PROCEDURES FOR TESTING LOCAL CLAYS: By Miska & Doris Petersham

Much information about clays can be found with simple tests and a minimum of equipment. This knowledge can be very helpful in evaluating a clay for possible use. Some of this information requires background and experience with clay because it is judgmental in nature while others only require recording of direct measurement. The final evaluation of clay, however, does require experience and actual work with the clays since tests at best are only an indication of possibilities.

Equipment need:

one or more pails
several bowls or plastic dishpans
centimeter ruler
gram scale (beam balance preferred)
plaster bats or bisque slabs
magnifying glass
30 mesh screen (window screen)
60 mesh screen
120 mesh screen
sponges
small test kiln with pyrometer (see enclosed drawing)

When possible, for a truly representative sample of a deposit, the material should be a mixture of samples taken several feet apart or a quartered sample if using an already dug clay. (Example of quartering -- divide pile in quarters and take some clay from each quarter to mix together for the sample to be tested). Any method that ensures a blended sample will more accurately represent variation within a given deposit. Tropic (i.e. geologically fast weathered) clays are more likely to have gross physical differences within a small area and therefore more care must be taken to get a blended sample.

Information to be gathered

A. Working qualities of clay, requiring experience (judgmental in nature)
   1. plasticity
   2. body
   3. grain
   4. green strength at leather hard stage
   5. green strength at dry stage

B. Fired qualities of clay requiring experience (judgmental in nature)
   1. maturing temperature
   2. fired strength - ring
   3. brittleness - chipping
   4. aesthetics of color, texture etc.

C. Qualities that can be measured
   1. ease and length of time to slake
   2. 30 mesh and over-screening
      a. per cent of non-clay materials
      b. make up of materials
   3. 60-30 mesh screening
      a. per cent of non-clay materials
      b. make up of materials
   4. 120-60 mesh screening
      a. percent of non-clay materials
      b. make up of materials
   5. total sample--percentage of clay and fine non-clay materials
   6. shrinkage, plastic to dry
   7. shrinkage, dry to 1000° C
   8. shrinkage, 1000° to maturity
   9. shrinkage total
   10. absorbtion at maturity
   11. water of plasticity
   12. casting properties

A. Locate and collect
B. Identify site on map by reference to known landmarks
C. Break up lumps and spread out to dry -- the smaller the lumps, the easier to dry and slake. Clay is very difficult to slake when wet because the water cannot penetrate the plastic clay easily, therefore thorough drying is important.
D. Slake -- in two separate containers -- add dry clay to water. In first 100 grams of dry and in second approximately three times this amount. It is only necessary to weigh the 100 gram batch. Clay should reach to just under the water surface--allow to slake till soft, noting time required for this. Some clays slake in minutes, others can take 12 to 24 hours and others require mechanical stirring. DO NOT STIR until satisfied no further change will occur.

   In general a clay that is difficult to slake may contain montmorillinite. Many other factors affect slaking action such as particle size, non-clay materials present, etc., so this time factor can only be used as an indicator when taken together with other clues.
E. Stir the 100 gram sample to thin slip (thin cream consistency) add water if necessary. Screen thru 30 mesh screen or (window screen). Retain and dry any residue. When dry observe thru a magnifier -- note kind of material present, such as rock fragments, quartz, feldspar, etc. This gives a good indication of what the fine non-clay material will consist of. Weight this dry residue, the figure in grams is the per cent of over 30 mesh material; i.e. 12 grams of residue means 12% of the sample is over 30 mesh non-clay material.

   Repeat this for both 60 and 120 mesh screens. Some clays will contain large amounts of coarse material and some almost none. It is usual that sedimentary or alluvial clays will contain more uniform particles and material quite different from the parent rock. Primary clays will contain more rock fragments of many sizes and resemble the clay in color. Remember, there are many variables so consider all the clues.

F. Dry till plastic on plaster or bisque tile. Make one or more test tiles approx. 2c x 10c x .5c from the remaining clay. Note plasticity, body color, etc. Mark a 10 centimeter line and an identifying mark on the slab and set aside to dry (gives 120 mesh tile).

G. Screen remaining sample thru 30 mesh screen (or window screen) which will give a sample that can be fired safely. Rock fragments larger than 30 mesh will sometimes explode in firing. Note plasticity, body, etc. Make several tiles 10 centimeter lines and identifying marks -- at least five are needed (gives 30 mesh tile). Note: since plasticity increases with aging a sample only semi-plastic at initial testing will probably be considerably better when made in quantity.

