

successful tips for buying and using pottery clay



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estimate your clay needs,
and test clays for better results

Successful Tips for Buying and Using Pottery Clay

How to select the right clay, estimate your clay needs, and test clays for better results

Buying the right pottery clay is one of the keys to your success in the studio. There are many variables that determine the right pottery clay for your needs including color, temperature range, the type of pottery you make, and what kind of forming methods you use, just to name a few. When someone offers you a bunch of free clay, watch out! Most of the value in a piece of pottery is in the time and effort you invest, and the clay is one of the least expensive elements.

Selecting a Clay Body by Bill Jones

Most potters use commercially-prepared clays, and ceramic suppliers and clay manufacturers want to make sure you're getting the clay you need. Here's a checklist for selecting the right pottery clay for you whether it's earthenware, stoneware or porcelain.



Buying Porcelain by Antoinette Badenhorst

The lure of porcelain can be so irresistible! Working with a pottery clay that's smooth, white, and translucent certainly has its appeal, but at what cost? Working with porcelain takes a bit of a change in how you work, what you make, and what your skill level is. Check out what it may take for you to switch—porcelain may be just the thing!



Cooking with Ovenware Clay by Jonathan Kaplan

Wouldn't you love to show off your work by baking a favorite dish in it? Clay has been used in the oven for centuries, but there are a few limitations when it comes to using just any pottery clay. Find out some of the characteristics you need to consider before you use your work in the oven, then *bon appetite!*



How Much Clay Do You Need? by Robin Hopper

For potters it's hard to visualize just how much clay you need to last a month or three months or six months. But if you know that you can get 50 coffee mugs from a 50 lb. box of clay, you at least have an idea of what you'll need before you order again. If you make a chart like Robin Hopper's, you'll be able to judge your clay supply with no problem.

How to Wedge Pottery Clay by Michael Wendt

No potter really likes to wedge, but it's a necessary step in getting clay uniform for throwing or handbuilding. While spiral wedging is widely practiced, over time it's hard on the hands and wrists. With this stack and slam method of wedging, you can blend colors, textures, and moisture levels into a smooth blend in just minutes without pain.



Clay Mixers and Pug Mills by Bill Jones

If you use a lot of clay, maybe a clay mixer or a pug mill is for you. These versatile machines take a lot of the work out of mixing your own pottery clay, reclaiming scraps, and preparing clay for throwing and handbuilding. Here's a look at what's available and the different types of machines you can choose from.

Understanding Pottery Clay by Paul A. Wandless

Pottery clay bodies have the potential to be really versatile. The more we know about a clay body, the more we can understand its limits—how high will it fire, how low can it go, what happens to the color? You may just find that you have a whole lot of choices with your clay that you just didn't know about. Here's how to test your clay body.



Glossary by Vince Pitelka

You'll find the glossary helpful when deciphering the unique language of clay.

Selecting a Clay

by Bill Jones

Most potters use commercially prepared clay, and ceramic suppliers have met their needs by offering a vast, though sometimes bewildering, selection of clay bodies to choose from. If you're using the clay someone else just handed you, maybe it's not the right one for the work you're doing. Every clay body is formulated for a specific use, and finding the right one for your needs takes a bit of research and experimentation. There are several decisions to make when finding a clay body or bodies that meet your skill level, techniques, and aesthetic.

Choosing a Clay Supplier

Now why would you choose a supplier first? They work with amateurs, professionals, students, teachers, sculptors, tile makers, etc., and have solved a wide variety of problems. There are three types of suppliers: those that manufacture their own clay bodies, those that sell clay from other manufacturers, and those that do both. And, if you have problems a supplier can't answer, either you or the supplier can contact the manufacturer.

Handbuilding or Throwing?

Clay bodies are formulated for different applications. Throwing tableware requires a clay body that is plastic (malleable) and smooth, while constructing a large sculpture may require "toothier" (coarse-grained) clay. In many cases, a clay body may be used for several applications, but some are highly specialized—raku or ovenware, for example. Make a list of the things you want to do, and you may end up with several bodies to achieve the best results.

Firing Stoneware, Earthenware, and Porcelain

Clay bodies are formulated to fire at specific temperatures within three general ranges: low-fire (cone 06–2), mid-range (cone 3–7) and high-fire (cone 8–10). Within a range, the higher you fire, the greater the shrinkage and the lower the absorbency of the fired clay. Low-fire clay bodies, such as earthenware, are easy to work with and fire, and there is a wide range of colorful glazes available. These clay bodies are also used for raku and pit firing. Mid-range clays are more durable and include stoneware and some porcelain bodies, but color is more limited. This situation improves each year as glaze companies improve and expand their offerings. High-fire clays are very durable and include stoneware and porcelain. Color palettes vary depending on firing atmosphere (oxidation or reduction).

Choosing a Clay Body Color

Color in basic studio clay bodies results mostly from naturally occurring iron and/or iron that has been added. Por-

celain contains no iron, light buff bodies have some iron, and earthenware bodies may have over 10% iron. The body color (as well as the glazes) changes based on the type of firing atmosphere you have—reduction (from fuel firing) or oxidation. Reduction firing deepens or darkens an otherwise neutral-colored clay body. Some clay companies have duplicated this effect by adding more colorants to their formulas making it possible to achieve "reduction" colors from an electric kiln. Since the iron and other colorants in a body color affect glaze color, you'll need to test your glazes with each body.

How Much Tooth?

Texture can range from smooth to rough. Smooth bodies contain very small particles of clay, which tend to shrink more. These are best suited for small, fine, and/or detailed work. Adding grog (ground-up fired clay) or sand gives the body "tooth," and the larger the particle size, the less water the piece will need (hence less shrinkage). Manufacturers offer a range of bodies that incorporate finer particles of grog and sand to get a texture between smooth and rough.

Buy What You Need

Buying prepared clay requires a little judgment. First, try to find a supplier that is nearby because shipping costs can add up and sometimes equal or exceed the cost of the clay body itself. Next, test a sample before purchasing a large quantity. If you're buying several types of clay bodies, suppliers will typically allow you to combine the weights for a better discount. Finally, buy only enough clay to last you a year maximum. Clay loses moisture in storage and becomes stiffer, possibly even unworkable. You can ask your supplier how long they have stored the clay. A good supplier will only stock what they can sell within a reasonable amount of time.

Mother Nature vs Clay

All commercially-prepared clay bodies are made from naturally occurring elements scooped from the earth for industrial users. Studio potters do not purchase enough materials to be a major user, so we have to make do with a small portion of what the industry uses (brick and tile manufacturers, china companies, steel industry, paper mills, pharmaceuticals, etc.). Mother Nature did not use any quality control when she created clay deposits, so veins of clay vary from one spot to another. And a mammoth front loader is not a delicate material-selection tool. The good news is that the industry often requires a degree of consistency in their raw materials, so that clay mines make every effort possible to provide them with the very best product out there for an intended application. To make sure your clay meets your every needs and your own quality standards, always test each batch everytime.

