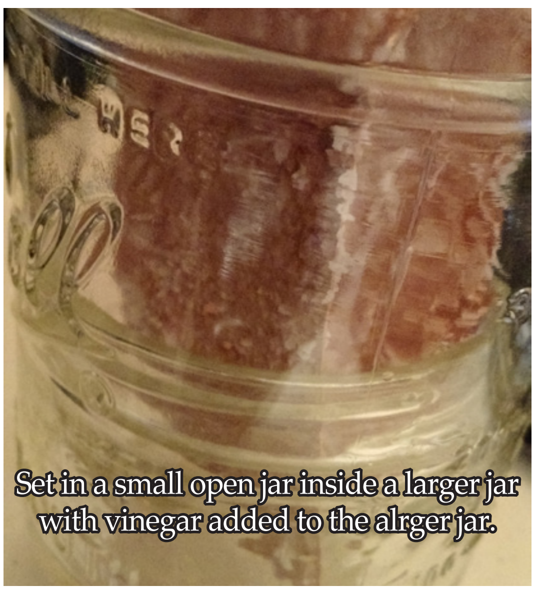
> *"If you want to make a green pigment, take a piece of oakwood, as long and as wide as you wish, and hollow it into the shape of a little chest. Then take some copper and thin it out into sheets of any desired width but of a length sufficient to span the [inside] width of the chest. After this take a flat pan full of salt and, pressing the salt down firmly, put this pan in the fire and clover it with [glowing] coals for the night. Next morning grind the salt very carefully on a dry stone. Get some thin twigs and place them in the above-mentioned chest in such a way that two thirds of the cavity are beneath [the twigs] and the other third is above them. Smear the copper sheets on both sides with pure honey and sprinkle the ground salt on them. Then lay them next to each other on the twigs and cover them carefully with another piece of wood, fitted for the purpose, so that no vapors can escape. Next, in the corner of this piece of wood drill a hole through which you can pour in heated vinegar or hot urine until a third of [the chest] is filled; then block up the hold. Put this chest in a place where you can pile dung all over it. After four weeks pry off the lid, scrape off whatever you find on the copper, and keep it. Put [the copper] back again and cover it as above."*

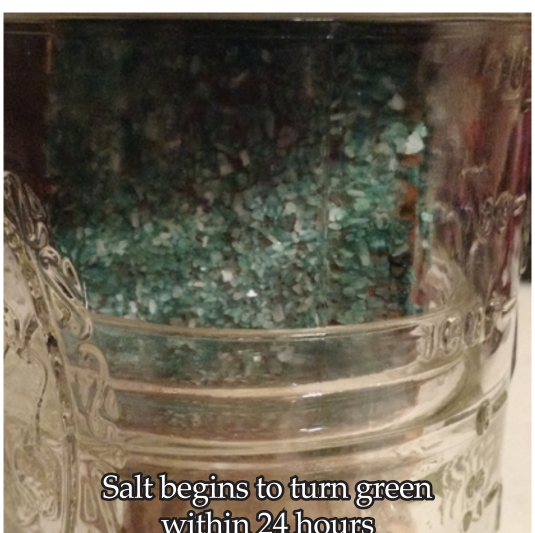
Again, I've used glass jars in place of wooden boxes as they allow for a more secure seal. I've also used a second small jar in place of twigs to keep the copper from being directly in contact with the vinegar.

Kosher salt was heated in a pan while I cleaned a 2"x8" 20ga sheet of copper with fine sandpaper. I then coated the copper sheet with honey and sprinkled a thick layer of the salt onto it. I folded the copper sheet over so that it fit inside a small jar that nests inside a larger jar. I put as much white vinegar into the larger jar as possible without overflowing into the small jar. I placed the jar in a warm window as this is preferable and more convenient than burying it in dung.

