

Appalachian Center for Craft - Clay Studio

Vince Pitelka, 2016

Glossary of Ceramic Raw Materials

Pay close attention to the toxicity warnings. All powdered materials are toxic in inhalation, some are toxic when ingested, a few are toxic through skin absorption. In general, inhalation of any kind of dust even in smallest quantities is unacceptable abuse to your lungs. Always wear appropriate dust mask with P-100 particulate filter whenever dust is present in the air, and make sure no one else is present without a respirator. See the handout on studio safety.

Note: AT = all temperature, LT = lowfire temperature, MR = midrange temperature, HT = highfire temperature.

ADDITIVE A: Wood-extract product used as clay additive to improve plasticity, dry strength, workability, most often in brick/tile-manufacture, rarely in studio clay since it is a **deflocculant**. Very small quantities can be effective in bodies high in kaolins. Does not change color of clay.

ALBANY SLIP CLAY: Traditional dark brown slip-clay used as liner-glaze in high-fired Early American wares. No longer being mined. Substitute is **Alberta slip**.

ALBERTA SLIP CLAY: Substitute for Albany slip. Highly fluxed with iron – true slip clay – will form glaze at HT.

ALUMINA HYDRATE: $\text{Al}(\text{OH})_3$ – Alumina source, rarely used in claybodies or glazes because all needed alumina comes from clay, feldspar. Used primarily for shelf-wash and wadding - better adhesion/suspension than **aluminum oxide**. Small additions increase viscosity of glaze melt. Inappropriate as matting agent in functional glazes - produces immature glaze.

ALUMINUM OXIDE: Al_2O_3 – See **aluminum hydrate**.

ANTIMONY OXIDE: Sb_2O_3 – rarely-used colorant – soluble, toxic, expensive, produces yellow with titanium. **Highly toxic in ingestion, inhalation.**

ASH: See **wood ash**

AVERY KAOLIN: Kaolin no longer mined, once popular for flashing slips in woodfiring. See **Helmer kaolin**.

BALL CLAY: $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ – highly-plastic fine particle-size secondary clay deposited in swamps, deltas where organic acids leach out contaminants, break up particles. Added to most claybodies for **GPD**, increased plasticity. Large quantities promote high shrinkage.

BARIUM CARBONATE - BaCO_3 – active HT **alkaline earth** flux, can promote matt glaze surface. Unsafe for low-fire functional glazes. Controversial in HT functional glazes, but toxicity issues in balanced HT glaze unproven. Very small amount added to problem claybodies renders sulfates insoluble, reducing **scumming**. **Toxic in inhalation, ingestion.**

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 depositions of airborne volcanic ash – finest particle-size of all clays. Often added up to 3% of dry materials weight as suspension agent in glazes, plasticizer in claybody.

BISMUTH SUBNITRATE: Soluble metallic salt – gives metallic luster under LT reducing conditions in sagger-firing. **Toxic in inhalation, ingestion.**

BONE ASH; CALCIUM PHOSPHATE: $\text{Ca}_3(\text{PO}_4)_2$ – HT calcium flux. Introduces translucence or opalescence in HT glazes (from colloidal phosphorus globules) and is traditionally a primary flux in translucent *bone china*. **Toxic in inhalation.**

BORAX; SODIUM TETRABORATE: $\text{Na}_2\text{O}\cdot 2\text{B}_2\text{O}_3\cdot 10\text{H}_2\text{O}$ – a major LT alkaline flux, available in granular or powdered form. Gives smooth finish, bright colors – water soluble, so we usually use sodium-borate frit instead. Excessive amounts create brittle glass, can cause blistering, pinholing. Sometimes used with salt or soda in vapor glazing to lower firing temperature and/or achieve a smoother, shinier surface. **Toxic in inhalation, ingestion.**

BLACKBIRD/BARNARD: Slip-clay with high iron content, occasionally used as brown colorant for decorating slips, claybodies, glazes.

BURNT UMBER: Iron-manganese ore occasionally used as color source for basalt claybodies, slips and glazes.

CALCINED KAOLIN: See *kaolin, calcined*.

CALGON-S; SODIUM HEXAMETAPHOSPHATE: Commercial product sometimes used as a deflocculant. Widely used in water softeners and recent changes in composition for that application render it less useful in ceramics. Use *Darvan #7, sodium silicate*, and/or *soda ash*.