Buying Porcelain

by Antoinette Badenhorst



Before making a large investment in porcelain, test several bodies to see which one best suits your needs.

If you've only worked with red, brown or buff clay in the past and you're looking for a change, maybe porcelain is the right clay for you. Planning, research, and evaluation are the best ways to assure any future success in making a switch from one clay body to another.

To determine if porcelain is what you're looking for, you'll need to evaluate where you want to go with your clay work, your skill level, and your vision as a potter. Decide if you're happy with your current work, and if so, consider the effect that work will have if made with a white or porcelain clay body. Not all works in clay maximize the qualities that porcelain has to offer, so if you have to change your work in order to use porcelain, evaluate whether that's something you want to do.

In my own experience, I had a vision of pots dancing

like ballerinas—soft figurines moving around in bright colors against pure white backdrops. I also envisioned translucent light and instantly knew what to do, but it took some time to find the right porcelain and to develop a body of work.

Studio Setup and Working Methods

Do you have the right studio setup for porcelain and are you able to adjust your current workplace with ease? Can you work with precision and in a clean studio? Do you work with other clay bodies that might contaminate porcelain, or are there other potters working with you that might not respect a porcelain work station? Which techniques do you use most? For instance, if you work mostly with an extruder with a steel chamber and plunger, you'll

need to replace it with a stainless steel or aluminum one to avoid possible rust contamination.

Skill Level

It's important to know your own abilities and skill level. If you're a beginner who wants to throw 20-inch pots, you'll have a lot of difficulty achieving your goals and there will be a whole lot of frustration, time, and money wasted before you can reach them. In such a case, it's better to use white stoneware clay and gradually work your way first through a semi-porcelain body and then eventually use pure porcelain as your skills improve.

Different Porcelains

If you want to become a porcelain production potter, you'll look at a different clay body than someone who wants to make one-of-a-kind porcelain pieces, porcelain sculptures or strictly handbuilt forms. Your working methods will differ dramatically from theirs. Maybe you need a clay body that combines some or all of the above mentioned clay techniques.

Once you decide that you want to take on the challenges that porcelain offer, you'll have to find the clay that suits your newly set goals. There are many different porcelain clay bodies available on the market.

I tested several commercially available cone 6 porcelain bodies and suggest you do the same before settling on one. Each clay had some special characteristic that I could use for my own work and could see used by anyone else. Commercial porcelain clay bodies meet almost all the needs of the potter, and there are some excellent throwing, handbuilding, and sculpture bodies available. The producers and suppliers know which one best suits each purpose, and they are an excellent resource when you are trying to figure out what you need.

They develop some bodies to be more plastic and stretchable, but less white and translucent. These bodies can go further in height and thinner in walls than some others that might be pure white and translucent, but may be a little harder to throw.

If you choose to work with pure white, translucent clay, you can always throw thicker and trim thin afterward. If

you need an all translucent, white, and a non-warping clay body, it might cost a little more, but your ceramic supplier can recommend the right clay body for your purposes.

Amazingly, you will even find that some of the semi-porcelaneous clay bodies meet all the characteristics of porcelain and have the added green strength that is often missing in true porcelains. Add these qualities to the fact that you can save energy because many of the commercial clays are formulated for firing at cone 6 electric, and there are very few restrictions left that would limit you from working with this material.

Test several clay bodies for their ability to throw, trim, and to keep their shape when stretched beyond their limits. Also test them to see how they stand up to adjustments and attachments, then fire them to the proper cone in an electric kiln. Check them to see if shrinkage can cause problems. Compare the tests for shrinkage, color, and translucency.

Transition Carefully

It's always best to start by buying one bag of clay and testing it thoroughly. Then, even when you think you're satisfied with your choice, make the transition to your new style and clay body slowly and carefully. Porcelain is expensive but if you take a conservative approach, and do

enough testing to make an informed decision, it will pay to make an investment in a large batch of clay.

I've seen porcelain clay bodies improve from one batch to another. Clay companies are constantly doing research to improve their clays. If you consult your clay company, they'll know what to recommend to you only if you understand your own needs and what you want. To

us, as potters, that's good news, because it means that if we admire a specific clay body today, but it's not working for our circumstances, it's worth discussing that with our clay producer and retesting a body again to see if it has changed. Maybe your skills improve, perhaps the clay composition improves, or maybe you and that specific clay body simply get in sync with each other.

Read the literature available online, then talk to a sales representative and they'll be able to recommend the right clay body for your needs.

Once you decide that you want to take on the challenges that porcelain offers, you'll have to find the clay that suits your newly set goals. There are many different porcelain clay bodies available on the market.

Cooking with Ovenware Clay

by Jonathan Kaplan



This baking dish, by Columbus, Ohio artist Lisa Bare Culp, works well in the oven due to its low-profile, flat-bottomed design. The cheesy potato casserole was made by the Ceramic Arts Daily editor's husband, and it was delicious.

Ovenware can be defined as ceramic pieces that can be used in the oven to cook food. While most high-fired clay bodies can generally be used in the oven, there are some important considerations you should understand before you attempt baking with pots you've made for the family feast.

Thermal Shock

If any clay body is subjected to quick heating or quick cooling, the body may crack or fail due to thermal shock. When selecting a clay body for ovenware, whether purchased from a supplier or mixed in your studio, avoid those with a high silica content. Many ball clays are high in silica and therefore prone to thermal shock, so low temperature clay bodies that are primarily ball clay should not be used as ovenware. Clay bodies that contain pyrophyllite, fire clays, and lithium feldspars, such as spodumene or petalite, are better suited for ovenware use. Lithium materials and pyrophyllite are low-expansion materials and can help provide the benefits of lowering the expansion of the clay body. So in general, if your clay body is compounded with fireclay, stoneware clay, a small percentage of ball clay, some silica, some lithium feldspars, and pyrophyllite, it may be a good candidate for use in the oven.

Both the clay body and the glaze should have a low expansion so that the heating and cooling have less impact on them. Note: Do not confuse ovenware with flameware, which is comprised of a clay body that can be used in direct contact with a heat source such as a gas or electric stove-top burner.

Designing for Ovenware Clay

The design of ware for oven use is also important. A small foot ring may be unstable on an oven rack, whereas flat bottoms provide stability. Delicate knobs, handles or other protrusions may also not fare well. Low profile items may heat more uniformly than tall ware. Also, avoid sharp angles between the bottom, sides, and corners. The more simple the design of the piece, the greater the chance it can be used successfully as ovenware.

