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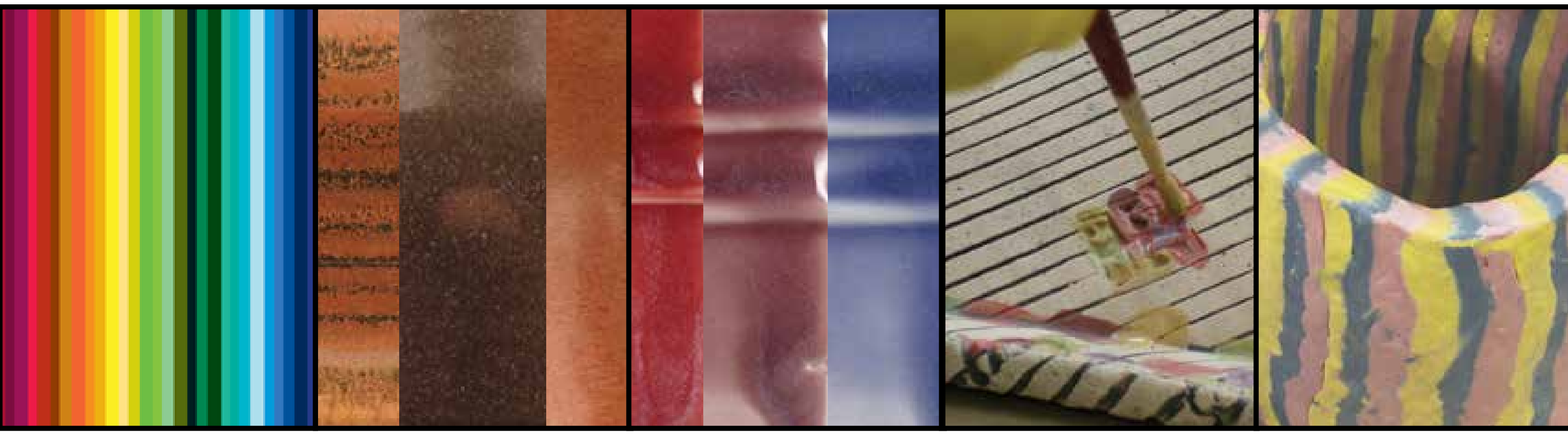
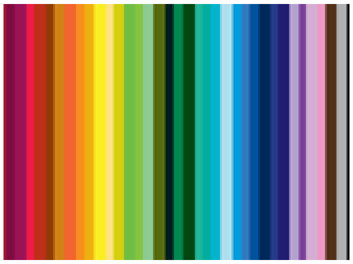
how to add color to your ceramic art



a guide to using ceramic colorants, ceramic stains, and ceramic oxides

How to Add Color to Your Ceramic Art
A Guide to Using Ceramic Colorants, Ceramic Stains and Ceramic Oxides

Adding color to your ceramic art can be a tricky proposition. Unlike working with paints, what you put on your prize pot or sculpture can look very different after firing compared to what they look like before firing. As a general rule, ceramic stains and ceramic pigments look pretty much the same before and after firing while ceramic oxides like iron oxide, cobalt oxide, and copper oxide as well as cobalt carbonate and copper carbonate all look very different. In this guide you'll discover a little help to better understand what, how, and why ceramic colorants work in a glaze. Enjoy!



The World of Ceramic Colorants

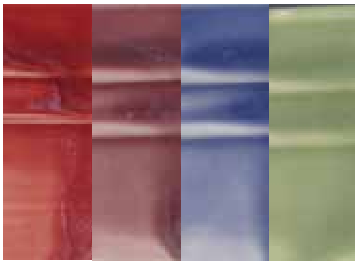
by Robin Hopper

The potter's palette can be just as broad as the painter's because there are so many ceramic colorants and combinations to choose from. By combining ceramic oxides, ceramic stains, and ceramic pigments in various proportions, you can get virtually every color in the spectrum.