CARBONDALE CLAY: Refractory red stoneware clay, used to obtain rich red and brown colors in highfire claybodies.

CARBOXYMETHYLCELLULOSE GUM: See *CMC gum*.

CHROME OXIDE: Cr_2O_3 – standard vivid green colorant – color often softened with a little iron or manganese. Very refractory. With tin produces pink. May go gray-brown in reduction.

Highly toxic in inhalation, ingestion.

CMC GUM: Carboxymethylcellulose – organic gum used as suspension/adhesion agent in glazes. Small amount of gum is added to quart of warm water, left overnight to dissolve. Thick solution added in small doses to glazes, slips, engobes to improve application performance.

COBALT CARBONATE: CoCO_3 – standard blue colorant for slips/glazes – very powerful – 5% gives dark blue in glaze or slip. Can cause crawling if used raw for underglaze brushwork. **Toxic in inhalation, ingestion.**

COBALT OXIDE: Co_3O_4 – calcined cobalt carbonate – twice the power and coarser than carbonate, may give mottling in glaze. Works well for underglaze brushwork with few crawling problems. **Toxic in inhalation, ingestion.**

COLEMANITE: See *Gerstley borate*.

COPPER CARBONATE: CuCO_3 – a major glaze colorant to produce greens and blue-greens in LT and HT, copper reds in HT reduction. **Toxic in inhalation, ingestion.**

COPPER OXIDE, BLACK; CUPRIC OXIDE: CuO – alternate source of copper, coarser particle size, twice as powerful as copper carbonate. **Toxic in inhalation, ingestion.**

COPPER OXIDE, RED; CUPROUS OXIDE: Cu_2O – rarely-used alternate source of copper because it is immiscible with water unless several drops of detergent added to break surface tension.

Toxic in inhalation and ingestion.

COPPER SULFATE: CuSO_4 – color source for sagger firing and pit firing. Water-soluble, and **toxic in absorption, inhalation, ingestion.**

CORDIERITE: $2\text{MgO}\cdot 2\text{Al}_2\text{O}_3\cdot 5\text{SiO}_2$ – magnesium/aluminum silicate clay mineral, used to make grog for refractory products – promotes formation of **mullite.**

CORNWALL STONE; CORNISH STONE: $\text{K}_2\text{O}/\text{Na}_2\text{O}/\text{CaO}\cdot \text{Al}_2\text{O}_3\cdot 10\text{SiO}_2$ – popular HT feldspathic alkaline flux no longer being mined. Substitution: Custer – 31, flint – 29, nephylene syenite – 24, EPK – 13, Wollastonite – 3. **Toxic in inhalation.**

CRYOLITE; SODIUM ALUMINUM FLUORIDE: $\text{Na}_3\cdot \text{AlF}_6$ – small amounts promote crackle effects, larger amounts become very volatile with silica due to fluorine and may cause blistering. Used for special effect crater glazes. **Toxic in inhalation.**

CUSTER FELDSPAR: $\text{K}_2\text{O}\cdot \text{Al}_2\text{O}_3\cdot 6\text{SiO}_2$ – a common potash **feldspar** – HT alkaline flux. Close match to old **G-200** but not **G-200 HP.** See **feldspar,** see **G-200 HP** for substitution. **Toxic in inhalation.**

DARVAN #7: Common deflocculant for casting slips produced by R. T. Vanderbilt Company.

DOLOMITE; CALCIUM/MAGNESIUM CARBONATE: $\text{MgCO}_3\cdot \text{CaCO}_3$ – HT alkaline earth flux, promotes hard, durable surfaces and re-crystallization/matting in glazes. Occasionally added to claybodies to give longer firing range, and can promote more durable low-fire bodies.

EPK; EDGAR PLASTIC KAOLIN: $\text{Al}_2\text{O}_3\cdot 2\text{SiO}_2\cdot 2\text{H}_2\text{O}$ – common **secondary** kaolin, less plastic than **Tile-6** kaolin, frequently used in glazes.

EPK, CALCINED: See **kaolin, calcined.**

EPSOM SALTS; MAGNESIUM SULFATE: MgSO_4 – Water soluble, rarely used as magnesium source in glazes. Most often used as flocculant for slips and glazes. Often added to porcelain and porcelaineous stoneware bodies (1/2 of 1% of dry materials weight) to counteract deflocculating alkalinity released by kaolins or fluxes.