Using Ovenware

Studio potters do not have access to the technology and equipment necessary to create ovenware that rivals commercial pieces such as Corningware. It is important not to subject any clay body to quick heating or quick cooling as it puts undue stress on the body and glaze and may cause the ware to fail. As a precaution, users of handmade ovenware should never take it directly from the freezer to the oven, never place it in a preheated oven, and should fill the piece so food contacts all interior surfaces.

Buying Ovenware Clay

Your clay supplier can be very helpful in providing general information as to the composition of their premixed clay bodies and will be able to provide you with recommendations based on their testing and customer experience. If you are making work primarily for food use, storage, and cooking, it is advisable to make a few small pieces out of the clay body you wish to use, glaze them, and then test them in an oven before committing to a larger production of work.

How Much Clay Do You Need?

by Robin Hopper

If you're doing repetitive throwing or production work, keep a chart of weights and measures showing the amount of clay needed and size of objects at the throwing stage. Here is a list of weights and measures of standard items produced in my studio. These are for an average throwing thickness of $\frac{3}{16}$ in. for smaller objects, and $\frac{3}{8}$ in. for larger objects. Adjust accordingly if throwing thinner or thicker.

Excerpted from Functional Pottery by Robin Hopper and published by The American Ceramic Society.

Weights and Measures for Basic Production Items

ITEM	WEIGHT		HEIGHT		WIDTH	
	Grams	lb./oz.	inches	cm	inches	cm
Drinking vessels						
6 oz. coffee mug	275	10 oz.	3	7.5	3	7.5
8 oz. coffee mug	400	14 oz.	5	12.5	3	7.5
14 oz. beer mug	600	1 lb. 5 oz.	7	17.5	3.5	8.5
chalice (cup only)	500	1 lb. 2 oz.	4	10.0	4	10.0
goblet (cup only)	340	12 oz.	5	12.5	3	7.5
cup	300	11 oz.	2.75	7.0	3.75	9.5
saucer	350	13 oz.	1	2.5	5.5	13.5
large dinner plate	1800	4 lb.	1.25	3.0	11.5	29.0
medium dinner plate	1350	3 lb.	1	2.5	10	25.0
side plate	1000	2 lb. 3 oz.	1	2.5	8	20.0
bread and butter	600	1 lb. 5 oz.	.75	2.0	6.5	16.0
glutton plate	2300	5 lb. 2 oz.	1.25	3.0	14	35.0
Bowls						
large	2600	5 lb. 12 oz.	6	15.0	12	30.0
medium	1800	4 lb.	4.5	11.0	10	25.0
small	600	1 lb. 6 oz.	3	7.5	6	15.0
onion soup	600	1 lb. 5 oz.	3	7.5	6	15.0
large mixing bowl	1800	4 lb.	4.5	11	10	25.0
Casseroles						
4 quart	2600	5 lb. 12 oz.	8	20	12	30.0
lid	1600	3 lb. 8 oz.	-	-	-	-
2 quart	1800	4 lb.	4.5	11	8.5	21.0
lid	1000	2 lb. 3 oz.	-	-	-	-
1 quart	1000	2 lb. 3 oz.	4	10	6.5	16.0
lid	750	1 lb. 12 oz.	-	-	-	-
individual	600	1 lb. 6 oz.	3	7.5	5.5	13.5
lid	450	16 oz.	-	-	-	-
Pots for pouring						
cream pitcher	400	14 oz.	5	12.5	3	7.5
1 pint pitcher	675	1 lb. 8 oz.	6.5	16.5	4	10.0
4 pint pitcher	2600	5 lb. 12 oz.	14	35	6	15.0
coffee pot	1800	4 lb.	11	27.5	4.5	11.0
lid	400	14 oz.	-	-	-	-
large teapot	2000	4 lb. 6 oz.	8	20	8	20.0
lid	250	9 oz.	-	-	-	-
medium teapot	1500	3 lb. 6 oz.	6	15	6	15.0
lid	200	7 oz.	-	-	-	-
small teapot	1000	2 lb. 3 oz.	4.5	11	5	12.5
lid	150	5 oz.	-	-	-	-
1 liter decanter	2000	4 lb. 6 oz.	12	30	6	20.0
small decanter	1200	2 lb. 11 oz.	8	20	5	12.5
liqueur or sake bottle	1000	2 lb. 3 oz.	-	-	-	-
Storage containers						
large storage jar	2250	5 lb.	12	30	5	12.5
medium storage jar	1500	3 lb. 6 oz.	10	25	4	10.0
small storage jar	800	1 lb. 12 oz.	7	17.5	3	7.5
jam or honey pot	450	16 oz.	3.5	8.5	4	10.0
Serving dishes						
large cooking/serving	2500	5 lb. 8 oz.	3.5	8.5	15	37.5
small cooking/serving	1350	3 lb.	2.25	6	10	25.0
cheese bell	2000	4 lb. 6 oz.	6	15	10	25.0
base	1500	3 lb. 6 oz.	-	-	-	-
butter dish	600	1 lb. 5 oz.	3	7.5	5.5	13.5
base	600	1 lb. 5 oz.	-	-	-	-
salt and pepper shakers	400	14 oz.	4.5	11	3	7.5
egg bakers	400	14 oz.	1.25	3	3.5	8.5

How to Wedge Pottery Clay

by Michael Wendt

Stack-and-slam wire wedging is a method for wedging that is quick, effective, versatile, and easier on the hands and wrists than any other type of manual wedging. This method allows you to uniformly wedge very large pieces of clay for large pots. You also can add water (or softer clay) to pieces of clay that have become too stiff, or even mix clays with different characteristics such as stoneware and porcelain. In addition, this method offers a superior way to get perfectly flat slabs for tile work or handbuilding.

To illustrate this method, I took two 3-pound balls of clay of different colors and spiral wedged them for two minutes. I sliced through the ball to see how

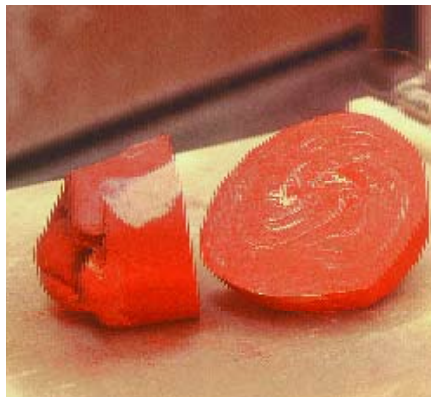
uniform the mixing had become. After two minutes of spiral wedging, there were still pockets of red and white clay in the pink mixture that had not been completely dispersed. I repeated the exercise with two more balls of different colored clays using the stack-and-slam wire-wedging technique. The bottom photos show the remarkable change that took place.