The Many Faces of Iron Oxide

by Dr. Carol Marians

Glaze ingredients, the clay body, firing atmosphere, and even kiln-stacking techniques can all affect your firing results. Red iron oxide is one of the ceramic colorants that's quite temperamental and affected by a lot of variables. From dark brown to unusual speckles, red iron oxide can offer a lot for a single ceramic colorant.



Discovering New Glaze Colors with Ceramic Stains

By John Britt

Commercially prepared ceramic pigments, commonly referred to as ceramic stains, expand the potter's palette with infinite color options. Ceramic pigments are easy to use and the simplest way to introduce a wide range of color into your work.

How Lana Wilson Uses Ceramic Pigments

by Annie Chrietzberg

Lana Wilson's work is mostly black and white with bits of vibrant color splashed about. She gets her color from ceramic pigments mixed with a clay slip which she makes from a commercial clay body. She explains how to mix the slip, how much ceramic pigment to add for each color, and how to use the glaze on a finished piece.

Bright Pottery Colors Inside and Out

by John Conrad

One way to create colorful pottery is to use a glaze or colored slip on the surface. But in this fun project, John Conrad shows how to use metallic oxides and ceramic stains to color the clay itself so the color is incorporated into the form. Then he shows a great way to turn a colored block of clay into a wheel thrown pottery bowl.

The World of Ceramic Colorants

by Robin Hopper

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 temperatures are copper, iron, and nickel. The results with nickel are 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.

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.

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

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 Chromium bases: 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.

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

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.

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	
Silica	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.

Excerpted from The Ceramic Spectrum: A Simplified Approach to Glaze and Color Development, *published by The American Ceramic Society.*

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, non-opacified glazes.

The Many Faces of Iron Oxide:

by Dr. Carol Marians

One of the more fascinating, but sometimes frustrating parts of ceramics is learning to balance the innumerable factors that affect the outcome of a firing. Glaze ingredients, the clay body used, firing cycles, atmospheres, kiln-stacking techniques, and geography (to name a few variables) can all affect firing results.

This may be frustrating if you don't control those variables, but if you do, there is opportunity for new discoveries. By changing just one variable, the same glaze recipe can be deliberately manipulated to yield different results. In this instance, I decided to investigate one variable in an iron-rich glaze: the cooling period.

I achieved greatly differing results in a single glaze with a single clay body, consistent glaze thickness and application, and the same heating schedule for all of the firings. The differences in the resulting appearance of the glaze on the pots came exclusively from their heat treatment after they reached maturity.

When the witness cone bends, the glaze should be fully vitrified. The kiln has reached temperature, but has not yet begun to cool. I studied what happens between that point and the return of the kiln's temperature to room temperature. I found that I could get a glossy black surface, a densely textured rough surface, a golden red/mud color, or anything in between, just from different cooling schedules.

How does this happen?

At the top of the firing cycle, the glaze is matured, but not watery; it doesn't flow off the pot. At this point, the glaze is not a homogenous melt, but a mixture of several melts. It is not fully blended. It may contain a dissolved second phase—in our case an iron compound—analogous to sugar dissolved in hot tea. More sugar dissolves in hot tea; less as the tea cools. The sugar precipitates as crystals as the tea cools. Our glaze, when melted, has a dissolved iron compound—the "sugar" in the tea. The iron precipitates as the glaze cools. So how does the iron form in the glaze?

Glaze is more complex and more viscous than tea, inhibiting motion. The iron crystals cannot precipitate and sink to the bottom of the glaze, nor can they grow very large, as the iron ions do not congregate in the same location. Instead, as the glaze cools, the dissolved iron separates out, forming numerous small crystals suspended in the glaze. The number of particles, and their eventual size, is affected by the surface texture of the underlying clay body, the cooling speed of the melt, the thickness of the glaze application, and several other factors. The competition between the number and size of particles as the glaze cools results in the variety of desirable effects (*see accompanying figures*).

As it cools, the glaze becomes progressively more viscous and less

recipe

The glaze used in these tests is a minor modification of the glaze GA16, from Michael Bailey's *Cone 6 Glazes*, poured thick on Georgies Ceramic Supply's G Mix 6 clay body.

