EARTHENWARE CLAYS

Gail Kendall, Tureen, handbuilt

Earthenware usually means a porous clay body maturing between cone 06 – cone 01 (1873°F - 2152°F). Absorption varies generally between 5% -20%. Earthenware clay is usually not fired to **vitrification** (a hard, dense, glassy, non-absorbent state - cf. porcelain). This means pieces with crazed glaze may seep liquids. Terra sigillata applied to the foot helps decrease absorption and reduce delayed crazing. **Low fire fluxes melt over a shorter range than high fire materials**, and firing an earthenware body to near vitrification usually results in a dense, brittle body with poor thermal shock resistance and increased warping and dunting potential. Although it is possible to fire terra cotta in a gas kiln in oxidation, this is often difficult to control. Reduced areas may be less absorbent than the rest of the body and cause problems in glazing. Most lowfire ware is fired in electric kilns. Raku firing and bodies are special cases.

A less dense body has better thermal shock resistance and will insulate better. **Earthenware generally shrinks less than stoneware and porcelain**, and as a result is often used for sculpture. See Etruscan full-size figure sculpture and sarcophagi in terra cotta.

At low temperatures, glaze may look superficial & generally lacks the depth and richness of high fire glazes. The trade-offs are:

- a brighter palette and an extended range of color. Many commercial stains burn out before cone 10 or are fugitive in reduction.
- accessible technology. Small electric test kilns may be able to plug into ordinary 115 volt outlets, bigger kilns usually require 208 or 220 volt service (the type required by many air conditioners and electric dryers).
- less energy use. Fewer BTU's needed to reach lower temperatures. Actual savings depend on the local cost of gas vs. electricity.
- faster firing and cooling cycles
- surface results are often more dependant on application than firing method, and some may be more easily controlled and repeated.

Etruria, *Veii Sarcophagus*

Earthenware has long been a respected sculpture material, but its reputation as a pottery material has varied. Many people associate fragile, under-fired, earthenware pottery from low-technology cultures as earthenware, and mistakenly believe that it can't be a durable body for tableware. In spite of a long and glorious history in ceramics, the 50's and 60's stoneware aesthetic did not look kindly on low fire. Earth tones, iron spots, and ash glazes were in demand. Some artists without access to gas reduction firing tried to simulate high fire results with low-fire electric firing. The results rarely rivaled the originals.In the 60's artists became less interested in tradition and began to explore low fire materials for their own intrinsic qualities. Pop and funk promoted interest in bright color and populist materials and technology. "Hobby" materials were used to make art. Since then the field has broadened, and many ways of working with earthenware have been revitalized.

See ceramic works from the following cultures: Minoan, Mycenaean, Greece, Ife, Nok, Nazca, Moche, Mimbres, and other new world works, Yang Shao, Jomon, Haniwa, Han, Hispano Moresque, and Italian ceramics.

Contemporary artists in lowfire include: Viola Frey, Andrea Gill, Judith Salomon, Patti Warashina, Lisa Orr, Betty Woodman, Ron Nagle, Ken Price, Michael Lucero, Stan Andersen, Walter Ostrom, Bruce Cochrane, Gail Kendall, Lucy Breslin, Woody Hughes.

Earthenware clays are plentiful in nature and often have good plasticity. The presence of various forms of iron oxide and other impurities can make raw clay grey, green, ochre, red, or brown-colored, and fire to a buff to orange color. White low-fire bodies do not occur in nature, and are a mixture of kaolin and/or ball clay and flux.

Daniel Rhodes suggests basing earthenware on a red clay, testing the properties, and adjusting.

- If the clay is refractory and not fused enough at the desired temperature, add flux.
- If the clay is too fused, add refractory materials (fireclay, kaolin, ball clay, stoneware clay, flint, fine grog).
- If the clay is "fat" (too plastic, sticky, high shrinkage), add less plastic clays (fireclay, kaolin) or non-plastic ingredients (grog, flint).
- If the clay is not plastic enough, add ball clay and/or up to 2% bentonite.
- If the color isn't deep enough, iron oxide or slip clay (Barnard, Alberta) may be added.