Stack and Slam

Choose a comfortable amount of clay for the first attempt. I seldom wedge less than 3 pounds because it is too slow to wedge each piece one at a time. I prefer to wedge enough clay for several pots at one



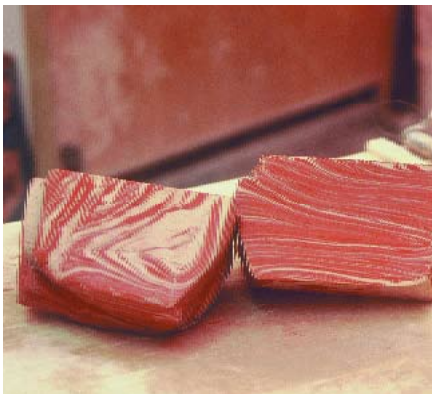
Two 3 pound lumps of clay.



Clay after spiral wedging for 2 minutes.

Tip

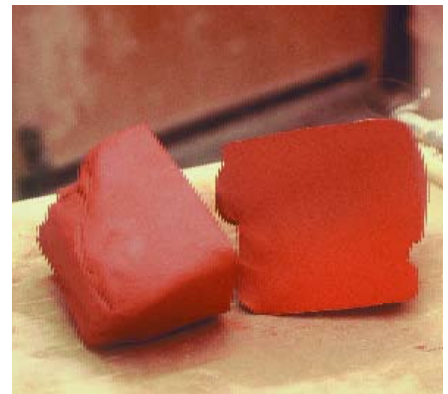
Do not wedge more clay than you can use in a throwing session since clay loses uniformity in storage and requires wedging again if it's stored for very long. Always wrap wedged pieces immediately to avoid the inevitable hardening that happens if they are exposed to air for very long.



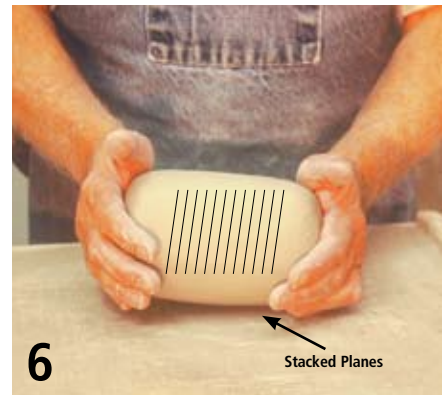
Stack-and-slam wedge 10 times:
1,024 layers.



Stack-and-slam wedge 20 times:
1,048,576 layers.



Stack-and-slam wedge 30 times:
1,073,741,824 layers.



time because, with this stack-and-slam wire-wedging technique, it is just as easy to wedge a large amount as it is to wedge a small amount.

First, block the clay into a rough rectangular shape (*figure 1*). Next, you will lift the piece by the sides and cut it roughly in half (*figure 2*) passing the left arm under the wire as you place the two pieces back onto the wedging table (*figure 3*). Make sure the cut is parallel to the front edge of the table.

Take the piece closest to the table edge and carefully place on top of the other piece (*figure 4*). Be sure not to make any dimples in either of the mating surfaces.

Roll the joined pieces toward you, flipping them over so the bottom is now on top. Pick up the clay and slam it down with enough force that it ends up bringing the original thickness you started with (*figure 5*).

Repeat steps 1–3 at least 30 times. This will give you over a billion layers of clay particles! It is very critical that you pay attention to the lamination pat-

tern since the final goal is to layer the clay rather than cross the layers with each other.

Once you have completed the required number of cycles, place your left hand on the top of the piece and roll it to the left onto its side. Now your right hand can be placed on the area that was the bottom on the table surface. The goal is to keep track of these two surfaces while converting the block into a cylinder by repeatedly tapping it onto the table surface and finally rolling it round (*figure 6*).

Taking this extra step assures you can keep track of the laminated face. I have found that orienting the laminations parallel to the wheel head minimizes cracks on the bottom of all of my pieces, and that selecting the smoothest end for the top further reduces losses.

Changing Softness of Clay

Sometimes clay is too hard for our liking. Water can easily be added with wire wedging resulting

in the right feel every time. Slice the block first into thin sheets. Spread them onto the table surface and spray with water. Restack and wedge as previously explained or mix some softer clay with the harder clay. This lets you reclaim pots that have failed rather than drying them out and reusing them later. If some of your pugs are too hard and others are too soft, weigh out different proportions of stiff and soft clay. Record the amounts so that you can gauge how much needs to be added the next time.

Conclusion

If you're already happy with the results from your current wedging or pugging, there's no reason to change. But if you're struggling with uneven clay and would like a method that gives you more control, try wire wedging. It can create some troubles if done improperly—most notably, the introduction of air pockets due to poor joining surface quality—but this is easy to diagnose and cure. I have used this method for over thirty years and have no wrist or hand problems.

Constructing a Better Wedging Table

Wedging Table tips

Tables suitable for stack-and-slam wire wedging must be solid with a fairly thick top to reduce noise. My table is made with two sheets of $\frac{3}{4}$ -inch plywood featuring support legs directly under the area where the clay hits. It is bolted to the floor to prevent any kind of rebound or side movement. The height from your elbow to the top of the table should be no more than 4–6 inches when you are standing straight. Higher and you may bang your arms into the front edge of the table; lower and you have to reach down too far. Use heavy canvas for the top because clay barely sticks to it and replacement is easy. Periodically spraying the surface with water keeps the dust down and assures the layers will bond to each other better.

Wire and Frame

If your table is against a wall, it is easy to screw a hook into a stud or a concrete anchor to attach the top end of the wire. If the table is free standing, you'll need to weld a steel frame out of 1×1-inch angle iron



If you do not have a wall stud to anchor the wire, you'll need to weld an angle-iron bracket to the table.

and screw it to the table. I added a counter to keep track of the number of times I cut and slam the clay. Guitar strings make good wires because they are very thin, strong, inexpensive and last a long time. Attach the wire to a turnbuckle, which will allow you to periodically tighten the wire as it loosens with use. Always keep spare wires on hand.

Clay Mixers and Pug Mills

by Bill Jones

In all studios, potters are faced with the dilemma of recycling scrap clay, and in many studio situations, it's essential to be able to mix custom clay bodies. Additionally, some studios require clay that is ready to use without any additional wedging, either because of time constraints or concern for wear and tear on the wrists. With the right machine, you can easily deal with scrap clay and mix custom clay bodies when they're needed.

Types of Machines

There are four common types of clay processors on the market: the horizontal-shaft hopper mixer, the vertical-axis rotating-drum Soldner mixer, the pugmill, and the combination mixer/pugmill.

