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33 tried & true glaze recipes

| Second Edition |

recipe cards for our favorite pottery glazes

SIERRA NEVADA COLLEGE

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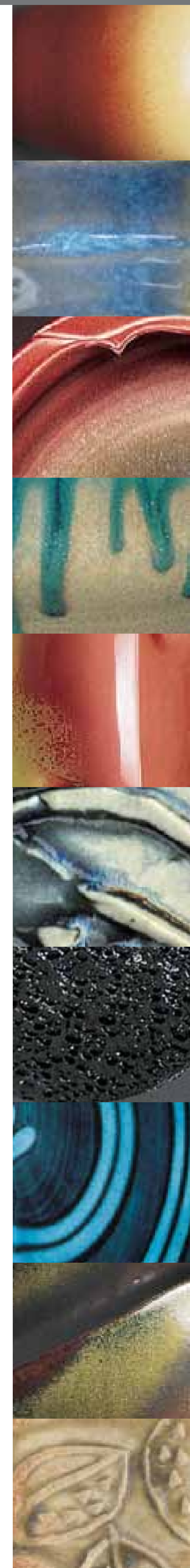
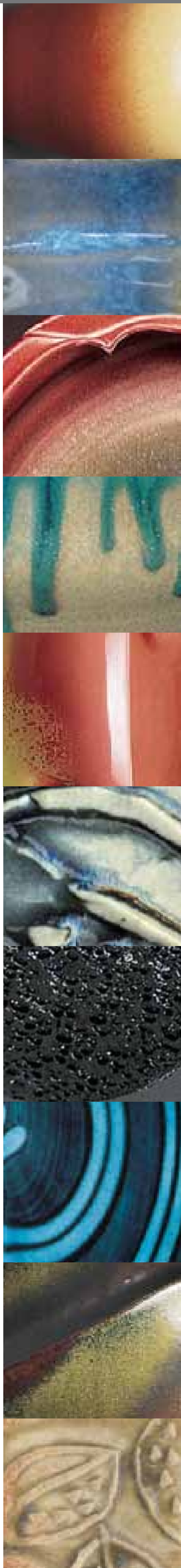
Contents

33 Tried & True Glaze Recipes



Glazes are Good



If you've downloaded this free recipe book, you agree that glazes are good. And it's true, these glazes are good. But, when you are looking at all the wonderful surfaces on all the wonderful forms, don't make the mistake of thinking you should mix up a 5-gallon bucket of one of these glazes, plunge an entire kiln load of work into it, planning all the while to go sell the whole load and get rich. Yes, these glazes have been proven by those who submitted them to *Ceramics Monthly* as part of feature articles, but every one of those very accomplished artists will tell you that you will need to prove these recipes yourself, under your own firing conditions.

All of these glazes come from different kilns, different firing cycles, different altitudes and indeed, different attitudes toward glazing and firing. You will undoubtedly be approaching your work with your own set of requirements—your own attitude. I suggest that, regardless of the recipe, you mix up a small batch to begin with, say 500 grams. Heck, mix up several of them. You may find that a few work "right out of the box." We all love it when that happens. But let's say, for the sake of argument, that your clay or your forms or your firing schedule causes your results to vary from those pictured; what does this mean? It could mean you have a wonderful glaze that happens to look slightly different than what you expected. Or it could mean that you have been hooked, because you must discover the secrets of achieving the exact results you want. You will have begun your journey through the world of glaze calculation and chemistry. Don't worry, it's not as scary as it sounds. To help you along this path, we've included several useful references at the end of this book:

"Glazes: Materials, Mixing, Testing and Firing," by Jeff Zamek (see page 23), is an overview of the things you need to keep in mind when assessing and testing new glazes. Who knew that the size of a kiln or the rate of cooling could matter so much in the success of a glaze? Okay, maybe you knew that, but there are many factors necessary to successful glaze testing and firing, and Zamek explains many of them in order to keep us on the path to successful glazes.

"The Potter's Palette," by Robin Hopper (see page 26), is a reference you can use to begin altering the color of a glaze. Let's say you see a glaze surface you love, you've tested it and it works wonderfully on your favorite bowl form, but it would just blow you away if it were red. And not just any red, but that perfect red that would make your famous pea soup even more famous. Well, Hopper's years of innovation and testing provide a great place to start.

"Primary Function of Common Ceramic Materials in Clay Bodies and Glazes," on page 29, is an overview of what different materials contribute to glazes and clay bodies. If you see a glaze you like, but you haven't worked with one of more of the materials before, this chart will list the main reason it is included in a glaze or clay body, and will help you decide whether or not a given recipe is formulated to suit your work and firing methods.

Taken together, these references will illuminate the recipes in this book beyond the images, as well as other recipes not included here. You will be able not only to assess the glazes in terms of their suitability for your studio and your work, but you will begin to learn about how different glaze materials behave. You will discover that you have favorites, as well as enemies, and you may even decide that it is time to begin formulating your own glazes. Here's to those glazes being good!

Sherman Hall
Ceramics Monthly magazine,
Ceramic Arts Daily

Linda Arbuckle's Majolica Glaze

(Cone 04)

Frit 3124 (Ferro)	65.72 %
Kona F-4 Feldspar	17.23
Nepheline Syenite	6.24
Edgar Plastic Kaolin	10.81
	100.00 %
Add: Tin Oxide	5.00 %
Zircopax	10.00 %
Bentonite	2.00 %

From Steve Davis-Rosenbaum, *Ceramics Monthly*, January 1998. This recipe is for the stiff base glaze, over which stains are applied.

LOW FIRE

Low-Fire Crystals

Lithium Carbonate	23 %
Barium Carbonate	18
Potash Feldspar	38
Whiting	6
EPK Kaolin	9
Silica	6
	100 %
Add: Bentonite	1 %
For Blue, add:	
Copper Carbonate	2 %
Rutile	1–2 %
For Lime Green, add:	
Chartreuse Stain	6 %
Rutile	1–2 %

From Deanna Ranlett, *Pottery Making Illustrated*, Mar/Apr 2012.

Crater Underglaze

(Cone 08–04)

Borax (powder)	5 %
Talc	15
Frit 3269	25
EPK	15
Kentucky Ball Clay (OM 4)	15
Silica (Flint)	25
	100 %

Add: Silicon Carbide (100 mesh) . . . . . 2 %

Top Crater Glaze

(Cone 08–04)

Frit 3134	52.1 %
EPK	11.1
Silica (Flint)	36.8
	100.0 %

Add: Silicon Carbide (100 mesh) . . . . . . 1 %

From James Haggerty,
Ceramics Monthly, November 2005.

LOW FIRE

White Crackle Glaze

(Cone 06)

Frit 3134	85 %
Kaolin	15
	100 %

Whitten Sculpture Body

(up to Cone 10)

F-1 Wollastonite	6.25 %
6-Tile Clay	15.63
Edgar Plastic Kaolin	31.25
Kentucky Ball Clay (OM 4)	15.62
Kyanite (35 mesh)	12.50
Extra-Fine Grog	6.25
Fine Grog	6.25
Medium Grog	6.25
	100.00 %

Stir Wollastonite into the mixing water and screen. Though somewhat expensive, this body is practically immune to thermal shock.

From George Whitten,
Ceramics Monthly, April 2000.