Fluxes for Earthenware

Fluxes are added to lower the melting point and help a body mature at a desired temperature. Flux is considered a non-plastic addition to a clay body. With some clays, the addition of sufficient flux to mature the body at low-fire temperatures will reduce plasticity and require the use of more ball clay. **Feldspars** do not melt at a low enough temperature to be useful low-fire fluxes. **Nepheline syenite, talc, frit, or combinations** are used as low-fire body fluxes. Other higher-melting fluxes may be tested as supplementary body fluxes that may form eutectics with other body fluxes (e.g. whiting, strontium, etc.)

Frit. Care must be used in selecting frits, as some are partially soluble and may **deflocculate** clays (making the body difficult to work) and/or accumulate soluble salts on the clay body during drying that will fuse during firing leaving areas of reduced absorption. Rhodes suggests countering the deflocculation with additions of .5% aluminum sulfate or magnesium sulfate (Epsom salts). Frit also tends to have a narrower melting range than other fluxes. Rhodes suggests that range may be within two cones vs. the range of a natural clay body of 4-5 cones.

Talc ($3\ MgO{\cdot}4SiO_2{\cdot}H_2O$) has a long firing range, but needs to be used in large amounts if the only flux, e.g. low-fire whiteware bodies may be 60% ball clay, 40% talc for cone 05. This may produce a chalky, powdery body that is not very plastic, but could be adjusted for casting. (Note: talc works at low-fire temperatures because its refractory silica and magnesium are in proportions that form a **eutectic** that depresses the melting point.)

Nepheline syenite ($K_2O{\cdot}3Na_2O{\cdot}4Al_2O_3{\cdot}9SiO_2$) is **similar to a feldspar**, but with a **higher ratio of flux to alumina and silica** so that it **melts at a lower temperature than spar**. May be partially soluble and deflocculate the clay body, leading to working and drying problems. I've used 5% or lower, but for larger amounts, it would be better to use other fluxes.

Other Body Additions

Bentonite (2-5%) can be added to increase plasticity and help make a short clay more plastic. Ranger Red and Redart have a fine particle size and are fairly plastic.

White Earthenware Bodies

Low fire whiteware **does not occur in nature**. White bodies are **based on kaolin**, cream colored bodies are **based on ball clay.** Both mature above earthenware temperatures, and **require a large addition of flux**. Flux is a non-plastic addition. To counter large amounts of non-plastic ingredients, white bodies are sometime compounded using ball clay for its plastic qualities. This may make for a chalky clay body that still has limited plasticity. Some lowfire whiteware bodies may remain punky (very open and porous) at suggested firing temperatures, and require a higher bisque to make the body a bit denser (but still porous enough to accept glaze), then a lower glaze firing. It depends on the ingredients in the specific clay body. Test under your conditions. If a bisque at regular temperatures (cone 06-05) leaves the body too absorbent, try bisquing a bit higher.

Red Earthenware (terracotta) bodies

Many local clays are earthenware clays with iron impurities giving the red color. The iron content helps flux the body.

The most available red clays in our area are:

- Cedar Heights **Redart** from Pennsylvania
- **Lizella** from Burns Brick in GA
- **Ranger Red** from Texas (Trinity Ceramics, Dallas). Note: Ranger Red has at times had small black incursions that pop out after majolica glaze firing. Not recommended for majolica work.
- **Neuman Red**, a western clay. Not air-floated, often used for bricks. My experience is that this clay can be fine-grained, plastic, and work well, or there may be batches with inclusions the size of 48-mesh grog that can cause problems under viscous glazes like majolica. If you want a fine-grained body w/o these inclusions (which also caused pin-holing and gassing), screen the dry clay w/a 60-mesh screen before mixing.

Ochmulgee is more refractory and may have chunkier particle size than Redart. It is not generally available now, but Lizella, which is a bit finer-grained, may be substituted for Ochmulgee.