Hopper Mixer

This type of machine is simply an adaptation of the traditional commercial dough mixer and consists of an open or lidded hopper with a horizontal mixing shaft. In a hopper-type mixer, it's normal to add dry materials first, unless you're reclaiming scrap. Some hopper mixers are equipped with a reversing switch to allow you to reverse the direction of the blades several times to ensure complete mixing. When reclaiming scrap, clay should be in a slurry-like mix, meaning it should be slaked first



An example of a horizontal mixer. The hopper on this model from Bluebird Mfg. tilts forward to aid in emptying the machine once the batch has been mixed. (Photo courtesy Bluebird Mfg.)

(dried then soaked in water). Recycled clay may require adding more dry mix until the correct consistency is reached. Mixed clay is removed from the hopper by hand.

Soldner Mixer

Named after its designer, Paul Soldner, this mixer consists of a chain-driven rotating reinforced concrete tub with stationary interior bars that mix and blend the clay quickly and effectively. The Soldner mixer works best when the water is added first. After dry materials are added, the mixture is rotated through stationary bars that chop and blend the clay until the desired consistency is reached. Many studios use the mixer as a slurry bucket. When the tub is half full, they turn it on, let it run for a while and then add dry clay mixture to it. When the mixing is complete, the mixer is unloaded by hand and stored.



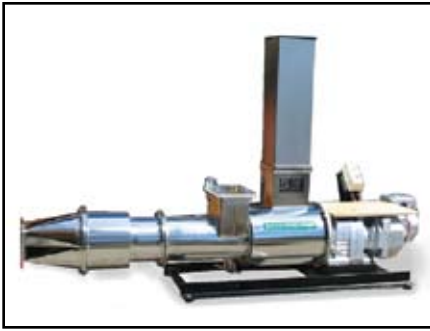
The Soldner mixer is an example of a vertical shaft mixer. This mixer uses a concrete tub that carries clay through stationary bars that blend the clay as it moves through. (Photo courtesy Muddy Elbow Mfg.)

Pugmills

The simplest common analogy for a pugmill is an oversized meat grinder. Moist clay is fed into a hopper, forced through a horizontal barrel by a series of rotating blades, and, after blending, is finally extruded from a restricted opening at the end of the barrel. A pugmill equipped with a de-airing vacuum attachment can produce clay that is ready to throw without any further wedging. The pugmill is best suited



Pugmills blend and homogenize clays. A de-airing vacuum pump removes air from the clay, which in most cases eliminates the need for further wedging. (Photo courtesy Axner Pottery)



Pugmills are manufactured in many sizes up to large industrial models. Most manufacturers produce a range of sizes suitable for a variety of studios. (Photo courtesy Venco Products)

for final blending of clay bodies, for processing clay mixed as slurry and stiffened, to plastic consistency, and for processing slaked, stiffened and reclaimed clay. It can also be used for blending several clay bodies together, and is especially useful for adjusting the moisture content in clay.

Mixer/Pugmills



Some mixer/pugmills operate in each mode independently, and many models have optional de-airing available for ready-to-use clay. (Photo courtesy Bailey Pottery Equipment)

As the name implies, the mixer/pugmill provides the features of two machines. Consisting of a hopper for blending dry materials or reclaim feeding into a pugmill, these machines are an alternative to buying two separate machines. Within this group of machines, the pugmill portion can serve in one of two ways—as a discharge unit for the mixer or as a separate, fully functioning pugmill. In the former case, clay constantly moves through the machine and has to be returned to the mixer after being extruded. In the latter type, a switch controls separate mix-

ing and pugging actions.

Buying Considerations

Clay mixers and pugmills are great machines designed to help potters in a variety of settings.

Among the major manufacturers, there are literally scores of options available, so you would be wise to do some homework before you charge ahead.

Function

What do you need? If all you want to do is mix your own clay, you need a mixer at a minimum. If you want a mixer that empties itself, go for the mixer/pugmill or a mixer with a tilting hopper. If you need clay that's ready to throw without any further wedging, you'll need a de-airing pugmill either as a stand alone machine or as part of a mixer/pug mill. If your concern is just recycling, a pug mill or a mixer/pug mill can do the job, but you'll need to ask the dealer about what condition the clay has to be in before it can be processed, for example, stiff, bone dry, slurry, etc.

Capacity. Don't underestimate your needs and purchase a machine that won't keep up with your pace or future plans. Likewise, don't purchase a machine you'll only use once or twice a year. Manufacturers make machines of varying capacities and rate them by batch-mixing sizes (in pounds), mixing rates (pounds/hour) and pugging rates (pounds/hour). In addition to these rates, you'll need to consider times for batching, unloading, and wedging to get an idea of total clay through put.

Ventilation. If you're planning to mix clay, you'll need a ventilation system to control dust even if the clay mixer has a tight fitting lid on the hopper. There are dust collection systems available or you may have an existing system to tie into. Caution: Even with a ventilation system, you'll still need to



Mixer/pugmills are manufactured in a variety of sizes, and most models are capable of processing both dry and moist clay, as well as scrap in any form. (Photo courtesy Peter Puggler)

wear a respirator when working with dry materials.

Electrical requirements. Larger machines have larger motors and hence draw more power. And if you opt for a separate mixer and pug mill, you'll need to allow for two machines. Find out how much electrical service you have (in amps) and whether your system can handle the additional draw (this is not usually a problem, but worth knowing in advance). You'll also need to know whether you have single phase (residential) or 3 phase (commercial/schools) service as this affects the type of motor.

Cleaning and storage. When switching from dark to light clays, or buying a machine without a tight seal, you'll need to clean the machine. If this is a concern, check out how easy it is to dismantle the machine for cleaning. When storing a machine for days or weeks at a time, or even over summer holidays at schools, most machines can just be sealed and the clay inside remains moist.

Safety. All machines are potentially dangerous, and pug mills and mixers are no exception due to the tremendous torque required to blend and move clay. Most machines are equipped with safety shutoffs and guards that prevent hands from coming in to contact with moving blades and augers. Check and compare safety features before purchasing.

Understanding Pottery Clay

by Paul Andrew Wandless

At some point we all change clay bodies for one reason or another. Whether you want a body that shrinks less, has more/less absorption, a lower/higher maturation point or just a different color, there are hundreds of commercial clays to choose from. While most clays have pretty good general catalog descriptions of what they are and what they can do, once we apply our specific working and firing processes other issues can arise. A combination of tests can give you plenty of information that makes choosing and learning about a clay body a little easier.

Why Test Clay?

Testing clay bodies provides you with information that you can observe, touch, and feel first hand in your own environment. While a catalog photo shows what a body may look like fired at one or several cones, it may not tell you what it will do at the cone you're firing to. Basic clay bar tests give you information more specific to your needs, and a 25-pound sample is usually enough to complete all the tests you need.