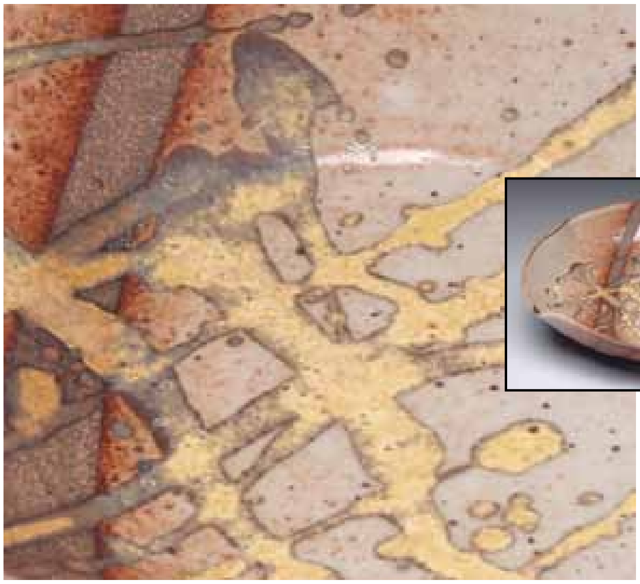
Red Green Glaze

(Cone 06)

Frit 3134 (Ferro)	50.0 %
Custer Feldspar	50.0
	100.0 %

Add: Copper Carbonate . . . . 3.2 %

From Ramon Camarillo
Ceramics Monthly, April 2002.



Cherry Blossom Shino

(Cone 6)

Soda Ash	10 %
Nepheline Syenite	40
Spodumene	40
EPK Kaolin	10
	100 %

Woo Yellow

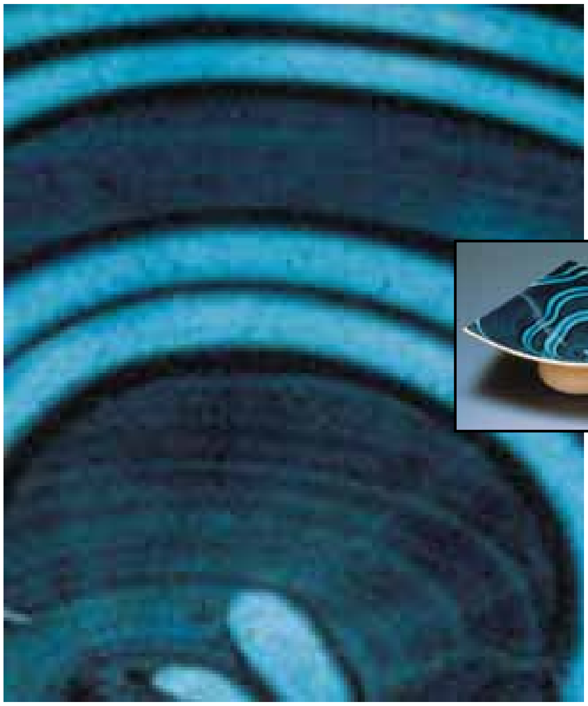
(Cone 6)

Dolomite	15.41 %
Strontium Carbonate	23.90
Nepheline Syenite	42.50
Kaolin	9.04
Silica (Flint)	9.04
	100.0 %
Add: Zircopax	19.23 %
Bentonite	4.76 %
Epsom Salt	1.19 %
Red Iron Oxide	3.57 %

From John Britt,
Ceramics Monthly, October 2008.

mid-range

mid-range

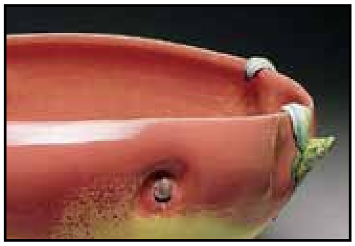


Wright's Water Blue Glaze

(Cone 1–6, oxidation)

Lithium Carbonate	3 %
Strontium Carbonate	9
Frit 3110	59
Edgar Plastic Kaolin	12
Flint	17
	100 %
Add: Bentonite	2 %
Copper Carbonate	5 %

From David Wright,
Ceramics Monthly, April 1998.



Rob's/G.A. Blend Glaze

(Cone 6)

Gerstley Borate	2.9 %
Lithium Carbonate	1.7
Strontium Carbonate	9.3
Whiting	8.4
Cornwall Stone	34.6
Frit 3110(Ferro)	10.6
Kona F-4 FEldspar	23.2
Flint	9.3
	100.0 %
Add: Bentonite	3.0 %

Warm Pink:

Coral Stain	5 %
Rutile	3 %

Apple Green:

Green Stain	5 %

Matt "B" Glaze

(Cone 6, oxidation)

Lithium Carbonate	2.7 %
Strontium Carbonate	26.5
Nepheline Syenite	57.5
Kentucky Ball Clay (OM 4)	6.2
Flint	7.1
	100.0 %
Add: Bentonite	3.0 %

The matt quality of this glaze is easily affected by colorants, so variations have different surface qualities as well as colors.

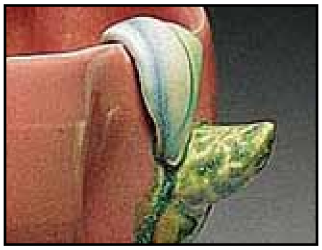
Dark Green:

Copper Carbonate	3 %
Nickel Oxide	2 %

Orange:

Encapsulated Orange Stain	5 %
Zirconium Yellow Stain	5 %

From Geoffrey Wheeler,
Ceramics Monthly, January 2001.



mid-range

Fake Ash

(Cone 6, reduction)

Bone Ash	5 %
Dolomite	25
Lithium Carbonate	2
Strontium Carbonate	9
Frit 3134 (Ferro)	10
Kentucky Ball Clay (OM 4)	24
Cedar Heights Redart	23
Silica (Flint)	2
	100 %

This is a beautifully variegated fake ash glaze. It is a brighter yellow on porcelain with hints of green where thicker and terra cotta-colored where thin. It is not stable because it is low in silica, but to alter it would change the ash effect. While it does not meet strict requirements of stability, I use it anyway because I substituted strontium for barium.

From Diana Pancioli,
Ceramics Monthly, June 2006.

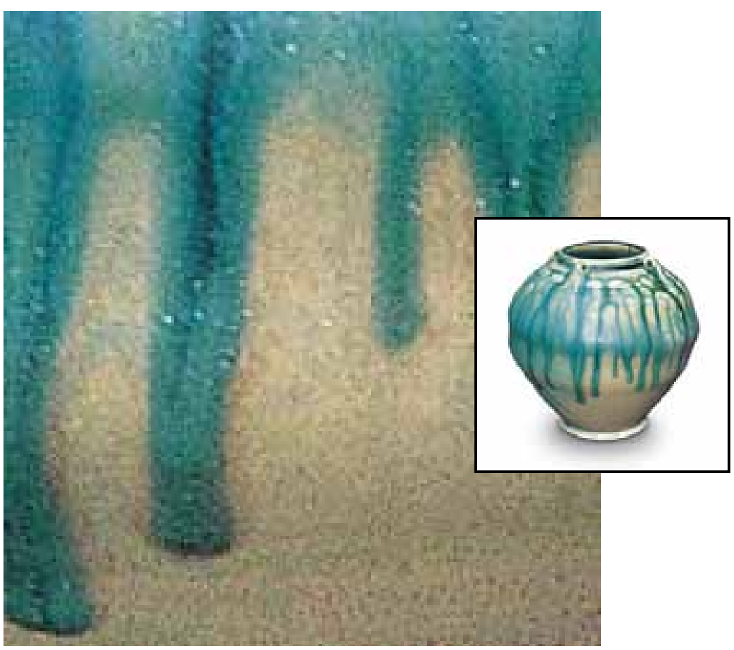
Floating Blue Glaze

(Cone 6, oxidation)

Gerstley Borate	26 %
Nepheline Syenite	48
Edgar Plastic Kaolin (EPK)	6
Flint (325 mesh)	20
	100 %
Add: Cobalt Oxide	1 %
LightRutile	4 %
Red Iron Oxide	2 %

From Jeff Zamek,
Ceramics Monthly, October 2001.

mid-range



Frasca Wood Ash Glaze

(Cone 6, oxidation or reduction)

Whiting	11.36 %
Wood Ash (unwashed)	54.56
Potash Feldspar	11.36
Ball Clay	11.36
Silica (Flint)	11.36
	100.00 %
Green:	
Copper Carbonate	4 %
Blue:	
Cobalt Carbonate	2 %

From Harry Spring,
Ceramics Monthly, October 2002.

mid-range

Temmoku Glaze

(Cone 6, reduction)

Whiting	20 %
Custer Feldspar	35
Kentucky Ball Clay (OM 4)	15
Flint	30
	100 %
Add: Red Iron Oxide	10 %

A cone 10 that works equally well at cone 6; yields yellow "tea dust" crystals in reduction. Not as interesting in oxidation; just lies there and looks brown.