Many red clays have soluble salts that will **"scum"** (form a white scum on the pot surface after firing). To prevent this **.5% (½%) addition of barium carbonate will form barium sulfates and render the salts insoluble.**

Testing clays or clay bodies

To test shrinkage, mix up a 500 gram batch of your recipe. Mix with water to a workable consistency, bag and let hydrate at least over night. Roll a coil the size of your finger and wrap around your finger to test for plasticity. Note any physical characteristics of the clay. Roll a slab at least ½" thick. Cut a small bar. Inscribe a 10 cm line with clear end marks. Dry slowly and evenly. Measure this again when bone dry, when bisqued, and at maturity to determine the shrinkage of the body at each state.

To test absorbency at maturity, weigh the bar. Place in boiling water for at least 15 minutes. Remove. Pat dry to remove all surface water. Weigh again to determine the percentage of absorption. This should give you information in terms of plasticity, drying and firing shrinkage and vitrification for comparing clays and bodies.

Resources

Studio Potter magazine	*Earthenware Issue V.11 No.2*
Brody, Harvey	*The Book of Low Fire Ceramics*
Nigrosh, Leon	*Low Fire*
Rhodes, Daniel	*Clay and Glazes for The Potter*
Wechsler, Susan	*Low-Fire Ceramics*

Earthenware potters on the web

Bruneau, Joan	http://www.joanbruneau.com/
Hora, Niel	http://www.nielhorapottery.com/
Horie, Ayumie	http://ayumihorie.com/
Orr, Lisa	http://lisaorr.com/
Ostermann, Matthias	http://matthiasostermann.com/
Ostrum, Walter	http://www.walterostrom.com/
Rasasch, Kari	http://kariradasch.com/

Lowfire white clay bodies

Cushing 04 White Sculpture Body For heavy massive work. Strong, low shrinkage.		**Cushing 04 White, Vitreous Porcelain-like Body** Good glaze fit. Can be used for throwing.		**Betty Woodman White 05**	
EPK	10	Grolleg	25	Kaolin	50
Grolleg	20	#6 Tile	25	OM 4	50
Ball clay	10	Tenn. Ball	10	Pine Lake	50
Ferro #3124	10	Frit #3124	30	Wollastonite	12.5
Talc	10	Talc	5	Fine Grog	12.5
Wollastonite	10	Flint	5	Talc	5
Molochite	30		100		180
+ Bentonite 2%	100	+ Bentonite or Macaloid 2%		+ V-Gum .75 or Bentonite 3%. Mix w/warm water and let sit overnight before adding to clay.	
Nylon fiber if desired					
Frank Boyden White 04 Fine-grained, throwing		**Rob's 03 White**		**Betty Woodman White 2 03**	
OM 4 Ball	50	Ball	35	ball clay	25
Talc	38	EPK	15	talc	35
Neph Sy	12	Neph Sy	25	fireclay or Goldart	25
	100	Talc	25	EPK	10
+Macaloid	1		100	Custer	10
		+ Bentonite 3%			105
Patty Warashina Whiteware		**Harvey Brody White**		**Graham's Buff 04**	
Ball clay	50	ball	60	fireclay	30
Talc	50	talc	40	Goldart	30
	100			ball clay	15
		cone 05 shrinkage 4%, absorption 14.5%		frit 3124	15
		cone 1 shrinkage 6%, absorption 9.5%		talc	10
Alfred White Base Clay 02		**Penland White Earthenware 02**		**White Casting 04**	
talc	43	Talc	37	Kentucky OM #4	50
ball clay	43	XX Sagger	25	Talc	35
200 mesh silica	13	EPK	5	EPK	15
		Kentucky OM #4	32		100
blue = + 8% Mason 6379				+Sodium silicate	0.3
Cerulean blue				+Soda ash	0.1
yellow = 10% Mason 6483					