H. When tiles are dry note plastic to dry shrinkage, warpage, cracking, etc. Compare 120 mesh and 30 mesh tiles.

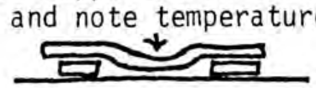
I. Break one tile at leather hard stage and note toughness.

J. Break again at dry stage and note.

K. Fire remaining samples to 1000^{o}C. Prop one so it can sag (if it is going to do so before this temperature) by bridging across two others just touching on either end.

L. After firing measure shrinkage and check sagging -- if sagging occurs, the clay will not fire to that temperature.

Note color, note ring (tap with metal object), note warpage, note surface or other cracking.

M. Check maturing temperature by firing with pyrometer and/or set of cones till sag occurs. Position tile in front of kiln peep hole supported on each end so you can see when sag occurs. Shut off at sag point and note temperature. Maturing temperature is probably about two cones lower. 

N. Fire a tile to probable maturing temperature again supporting so sag can occur. If no sagging note shrinkage, ring, color, etc.

O. Break the tile and record estimate of brittleness, hardness, etc.

P. Test absorbtion by weighing a tile--record its weight in grams as W.D. Soak tile in water twelve hours or boil 1/2 hour--pat dry and weight again which is W.W. To find per cent of absorbtion.

$$\frac{WW-WD}{WD} \times 100 = \% \text{ of absorbtion}$$

<u>Note</u>: Standard clay theory suggests for a stoneware clay in the C/6-C/10 range, the total shrinkage should be under 15% and the absorbtion o-1%.

For an earthenware clay C/06-C/02 total shrinkage of under 12% and absorbtion of under 10%.

Tropical and volcanic clays are quite different and <u>do not</u> react according to classic clay theory. With understanding, however, <u>they may</u> be used to produce good quality ceramics.

We have found shrinkage to be high, plastic to dry from 10-17% and totals up to 30%.

An acceptable range therefore might be anything up to 20% for total shrinkage.

We have not been able to place tropical clays in the standard categories (i.e. earthenware, ball clay, etc.). They seem rather to have elements of several categories. Almost all contain iron and many are weathered by hydraulic action rather than surface water. Kaolinite, when present, is usually disordered in the form of Hallosite and there is often some form of montmorillinite which no doubt accounts for the high shrinkage.

Absorbtion seems to be high and the vitrification range short so that even at high temperatures it is difficult to reduce the absorbtion below 5-8% without causing warping and bloating.

We, therefore, suggest that testing done on tropic clays not rely to heavily on classic theory.

Firing bisque must be extremely slow since there is additional water given off at both $100^{o}C$ and $500^{o}C$. In the case of some clays this can be four times as much as normal Kaolinite.

Q. Additional information if desired can be found by testing shrinkage and absorbtion every $50^{o}C$ up to sag point. This information when plotted on a graph gives a good indication of changes taking place.

R. Water of plasticity is found by weighing a lump of the desired plasticity W.P. then drying this lump to 100^{o}C and weighing = W.D. (Make sure the sample is bone dry.)

$$\frac{WP-WD}{WD} = 100 = \text{water of plasticity}$$

S. Casting qualities are determined by the effectiveness of deflocculation. Clays containing montmorillinite generally deflocculate poorly and thus have poor casting qualities. Equipment need: 1. 500ml measure, 2. beaker, 3. gram scales, 4. eye dropper, 5. N. Brank Sodium Silicate 10% solution, 6. small plaster mold.

* Weigh out 100 grams of dry screened clay -- set aside -- weigh four or five batches of 25 grams each. Record all amounts.

measure 100ml of water into container
add 100 grams of clay
add additional clay in 25 gram units till slip is very thick
add eight drops N. Brank Sodium Silicate
if slip thins (at this point) it may cast, if not will probably not cast
alternate additions of clay to thick state and SS to thin state till no change occurs with SS recording quantities of each -- this is the formula for that clay

* Instead of this test for deflocculation I recommend you use the one I have given you... "A PRACTICAL METHOD FOR TESTING THE CASTING PROPERTIES OF CLAY." You may also want to test clays with other deflocculants. Mixtures of Sodium Silicate and Soda Ash, for example, deflocculate impure (earthenware) clays better then does Sodium Silicate alone. You might also want to try DARVAN. V.C.

Note: Most tropical clays that will cast average: 175-225 gram clay/100ml H_2O/16-24 drops SS.

T. A chemical and/or mineralogical analysis can also be useful as an indicator of what to expect. It can confirm or reject why certain physical properties are occuring.

U. There however can be no substitute for a trained observer actually using the material to produce an item. The final proof regardless of test results is whether the particular clay works. If pots are to be made from the clay several pots must be made by various methods, fired and glazed -- only then can any assurance be given.