GA16 Variation
(Cone 6)

Bone Ash	4.6 %
Dolomite	13.6
Lithium Carbonate	4.6
Red Iron Oxide	9.1
Unispar	22.7
Bentonite	1.8
OM4 Ball Clay	20.9
Silica	22.7
	100.0 %

Empirical Formula

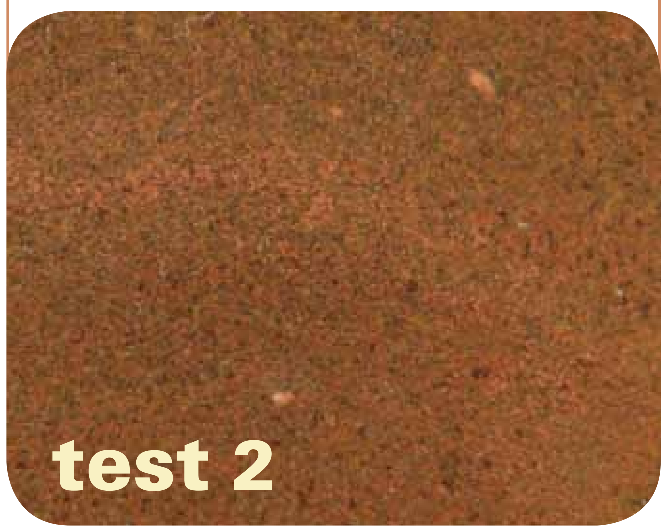
CaO	0.4126
K2O	0.0454
Li2O	0.2013
MgO	0.2521
Na2O	0.0886
Al2O3	0.3424
SiO2	2.7566
P2O5	0.0480
Fe2O3	0.1912
TiO2	0.0104

Cool down: A continuous cool from Cone 6 to 1500°F at –150° per hour.

Results: This is the cool-down profile from Hesselberth and Roy. It gave a predominantly glossy black glaze, not greatly different from the quick cool, but with a hint of variegated color. I could see isolated metallic bronze and red flecks, but no crystals breaking the surface.

Cool down: An uncontrolled drop from 2200°F to 1750°F, then –50° per hour from 1750°F to 1500°F.

Results: The cooling was slower from 2200°F down to 1450°F. Because the solubility of iron in glaze decreases at lower temperatures, I cooled at ⅓ the speed between 1750°F and 1500°F. The result was a substantially textured surface, with much visible variation, and crystals of a variety of colors breaking the surface. The glossy black was gone, and the surface variation uniformly distributed. There were a relatively small number of largish particles. The color was intermixed red, bronze and mud brown. Bronze predominated where the glaze was thickest. I interpreted this as substantial particle growth below 1750°F, with little precipitation of new particles.



mobile, until it reaches a temperature at which it "freezes" and nothing can move or precipitate within it. If the glaze is held at a temperature high enough to permit continued mobility of the iron into progressively larger crystals, but low enough that the glaze doesn't run off the pot, the surface will become matt. The multitude of tiny iron particles disrupt light transmission. Otherwise, the glaze solidifies with the same smooth, glossy surface as it had while fully melted. If the glaze is cooled quickly, few visible, very small particles form. Most of the visible color is the reflection off the smooth surface. This gives an aesthetically pleasing, clear, glossy, black glaze, somewhat akin to a temmoku (*see test 1*). The opacity and depth of the glossy black show that the glaze can dissolve quite a lot of iron.

As the glaze cools and becomes more viscous, crystals begin to form at edges and imperfections in the body. If the glaze layer is thin, different kinds and shapes of crystal will form. If the crystals are stuck to the clay body at the bottom of a thick opaque glaze layer, they will be largely invisible. Crystals that float on top of the glaze give the appearance of sandpaper, which can present utilitarian problems. We want the crystals near the surface but not on it, large enough to create surface and color effects, but not be overwhelming.