F-4 FELDSPAR: $\text{Na}_2\text{O}\cdot \text{Al}_2\text{O}_3\cdot 6\text{SiO}_2$ – a soda feldspar no longer being mined. **Toxic in inhalation.**

FELDSPAR: HT alkaline flux – insoluble aluminum silicates of potassium, sodium, and/or lithium – inexpensive flux for clay and glaze. Substitution of soda spar for potash spar can lower vitrification by 100°F. **Toxic in inhalation.** See **Custer, G-200 HP, F-4, NC-4, Minspar-200, spodumene, nephylene syenite.**

FERRO FRIT: See **frit.**

FIRECLAY: Refractory clay added to most stoneware bodies to improve **GPD.** Tremendous variation between different brands, some too coarse and non-plastic for studio claybodies.

FLINT: See **silica. Toxic in inhalation.**

FLOCS: Commercial flocculant used in glazes – 1/4 tsp. per gallon of glaze.

FLUORSPAR: CaF_2 – limited use as flux. As with **Cryolite,** fluorine reacts violently w/silica at HT, can cause pinholing, blisters. Useful in special-effect crater-glazes. **Highly toxic in inhalation, ingestion.**

FRIT: Ceramic raw materials that have been melted to glass, cooled, and ground to powder in order to stabilize soluble and/or toxic components during handling of unfired material. **All frits are ground glass, toxic in inhalation.** Frits commonly used in studio clay are:

FERRO 3124 – high-alumina calcium-borate frit, often used as a flux giving greater

strength in LT claybodies and as a flux in midrange glazes.

FERRO 3134 – calcium-borate frit often used as substitute for gerstley borate in low-fire glazes when greater reliability and/or insolubility is desired.

FERRO 3110 and **3195** – both very similar to 3134 – run tests to determine which works best for your needs. 3110 often used for *crystalline glazes*, but **Fusion 75** is substitute.

FUSION FRIT-75: Calcium-borate frit often used in crystalline glazes. Substitute is **Ferro 3110**.

G-200: $K_2O \cdot Al_2O_3 \cdot 6SiO_2$ – common potash feldspar no longer being mined. See **G-200 HP**.

G-200 HP: HT alkaline flux, new version of G-200, more refractory, no longer direct match to Custer feldspar. To get equivalent of Custer, blend .7 G-200 HP and .3 soda feldspar. **Toxic in inhalation.**

GERSTLEY BORATE; COLEMANITE; CALCIUM BORATE: $2CaO \cdot 3B_2O_3$ – major LT alkaline flux – often gives slight opalescence in glaze – for greater transparency and longer-term raw-glaze stability substitute Ferro 3134 or commercial Gerstley borate substitute. **Toxic in inhalation.**

GLOMAX: Calcined kaolin. See *kaolin, calcined*.

GLYCERIN; GLYCEROL: Concentrated sugar-alcohol syrup derived from fats/oils. Water-soluble thus useful as brushing medium for engobes, adhering medium for re-glazing fired wares, lubricating medium in burnishing. For applying glaze to vitrified surfaces, combine one teaspoon glycerin per 100 grams dry glaze and add water carefully to achieve application consistency.

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

GROG: Hard-fired clay crushed, graded, used in claybodies to improve working structure and decrease shrinkage. Grit sizes from 15-mesh (very coarse) to 150M (extra fine). Does not shrink in firing and may show texture through glaze. **Toxic in inhalation.**

GROLLEG KAOLIN: $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$ – fine white English kaolin, more costly than other choices, but gives whiter porcelain. Less plastic than TILE-6. Best kaolin for translucent bone china.

HAWTHORN BOND: Plastic *fireclay* often used in stoneware claybodies.

HELMER KAOLIN: $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$ – clay containing both *kaolinite* and *halloysite*, more plastic than other primary and many secondary kaolins. Works very well as flashing slip for salt, soda, wood, especially since Avery kaolin no longer mined.

HYDROCAL: Enhanced plaster from US Gypsum with greater tensile strength, good for press molds, not as absorbent as standard plaster and rarely used for slip-casting. See *plaster*.