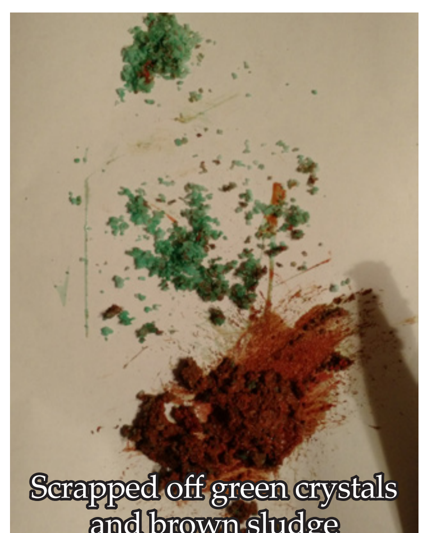

Clean Copper being covered in Honey

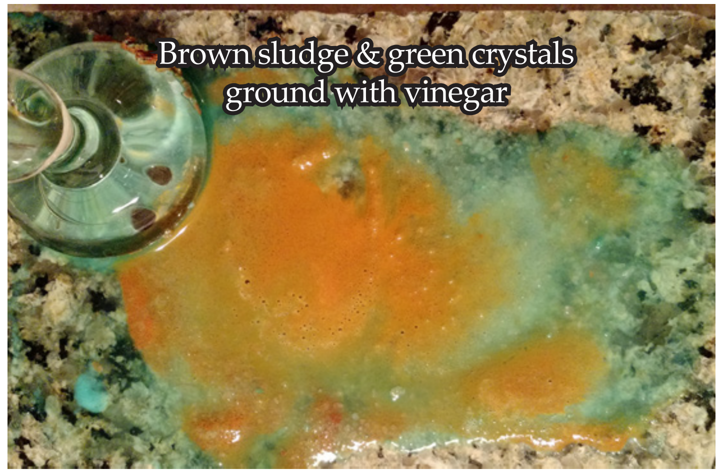

then covered in kosher salt


Set in a small open jar inside a larger jar with vinegar added to the alrger jar.


Salt begins to turn green within 24 hours


Two weeks later


Scrapped off green crystals and brown sludge



The salt began turning green the very next day. Two weeks later I removed the copper sheet and carefully scrapped off the surface contents. Alarmingly, the surface contents included the honey which has turned to a potent dark copper sludge.

I managed to separate some of the green crystals with minimal dark honey and ground these with a bit of vinegar. As the vinegar seemed to clear up what little "contamination" I had, I tried grinding the dark sludge and the rest of the green salt along with vinegar. Before long the brown was gone leaving a pale green. I poured both sets into oyster shells to evaporate.

I used glair to mix each of my pigment batches into paint for testing.

The Spanish Green made with white vinegar (Spanish Green #1) produced a translucent color very much between blue and green. The batch produced with apple cider vinegar has a darker tone and is a bit more to the green side of the spectrum. Both produce a lovely grass green when mixed with verdigris (Cennini, 30).

When mixed with Sap Green (***see appendix page 40***) per the analysis of the Macclesfield Psalter (Panayotova, 342), Spanish Green #1 produced a gorgeous dark grass green. Spanish Green #2 mixed with sap green is a bit more in the olive spectrum, but more green than sap green by itself.

Overall, the Spanish greens are a success. I like the color of the #2 batch best even if this seems to take longer produce.

Both Salt Greens proved pale in color. The darker color on top of the shells hid the much paler color of the salt below. Salt Green B, which was the batch heavy in the brown sludge and ground with vinegar to clear it, proved slightly darker than the crystals-only batch. I need to try this process again with a verified "real" honey and a longer time period to see if I can get a darker color.

To Make Egg Shell White

for use in illumination work
& making lake pigments

The unknown author of De Arte Illuminadi extolls the virtues of lead white above all other whites (pg 2,3). Unfortunately, lead is incompatible with orpiment or verdigris pigments. Bone white or eggshell white are needed to lighten either pigment (Thompson, 95,96). Additionally, eggshell white can also be used as the white substrate for many lake pigments, such as weld. Given the relatively expensive cost of purchasing pre-made eggshell white, I would like to be able to produce my own. I have attempted two similar recipes, one 14th century and the other 16th century for this pigment.