A series of cool-down profiles with lots of jigs and jags showcases a different phase, exposing a range of surface effects. This translates into profiles with one or more narrow temperature ranges with extreme slow cooling and/or long holds, and possibly no retarded cooling outside the selected ranges. Since extended firing cycles can be costly, I framed my experiments with a maximum extension to the firing cycle of four hours.

Cool down: An uncontrolled drop to 1750°F, then –50° per hour to 1600°F, a hold at 1600°F for one hour, then –50° per hour to 1500°F.

Results: By adding a one-hour hold at 1600°F, the color shifted from gold/brown to red/gold. The red and brown regions followed the throwing lines, indicating that glaze thickness has significant influence. The strength of this effect showed there is a critical region for this glaze's development somewhere near the temperature 1600°F.

Cool down: An uncontrolled drop to 1750°F, hold at 1750°F for half an hour, then –50° per hour to 1650°F, hold at 1650°F for one hour, then –50° per hour to 1500°F.

Results: Adding a half-hour hold at 1750°F and a one-hour hold at 1650°F gave smaller particles and a near-smooth, lustrous satin, variegated bronze glaze with small specks of red and brown. The original glossy black was completely gone. Color variation in the throwing line showed the considerable effect that glaze thickness has. The half-hour hold at 1750°F facilitated the formation of a large
5 number of small particles, leaving little free iron to add to crystal growth later. This uniform result was much like a pointillist painting, with exceedingly fine points. Moving the hold from 1600°F up to 1650°F could have a similar effect. Alternatively, we could see this change as a result of the glaze spending more time in the critical temperature interval for crystal development.

Cool down: An uncontrolled drop to 1800°F, then –50° per hour to 1450°F.

Results: As the previous test result could have come from extended time in the crystal growing range, or specifically from the hold at 1650°F and 1750°F, I gave this firing just as much time in the sensitive zone, but uniform decrease in temperature over the extended region. The results were similar to the previous test, but with larger grain size and a lizard-skin feel to the texture. The glaze was mottled and less uniform. The smooth satin look was gone. I concluded one of the holds in the previous test hit the "sweet spot," at which point many small particles form. I did not know at which level.

Cool down: An uncontrolled drop to 2000°F, then –50° per hour to 1650°F.

Results: The slow cool from 2000°F to 1650°F gave a surface and color as in test 1, with a much greater number of gold particles. This also shows that the effects of test 4 depended on the 1650°F hold. This critical test showed that the greater color effect I wanted needed two holds.

Cool down: From Cone 6 to 2100°F at –50° per hour, then uncontrolled cooling to 1700°F, then –25° per hour to 1600°F.

Results: To test a second slow-cooling region, the kiln was cooled quickly from the top temperature to 1700°F, then slowly to 1600°F. The result was an intensely variegated effect with relatively few but larger particles in red and brown. The throwing lines were not prominent, so glaze thickness was not as important. The texture is lizard-skin satin, not the gloss of tests 1 and 5, nor the smooth satin of test 4. This result was related, but not quite like anything previous. This could be a jumping off point for a new series of tests.

I started out with the firing profile in Hesselberth and Roy's *Mastering Cone 6 Glazes*. The ramp for reaching temperature was a fast rise (200°F in the first hour, then 500°F per hour to 2100°F) until the last three hours, which had a rise of approximately 30°F per hour. Orton cones showed a hard Cone 6. These firings were done in a very old Skutt 1227 with a computer controller. I examined the results of my firings and based my next firings on those results, only changing one factor with each firing. I chose 1450°F as a low end for controlled cooling, selecting intervals for markedly slow cooling in the temperature range 2200°–1450°F.

Speculation

With this limited series of tests, I produced a variety of textures and colors, by "poking" the cool-down profile. Each firing included several identically glazed test pieces distributed throughout the kiln. I obtained an encouraging indication that the different results were caused by the cooling-down profiles and not extraneous effects. I next will explore whether maximal particle size growth takes place "hotter" than the temperature at which the greatest number of particles is formed. Cooling to approximately 1600°F, then reheating to around 1800°F should obtain both good numbers and development of microcrystals.