From Rick Malmgren,
Ceramics Monthly, October 2000.

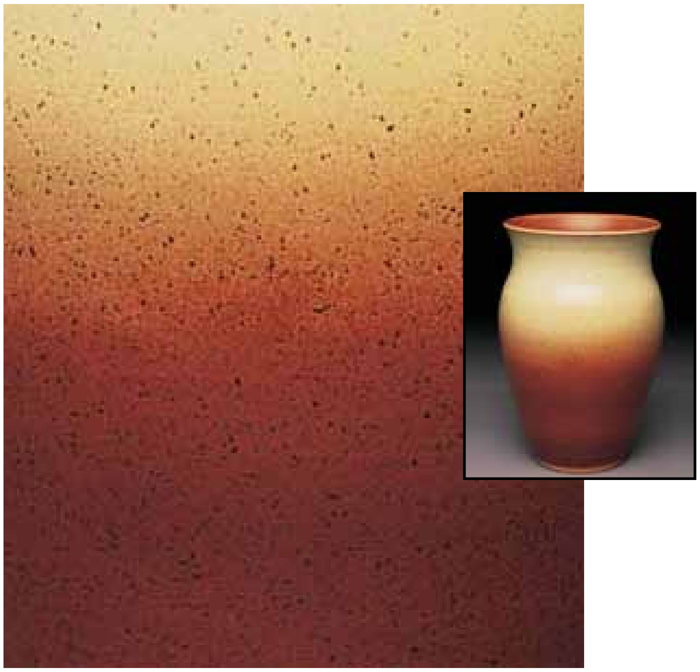
Marilee's Lava Glaze

(Cone 6, oxidation or reduction)

Whiting	23.91 %
Custer Feldspar	49.73
Edgar Plastic Kaolin	13.18
Flint	13.18
	100.00 %
Add: Titanium Dioxide	11.29 %
Silicon Carbide	3.4%

A Very rough glaze; not intended for food surfaces. Fine silicon carbide seems to work best. For a gray to black variation, add 7% Mason stain 6600.

From Rick Malmgren,
Ceramics Monthly, October 2000.



Eggshell Glaze

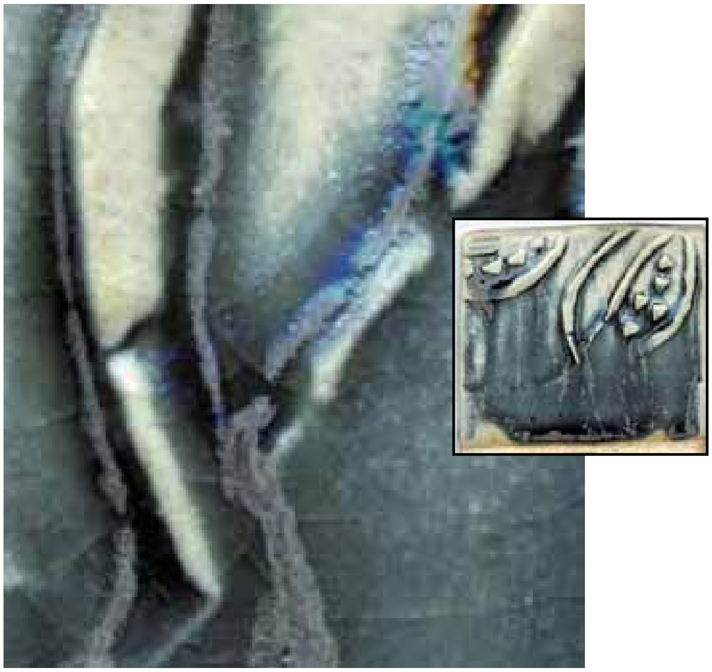
(Cone 6, oxidation)

Whiting	9.5%
Zinc Oxide	5.5
Ferro Frit 3124	44.5
Custer Feldspar	20.0
Bentonite	7.5
EPK Kaolin	5.0
Silica	8.0
	100.0 %
Add: Tin Oxide	9.0%
Red Iron Oxide	3.0%

From Central Carolina Community College, *Ceramics Monthly*, October 2004.

mid-range

mid-range



Textured Blue

(Cone 6, reduction)

Talc	17.0 %
Whiting	10.0
Frit 3134 (Ferro)	20.0
Nepheline Syenite	30.0
EPK	13.0
Silica	10.0
	100.0 %
Add: Zircopax	10.0 %
Cobalt Carbonate	0.5 %
Copper Carbonate	1.0 %
Rutile	3.0 %

This is Marcia Selsor's Waxy White base with a number of colorants added. This variation was derived from a 50/50 color blend with rutile incorporated in the base for texture. Goes glossy on interiors and breaks beautifully over textures.

From Diana Pancioli, *Ceramics Monthly*, June 2006.

Candace Black

Cone 10

Dolomite	5 %
Whiting	5
F-4 Soda Feldspar	65
Kaolin	5
Silica	20
	100 %
Add: Red Iron Oxide	8 %
Cobalt Carbonate	2 %

John's SG-12

Cone 10/11 Oxidation

Bone Ash	2.06 %
Dolomite	5.53
Talc	3.08
Whiting	1.73
Custer Feldspar	38.03
Red Art Clay	40.12
Kentucky Ball Clay	9.46
	100.00 %
Add: Red Iron Oxide	4.50 %
Rutile	1.00 %

Hamada Rust

Cone 10

Gerstley Borate	12.40 %
Whiting	6.20
Custer Feldspar	77.00
EPK Kaolin	4.20
Silica	0.20
	100.00 %
Add: Synthetic Red Iron Oxide	8.70 %

From John Britt,
Ceramics Monthly, May 2011.

high-fire

Malcolm Davis Shino Glaze

(Cone 10, reduction)

Soda Ash	17.27 %
Kona F-4 Feldspar	9.82
Nepheline Syenite	40.91
Edgar Plastic Kaolin	18.18
Kentucky Ball Clay (OM 4)	13.82
	100.00 %

For use on porcelain,
add 6% Cedar Heights Redart
From Mel Jacobson,
Ceramics Monthly,
December 2000.

high-fire

Hank's Shino Glaze

(Cone 10, reduction)

Cryolite	0.6 %
Nepheline Syenite	55.4
Low-Melt Spodumene	18.0
McNamee Kaolin	26.0
	100.0 %
Add: Veegum T	1.0 %

White where thick; red where thin. Best with early reduction and a long, concluding period of oxidation, or an oxidation soak during cooling. Yields a very soft and fat surface with crawling. Crawls more strongly if fired soon after glazing.