What to Test

Tests should be done at multiple temperatures to yield the widest range of information on the body. You need to understand the same general characteristics at every temperature you fire to, and even at temperatures you may want to fire to in the future. I test at every potential cone I may fire to and keep records of all the results.

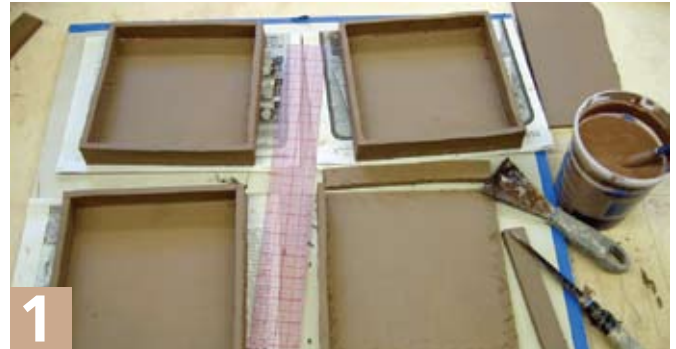
The three important general characteristics are shrinkage, absorption, and warping/slumping. Other important qualities to note are color, texture, plasticity, and hardness. Some results are determined with visual and touch tests while others require simple formulas. All require consistency of procedure so the results you achieve are created under the same conditions.

Firing Box and Stilts

When firing above a recommended temperature either on purpose or by mistake, clay bodies start to melt and fuse or stick to the shelves. To test clay bars, you'll need a shallow firing box to protect your kiln shelves and make handling and transportation easier. You'll also need clay stilts for the warping test.

Using a high-fire clay, make a simple clay box that's 8–10 inches square with a 1-inch high wall. Make several boxes at the same time so you can test multiple bodies in the same firing or to have on hand for later (*figure 1*).

Make triangle stilts about the thickness of your pinky and long enough to span the width of the clay bar (*figure 2*). All stilts must be the same height.



1 Construct test trays from a high fire clay body.



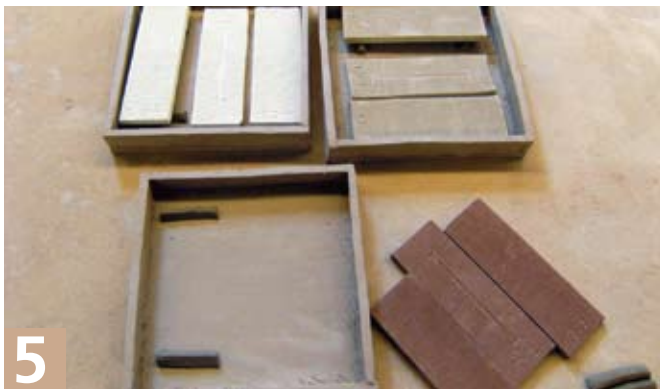
2 Prepare triangular stilts to support the bars.



3 Four test bars with a measured and marked 10 cm line.



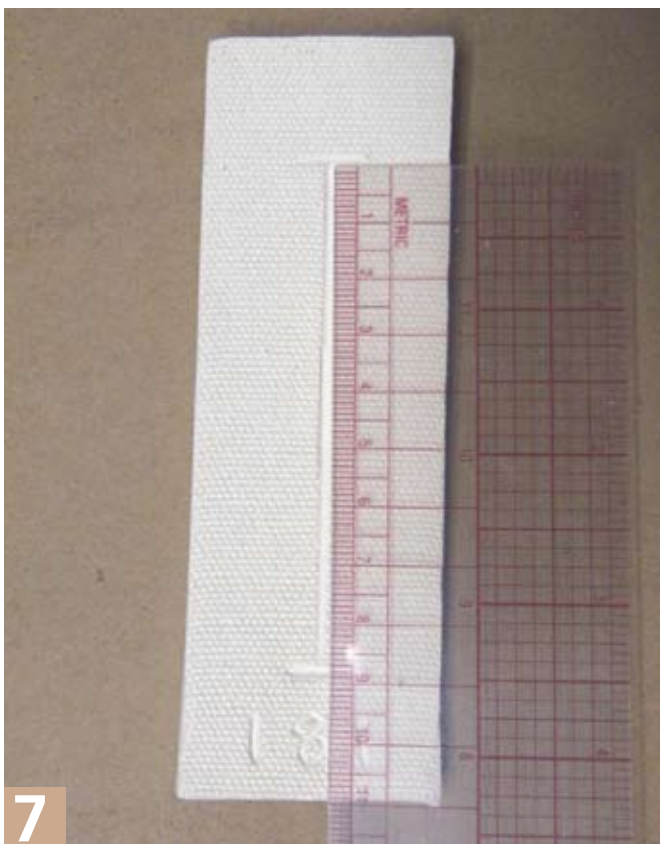
4 Dry trays and bars slowly and evenly.



5
Place one bar on stilts and two of them flat in the tray.



6
After each firing, measure the amount of deflection.



7
Measure the 10 cm line to determine shrinkage.

Clay Bars

You'll need three clay bars for each body you're testing. For consistency and accuracy of results, use the same dimensions for all your clay bars. While some tests yield correct results regardless of the bar dimensions, if they are consistent, you can always rule out size and dimension as variables that could cause any irregularities. I make $\frac{1}{4}$ -inch thick bars measuring 2 inches wide by 6 inches long. For thicker work, make bars to match, but don't exceed a $\frac{1}{2}$ inch in thickness. After cutting the bars to size, draw a 10-cm-long line on one of them with a hash mark at each end. This will be used for a shrinkage test later (*figure 3*).

For the tests here, I've selected four bodies to test: two white bodies from Standard (#257 Grolleg Porcelain cone 8–10 and #181 White Stoneware cone 6–10) and two from Amaco (#29 Brown Stone Earthenware cone 06–04 and #77 Terra Cotta Clay cone 5). All four bodies have different characteristics at the temperatures to which I'm interested in firing them, and testing several bodies at the same time takes better advantage of each firing. Write the clay number on the back of each tile.

Once all bars are cut and firing boxes are built, let them dry to bone dry. They can be stacked with newspaper layered in between and a board on top for a little weight to keep from warping. It's important that the firing boxes and clay bars stay flat while drying to assure accurate test results (*figure 4*).

Pre-Bisque

At the bone dry stage, visually examine the bars for a color change if any. Use a ruler to measure the shrinkage line to see if it has changed from its original 10 cm length. Record the results.