Processes:
The first instructions I found for making eggshell white are incidentally included in De Arte Illuminadi as part of the instructions for making rose color from brazilwood.

Eggshell White from *De Arte Illuminadi* (page 9)**:**

> *"Likewise, if, into the brazil dissolved in lye as above, you put, for body, eggshells," kept overnight in strong vinegar, with the membranes removed in the morning, and washed with clear water and ground to an impalpable paste on the porphyry,"*

Similar instructions are found in the ***Booke of Secrets*** on page 14:

> *"To make a chalke of egshels. Take egshels, and let them lie three daies in vinegar, then wash them well in faire water, drie them in the sun, and beat them to powder, then grind them upon a stone."*

Handily, a 4 egg breakfast provided me with 4 white eggshells to start with. I crumbled the eggshells a bit and put them in a jar. After covering them in white vinegar, I let them sit overnight. Crumbling the shells was a mistake as it made removing the membrane a bit more difficult. The membranes slide right off of the larger pieces. The membrane-less shells were well rinsed and allowed to dry before being ground to powder with a glass muller on my granite plate. As the grinding proved a bit dusty, I also tried wet grinding the shells. Once dry, I gave it another round with the mortar and had a fine powder.

For the second round, I again started with the shells of four eggs. This time I kept the shells as whole as possible and let them soak in vinegar for 3 days before pulling out the membranes and washing the shells. Three days appears to be excessive as parts of the shells had crumbled by the time I tried to remove the membranes. The washed and dried shells were then ground with the glass mortar and granite slab. Sample #2 still requires more grinding to be usable.

The third time, I soaked the shells overnight and used my porcelain mortar and pestle to grind the shells to fine powder. With a larger supply of eggshell white on hand, I was able use it to make lake pigments (*See appendix on page 38 for additional information*).

This may well be the simplest pigment I have made thus far. I mixed batch #1 with gum arabic, it forms a transparent white paint. The pigment seems effective in lightening verdigris.

As a base for making lake pigments, the eggshell white proves effective though it lends more transparency to the resulting color than marble dust.

Section of illumination showing the light pink madder pigment made with the eggshell white.

Cochineal (left) and Madder (right) lakes make with eggshell white

Resources:

An Anonymous Fourteenth-century Treatise, De Arte Illuminandi: The Technique of Manuscript Illumination. Translated by Daniel Varney Thompson, George Heard Hamilton. Yale University Press, 1933. Book.

A Booke of Secrets, Shewing Divers Waies to Make and Prepare All Sorts of Inke, and Colours. Anonymous. London: Adam Islip, 1596. Book.

Cennini, Cennino d'Andrea. *The Craftman's Handbook "Il Libro dell' Arte".* Translated by Daniel Varney Thompson, Jr. Dover Publications Inc, 1933. Book.

Kirby, Jo, Maarten van Bommel, Andre Verhecken. *Natural Colorants for Dyeing and Lake Pigments.* London: Archetype Publications Ltd, 2014. Book.

Panayotova, Stella. *The Macclesfield Psalter*. New York: Thames & Hudson, 2008. Book.

Theophilus, John G. Hawthorne, and Cyril S. Smith. *On Divers Arts: The Treatise of Theophilus*. New York, Dover Publications, Inc., 1979. Book.

Thompson, Daniel V. *The Materials and Techniques of Medieval Painting.* New York: Dover Publications, 1956. Book.

Appendix: Making Lake Pigments with Eggshell White

In searching for more reds for my period color pallet, I've started experimenting with Madder and Cochineal. Both dye materials were commonly used for textile dyes in period and indirectly turned into pigments for illumination. That process starts with dyed fiber scraps (Thompson, 115). At this time I have not yet attempted pigment extraction from dyed textile. I have tried a more direct route similar to creating rose pigment by making a lake from Brazilwood.

