

FLUXES

Glaze Materials: Glaze is a layer of glass fused to a clay body, composed of a glass-former, fluxes, and viscosity agents.

GLASS-FORMERS (RO₂)

Silica (SiO₂) is the major glass-former. Refractory, but forms eutectics w/many fluxes. Low coefficient of expansion, used to adjust crazing. Makes glaze harder, more durable. **Sources:** FLINT (a.k.a. quartz) as a pure source, or silica combined w/other ingredients in FELDSPAR, FRIT, TALC, CLAY, NEPHELINE SYENITE, CORNWALL STONE, PYROPHYLLITE, AND WOLLASTONITE.

VISCOSITY AGENTS (R₂O₃)

Alumina (Al₂O₃) is the major viscosity agent. Refractory. Inhibits crystal growth and devitrification. **Sources:** ALUMINA HYDRATE as a pure source or alumina, or combined with other materials in FELDSPAR, CLAY, FRIT, NEPHELINE SYENITE, CORNWALL STONE, PYROPHYLLITE. **BORON** is both a flux and viscosity agent.

FLUXES (RO, R₂O)

Alkaline fluxes: SODIUM, POTASSIUM, LITHIUM

Alkaline earths: CALCIUM, BARIUM, STRONTIUM, MAGNESIUM

Metallic fluxes: LEAD, ZINC

+ Classified as a viscosity agent, also acts as a flux: BORON

Flux	Active temp.	Characteristics	Sources (*soluble)
SODIUM Na ₂ O alkaline flux Note: KNaO is shorthand for ANY combination of sodium and/or potassium.	low-high	<ul style="list-style-type: none"> ▪ similar to potassium but a bit more active ▪ produces soft glaze surfaces that are easily abraded or attacked by acids ▪ <u>high</u> coefficient of expansion (crazes) ▪ brilliant color: Cu = turquoise, Mn = purple, Co = ultra-marine blue, Cr = yellow green, chartreuse w/ small amounts of Cr ▪ slightly more active than K or Li 	SODA ASH * SALT * SODIUM BICARBONATE * FELDSPAR (Kona F-4) FRIT (may be part soluble) NEPHELINE SYENITE CORNWALL STONE CRYOLITE
POTASSIUM K ₂ O alkaline flux	low-high	<ul style="list-style-type: none"> ▪ similar to sodium, generally, but a bit less active 	PEARL ASH * FELDSPAR (Custer) FRIT (may be part soluble) NEPHELINE SYENITE CORNWALL STONE
LITHIUM Li ₂ O alkaline flux	low-high	<ul style="list-style-type: none"> ▪ similar to KNaO, but has a <u>low</u> coefficient of expansion 	LITHIUM CARBONATE (may deflocculate glazes) Li FELDSPARS (Spodumene, Lepidolite, Petalite) FRIT MACALOID

Flux	Active temp.	Characteristics	Sources (*soluble)
LEAD PbO metallic flux	low-med	<ul style="list-style-type: none"> ▪ volatilizes @ cone 6 ▪ blisters in reduction ▪ med. coeff. of expansion ▪ soft glaze, may be leached w/acids ▪ poisonous raw, may be leach toxic amts. in the fired state ▪ warm color response: + Fe = amber, warm brown.+ Cd & Se = red.+ Mn = plum. + Cr = orange. + Cu = grass green transp. 	WHITE LEAD RED LEAD LITHARGE GALENA LEAD CHROMATE FRIT (eg. Ferro 3300 or O'Hommel Pb series)
ZINC ZnO metallic flux	med-high	<ul style="list-style-type: none"> ▪ low coeff. of expansion (in small amts. decreases crazing) ▪ high Zn opacifies and matts ▪ excess may cause crawling ▪ promotes crystals w/Ti & low Al ▪ nice Co blues, muddy Fe browns, + Cr = brown. + Cu = bluish green ▪ In cone 10 reduction, Zn is completely volatilized. See ClayArt archives for discussion: http://lsv.uky.edu/archives/clayart.html 	ZINC OXIDE CALCINED ZINC OXIDE FRIT
CALCIUM CaO alkaline earth flux	high	<ul style="list-style-type: none"> ▪ produces hard glaze ▪ helps thermal shock resistance ▪ favors celadon greens in reduction ▪ NOT good for Cu red ▪ excess will matt or cloud ▪ forms eutectics often in small amounts ▪ + Cu = toward green in low temp. oxidation. 	WHITING DOLOMITE BONE ASH WOLLASTONITE FLUROSPAR FELDSPAR FRIT GERSTLEY BORATE CEMENT PLASTER
BARIUM BaO alkaline earth flux	high	<ul style="list-style-type: none"> ▪ not very active flux ▪ good matting agent ▪ Ba + B form eutectic & will not mat ▪ hardens glaze ▪ toxic raw, may leach in high Ba matt glazes. See article by Janet DeBoos in Janet DeBoos Ceramics Technical #3 (1997). Not recommended for food ware. Substitute .75 SrCO₃ instead. ▪ good for Cu reds in reduction ▪ Cu + high Ba = matt blue even in reduction. + Fe = blues in reduction. + Cr = warmer opaque green. + Co = purple-blue. 	BARIUM CARBONATE FRIT

Flux	Active temp.	Characteristics	Sources (*soluble)
MAGNESIUM MgO alkaline earth flux	high	<ul style="list-style-type: none"> ▪not very active flux ▪good for crystal glazes ▪high Mg = buttery matt & opaque ▪hardens glaze ▪colors toward pastels ▪Mg + Co = purple 	MAGNESIUM CARBONATE DOLOMITE TALC FRIT
STRONTIUM SrO alkaline earth flux	high	<ul style="list-style-type: none"> ▪similar to Ca in glaze effect, but slightly more active while less fluid. ▪use .75 SrCO₃ to replace 1 BaO (test!) Slow to melt: soak. 	STRONTIUM CARBONATE (slightly soluble)
BORON B ₂ O ₃ viscosity agent that also functions as a flux	low-high	<ul style="list-style-type: none"> ▪classified as a viscosity agent but also acts as a flux ▪produces high gloss ▪boils at high temps. ▪wide firing range ▪small amounts decrease crazing, large amounts may cause crazing ▪inhibits crystal growth & devitrification ▪thickens melted glaze, excess may cause crawling ▪may have a solvent effect and leach slip color ▪color may be opalescent, mottled w/ high B 	BORAX * BORIC ACID * GERSTLEY BORATE FRIT

FRIT	Substitutes	Melting °F	Comments * (coefficient of expansion x 10 ⁻⁶)
3110 Ferro	P-IVo5 Pemco	1400	Highly alkaline. Somewhat soluble: not recommended as a body flux. As a main flux causes crazing. Coefficient of exp.10.1 *
3195 Ferro		1500	Alkaline-boron. Not as alkaline as 3110, w/more Ca, B, Al, but still tends toward alkaline color response. Coefficient of exp.6.5 *
3124 Ferro	P-311 Pemco O Hommel 90	1600	Borosilicate, high calcium, good for tableware. Coefficient of exp. 7.9*
3134 Ferro	P-54 Pemco O Hommel 14	1450	High sodium, calcium, and boron. No alumina. Coefficient of exp. 9.6*
3289 Ferro	Fusion Frit 65 GF129	1500	Barium-some sodium. Coefficient of exp. 8.2*
3819 Ferro	P-25 Pemco O Hommel 259	1400	Alka-boron. Low Ca. Coefficient of exp. 10.3*