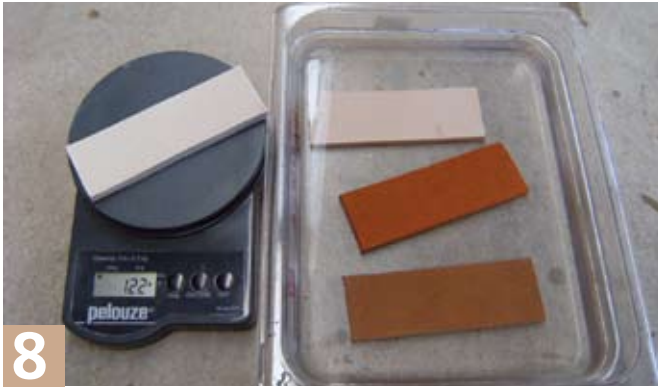
For each firing, place the bars side by side in the firing box, and place one of them on the triangle stilts (*figure 5*). The stilts should be placed about $\frac{1}{4}$ to $\frac{1}{2}$ inch in from the ends of the bar. If the stilts are too close, the bar may not warp or slump to its fullest potential. The shrinkage bar and the other regular bar are simply placed in the bottom of the box.

Firing Clay Samples

While the test firing can be done in any kiln, the results are most applicable if done in the same kiln used for your work. Indicate in your notebook or worksheet if it's an electric or gas kiln, oxidation or reduction firing, salt, wood, soda, etc. For best results, start firings at the lowest cone temperature and then progressively refire the bars at higher cones until the highest desired cone is reached. A sample for progressive test firings for a cone 10 clay body would be cone 06, cone 01, cone 6 then finally cone 10.

Clay Bar Tests

The following traditional tests give a good range of basic information that helps you to better understand your clay body. Keep good records in your notebook or worksheet so you'll have the results for future reference. If there are other specific qualities, such as glaze fit or color effect, test for these as well.



8 Soak bars in water and weigh them after 24 hours.

Warping/Slumping

Visually examine for any warping or sagging movement in the center. Remove the bar from the stilts, turn it over and place it on flat surface so the gap (if any) can be measured (*figure 6*). This test informs you at what temperature the walls may start to warp or deform or a plate may begin to slump. The information can be applied to the sculptural or structural applications of the clay body. An exact percentage for this is not as important as just knowing when the clay body starts to move.

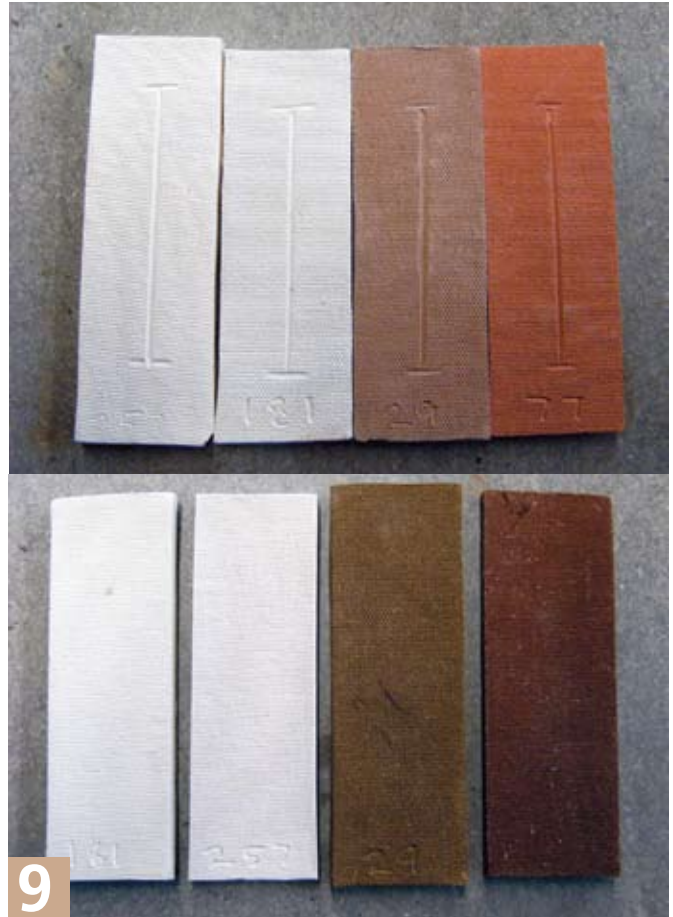
Shrinkage Test

Measure the length of the line in centimeters on the shrinkage bar (*figure 7*), and subtract it from 10 (based on the original 10 cm line). For example, 10 cm – 8.5 cm = 1.5 cm. An easy way to convert this result to a percentage is to move the decimal to the right one place, so 1.5 cm means 15% shrinkage. Knowing the shrinkage rate helps in determining which glazes will fit the body and even which two bodies can be used together.

Absorption Test

There are two types of tests that can determine the absorption of a clay body. One is a simple visual test and the other is a weight calculation. For the visual test, place a few drops of a liquid (like ink) on the surface of the bar to create a stain. Let it soak in for an hour then wash off the surface with water. The darker the stain, the more absorbent the clay body. This is not an exact test, but it gives a quick and useful general result.

The weight calculation test is more specific. Weigh the fired bar on a gram scale and record the result (*figure 8*). Soak the bar in water for 24 hours, pat dry, then weigh again and record the result. Subtract the first weight (dry bar) from the second weight (water soaked bar) to get the weight of the absorbed water. Divide the weight of the absorbed water by the original dry weight and move the decimal two places to the right to find the absorption rate.



9 Note the color of the clay after each firing. Here are four clays fired to cone 04 (top) and cone 7 (bottom).

Example: Original bar weight of 4.2 grams is subtracted from soaked bar weight of 4.6 grams giving you an absorbed water weight of .4 grams. Divide .4 by 4.2 which equals .095 making absorption 9.5%.

Color Test

Visually examine a bar to see if there has been a color change (*figure 9*). The color change can sometimes be dramatic depending on the cone it was fired to and is important for aesthetic purposes. It can also help you determine the best glazes to work visually on the surface.

Surface/Texture

Visually examine the bar to determine if the surface has changed. Run your fingers across the bar to see if it's the same, smoother or more coarse. This information is important aesthetically and helps you determine if it meets your visual and tactile needs.

Hardness

Using a metal nail or similar tool, see if you can scratch the surface to see how hard or soft it is at the fired temperature. This test helps determine the surface durability at different temperatures.

Glossary

by Vince Pitelka

ABSORPTION The ability of a fired clay to absorb water. Used as a gauge of vitrification.

AIR-FLOATED; AIR-FLOATING Industrial method used in processing of raw clays, where powdered clay is floated in an airstream to settle out heavier particles.

BALL CLAY $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ —Deposited in marshy areas. Very fine particle size, high plasticity, high drying shrinkage, high in organic contaminants. Fires white or off-white.

BASALT BODY; BASALT WARE Clay body with sufficient amounts of dark clays and/or metallic oxides to fire dark brown or black.