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Discovering New Colors

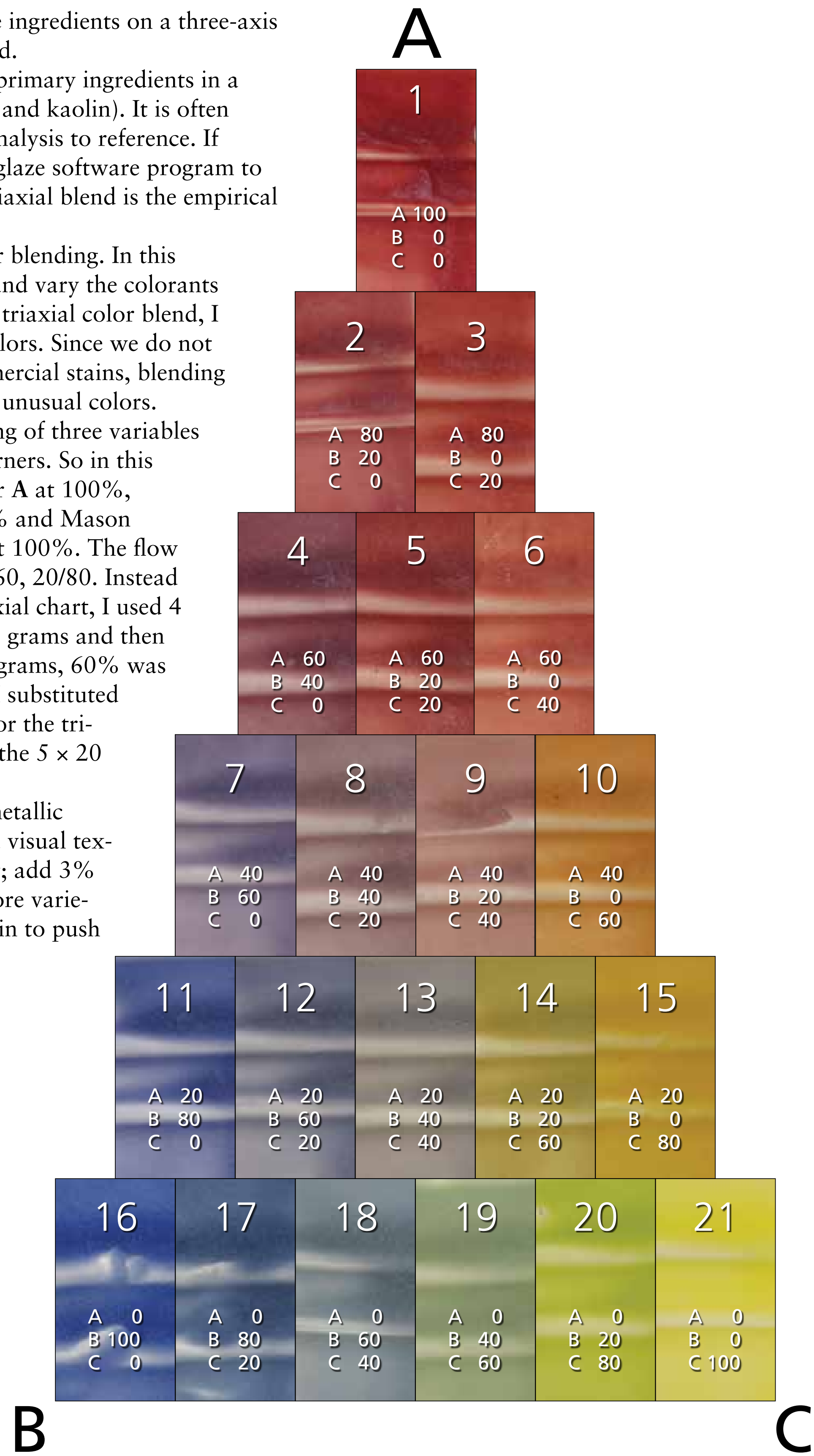
A triaxial blend is a method of testing three ingredients on a three-axis system similar to a two-ingredient line blend.