From Hank Murrow,
Ceramics Monthly, September 2001.

high-fire

high-fire

Rhodes Crackle Slip

(Cone 10, reduction)

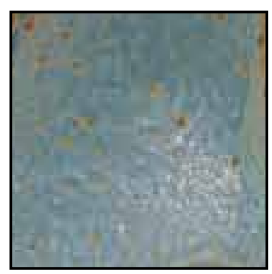
Borax	5 %
Zircopax	5
Custer Feldspar	20
Calcined Kaolin	20
Edgar Plastic Kaolin (EPK)	15
Kentucky Ball Clay (OM 4)	15
Flint	20
	100 %

For use on green- or bisqueware

Mark Nafziger's Gold Glaze

(Cone 10, reduction)

Bone Ash	2 %
Dolomite	22
Whiting	3
Custer Feldspar	48
Kentucky Ball Clay (OM 4)	25
	100 %
Add: Rutile	8 %



Jim Brown's Blue Glaze

(Cone 10, reduction)

Whiting	28.00 %
Custer Feldspar	60.00
Edgar Plastic Kaolin (EPK)	12.00
	100.00 %
Add: Cobalt Carbonate	0.75 %
Rutile	4.00 %

From Tony Winchester,
Ceramics Monthly, November 2001.

Peach Black Temmoku Glaze

(Cone 10, reduction)

Whiting	17 %
G-200 Feldspar	50
Edgar Plastic Kaolin (EPK)	10
Flint	23
	100 %
Add: Tin Oxide	1 %
Red Iron Oxide	10 %
Macaloid	1 %

Tom Turner Porcelain Body

(Cone 10, reduction)

Custer Feldspar	23.5 %
6-Tile Clay	29
Kaopaque 20	14.5
Kentucky Ball Clay (OM 4)	4.5
Flint	27
Veegum T	1.5
	100.0 %

From Craig Martell,
Ceramics Monthly, May 2002.

Celadon Liner Glaze

(Cone 10, reduction)

Dolomite	4.7 %
Whiting	15.9
G-200 Feldspar	30.2
Grolleg Kaolin	18.9
Flint	30.3
	100.0 %
Add: Tin Oxide	3.0 %
North Fork Stone	6.0 %
Macaloid	1.0 %

North Fork Stone is a native basalt material; Alberta or Albany slip can be substituted.

Magnesia Matt Glaze

(Cone 10, reduction)

Dolomite	4.7 %
Lithium Carbonate	2.0
Talc	8.0
Whiting	15.9
G-200 Feldspar	20.2
Grolleg Kaolin	18.9
Flint	30.3
	100.0 %
Add: Tin Oxide	3.5 %
Macaloid	1.0 %

Coleman Vegas Red Glaze

(Cone 8–10, reduction)

Barium Carbonate	2.55 %
Dolomite	5.61
Gerstley Borate	9.18
Whiting	8.68
Custer Feldspar	53.57
EPK (Edgar Plastic Kaolin)	2.55
Silica (Flint)	17.86
	100.00 %
Add: Copper Carbonate	0.41 %
Tin Oxide	2.04 %
Titanium Dioxide	0.10 %
Yellow Iron Oxide	0.10 %

oxblood with purple undertones

From Tom & Elaine Coleman,
Ceramics Monthly, January 2003.

Green to Black

(Cone 10)

Bone Ash	5.5 %
Dolomite	17.3
Whiting	7.0
Custer Feldspar	35.1
EPK	35.1
	100.0 %
Add: Copper Carbonate	9.4 %
Tin Oxide	3.4 %

The glaze will be matt black when applied thick and soda fired in oxidation or reduction. A thin application combined with light soda glaze coverage can produce pumpkin oranges next to olive greens.

From Ryan McKerley,
Ceramics Monthly, March 2006.

Elaine's Celadon Base Glaze

(Cone 8–11, reduction)

Whiting	21.2 %
Zinc Oxide	2.7
Custer Feldspar	24.9
Frit 3110 (Ferro)	8.8
EPK (Edgar Plastic Kaolin)	17.5
Silica (200-mesh Flint)	24.9
	100.0 %

White:

Tin Oxide . . . . 0.7 %

Green:

Mason Stain 6201 . . . . 0.9 %

Iron Blue:

Mason Stain 6391 . . . . 1.6 %

Yields a smooth transparent glaze that is great over carved or incised decoration on porcelain.

From Tom & Elaine Coleman,
Ceramics Monthly, January 2003.

Glazes: Materials, Mixing, Testing and Firing

By Jeff Zamek

How many times have you copied a glaze formula, only to find that it didn't work as expected? It is not unheard of for glazes with the same formula to produce different results. While this may seem like a dead end, it does not have to be.

A high-temperature feldspathic green, transparent, gloss celadon glaze can be obtained with many different glaze formulas. The flexibility to know which formulas will produce the same glaze effect is a function of experience and the ability to interpret glaze tests. Adjusting glaze formulas requires a knowledge of how ceramic raw materials react in various combinations, temperatures, and kiln atmospheres. Taking a course in glaze calculation and raw materials is probably the most efficient way to learn about the "building blocks" of glazes. The lone ceramist in his or her studio, testing a small number of materials, cannot equal the multiplying effect of many students testing glazes with various raw materials and sharing the information. A narrow, limited education in ceramics can yield many areas for failure.

Raw Materials

When choosing glaze materials, the cost of the actual material is not the most important factor. Time, labor and a low defect rate should be more important. Every raw material should be considered for its technical and aesthetic benefit to the glaze. Some unique glazes are worth any irregularities of raw materials or difficulties with mixing, storage, application or firing.

The practice of using generic names for very specific raw materials creates challenges in choosing the appropriate ingredients when trying to duplicate glazes. Different ceramics suppliers use different manufacturers or distributors for the same raw materials. Each processor or wholesaler of raw materials can have several different grades of that material. The result is a common name for a raw material that can be different in particle size, chemical composition or trace elements, depending on where it is processed and eventually sold.

Particle Size

The particle size of a raw material is a critical factor in glaze melt. A smaller particle size means increased surface area for a given weight, and melting is more efficient. My ZAM Gloss Blue can drip or run on vertical surfaces if a finer mesh nepheline syenite, flint or whiting is used.

It is important to know the actual mesh size when trying to duplicate any glaze formula. Silica, a major component in any glaze, can be purchased in 60-, 100-, 200-, 325- and 400-mesh particle sizes. The larger mesh numbers indicate smaller particles. Frequently, a glaze formula will not specify a mesh size for silica. In such instances, use 325 mesh. Nepheline syenite, a common high-temperature glaze flux, is produced in 270 and 400 mesh. If the glaze formula does not specify a mesh size for nepheline syenite, use 270 mesh. Coarser mesh whiting can cause the solids in a glaze to sink to the bottom of the glaze bucket. It also can cause a transparent glaze to become semi-opaque when fired due to incomplete melting of the material in the glaze matrix. Unless otherwise noted, use 325-mesh whiting. When ordering any glaze material, always specify the mesh size where applicable.

Materials Substitution

Problems can occur when potters use inappropriate substitution materials in the glaze formula. If the glaze requires nepheline syenite, a sodium feldspar, it is best not to substitute a potassium feldspar or a lithium feldspar. Clays are grouped as ball clays, bentonites, earthenwares, fireclays, kaolins and stoneware clays. Feldspars are grouped as potash, sodium or lithium. When making a substitution, always use a material from within the same group of clays, feldspars or raw materials.

Some glazes were developed using materials that are no longer in production. For example, Oxford feldspar, a potassium feldspar, is no longer being mined. If you have a container of Oxford feldspar in your studio and use it in a glaze, there might not be a readily available supply when you run out. Before mixing a glaze formula, make sure all of the materials are still in production.

In some instances, continually available materials may subtly change in chemical composition, particle size or organic content over time. All of these can alter the glaze. Often the supplier is unaware of changes in the raw materials they sell. The best course of action, though time consuming and inefficient, is to test raw materials before committing to a production glaze batch.