BENTONITE $\text{Al}_2\text{O}_3 \cdot 5\text{SiO}_2 \cdot 7\text{H}_2\text{O}$ —montmorillonitic clay formed from decomposition of airborne volcanic ash—finest particle size of all clays—plasticizer (three times as powerful as ball clay), suspension agent, should be used in quantities of no more than 3% of dry materials weight.

BONE CHINA Translucent porcelain containing bone ash.

CARBONDALE CLAY Refractory red stoneware clay, used to obtain rich red and brown colors in high-fire clay bodies.

CHINA CLAY See **KAOLIN**.

CLAY Widely occurring aluminum silicate mineral resulting from natural decomposition of feldspar and granite. Composed of microscopic disk-shaped platelets that give clay its slippery, plastic quality.

CLAY BODY Clay mixture formulated of clays and other ceramic raw materials to give desired working characteristics.

DEAIRING The process of removing the air from a plastic clay mass, usually accomplished through wedging, or far more effectively with a vacuum deairing pugmill.

EARTHENWARE CLAY Natural low-fire secondary clay—fluxed with iron, fires porous. Often called “common” clay, found almost everywhere, matures below 2000°F.

EPK KAOLIN $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ —pure white kaolin, less plastic than Tile-6 kaolin, frequently used in glazes.

FIRE CLAY Highly refractory secondary clays with minimal fluxes and usually fairly coarse particle size—low shrinkage, buff-color, often nonplastic.

FIRE CLAY Very refractory clay, for sculpture and raku bodies. Tremendous variation among different brands.

FLAMEWARE Wares made to withstand stove-top heat. Explosions from trapped moisture, and resulting lawsuits have caused studio flameware to disappear from the domestic market.

GOLDART Buff stoneware clay, produced by Cedar Heights Clay Company.

GROG 1 Crushed hard-fired clay—a source of grit for clay bodies—graded in sizes from 15-mesh (very coarse) to 150M (extra fine). Does not shrink in firing, so medium and coarse grades will show texture through thin to medium glaze.

GROG 2 Filler or tempering grit formed by grinding high-fired clay; added to clay bodies to reduce shrinkage and give structure for throwing or handbuilding.

GROLLEG KAOLIN $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ —English kaolin, more costly than other choices, but gives whiter porcelain. Less plastic than **TILE-6**. Best kaolin for translucent bone china.

HAWTHORN BOND Refractory stoneware clay or fireclay, used in stoneware clay bodies.

HELMER KAOLIN $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ —Kaolin that works especially well as flashing slip for salt, soda, and wood firing, especially since Avery kaolin is no longer being mined.

HIGH-FIRE High-temperature firing range usually including cone 8 to cone 12, for firing stoneware or porcelain.

KAOLIN; CHINA CLAY $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ —very refractory white primary clay—essential ingredient of porcelain and whiteware—less plastic than most other clays. See **EPK**, **GROLLEG**, **HELMER**, **TILE-6**.

KAOLINITE Crystalline clay mineral forming the basis of most clays we use in ceramics.

LIZELLA CLAY High-iron (4%) orange-red stoneware clay—substitute for Ocmulgee which is no longer being mined.

LOW MID-RANGE Firing range usually including cone 01 to cone 3, under used in studio ceramics, useful for functional earthenware, refractory sculpture bodies, and outdoor terra cotta work.

LOW-FIRE Low-temperature firing range, usually below cone 02 (2048°F), used for most bisque-firing and for glaze-firing terra cotta and whiteware.

MID-RANGE Firing range usually including cone 4 to cone 7, very popular with electric kilns.

MONTMORILLONITE Clays such as bentonite, resulting from the breakdown of airborne volcanic ash. The finest particle size of all clays. Very high shrinkage, and generally used only as an additive to clay bodies or glazes. See **BENTONITE**.

NEUMAN RED CLAY Refractory red stoneware clay, used to obtain rich red and red-brown colors in high-fire clay bodies.

OM-4 (Old Mine #4) A well-known Kentucky ball clay.

PAPER CLAY Technique utilizing a clay body or slip containing paper pulp which reduces shrinkage in drying stage, and encourages extremely strong joinery, allowing unconventional joinery such as wet to dry.

PIONEER KAOLIN $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$ —plastic secondary kaolin—wider particle distribution gives greater plasticity, green strength.

PLASTICITY Quality of moldable flexibility in damp clay—superior plasticity depends on smaller clay particle size, slight acidity, fewer nonplastic additives, aging of damp clay body, adequate water content, and/or addition of accessory plasticizers, such as Veegum T or Macaloid.

PLASTICIZERS Materials added to some clay bodies, especially those high in kaolins, to increase plasticity and dry strength—includes bentonite, Macaloid, Veegum T.

PLATELETS Flat, thin crystals that make up clay. When wet they become sticky and slippery, creating the phenomenon we call plasticity.

PORCELAIN High-fired vitreous clay body containing kaolin, silica, fluxes and, often, ball clay to increase plasticity, with total clay component not more than 50%. Usually pure white or “eggshell” in color; some porcelains may fire translucent where thin.

PORCELANEOUS White-firing stoneware clay bodies closely related to porcelain.

REDART Brick-red earthenware clay, produced by Cedar Heights Clay Company.

SAND Granular silica (usually)—source of grit for claybodies—high shrinkage in HT claybodies, but gives smoother fired surface than grog. Toxic in inhalation.

SECONDARY CLAYS; DEPOSITED CLAYS; SEDIMENTARY CLAYS Clays that have been transported away from their points of geologic origins by wind or water. Finer particle size gives greater plasticity—ball clays, stoneware clays, fireclays, etc.

SECONDARY KAOLINS Kaolins that have been transported some distance from the parent rock and are still very pure, but considerably more plastic than primary kaolins.

SLAKING; SLAKE DOWN The process of returning dry unfired clay to a slip by soaking in water.

STONEWARE CLAY Naturally occurring refractory clays with adequate fluxes to fire in stoneware temperature range.

TERRA COTTA Low temperature, porous earthenware clay body, fires red-brown due to high iron content, which also fluxes clay, making it the most durable low-fired clay after firing.

THERMAL SHOCK RESISTANCE Resistance to the damaging effects of thermal shock.

THERMAL SHOCK Effect of sudden temperature changes during firing or during subsequent heating and cooling in daily use.

TILE-6 KAOLIN $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$ —air-floated secondary kaolin—broader particle distribution than primary kaolins, greater plasticity, green strength.

WATER OF PLASTICITY Amount of water required to bring a dry clay to its state of ideal plasticity. Common clay test used to determine this amount. The more water needed, the finer the particle size, the more plastic the clay, and the greater the drying shrinkage.

XX-SAGGER A plastic refractory stoneware clay, often used in sculpture and raku bodies.

Excerpted from Clay: A Studio Handbook, by Vince Pitelka, published by The American Ceramic Society, 2001.