Often triaxial blends are used to test the primary ingredients in a glaze base, (for example, feldspar, whiting, and kaolin). It is often employed when you don't have a percent analysis to reference. If you have a percent analysis, you can use a glaze software program to predict glaze surfaces, but if you don't, a triaxial blend is the empirical method to see how they melt.

Another use of the triaxial system is color blending. In this method, you keep the base glaze the same and vary the colorants (oxides or stains or even opacifiers). In this triaxial color blend, I tested various stains to develop different colors. Since we do not know the exact amounts of oxides in commercial stains, blending them in a triaxial can reveal surprising and unusual colors.

A 21-point triaxial is a systematic blending of three variables with 100% of each variable at the three corners. So in this case, Mason Deep Crimson #6006 is corner **A** at 100%, Mason Sky Blue #6363 is corner **B** at 100% and Mason Praseodymium Yellow #6433 is corner **C** at 100%. The flow along the vertices is then 80/20, 60/40, 40/60, 20/80. Instead of using the numbers directly from the triaxial chart, I used 4 grams of stain at each corner. So 100% = 4 grams and then I figured out that 80% of 4 grams was 3.4 grams, 60% was 2.4 grams, and 20% was 0.8 grams. Then I substituted those numbers into the triaxial mixtures. For the triaxial glaze chart shown at the right, I used the 5 × 20 Base Glaze as shown below.

For additional testing you can also add metallic oxides to stains to change the colors or add visual textures; add 3% Zircopax to brighten a color; add 3% titanium dioxide to make colors slightly more variegated; add 1% copper carbonate to any stain to push it toward green. The list can go on and on.



5 X 20 BASE GLAZE

Cone 6

Wollastonite	20 %
Custer Feldspar	20
Ferro Frit 3134	20
EPK Kaolin	20
Silica	20
	100 %

21-Point Triaxial Blend Grid: Hansen 5 × 20 Clear Glaze mixed with A–Mason stain Deep Crimson 6006 (Cr, Sn), B–Mason stain Sky Blue 6363 (Co, Al, Si), and C–Mason stain Praseodymium Yellow 6433 (Pr, Zr, Si,) dipped on porcelain, fired to cone 6 in an electric kiln.

How Lana Wilson Uses Ceramic Pigments

by Annie Chrietzberg

Lana Wilson's work is mostly black and white with bits of vibrant color splashed about. She says, "I have a background in painting, and this technique really appeals to the painter in me." She gleaned this current surface treatment from two artists, Denise Smith of Ann Arbor, Michigan, and Claudia Reese, a potter from Texas.

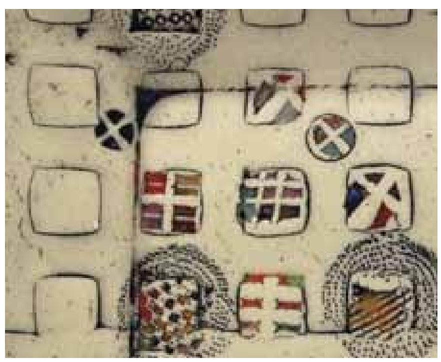
Simple Slip

To prepare the slip, Wilson takes 100 grams of small pieces of bone dry clay and adds 10–50 grams of a stain. The percentages of stains varies according to the intensity of color she is trying to achieve.

The clay Wilson uses is Half & Half from Laguna, formulated for firing at cone 5, though she fires it to cone 6. This clay body is half porcelain and half white stoneware. It's not as white as porcelain, but it does fire white rather than yellow in oxidation, isn't as finicky as porcelain, and works well with Wilson's making methods. If you're buying clay from the East Coast, she suggests a clay body called Little Loafers from Highwater Clays.