ILMENITE: $FeO \cdot TiO_2$ – iron ore with significant titanium - most often used in granular form to produce dark specks in clay or glaze. Higher iron concentration than rutile.

IRON CHROMATE: $FeO \cdot Cr_2O_3$ – glaze colorant producing pink or red with tin, brown with zinc, gray with alkaline fluxes. **Highly toxic in absorption, inhalation, ingestion.**

IRON OXIDE, RED, FERRIC: Fe_2O_3 – powdered rust – refractory red in oxidation, in reduction converts to *black iron oxide*, a powerful flux. Low quantities in clear glaze produces celadon-green; high quantities produce *temmoku* brown-black, *tessha*, or *saturated iron* red. More than 5% in glaze significantly increases fluxing in reduction.

IRON OXIDE, BLACK; FERROUS: FeO – reduced form of iron oxide - gives same results as red iron in the firing, dependent on oxidation/reduction. Powerful flux in reduction.

IRON OXIDE, YELLOW: See **YELLOW OCHRE**

KAOLIN; CHINA CLAY: $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O}$ – refractory white-firing **primary** or **secondary** clay – essential ingredient of porcelain and whiteware – less plastic than most secondary clays. See **Grolleg, Helmer, Tile-6, EPK**.

KAOLIN, CALCINED: $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ – used in place of regular kaolin to adjust raw fit (reduce glaze drying-shrinkage) in glazes and engobes.

KINGMAN FELDSPAR: Potash spar no longer mined. Substitute **Custer**.

KYANITE: $3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ – aluminum silicate mineral formed by metamorphic alteration of clay, sometimes added to claybodies to promote formation of mullite crystals, increase thermal shock resistance. Coarser grits used as grog in refractory bodies for kiln-furniture.

LANTHANIDES; RARE-EARTH ELEMENTS: Group of metallic elements that can give subtle pastel hues in glazes.

LEAD CARBONATE; WHITE LEAD: $2(\text{PbCO}_3) \cdot \text{Pb}(\text{OH})_2$ – Former source of lead for glazes. **Highly toxic in absorption, inhalation, ingestion. Remove from studio and dispose of in a responsible fashion.**

LEAD OXIDE, RED LEAD: Pb_3O_4 – Former source of lead for glazes. **Highly toxic in absorption, inhalation, ingestion. Remove from studio and dispose of in a responsible fashion.**

LEAD SILICATE: $3\text{PbO} \cdot 2\text{SiO}_2$ – fritted lead compound – LT flux, but resulting glazes may be toxic, and should not be used on functional ware. Most powerful of all fluxes, promotes smooth flowing, self-healing glazes. **Highly toxic in inhalation, ingestion.**

LEPIDOLITE: Lithium feldspar – HT alkaline flux – used for thermal shock bodies and matching glazes. Contains some fluorine with associated problems. **Toxic in inhalation.**

LITHIUM CARBONATE: Li_2CO_3 – powerful AT alkaline flux, especially with soda or potash feldspars. Forms low-temperature eutectic with silica, promotes hardness and re-crystallization mattness in LT glazes. **Toxic in inhalation.**

LIZELLA CLAY: High-iron (4%) orange-red stoneware clay – best substitute for **Ocmulgee**, which is no longer mined.

LYE: Potassium hydroxide or sodium hydroxide. Caustic alkaline soluble that leaches out of wood ashes when soaked in water. **Toxic in ingestion, inhalation, may cause burns.**

MACALOID: Industrially-enhanced bentonite similar to **Veegum-T** – up to ½ of 1% of dry batch weight as glaze/slip suspension agent or brushing medium, up to 3% of dry batch weight as plasticizer in high-kaolin bodies. Mix with water before adding other ingredients.

MAGNESIUM CARBONATE: MgCO_3 – alkaline earth HT flux, promotes mattness and opacity in LT glazes, smooth, hard, buttery surface in HT glazes - promotes purples or pinks with cobalt. Very high **L.O.I.**, used to promote controlled crawl and beading glaze effects.

MAGNESIUM SULFATE: See **Epsom salts**.

MANGANESE DIOXIDE: MnO_2 – versatile colorant – with alkaline fluxes gives purple and red colors – by itself gives soft yellow-brown – with cobalt gives purple or black. Used with iron to color basalt bodies. Concentrations of more than 5% may promote blistering. **Highly toxic in inhalation, ingestion – fumes from firing are especially toxic.**

MICA: $\text{K}_2\text{O} \cdot 3\text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$ – aluminum silicate mineral with fine **sheet-lattice** structure, closely

related to clay and feldspar, found as iridescent flakes in some clays.