Coloring Oxides/Carbonates

Metallic coloring oxides can differ in metal concentration, particle size and trace-element content. As with other raw materials, there are many processors of metallic coloring oxides. For example, cobalt oxide (Co_30_4) is processed in three grades, 71.5%, 72.5% (ceramic grade) and 73.5%. The percentage represents the cobalt contained in the oxide. Each grade can affect the intensity of the blue that will be generated in a glaze. In addition, the quantity of trace elements in a metallic coloring oxide can influence its effect on the glaze color. For example, zinc oxide (French process) also can contain trace amounts of copper, lead, iron and manganese. Copper oxide also can have trace amounts of magnesium, sodium

chloride, lead and other heavy metals. Use the same processor of metallic coloring oxides when ordering materials. When this is not possible, always test the oxide. While slight differences in trace metallic oxide content usually will not cause a radical color change, particle size can affect the look of a glaze. For example, a coarser particle size of cobalt oxide can cause larger blue specks in a glaze than a finer grind of the same oxide.

Clay Body/Glaze Interaction

The point at which the fired clay and glaze meet and fuse together in the ceramic structure plays an important role in the development of the fired glaze. Some clay bodies will draw part of the flux content from the forming glaze during the firing process. This can cause opacity or dry surface textures in the glaze. A light colored clay body, such as a white stoneware or porcelain, can have an intensifying affect on a colored glaze. ZAM Gloss Blue, when applied to a white clay body, will be light blue. The degree to which the clay body matures in the firing can promote or retard glaze maturation. Always consider the clay body.

Mixing Glazes

Every glaze will require different amounts of water, but it is best to use less water in initial mixing. It is easier to add water than remove it. If too much water is used in a glaze containing soluble materials and the excess water is poured off, it can change the glaze formula (solubles leave with the water). Glazes should be run through an 80-mesh sieve three times for final mixing.

Glaze Application

Ease of application is especially important in production situations where time-consuming touch-ups mean a decrease in profits. Some glazes will become soft, dusty and fragile when drying on bisqueware. Other glazes will drip and run down vertical surfaces or pool unevenly in horizontal areas. Glazes containing high percentages of clay or light-density materials such as magnesium carbonate can become fragile and loose on bisqueware. This can develop into crawling in the fired glaze. While there are several gums that can improve glaze application, it is often more efficient to choose glazes that do not need additives.

Generally, a spray application will impart a uniform glaze layer as opposed to a dipped or brushed application. However, much depends on the skill of the individual. Dipping the pot into the glaze can result in drips as the excess glaze runs off the surface. Brushing also can result in uneven glaze thickness.

recipe

ZAM Gloss Blue

(Cone 8–10)

Gerstley Borate	10 %
Whiting	8
Nepheline Syenite	55
Silica (Flint)	27
	100 %
Add: Cobalt Oxide	6 %

Some glazes are especially sensitive to the way in which they are applied to the piece. Apply test glazes in varying thicknesses to determine the true glaze color and texture. The thinner the glaze application, the more the underlying color and texture of the clay body are likely to be revealed. Often, a thin glaze application can retard the development of color, texture and opacity in the fired glaze. A thick application can cause some glaze formulas to run and drip on vertical surfaces. ZAM Gloss Blue, when applied too thin, will not achieve a rich deep blue color. A great percentage of glazes can be applied slightly thinner than the thickness of a dime or about as thick as three business cards stacked together.

Glaze Testing Procedures

It is amazing that most glazes reproduce accurately with a minimum of additional information; however, it is always best to start a testing program with the knowledge that occasionally a glaze formula will not work as described. We all know of people who obtain a glaze formula and then mix up 30 gallons without considering that it might fail. Experimenting on such a large scale is not a good idea. Eventually, there will be a major glaze and/or kiln problem caused by a glaze failure.

One important, often-overlooked item required for testing glazes is a notebook. Writing down each step in the process and the results from each test is more effective than memory. While there is no single testing procedure that will suit all work habits and objectives, consistency of method will ensure greater accuracy in duplicating glazes.

It is important to know if a glaze will run or drip on vertical surfaces during firing. Vertical test tiles should be at least 4 inches in height and 2 inches wide. Tiles also must be of sufficient surface area to approximate the surface area of finished works. Many times, a small test tile will be successful because the weight of the molten glaze when heated is not enough to cause it to run down vertical surfaces. However, when larger areas are glazed, the increased weight of the fluid glaze might cause it to run.

Test tiles should have a smooth edge, a rough edge and any other textures likely to be used under the glaze, including throwing ridges. Some glazes can form razor-sharp edges on the fired clay. The testing stage is the time to find out if this is likely.

A gradual increase from a small test batch to the final large-volume glaze batch is important in ensuring a glaze formula's reliability. A 500-gram test batch will allow you to glaze several test tiles, which should be placed in a number of different kiln firings. If the test glaze does not need an adjustment,

it is often a good policy to mix up a preproduction batch of 4000 grams (makes roughly 1 gallon). This larger batch will allow you to glaze several pieces and place them throughout the kiln. Many kilns do not transfer heat evenly throughout their interior space, and not every kiln fires consistently every time. There are always slight variations. If possible, test in several different kilns. Once you are confident with a glaze, larger batches can be mixed and slowly incorporated into your existing glaze palette.

Kiln Size

Kiln bricks, posts, shelves and stacked pots all radiate heat. Therefore, larger kilns have greater thermal mass, and will radiate more heat during their heating and cooling cycles than smaller kilns. Small test kilns are an inaccurate indicator of clay body and glaze reactions when compared to larger kilns. ZAM Gloss Blue can run or drip in a larger kiln due to prolonged heatwork on the glaze. Conversely, it can fire light blue with a satin-matt surface texture in a small kiln.

Firing Cycle

A kiln fired at a fast rate of heat increase can cause the clay body to remain more porous, causing crazing and a less durable clay. Glazes fired at a very slow rate of heat increase can run and drip due to the extra heatwork acting on the glaze. While there is no perfect rate for ZAM Gloss Blue, I recommended a 75–80°F (23–26°C) heat increase per hour from Cone 06 (1828°F/997°C) to Cone 9 (2300°F/1260°C), for this type of glaze.

Kiln Atmosphere

Whether the glaze is fired in an electric, wood, natural gas, propane or oil kiln (with or without soda or salt), the atmosphere affects the glaze color, texture and melting capacity. Electric kilns produce clean, repeatable neutral atmospheres. Carbon-based fuels such as natural gas, propane, wood, coal, oil and sawdust can produce oxidation, neutral and various intensities of reduction atmospheres. It is reduction that can be very difficult to reproduce, as one potter's medium-reduction atmosphere can be another's heavy-reduction atmosphere. Reduction atmospheres can cause greater melting due to the increased fluxing action of the metallic coloring oxides contained in the clay body and glaze.

The cobalt oxide in ZAM Gloss Blue will fire blue in almost any kiln atmosphere, but there can be variations in the intensity of the color due to the atmosphere in the kiln and the fuel used to maintain that atmosphere. In soda, salt or wood firings, it can run or drip on vertical surfaces or pool in horizontal areas because of the fluxing action of sodium vapor or the alkaline content of the wood ash. Pyrometric cones are also subject to the fluxing action of sodium vapor, giving an inaccurate indication of the kiln temperature. In most instances, the glaze reactions to salt and wood firing are aesthetically positive.

Cone Reading Position

The actual pyrometric cone reading is a difficult piece of information to obtain, because potters read pyrometric cones at different positions. Many potters consider the cone reaching maturity when it bends to the 3 o'clock or 9 o'clock position (bending over halfway in relation to the bottom of the cone pack). Other potters read the cone as being mature when it actually touches the cone pack. ZAM Gloss Blue has a two- to three-cone maturing range and will not change significantly when fired to Cone 8, 9 or 10. Some glazes are very sensitive to slight temperature variations. If you do not get a good glaze result, consider firing half a cone higher or lower.

