Lecture II

CLAYS AND CLAY BODIES
(1)

Charles F. Binns

Clays are rarely pure. Even China clay contains a variety of substances other than the clay base, though the amount of these is small. For the most part this foreign matter is harmful, because it consists of fine particles of rocks and minerals which the potter will use anyway in compounding a working body. Every clay has its own properties and it is the business of the clay worker to make use of these for his purpose. Thus clays are to be differentiated from clay bodies. A clay is a natural substance. A clay body may be also natural, but more often it is a mixture prepared for a specific purpose. It must have certain properties, correctly proportioned. First, plasticity, the property of receiving and retaining form. To produce this a certain amount of water is necessary. Dry clay is not plastic and wet clay is fluid. A well proportioned clay body will require about 25 percent of water by weight in order to produce the maximum amount of plasticity. A body containing ball clay will require more water than a similar body made from China clay. For wares in the manufacture of which speed is important a very plastic clay body must be used. In the production of superior wares great speed is not possible because the body is made from china clays which are not very plastic.

The second required property is porosity. A clay body must possess tiny apertures or passages through which the water of plasticity may escape. If there were no such pores the manufactured piece would burst on being dried. It is sometimes found that a piece made from a very plastic clay will warp out of shape either in the drying room or the kiln. The reason is that moisture and combined water in their effort to escape and in the absence of free passage exert strains which the clay form cannot resist. Porosity is produced by sand and regulated by the proportion present or added. The sand in clays and clay bodies is not the coarse grained material that usually goes by that name. It may be of the same composition as this but it is exceedingly fine in grain. Any non-plastic mineral powder is sand whether it is coarse or fine. Both ground flint and ground feldspar are, therefore, considered as sand and they contribute equally to the porosity of the raw material. Posority is, in fact, the reverse of plasticity and these two properties are balanced against each other according to the requirements of the case.

The third property is that of yielding to the fire. This is spoken of generally as vitrification though it rarely proceeds as far as that term would indicate. A vitrified ware is quite dense or glass like, which is the true meaning of the word. Under the influence of a high temperature, a clay body will proceed towards vitrification but the progress is arrested at the point required and pre-determined. The word"densification"has been coined as explaining the process undergone by nearly all ceramic wares. In this process the active principle is feldspar. The term "feldspathic sand" is often used because there are generally present some fusible materials other than the feldspar itself. Thus the sand which produces porosity in the raw condition separates itself in the firing and each part performs a different function. The flint or silica sand remains practically inactive while the feldspathic or fusible sand softens when strongly heated and cements the clay and flint particles together. It is this action which produces the pleasant features of ceramic wares: density, strength, and sonority and ultimately translucency.

In a well prepared clay body then, these three properties, plasticity, porosity and density are present; the first two in the raw clay, the last in the fired ware. The porosity of the clay has nothing at all to do with any porosity that the fired pottery may possess.

Some natural clays have these properties in their own substances but such clays are almost always red. There is no natural white clay body avaialbe.

Pure clay, sometimes known as clay substance or clay base has a definite composition. Sometimes it is found in crystal form and is known as Kaolinite. This, however is rare. Generally it is found to be soft and without structure. In the coarser clays little accordian like forms can be found with a microscope but the bulk of the material is too fine in grain for difinition. Its composition is:

Silica	46.51	
Alumina	39.58	
Water	13.91	100.00

Some clays, such as the white clays of Georgia and Florida are in practice considered to be pure as they are about 98% clay base. Other clays contain from 70% to 90% clay base, the balance being sand as already described.

Pure Potash Feldspar has the composition:

Silica	64.74	
Alumina	18.35	
Potash	16.91	100.00

Commercial spar, however, is never as pure as this as will presently be seen.

Flint is practically quartz or pure silica and is considered as such.

From these facts, it is not difficult to determine the composition of a clay in terms of clay-base, feldspar and quartz. Suppose a clay contains 2 percent of potash: this indicates the presence of feldspar because neither clay base nor quartz contains potash and from this figure the amount of feldspar is ascertained by three steps. The first is to determine the proportion of alumina present in the feldspar represented by the 2% potash.

Potash		Alumina		Potash		Alumina
16.91	:	18.35	=	2	:	2.17

A simple way of making this calculation which often recurs is to establish as a factor the relationship between the potash and alumina in feldspar thus:

$\frac{18.35}{16.91} = 1.085$ so that the amouht of potash recorded in any clay, multiplied by this factor gives the amount of alumina combined with the potash.

Following a similar rule the silica in the feldspar can be found:

Potash		Silica		Potash	Silica
16.91	:	64.74	=	2	7.656

The factor in this case is $\frac{64.74}{16.91} = 3.828$

These three items can now be assembled:

Potash	2.00
Alumina	2.17
Silica	7.66
Amount of feldspar	11.83% in the clay.

The next step will be better understood if the analysis of an actual clay is considered.

Such a clay may contain:

Silica	~~64~~ 54
Alumina	~~25~~ 35
Potash	2
Water	9
	100

It will be seen at once that this is not a pure clay because it does not agree with the analysis given for pure clay base. The question now is how much clay base does it contain and what else is present. The amount of feldspar has already been determined as based on the 2% of potash.

The clay is now set out in tabulated form

	Clay	Feldspar	Remainder	Clay Base	Quartz
Silica	54	7.66	46.34	38.62	7.72
Alumina	35	2.17	32.83	32.83	
Potash	2	2.00			
Water	9		9.00	9.00	
	100	11.83		80.45	7.72

The first column is the clay under examination, the second is the feldspar as calculated above. Subtracting the items of the second column from those of the first the remainders are placed in the third. The clay base to be placed in the fourth column will contain all the remainder of the alumina and all the combined water. The water need not enter into the calculation because it all belongs to the clay base anyway. The question now is how much silica does the clay base contain in proportion to the alumina. The figures have already been given, Silica 46.51, Alumina 39.58. The ratio between those figures is 1.177 so that the amount of silica is found in the present case by 32.83 x 1.177 = 38.62, which figure is placed in the fourth column on the silica line.

This does not exhaust the silica, however. There is a remainder of 7.72 which is placed in the fifth column as pure silica or quartz.

This particular clay, therefore consists of the oxides:

Silica	54.00
Alumina	35.00
Potash	2.00
Water	9.00

and these are contained, as calculated, in the minerals:

Clay base	80.45
Feldspar	11.83
Quartz	7.72

By expressing the composition of a clay in this manner the potter obtains a much clearer understanding of its nature. He is accustomed to compose the bodies needed in his craft by the use of clay, feldspar, and flint, and the clay is now set before him in these same terms.