MINSPAR-200 FELDSPAR: $\text{Na}_2\text{O}\cdot\text{Al}_2\text{O}_3\cdot 6\text{SiO}_2$ – soda feldspar, interchangeable with **NC-4** and **F-4**. **Toxic in inhalation.**

MOLOCHITE: Porcelain **grog** - source of grit for pure white claybodies.

MONTMORILLONITE: Clay resulting from decomposition of wind-deposited volcanic ash, includes **bentonite**.

MULLITE: $3\text{Al}_2\text{O}_3\cdot 2\text{SiO}_2$ – as a raw material, calcined **Kyanite**; in MR and HT clay/glaze maturation, interlocking needle-like aluminum silicate mullite crystals that form above 1800°F and increase body strength, clay-glaze interface.

NC-4 FELDSPAR: $\text{Na}_2\text{O}\cdot\text{Al}_2\text{O}_3\cdot 6\text{SiO}_2$ – soda feldspar, interchangeable with **Minspar-200** and **F-4**. **Toxic in inhalation.**

NEPHELINE SYENITE: $\text{K}_2\text{O}\cdot 3\text{Na}_2\text{O}\cdot 4\text{Al}_2\text{O}_3\cdot 9\text{SiO}_2$ – **feldspathic** flux similar to soda feldspar but high in both soda and potash and lower in silica, therefore more powerful. Used in claybodies, glazes, especially MR. Increases firing range of LT and MR glazes. **Toxic in inhalation.**

NEWMAN RED CLAY: Refractory red stoneware clay used to obtain rich red and red-brown colors in HT claybodies.

NICKEL CARBONATE, GREEN: Ni_2CO_3 – weaker nickel colorant, reduces to **green nickel oxide** in firing. **Toxic in inhalation, ingestion.**

NICKEL OXIDE, BLACK: Ni_2O_3 – reduces to **green nickel oxide** in firing, produces similar effects. **Toxic in inhalation, ingestion.**

NICKEL OXIDE, GREEN: NiO – colorant or modifier - can give blues, tan, browns, greens, grays, dependent on fluxes present. Often used to mute effects of cobalt, copper, other colorants. **Toxic in inhalation, ingestion.**

OCMULGEE: Golden-brown stoneware clay no longer being mined. See **Lizella**.

OM-4: (Old Mine #4) – well known Kentucky **ball clay**. See **ball clay**.

OPAX: Zircon opacifier. See **zirconium silicate**. **Toxic in inhalation.**

OXFORD FELDSPAR: Potash feldspar no longer mined. Substitute **Custer**.

PEARL ASH; POTASSIUM CARBONATE: K_2CO_3 – HT alkaline potash flux, but water soluble.

PERLITE: Porous expanded granular silica useful in making insulating refractories. **Toxic in inhalation.**

PETALITE: $\text{Li}_2\text{O}\cdot\text{Al}_2\text{O}_3\cdot 8\text{SiO}_2$ – lithium feldspar HT alkaline flux – in clay bodies good for reducing thermal expansion, increasing thermal-shock resistance. **Toxic in inhalation.**

PETUNTSE: Chinese feldspathic rock containing potassium, sodium, and calcium, has plastic qualities. Traditional HT flux for Chinese porcelain claybodies and some Chinese glazes.

PIONEER KAOLIN: $\text{Al}_2\text{O}_3\cdot 2\text{SiO}_2\cdot 2\text{H}_2\text{O}$ – plastic secondary kaolin.

PLASTER: $\text{CaSO}_4\cdot 2\text{H}_2\text{O}$ – hydrated calcium sulfate manufactured from gypsum, sets to a porous solid when properly mixed with water. Used for making molds for pressing/casting clay forms.

PLASTIC VITROX: $\text{K}_2\text{O}/\text{Na}_2\text{O}/\text{CaO}\cdot\text{Al}_2\text{O}_3\cdot 10\text{SiO}_2$ – plastic high-potash **feldspathic** clay, similar in composition to **Cornwall stone** – used in place of potash feldspar in some porcelain bodies to increase plasticity. **Toxic in inhalation**

PORTLAND CEMENT: Calcium silicate aluminate – air-setting cement often added in small

amounts to homemade castable refractory mix to introduce air-setting qualities. **Toxic in inhalation**

POTASH FELDSPAR: See *G-200*; *CUSTER*.