Easy Application

The technique is simple. On a piece of bisqueware, first brush on black slip or one of the base colors (*figure 1*) then sponge it off, leaving slip in the crevices (*figure 2*). Then, using colored slips dab on bits of color here and there (*figure 3*). Remove some of that with steel wool (*figure 4*). "I can't use water for this step or it will muddy the colors," Wilson explains. **CAUTION**: You must wear a respirator during this stage. In the final step, she dips the piece in a clear glaze, and fires to cone 6. Through lots of experimenting, and with lots more to go, Wilson finds that ending with a dark color on top works best for her.



Recipes

There are two groups of colored slips. The first group Wilson uses for the base coat that she washes off, leaving color in all the recesses. The accent slips are more intense and removed with steel wool. All stains are Mason stains except for 27496 Persimmon Red, which is from Cerdec. Add the stains and bone dry clay to water and allow to sit for 30–60 minutes so it will mix easier.

Note: Stain-bearing slips applied to surfaces that come into contact with food need to be covered with a food-safe clear glaze.

Base Coat or Wash Colors

6600 Best Black	10 %
6339 Royal Blue	5–10 %
6069 Dark Coral	35 %

Accent Slips

6129 Golden Ambrosia	30 %
6485 Titanium Yellow	20 %
6024 Orange	30 %
6236 Chartreuse	50 %
6027 Tangerine	15 %
6211 Pea Green	50 %
6288 Turquoise	50 %
6242 Bermuda	10 %
6069 Dark Coral	35 %
6122 Cedar	25 %
6304 Violet	60 %
K5997 Cherry Red*	30 %
27496 Persimmon Red (Cerdec)*	30 %

* inclusion pigments

Kate the Younger Clear Glaze

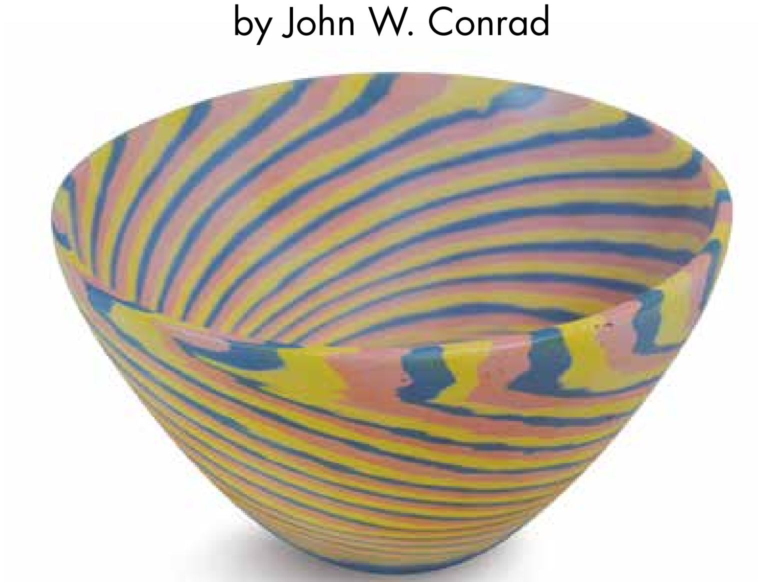
Cone 6

Ferro Frit 3195	70 %
EPK Kaolin	8
Wollastonite	10
Silica	12
	100 %
Add: Bentonite	2 %

From Richard Burkett. Use over colored slips. Shiny, resistant to crazing, cool slowly.

Bright Pottery Colors Inside and Out

by John W. Conrad



The finished bowl looks good both burnished and fired without a glaze for a decorative piece, or coated with a transparent glaze and fired for a more kitchen-friendly finish.

One way to have a striped surface pattern that carries through from the inside to the outside of a form is to work with colored clays. Open shapes ranging from plates to bowl forms show the pattern best.

Preparing a Colored Clay Block

To make this striped form, mix two to three or more balls of smooth white clay with metallic oxides or ceramic stains. As a starting guide for adding color, use one tablespoon of stain to a pound of clay (always wear gloves when working with stains or oxides). The easiest way to mix in the colorant is to put a depression in the ball of clay, pour in a tablespoon of water, sprinkle in the colorant, add water as needed, and mix completely to eliminate any lumps. Wedge the wet colorant into the clay until there are no streaks and the color looks uniform. Store the colored clay balls in a plastic bag for a few hours to allow moisture to distribute evenly.