Glazes with a wide maturing range are desirable, as not every kiln will fire evenly. While the glaze might not look the same at the lower end of the range as it does at the higher end, it should be functional, with a smooth nonpitted surface.

Soluble Materials

Whenever possible do not use soluble glaze materials. Borax, boric acid, colemanite, Gerstley borate, soda ash, wood ash, Gillespie borate, Boraq, potassium bichromate and pearl ash (potassium carbonate) are the primary sources of solubility in glaze formulas. Other glaze materials such as lithium carbonate, magnesium carbonate, nepheline syenite, strontium carbonate, and some frits can have lesser degrees of solubility but generally they do not interfere with the glaze application or fired glaze effects.

Soluble materials can take on atmospheric water in storage. This can affect the accurate measurement of the materials when weighing them. These materials will leach into the water in the glaze, changing its chemical composition over time, which can result in several glaze defects. As water evaporates from the glaze during application, soluble materials travel in a wicking action, drawing higher concentrations of material to the ridges and edges of the pot. Essentially, in the elevated edges of the pot, the glaze formula is different due to the concentration of soluble materials. This can cause blisters, pinholes, dry surfaces or changes in color.

The use of soluble materials is required in some instances as they contribute distinctive characteristics to a glaze. For example, in Shino (a high temperature viscous, feldspathic glaze developed in Japan more than 400 years ago), the inclusion of soda ash causes the glaze to melt at lower temperatures, sealing in carbon produced during body reduction. The carbon remains in the surface of the fired glaze. When soluble materials are required in a glaze formula, they should be stored in waterproof plastic bags. A conservative approach is to mix only enough material for one glazing session as the stored liquid glaze can change over time.

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The Potter's Palette

Note: Colors bars are for visual reference only, and do not represent actual colors.

Red to Orange

The potter's palette can be just as broad as the painter's. Different techniques can be closely equated to working in any of the two-dimensional media, such as pencil, pen and ink, pastel, watercolor, oils, encaustics or acrylics. We also have an advantage in that the fired clay object is permanent, unless disposed of with a blunt instrument! Our works may live for thousands of years-a sobering thought.

Because a number of colors can only be achieved at low temperatures, you need a series of layering techniques in order to have the fired strength of stoneware or porcelain and the full palette range of the painter. To accomplish this, low-temperature glazes or overglazes are made to adhere to a higher-fired glazed surface, and can be superimposed over already existing decoration. To gain the full measure of color, one has to fire progressively down the temperature range so as not to burn out heat-sensitive colors that can't be achieved any other way. Usually the lowest and last firing is for precious metals: platinum, palladium and gold.

For the hot side of the spectrum—red, orange, and yellow—there are many commercial body and glaze stains, in addition to the usual mineral colorants. Ceramists looking for difficult-to-achieve colors might want to consider prepared stains, particularly in the yellow, violet and purple ranges. These colors are often quite a problem with standard minerals, be they in the form of oxides, carbonates, nitrates, sulfates, chlorides or even the basic metal itself.

Minerals that give reds, oranges and yellows are copper, iron, nickel, chromium, uranium, cadmium-selenium, rutile, antimony, vanadium, and praseodymium. Variations in glaze makeup, temperature and atmosphere profoundly affect this particular color range. The only materials which produce red at high temperature are copper, iron and nickel—usually muted. Reds in the scarlet to vermilion range can only be achieved at low temperatures.

The chart should help pinpoint mineral choices for desired colors (note that the color bars are for guidance only and not representative of the actual colors—Ed.). Colors are listed with the minerals needed to obtain them, approximate temperatures, atmosphere, saturation percentage needed, and comments on enhancing/inhibiting factors. Because of the widely variable nature of ceramic color, there are many generalities here. Where the word "vary" occurs in the column under Cone, it signifies that the intended results could be expected most of the time at various points up to Cone 10.

By Robin Hopper, excerted from Glazes: Materials, Recipes and Techniques. *For the full text and complete explanation of these colorant charts, refer to Robin's book,* The Ceramic Spectrum: A Simplified Approach to Glaze and Color Development, *Krause Publications, 2001.*

COLORANT	CONE	ATMOS.	%	COMMENTS
Dark Red				
Copper	Vary	Red.	0.5%-5%	Best in glazes containing less than 10% clay content, and a high alkaline content. Needs good reduction. In low temperatures it can be reduced during cooling. Good reds as low as Cone 018.
Iron	Vary	Both	5%-10%	Good in many glaze bases at all temperatures. Can be improved with the addition of 2%-5% tin oxide.
Nickel	4-10	Ox.	5%-8%	Use in barium-saturated glazes.
Burgundy				
Iron				See Dark Red, Iron.
Copper	See Dark Red, Copper.			Owing to the unstable nature of copper, this colorant can produce a wide range of results. Very controlled reduction firing and cooling are important.
Maroon				
Chrome-Tin Stains	Vary	Ox.	1%-5%	Use in glazes with calcium. There should be no zinc in the glaze.
Copper	Vary	Red.	0.5%-5%	Best in high alkaline glazes.
Crimson				
Copper + Titanium	8-10	Red.	1%-5%	Try various blends of copper (1%-5%) and titanium (2%-5%).
Calcium-Selenium Stains	010-05	Ox.	0.5-5%	Best with special frits.
Indian Red				
Iron	Vary	Both	5%-10%	Best in high calcium glazes; small amount of bone ash helps. Tin addition up to 5% also helps. Also works well in ash glazes.
Brick Red				
Iron	Vary	Both	5%-10%	Similar to Indian Red. Tin to 2% helps.
Orange-Brown				
Iron + Rutile	Vary	Both	1%-10%	Various mixtures (up to 8% iron and 2% rutile) in most glaze bases.
Iron + Tin	Vary	Both	1%-5%	Various mixtures (up to 4% iron and 1% tin) in most glaze bases. Creamier than iron with rutile.
Orange-Red				
Cadmium-Selenium Stains	012-05	Ox.	1%-4%	Best with special frits such as Ferro 3548 or 3278 or both. Helps to opacify with zirconium.
Orange				
Iron	Vary	Both	1%-5%	Use in tin or titanium opacified glazes.
Rutile	Vary	Both	5%-15%	Many glaze types, particularly alkaline. More successful in oxidation.
Copper	8-10	Both	1%-3%	Use in high alumina or magnesia glazes. Addition of up to 5% rutile sometimes helps.
Orange-Yellow				
Iron	Vary	Both	2%-5%	With tin or titanium opacified glazes.
Rutile	Vary	Ox.	1%-10%	Best with alkaline glazes.
Yellow Ocher				
Iron	Vary	Both	1%-10%	Use in high barium, strontium or zinc glazes.
Iron + Tin	Vary	Ox.	1%-5%	Various mixtures (up to 3.5% iron and 1.5% tin) in many glaze bases.
Iron + Rutile	Vary	Both	1%-5%	Various mixtures (up to 2.5% iron and 2.5% rutile) in many glaze bases.
Vanadium-Zirconian Stains	Vary	Ox.		5%-10%Various mixtures in many Zirconium Stain glaze bases.
Lemon Yellow				
Praseodymium Stains	Vary	Both	1%-10%	Good in most glazes. Best in oxidation.
Pale/Cream Yellow				
Iron + Tin	Vary	Both	2%-5%	Various mixtures (up to 3.5% iron and 1.5% tin) in high barium, strontium or zinc glazes. Titanium opacification helps.
Vanadium	Vary	Both	2%-5%	Use in tin-opacified glazes.
Rutile + Tin	Vary	Ox.	2%-5%	Various mixtures (up to 2.5% iron and 2% tin) in variety of glaze bases. Titanium opacification helps.