POTASSIUM CARBONATE: See *pearl ash*.

PRASEODYMIUM: *Lanthanide* oxide used in manufacturing yellow ceramic stains.

PYRAX HS: Manufactured *pyrophyllite* product, promotes plasticity more than other pyrophyllite products. Product of the H.T. Vanderbilt Company.

PYROPHYLLITE: $\text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2 \cdot \text{H}_2\text{O}$ – used in HT claybodies (20% or less), especially porcelain, to add working structure, reduce thermal expansion, increase thermal shock resistance, reduce shrinkage, give stronger vitreous body. May reduce plasticity.

PYROTROL: A manufactured *pyrophyllite* product made by the Resco Company.

RARE-EARTH ELEMENTS: See *lanthanides*.

REDART: Popular red earthenware clay produced by Cedar Heights Clay Company.

RUTILE: Titanium ore, used as source of *titanium dioxide*, contains iron, other trace minerals - gives tan color, promotes crystallization giving mottled multi-color effects in some HT glazes or in under/overglaze wash (very refractory, use sparingly). Gives rich mottled medium blue in some MR and HT glazes. Dark rutile contains higher percentage of iron.

SALT: See *sodium chloride*.

SAND: Granular silica (usually) – source of grit for claybodies, gives smoother HT-fired surface than equivalent-grit grog. **Toxic in inhalation**.

SILICA; SILICON DIOXIDE; FLINT; QUARTZ: SiO_2 – main glass-former in clay and glazes – vitrification, fluidity, transparency/opacity controlled by adding fluxes and/or refractories.

Highly toxic in inhalation.

SILICON CARBIDE: SiC – highly-refractory material used in manufacture of kiln shelves. Used in very small quantities for localized reduction of copper reds – larger amounts for special-effects frothing glazes. **Toxic in inhalation**

SODA ASH; SODIUM CARBONATE: Na_2CO_3 – soluble source of soda, used as deflocculant or to supply soda in vapor-glazing process. Source of flux in Egyptian paste recipes. Brush solution over hi-fire glaze to increase carbon trapping. See *magic water* in glossary of terms. **Highly toxic in inhalation, ingestion. Skin irritant.**

SODA FELDSPAR: $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$ – feldspars contributing sodium (and potassium), primarily as MR and HT flux, includes *Minspar-200*, *F-4*, *NC-4*, *nephylene syenite*. **Toxic in inhalation.**

SODIUM CARBONATE: See *soda ash*.

SODIUM CHLORIDE; SALT: NaCl – table salt, rock salt – provides sodium source introduced into salt-firing. **Skin irritant.**

SODIUM SILICATE; WATERGLASS: Na_2SiO_3 – comes as a liquid (weigh like a solid) – used as deflocculant in slips, as air-setting binder for LT refractories. See *magic water* in glossary of terms. **Toxic in ingestion. Skin irritant.**

SPODUMENE: $\text{Li}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 4\text{SiO}_2$ – lithium feldspar - powerful HT alkaline flux – promotes copper blues - good for thermal-shock claybodies and matching glazes. **Toxic in inhalation.**

STAINS: Mason, Harshaw, Pembco, Ferro, etc. - stable *fritted* ceramic colorants available in

wide range of colors, suitable for coloring clays, slips, engobes, and glazes. Most are stable up to cone 5, many to cone 10. Can be mixed with 25-50% Ferro 3134 frit for Maiolica overglaze decoration. **Stains are ground glass and highly toxic in inhalation.**

STRONTIUM CARBONATE: SrCO_3 - alkaline earth, HT flux, similar to barium, slightly more powerful - gives semi-matt surfaces. Non-toxic in balanced glaze. Substitute .75 parts strontium to one part barium.