The next step is to make a colored clay block using alternating colors. Roll out each ball of clay into a ¼–⅜-inch-thick rectangular slab (*figure 1*). For this piece, I've made the slab 12×4 inches. Brush the surface with water where the slabs will overlap, then lay one colored slab flat on top of the other. Lightly roll the slab to smooth out the surface and squeeze out any trapped air. Next, wet and place the third slab on top, then slightly roll it to smooth.

Three balls of colored clay rolled into ¼-inch thick slabs and cut to rectangles.

Place wetted slabs on top of each other, cut in half, and repeat a few times.

A wire cutter and thickness strips are used to cut the slabs.

After creating a cylinder from the slabs, cut the base out of contrasting colored clay slab.

Join the base to the cylinder, secure it to the wheelhead, and use light pressure to throw into a bowl shape.

After throwing, scrape down the exterior of the form with a metal rib or fettling knife to reveal the pattern.

Now that all three colors are layered, cut the slab in half, wet the top surface of one and the bottom of the other, and attach the two using the same process. Repeat the process of cutting the slab in half, wetting, and stacking the pieces, forming a striped block (*figure 2*). Cover it with plastic and allow it to rest and equalize in moisture content overnight.

Set the aged block stripe-side-up on canvas between two thickness strips that are between ¼–⅜ inch thick. Using a cut-off-wire, press the wire against the thickness guides and slice the block (*figure 3*). Continue this process until all the strips are cut into thin, identically striped slabs. You'll use these to create a slab with a repeating pattern that you can form into a cylinder.

Forming the Cylinder

Wet the edges of each striped slab and join them together into a long rectangle. Roll over the slab lightly using a rolling pin to even out the join. When finished, curve the slab into a cylinder shape and join the two ends. Measure the diameter, and cut a disc out of contrasting clay to form the bottom of the cylinder. Be sure that the slab is the same thickness as the cylinder wall (*figure 4*). Score the cylinder and the disc, then join the two. Allow the form to rest under plastic for a few hours.

Throwing the Bowl

Place the cylinder on the potter's wheel, center it, and place clay lugs around the edge to keep the cylinder secured. Thin and shape the cylinder as you would any thrown bowl. Using light pressure from your inside and outside hands, shape the cylinder by pressing it out as you pull up, until you create the desired bowl form (*figure 5*). Keeping the pressure light prevents the strips from coming apart.

The rotation of the wheel and your hand's pressure cause the vertical strips to twist around the bowl form, making an attractive spiral design. When finished, allow the bowl to dry to leather hard, then trim the inside and outside surfaces to remove the muddy colored slip that obscures the pattern (*figure 6*). Follow this with a metal scraper and a kitchen scouring pad to completely clean the surface so the pattern is crisp.

Finishing

At this point you have a few options. You can burnish the surface and fire the piece to temperature without a glaze, or you can bisque fire the piece, sand it further if needed to smooth it out, wash it to remove dust, then apply a transparent glaze and fire it to the appropriate cone for your clay and glaze. Applying a glaze will make the bowl food safe.

Tip: Some metallic oxides and stains are refractory, non-plastic, and variable in particle size. These factors can make the colored clay more of a challenge to work with. These qualities mean you'll need patience when throwing the form to prevent the strips from coming apart.

Another interesting challenge with this technique is to shape a tall, hollow form like this into a vase, which results in an interesting stripe pattern that goes around the vase several times. It's a challenge, but worth the effort.

John W. Conrad writes technical ceramics books and articles for pottery magazines. He is a retired ceramics professor and now a guest professor at Luxun Academy in China. He lives in San Diego, California, where he also maintains his studio. To see more of his work, visit johnconradceramics.net. For questions or comments, please contact John at johnconradceramics@gmail.com.