The Potter's Palette

Yellow-Green to Navy Blue

The cool side of the glaze spectrum (from yellow-green to navy blue) is considerably easier, both to produce and work with, than the warm. In the main, colorants that control this range create far fewer problems than almost any of the red, orange and yellow range. Some are temperature and atmosphere sensitive, but that's nothing compared to the idiosyncrasies possible with warm colors.

The colorants known for creating cool hues are copper, chromium, nickel, cobalt, iron and sometimes molybdenum. For variations, some are modified by titanium, rutile, manganese or black stains. The usual three variables of glaze makeup, temperature and atmosphere still control the outcome, though it is less obvious in this range.

COLORANT	CONE	ATMOS.	%	COMMENTS
Yellow Green				
Copper + Rutile	Vary	Both	2%-10%	Various mixtures in a wide variety of glazes, particularly those high in alkaline materials. Almost any yellow glaze to which copper is added will produce yellow green.
Chromium	Vary	Both	0.5%-3%	In yellow glazes without tin or zinc.
Chromium	4-8	Ox.	0.25%-1%	In saturated barium glazes.
Chromium	018-015	Ox.	0-2%	In high alkaline glazes with no tin.
Cobalt	Vary	Both	0-1%	In any yellow glazes.
Light Green				
Copper	Vary	Ox.	0-2.5%	In various glazes except those high in barium or magnesium. Best in glazes opacified with tin or titanium.
Cobalt	Vary	Both	0-2%	In glazes opacified with titanium, or containing rutile.
Apple Green				
Chromium	Vary	Both	0-2%	In various glazes without zinc or tin. Good in alkaline glazes with zirconium opacifiers. Also use potassium dichromate.
Copper			1%-2%	See Light Green; use in non-opacified glazes.
Celadon Green				
Iron	Vary	Red	0.5%-2%	Best with high sodium, calcium or potassium glazes. Do not use with zinc glazes.
Copper	Vary	Ox.	0.5%-2%	Good in a wide range of glazes.
Grass Green				
Copper	010-2	Ox.	1%-5%	In high lead glazes; sometimes with boron.
Chromium	018-04	Ox.	1%-2%	In high alkaline glazes.
Olive Green				
Nickel	Vary	Both	1%-5%	In high magnesia glazes; matt to shiny olive green.
Iron	Vary	Red.	3%-5%	In high calcium and alkalines, usually clear glazes.
Hooker's Green				
Copper + Cobalt	Vary	Ox.	2%-5%	In a wide variety of glaze bases.
Cobalt +	Vary	Both	2%-5%	In a wide variety of glaze Chromiumbases: no zinc or tin. Good opacified with zirconium or titanium.
Chrome Green				
Chromium	06-12	Both	2%-5%	In most glazes; no zinc or tin.
Dark Green				
Copper	Vary	Ox.	5%-10%	Many glaze bases, particularly high barium, strontium, zinc or alkaline with a minimum of 10% kaolin.
Cobalt + Chromium	Vary	Both	5%-10%	Blends of these colorants will give a wide range of dark greens.
Cobalt + Rutile	Vary	Both	5%-10%	Dark greens with blue overtones.
Teal Blue				
Cobalt + Rutile	Vary	Both	1%-5%	In a wide variety of glazes.
Cobalt + Chromium	Vary	Both	1%-5%	In most glazes without tin or zinc.

COLORANT	CONE	ATMOS.	%	COMMENTS
Turquoise				
Copper	Vary	Ox.	1%-10%	In high alkaline and barium glazes. Bluish with no clay content; tends toward greenish tint with added clay.
Copper + Rutile	Vary	Both	1%-5%	In high alkaline and barium glazes.
Copper + Tin	Vary	Ox.	1%-10%	In high alkaline and barium glazes; usually opaque.
Light Blue				
Nickel	Vary	Ox.	1%-2%	In high zinc or barium glazes.
Rutile	Vary	Red.	1%-5%	In a wide range of glazes; best with low (10% or less) clay content.
Cobalt	Vary	Both	0.25%-1%	Use in most glazes, particularly those opacified with tin. Also use mixed with small amounts of iron.
Celadon Blue				
Iron	6-10	Red.	0.25%-1%	In high alkaline or calcium clear glazes. Black iron is generally preferable to red iron.
Wedgewood Blue				
Cobalt + Iron	Vary	Both	0.5%-2%	In most glazes; small amounts of cobalt with iron, manganese or nickel yield soft blues. Added tin gives pastel blue.
Cobalt + Manganese	Vary	Both	0.5%-2%	
Cobalt + Nickel	Vary	Both	0.5%-2%	
Cobalt	4-10	Both	0.5%-3%	In high zinc glazes.
Nickel	4-10	Ox.	1%-3%	In high barium/zinc glazes; likely to be crystalline.
Blue Gray				
Nickel	Vary	Ox.	0.5%-5%	In high barium/zinc glazes.
Rutile	Vary	Red.	2%-5%	In a wide variety of glazes, particularly high alumina or magnesia recipes.
Cobalt + Manganese	Vary	Both	0.5%-2%	In most opaque glazes.
Cobalt	Vary	Ox.	0.5%-5%	In high zinc glazes.
Ultramarine				
Cobalt	Vary	Both	0.5%-5%	In high barium, colemanite and calcium glazes; no zinc, magnesium or opacification.
Cerulean Blue				
Cobalt	Vary	Both	0.5%-5%	In glazes containing cryolite of fluorspar.
Cobalt + Chromium	Vary	Both	2%-5%	In most glazes except those containing zinc or tin.
Prussian Blue				
Nickel	6-10	Ox.	5%-10%	In high barium/zinc glazes.
Cobalt + Manganese	Vary	Both	5%-10%	In most glaze bases.
Cobalt + Manganese	Vary	Both	5%-10%	In most glazes; for example, cobalt 2%, chromium 2% and manganese 2%.
Navy Blue				
Cobalt	Vary	Both	5%-10%	In most glazes except those high in zinc, barium or magnesium.

Note: Colors bars are for visual reference only, and do not represent actual colors.

The Potter's Palette

Indigo to Purple

The indigo-to-purple part of the color wheel is small but significant. The colorants that produce this range are nickel, cobalt, manganese, umber, iron, chromium, rutile ilmenite, copper, iron chromate, and black stains. In short, one could say that the colorants needed include just about the whole group that are used for all the other colors in the spectrum. The only ones I haven't talked about previously in this articles series are umber, ilmenite, iron chromate and black stains.

Black stains Formulated from a variable mixture of other colorants, black stains are usually rather expensive due to their being saturations of colorant materials. Various companies produce black stains usually from a combination of iron, cobalt, chromium, manganese, iron chromate and sometimes nickel mixed with fillers and fluxes such as clay, feldspar and silica. I use the following recipe:

Black Stain

Chromium Oxide	20%
Cobalt Carbonate or Oxide	20
Manganese Dioxide	20
Red Iron Oxide	20
Feldspar (any)	8
Kaolin (any)	8
Flint	4
	100%

This mixture is best ball-milled for a minimum of four hours to limit its tendency toward cobalt specking, and to make sure that the colorants are thoroughly mixed. Because any black stain is a very concentrated mixture, only small amounts are normally needed to cause a strong effect. In a clear glaze, a maximum of 5% should produce an intense black. In opaque glazes, more stain than that may be needed. Black stains and white opacifiers mixed together will produce a range of opaque grays. Stains, like other ceramic materials, are subject to the three variables of glaze makeup, temperature and atmosphere.