SUPERPAX: Zircon opacifier. See *zirconium silicate*. **Toxic in inhalation.**

TALC; MAGNESIUM SILICATE; STEATITE; SOAPSTONE: $3\text{MgO}\cdot 4\text{SiO}_2\cdot \text{H}_2\text{O}$ – HT alkaline earth flux in glaze, promotes smooth buttery surfaces, partial opacity - similar composition to clay, but in LT claybodies gives low shrinkage and high thermal-shock resistance, as in standard 50/50 talc/ball clay whiteware body. **Highly toxic in inhalation.**

TILE-6 KAOLIN: $\text{Al}_2\text{O}_3\cdot 2\text{SiO}_2\cdot 2\text{H}_2\text{O}$ – popular air-floated plastic secondary kaolin, greater plasticity than **EPK**, does not flash in salt/soda/wood. For flashing substitute **EPK** or **Helmer**.

TIN OXIDE: SnO_2 - most powerful opacifier but expensive. Inert dispersoid in glaze melt – 5-7% will produce opaque white in clear glaze. **Toxic in inhalation, ingestion.**

TITANIUM DIOXIDE: TiO_2 – matting/opacifying agent. Promotes crystal growth, visual texture in glazes.

ULTROX: Zircon opacifier. See *zirconium silicate*. **Toxic in inhalation.**

VANADIUM PENTOXIDE: V_2O_5 – weak yellow colorant – toxic, expensive – usually fritted with tin to produce stronger yellow **stain**. **Highly toxic in inhalation, ingestion.**

VEEGUM-CER: Blend of **Veegum-T** and *carboxymethylcellulose* gum; suspension/adhesion agent in glazes. Product of H. T. Vanderbilt Company.

VEEGUM-T: Suspension agent/plasticizer similar to **bentonite** and **Macaloid**. Up to 2% of dry materials weight as plasticizer in high-kaolin claybodies, especially porcelain, up to ½ of 1% of dry materials weight as suspension agent/brushing medium in glazes and slips. Blend with water before adding other ingredients. Product of H. T. Vanderbilt Company.

VERMICULITE: Porous expanded mica product used to introduce mica flecks in claybodies, and as filler in insulating refractory layer on kiln exterior.

VOLCANIC ASH; PUMICE: HT alkaline flux, similar in composition to potash feldspar, but higher in silica, with at least 1% iron. May be substituted for 7 parts potash spar, 3 parts flint. **Toxic in inhalation.**

WHITING; CALCIUM CARBONATE; LIMESTONE; MARBLE; CHALK: CaCO_3 – alkaline earth, contributing calcium oxide to glaze – powerful AT flux – major HT flux for glazes – gives strong durable glass. Sometimes used in low-fire claybodies to extend firing range and give greater fired strength.

WOOD ASH: HT alkaline flux, variable composition similar to feldspar, used in ash glazes. Use fireplace, wood stove, bonfire ash, **not wood-kiln ash**. Washing ash by soaking in water, decanting off water removes soluble/caustic alkalies, but ash-glaze purists generally prefer unwashed ash. **Toxic in inhalation, ingestion. Unwashed wood-ash-water mixture highly caustic – wear eye protection/rubber gloves when preparing/using ash glazes.**

WOLLASTONITE; CALCIUM SILICATE: CaSiO_3 – used in partial replacement of silica and whitening

in HT bodies, improves thermal-shock resistance. In some cases used in place of whitening to eliminate **L.O.I.** in problem glazes **Toxic in inhalation.**

XX-SAGGER: Plastic refractory stoneware clay similar to **Goldart.**

YELLOW OCHRE: FeO(OH) – High-iron yellow iron oxide, used as colorant in glazes and slips, converts to red iron oxide in oxidation or black iron oxide in reduction.

ZINC OXIDE: ZnO – HT flux, promotes bright glossy surfaces in HT, can encourage opacity, mattness in LT. In low-alumina HT crystalline glazes encourages macrocrystalline growth. Volatizes from thin glaze areas in HT reduction but still contributes to glaze appearance in thicker glaze. **Toxic in inhalation.**

ZIRCONIUM SILICATE: ZrSiO_4 - zircon opacifier, inert dispersoid in glaze melt, low-cost substitute for tin oxide. 10% of dry batch recipe added to clear glaze makes opaque white. Includes **Zircopax, Opax, Superpax, Ultrox.** **Toxic in inhalation.**

ZIRCOPAX PLUS: Common **zirconium silicate** opacifier, replacement for original Zircopax. See **zirconium silicate.** **Toxic in inhalation.**