Lowfire red clay bodies

Studio Tableware Red 04-03		**Erica Elliott 04-03**		**Stan Andersen Red 03**	
Redart	100	Redart	60	Redart	65
Goldart	40	Talc	10	Goldart	15
Ochmulgee	40	Ochmulgee	10	Fire clay	15

talc + $BaCO_3$ ½ % Sand 0-12% Note: using while sand may make white specks in the red clay	17	Pine Lake OM 4 + ½ % Barium carb	10 10 100	Talc + ½ barium carbonate to prevent scumming. Or: omit fire clay, increase stoneware clay, + 1% fine grog. Good w/most majolica glazes.	10 100
Cushing 04 Sculpture-tan/orange Good for thick work, low shrinkage, not plastic		**Cushing 04 Almost Black Plastic Body** (Do Not Reduce)		**David Crane's Black 06-01**	
Ochmulgee Fireclay Talc Wollastonite Grog +Red iron ox. 5 Barnard clay 3 Barium carb. 1 1-2% bentonite will add workability. A cup or 2 of nylon fiber gives more green strength.	20 25 15 10 30 100	Redart Ochmulgee PBX Valentine Barnard Frit 3124 +Bentonite 2 Red iron ox. 6 Iron chromate 4 Manganese diox.2 Barium Carb. 1	20 30 20 22 8 100	Ochmulgee Redart fireclay Barnard slip clay + Manganese 20 iron oxide 15 grog/sand 5-20% Wear gloves to work with this clay. Mn is toxic. Do not breathe dust.	100 100 80 30
Arbuckle 04-03 **Resolute Terracotta #3 ***		**Pete Pinnell's Lowfire Red, Smooth, Throwing Body**		**St. John's Terracotta 04** Good for throwing	
Redart GoldArt Spodumene Kentucky OM #4 Hawthorne Bond – 50 mesh Talc + Barium Carb. Optional: Fine Grog or kyenite (90 mesh)	50 13 3 13 15 6 0.5 2	Ranger Red Clay Red Art 50 mesh Hawthorne Bond fireclay * ball clay wollastonite Add v-gum T (soln.) 1 barium carb. ¼ cup per 100 lbs. dry clay *Regular 28 mesh fireclay can be used but will result in tiny white specs in the red clay under a clear glaze.	50 25 10 10 5 100	Redart Goldart AP Green fireclay ball clay talc + $BaCO_3$ 0.5	50 10 10 10 20

*** Note:** clay is a mined material, and seams may change over time. Recipes that were fine can become unworkable. In 2008-9, something changed in some ingredient in the terracotta ingredients I use that caused the release of problematic amounts of gas at glaze-firing temperatures, creating a snowstorm of gas bubbles that were left as white dots in the viscous majolica color surface. Re-firing created even more dots, so the release seemed to continue at even higher temperatures. People reported bisquing higher to help. I could not bisque beyond 05 and still have a body porous enough to glaze and decorate. Re-formulating the body to favor low-sulfur ingredients helped some. The Resolute Terracotta #3 is the current recipe, and Highwater Clays is mixing for me. They were helpful during testing new formulations, and they have my thanks, especially Jennifer Hoolihan, their tech support person. If you have dot troubles, you may try bisquing a bit higher and/or slower, and glazing thinner if possible. Beyond that, try a different clay.

Terry Siebert's Terra Cotta 04		**Red clay for large tiles**		**Betty Woodman Terracotta 04-03**	
Redart	60	1 part Redart		Redart	60
talc	15	1 part fireclay		Goldart	30
AP Green	15	1 part coarse grog		fireclay	30
ball clay	23			talc	10
				grog	5
				+ ½ % $BaCO_3$	
Cushing 04 Red/orange/tan Plastic, Dense Throwing		**Brouillard Red for Bigware 04**		**Patrick Loughran's Red Casting 04**	
Redart	20	Foundry Hill Creme	24	Redart	80
Ochmulgee	20	Kentucky OM #4	24	ball	10
Calvert	20	A.P. Green	24	Goldart or fireclay	10
Ball	10	Redart	24	frit 3195	1.25
Goldart	10	Frit 3124	4	frit 3124	1.25
Ferro 3124	15				
Talc	5	+Red iron oxide	2	+ $BaCO_3$	0.2%
	100	fine grog	10	Sodium silcate (59 gms)	0.2%
+: Red iron	2	Barium carbonate	0.5	Soda ash	0.2%
Bentonite	1	From Bill Brouillard, for 24"		Water.	5 gals
Barium carb.	1	platters. Used for throwing w/o the grog.			