Glaze Chemistry

Let’s start with a very simple glaze formula.

This glaze was created by Bernard Leach, who was an influential potter in the early and mid 20th century. His book “The Potter’s Way”, is an important read.

This recipe is for a Cone 10 celadon glaze.

It is simply called a 4321 celadon, according to its ratio of ingredients.

Potash Feldspar 4

Silica 3

Whiting 2

Kaolin 1

Next we will discuss each ingredient, break down the chemical components, and consider what each one is contributing to the glaze.

Potash Feldspar

Feldspars are very important in glazes. They are one of the main sources of flux that allow the glaze to melt. Potash chemical formula is $KAlSi_3O_8$. K is the symbol for potassium, therefore the name Potash. Al (aluminum) and Si (silica) are the glass components. There are also Sodium and Calcium Feldspars. Together they make up about 41% of the earth's crust.

Silica

Also known as Flint, Silica is the main glass former and is the principal ingredient in ceramic glazes. It's formula is SiO_2. Because of its high melting point, 3110℉, it requires the potassium in the feldspar to melt at cone 10 (2284℉), almost a 1000 degrees cooler.

Whiting

Whiting is limestone or Calcium Carbonate ($CaCO_3$). It is also a flux at high temperatures. Because this glaze is made up of 30% silica and the feldspar also contains silica, this additional flux will create a glossy finish.

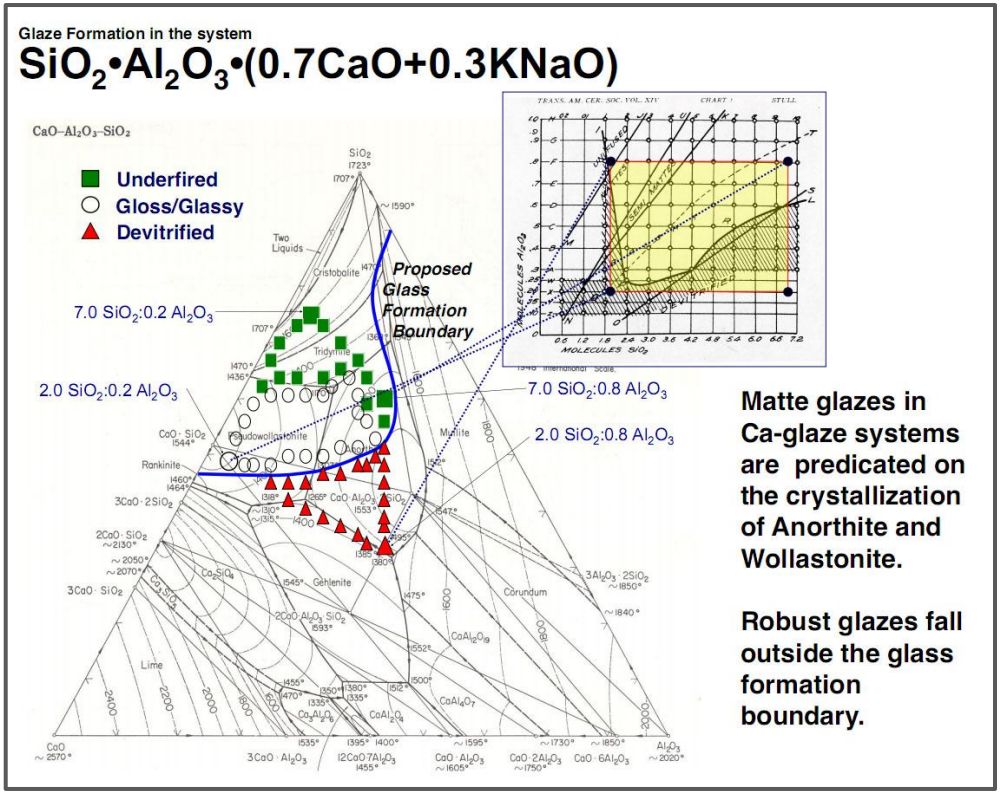
Kaolin

Kaolin is China Clay, basically porcelain. There are many different types and all have different formulas. The idealized chemical formula of clay is Al_2O_3 $2SiO_2$ $2H_2O$, but this does not exist in nature due to all sorts of chemicals added when clay is formed naturally.