This is not a completed project, but demonstrates the use of my eggshell white in making lake pigments.

Cochineal is a red dye extracted from a South American insect similar to Kermes lice. as Kermes is extremely difficult to procure, Cochineal makes an affordable and reasonable substitution. (Thompson, 116).

Madder root, that is the roots of the Rubea tinctorum plant, contains a cocktail of color producing chemicals. A range of oranges and orange-reds can be obtained by soaking the roots, then extracting the dyestuff with heat.

Materials:

Period Materials

- Madder Roots - from Aurora Silk
- Cochineal (reasonable substitute for Kermes lice or dyers grain) (*De Arte Illuminandi*, 8)
- Eggshell White (substitution for marble dust)
- Alum (*De Arte Illuminandi,* 8)
- Potash (potassium carbonate) (*De Arte Illuminandi,* 8) - from Kremer Pigments
- Sea Shells
- Distilled Water

Tools:	***Period Materials (if substitution was made)***
• Mortar and Pestle	
• Glass plate & glass muller	
• Pyrex dish	Metal pot
• Linen fabric (*De Arte Illuminandi,* 8)	
• Wooden skewers (and a poor knife that was used in a desperate moment)	
• Glass jars	

Reasons for non-period substitutions:

- I used a Pyrex dish as this is my non-food pyrex dish for making pigments.

I based my process off of the Rose pigment recipe in De Arte Illuminadi (page 8):

> *"The body-color pink is made in this way. Take some of the best brazil wood...and with a knife or a piece of glass, scrape off as much of this wood as you want. And put it into a lye made from the wood of vines or oaks.... And put this into a glazed dish which will stand the heat: and have the lye cover this brazil, so that whatever part of it is extractable may be thoroughly extracted by this lye. And let it stand in this lye for a night or a day to soften. Then put it on the fire, and heat it to the boiling point, but do not let it boil; and stir it often with a stick. Then take account of how much scraped brazil there was, and take the same quantity" of very nice white marble very thoroughly worked up on the porphyry to an impalpable powder, or scraped with a knife, and as much sugar alum or rock alum as there is of the brazil. And grinding them thoroughly, mix them gradually in this dish, always stirring it with a stick, until the froth which it*

makes subsides, and it is well colored. And then it is strained through a clean linen or hempen cloth into as glazed or unglazed porringer. ... And if anyone wants to make it richer, he may, when he puts in the brazil, put into the lye with it some dyer's grain,if obtainable, to the amount of an eighth or a sixth part of the weight of that brazil. more or less, at will, because it makes a more permanent color and will be more beautiful; and proceed as above. However, it is a more beautiful color with the brazil alone than mixed with the grain. Do whichever you like. And know that some say that the lye, after it is well colored, should be strained through a cloth into a glazed dish; and after getting it fairly hot, they put in the alum and marble. And it will take up the color immediately; and the water will separate almost clear above it, and you pour it off carefully."

I used the same process for both dyestuffs, with the following differences:

For the madder root, I soaked the roots in distilled water overnight, then heated them to 70 degrees C for an hour. The roots were then strained out (Kirby, Bommel, and Verhecken, 56).

The cochineal soaked overnight in distilled water with a pinch of potash at which point the source material was strained out through a linen cloth. This is not dissimilar in the treatment of cochineal with the brailwood.

I dissolved alum into the dye and then added some to the eggshell white. The mixture bubbled similarly to using marble dust. Once the reaction stopped, I poured the results into unglazed dished and drained off the liquid after the pigment settled out.

This particular batch of madder lake is a dark reddish-orange when dry. The cochineal is a deep violet color, due to not enough potash added in the process.

The colors may be off, but the eggshell white performed acceptably as the white substrate for the lake pigments.

Madder (left) and Cochineal (right) lakes
make with eggshell white