Outside the color wheel one finds tones of brown, gray and black. These moderate other colors. A color wheel could, I suppose, include the range of opacifiers since they also have a strong role in affecting color. The toning influence of brown, gray and black is just as much opacifying in result as are the white opacifiers such as tin, titanium and zirconium compounds such as Zircopax, Opax, Superpax, and Ultrox. Slight additional increments of any of these colors will render most glazes, colored or not, progressively darker as they are added.

Note: Colors bars are for visual reference only, and do not represent actual colors.

COLORANT	CONE	ATMOS.	%	COMMENTS
Indigo				
Nickel	Vary	Ox.	8%-15%	Use in high barium/zinc glazes. Also likely to crystallize.
Cobalt + Manganese	Vary	Both	5%-10%	Various mixtures in most glazes.
Cobalt + Black Stain	Vary	Both	5%-8%	Various mixtures in most glazes.
Violet				
Cobalt	Vary	Both	5%-10%	In high magnesium glazes.
Nickel	Vary	Ox.	1%-10%	In some saturated-barium glazes.
Manganese	Vary	Both	5%-10%	In high alkaline glazes.
Copper	Vary	Ox.	8%-10%	In some saturated-barium glazes.
Purple				
Copper	6-10	Both	8%-10%	In high barium and barium/zinc glazes.
Copper	8-10	Red.	1%-5%	In copper red glazes opacified with titanium.
Nickel	Vary	Ox.	5%-10%	In some high barium glazes.
Cobalt	Vary	Both	5%-10%	In high magnesium glazes.
Manganese	04-10	Ox.	5%-10%	In high alkaline and barium glazes.
Iron	8-10	Red.	8%-10%	In high calcium glazes; likely to crystallize.
Copper + Cobalt	Vary	Red.	2%-8%	Various mixtures in many glazes.
Chrome + Tin + Cobalt	Vary	Ox.	2%-8%	Various mixtures in many glazes.
Mauve or Lilac				
Cobalt	Vary	Both	1%-5%	In high magnesium glazes.
Nickel	Vary	Ox.	1%-5%	In some saturated-barium glazes.
Pink				
Cobalt	Vary	Ox.	1%-3%	In high magnesium glazes opacified with tin. Also in very low alumina content glazes.
Copper	Vary	Red.	0.2%-2%	In copper red glazes with titanium.
Copper	6-10	Ox.	0.2%-3%	In high magnesium or high alumina glazes.
Copper	8-10	Red.	5%-10%	In copper red glazes opacified w/min. 5% titanium.
Chromium	Vary	Ox.	1%-2%	In calcium glazes opacified with 5%-10% tin.
Iron	Vary	Ox.	1%-5%	In calcium glazes opacified with tin.
Rutile	Vary	Both	5%-10%	In high calcium and some ash glazes.
Nickel	018-010	Ox.	1%-3%	In high barium glazes with some zinc.
Manganese	Vary	Both	1%-5%	In alkaline glazes opacified with tin or titanium. Also in high alumina glazes.
Brown				
Iron	Vary	Both	3%-10%	In most glazes.
Manganese	Vary	Both	2%-10%	In most glazes.
Nickel	Vary	Both	2%-5%	In high boron, calcium and lead glazes.
Chromium	Vary	Both	2%-5%	In high zinc glazes.
Umber	Vary	Both	2%-10%	In most glazes.
Ilmenite	Vary	Both	2%-10%	In most glazes. High calcium may yield bluish tint.
Rutile	Vary	Both	5%-10%	In most glazes; golden brown.
Gray				
Iron	Vary	Red.	2%-4%	In many glaze bases; gray brown.
Iron Chromate	Vary	Both	2%-5%	In most glaze bases without zinc or tin.
Nickel	Vary	Both	2%-5%	In most glaze bases; gray brown.
Copper	8-10	Both	3%-10%	In high magnesium glazes. Warm gray in reduction; cold gray in oxidation.
Cobalt + Nickel	Vary	Both	1%-5%	Blue gray in most glazes.
Cobalt + Manganese	Vary	Both	1%-5%	Blue gray to purple gray in most glazes.
Black Stain	Vary	Both	1%-5%	Shades of gray in most opacified glazes.
Black				
Iron	Vary	Both	8%-12%	In high calcium glazes—the temmoku range.
Copper	Vary	Both	8%-10%	In a wide range of glazes.
Cobalt	Vary	Both	8%-10%	Blue black in most glazes except those high in zinc and magnesium.
Black Stain	Vary	Both	3%-10%	In most zinc-free, nonopacified glazes.

Primary Function of Common Ceramic Materials in Claybodies and Glazes

CERAMIC MATERIAL	GLAZE FUNCTION	CLAYBODY FUNCTION
Albany Slip clay	Glaze core	Colorant
Ball clay	Alumina Opacity	Plasticity
Barnard clay	Glaze core Color (ST, P)	Color
Bone ash	Opacifier	Melter (4–6)
Borax	Melter (5–6, E) Glassmaker Carbon Trap (ST, P)	Melter (4–6, E)
Boric Acid	Melter (5–6, E) Glassmaker	Melter (4–6, E)
Boron Frits	Glaze core (5–6, E) Melter Colemanite (s) Gerstley Borate (s)	Melter (4–6, E)
Colemanite	Glaze core (5–6, E) Melter Gerstley Borate (s) Boron Frits (s)	Melter (4–6, E)
Cornwall Stone	Glaze core (ST, P) (Low melter, high SiO_2)	Melter (P)
Dolomite	Melter (ST) Opacifier Whiting (s)	Melter (ST)
EPK kaolin	Alumina Opacity (ST, P)	Core (P, W)
Flint (silica)	Glassmaker	Glassmaker Glaze-fit
Fluorspar	Melter	
Gerstley Borate	Glaze core (4–6, E) Melter Colemanite (s) Boron Frits (s)	Melter (4–6, E)
Goldart clay		Core (ST)
Kentucky Stone		Core (ST)

key

(s)=substitute option
(E)=earthenware claybody
(ST)=stoneware claybody
(P)=porcelain claybody
(FL)=flameware claybody, c/9-10
(W)=white-burning claybodies, c/4-10

This chart is excerpted from *Out of the Earth, Into the Fire*, 2nd Edition, by Mimi Obstler, published by The American Ceramic Society, 2000.

Primary Function of Common Ceramic Materials in Claybodies and Glazes

CERAMIC MATERIAL	GLAZE FUNCTION	CLAYBODY FUNCTION
Lepidolite	Lithium glaze core	Melter (FL)
Magnesium Carbonate	Melter (ST, P, W) Opacifier	Melter
Nepheline Syenite	Glaze core (low SiO_2) (high Na_2O) (high Al_2O_3)	Melter (ST, P)
Ocmulgee Red clay	Color (ST)	Color Melter Core (E 4–6)
Petalite	Lithium glaze core (ST 9-10)	Melter (FL)
Potash Spars	Glaze core (ST, P)	Melter (ST, P)
Custer	G-200, K200 (s)	
G-200	Custer, K200 (s)	
K200	Custer, G-200 (s)	
Redart	Color	Melter Color Core (E)
Rotten Stone	Glaze core (ST, P)	Melter Color (ST)
Soda Spars	Glaze core (ST, P)	Melter (ST, P)
Kona F-4	C–6 (s)	
C–6	Kona F-4 (s)	
Spodumene	Lithium glaze core (ST, P)	Melter (FL)
Talc	Melter Opacifier	Melter (E, 4–6, W)
Volcanic ash	Glaze core (ST, P) Cornwall Stone (s)	
Whiting	Melter (ST, P) Opacifier Wollastonite (s) Dolomite (s)	Melter (ST)
Wollastonite	Melter (ST, P) Opacifier Whiting (s) Dolomite (s)	Melter (ST, P)
Wood Ash	Glaze core (ST, P) Melter (ST, P) Colorant	
Zinc	Melter (ST, P) Opacifier (ST, P)