Kaolin is only 10 % of the recipe but it adds an important feature. It helps to keep the glaze in suspension and allows it to stick to the bisque when applying. Too much and it will have an opacifying effect.

Glaze Unity

There is a concept called Glaze Unity. I understand the basic concept, but my knowledge is very, very limited. My understanding is mostly through trial and error. I am not a chemist.
The top of the pyramid is Silica, the right is Aluminum and the left is Calcium (the flux). Balancing each element with different proportions will create different varieties of glazes. There are many books if you want to explore, but I would just experiment!



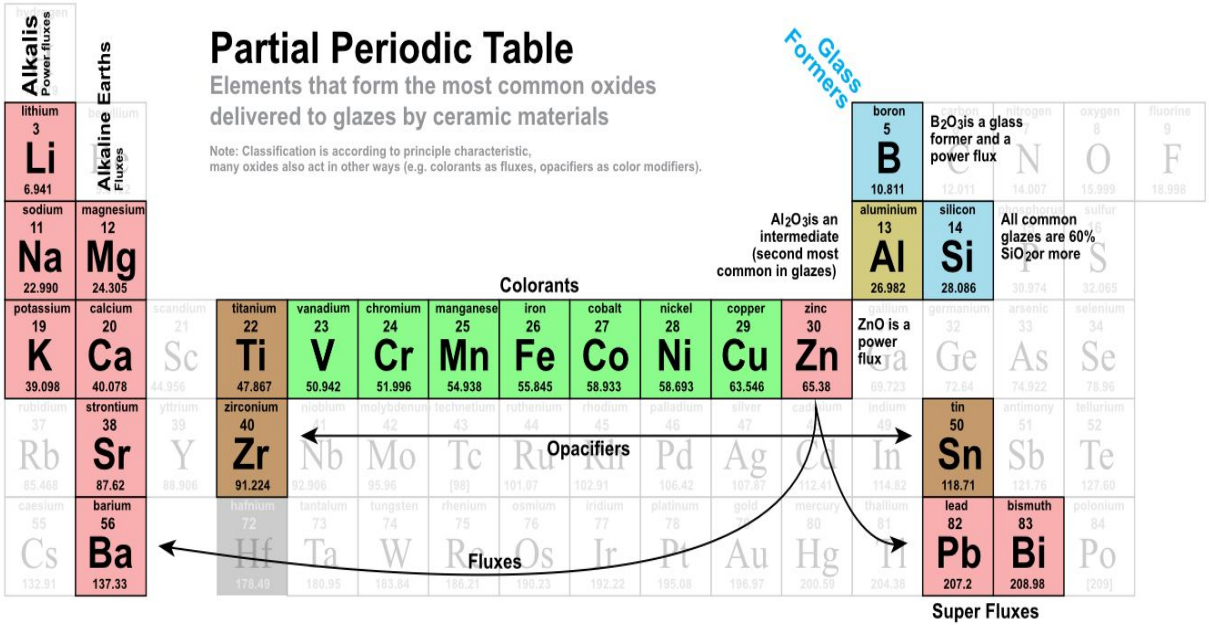
Colorants

The 4321 celadon is a glaze without any metallic oxides or carbonates. These are what add color to glazes. Iron, Copper, Cobalt, Chrome and Manganese are common ones. Oxide means the element is attached to an oxygen atom and carbonate to a carbon atom. There can be many forms of one element that can cause different results.

Such as Cobalt oxide creates a very powerful blue in small amounts and Cobalt carbonate will need much material to create the same effect.

The type of atmosphere or kiln firing, can also change the what color the colorant can produce. Copper in an electric kiln can produce a green, while in a gas kiln a red.

Periodic Table



In the previous Periodic Table, notice how are the colorants are in a straight line highlighted in green.

The fluxes are on the mostly on the left side in pink (we don’t us Lead (Pb) anymore)

The glass formers are in blue on the top right.

I think it is very interesting how the periodic table is organized according to chemical properties of elements, and in ceramics what we use elements corresponds to this.

Thanks everyone and please let me know if you have any questions!