Clay Body Formation for Ceramic and Sculpture Production

Dr. Abamwa, Oghenekevwe, E.&
Professor Abel Mac Diakparomre

abstract
Clay is a natural resource that can be found in almost every geographic region of the world. It is a medium that is profusely used by ceramists and sculptors. Its constituents and quality, however, vary from deposit to deposit. This variation is most noticeable in its plasticity and maturing temperature. Plasticity and the maturing temperature are very important elements of this medium in their application in ceramic and sculpture production. However, it is not in every clay body that these qualities may be found. The research burden, therefore, remains on how suitable plastic clay can be sourced for ceramic and sculpture production. This paper attempts to provide a solution to this problem by formulating clay-bodies that combine both qualities using locally-sourced materials and ingredients.
Keywords: clay, flints, bentonite, ceramics, sculpture

Introduction

Clay is considered one of the world's most abundant natural resources. It is commonly found because it is part of the earth's surface on which we tread. Geologic evidence suggests that it was formed millions of years ago from the decomposition of granite-like rocks that make up a large part of the earth's crust. Millions of years of weathering by sun, rain, wind and plants have broken down these decomposed rocks which contain feldspar into smaller and smaller particles that end up as clay. Congruent to its abundance, clay has also been used by man all through the ages. In buttressing this statement, Ahuwan (2014:1) said that "over the years, I have come to the terms with the fact that clay is for people and of the people. By implication, clay defines culture".

In Neolithic times, man used clay to produce terra cotta. The terra-cottas of ancient Greece and ancient China also exemplify some other traditions of superb terra-cotta traditions. The Mayan people also deployed the plastic quality of clay in remarkable ways. Indeed, man is said to have used it for more purposes than any other material. This is probably because, in its raw state, it can be formed into countless shapes; and when it is fired, it becomes hard and durable (Peter 1988:7). This versatile medium is composed largely of a hydrous silicate of alumina.

In comparison to other materials for art production, clay is a relatively cheap and wonderful material to handle. It lends itself to a variety of applications in the ceramic and sculpture arts such as in the production of figurines, terra-cottas, the making of models which are subsequently reproduced by casting in materials such as plaster, bronze, aluminium, and concrete as well as for the making of bricks, jewellery, table-wares, and sanitary-wares, among others. The physical properties that imbue clay with this versatility in the modelling techniques in ceramics and sculpture are its plasticity and ability to become hard and rock-like when fired. Plasticity specifically refers to how flexible a clay body is. This plasticity is greatly influenced by the clay body's particle size, the water of plasticity, and other mineral constituents which include oxides and other organic substances.

The plasticity of clay makes possible intricate and detailed modelling and highly textured surfaces that are practically impossible in other media of art production. It is also the plasticity of this medium that is exploited in providing clues to the immediate handling of the medium in sculpture practice. This plastic quality was highly exploited by Giovanni da Bologna in his model for a sculpture representing a *River God.* The wet-looking, smeared and rippling surface of this model is suggestive of the watery essence of the being it represents. This expressiveness is made possible by the plastic nature of the medium

.

The degree of plasticity of any clay body is partly dependent on the percentage of the organic elements it contains. The more organic materials in a clay body, the more plastic that clay body is. In view of the fact that the plastic quality of clay varies from one deposit to another, and given the significance of this property to the modelling arts of ceramics and sculpture, the ceramist and the sculptor inevitably has to formulate clay bodies that are suitable to his or her needs. This can, however, only be achieved by a thorough understanding of the clay deposits available in the immediate environment and a careful analysis of one's needs.

It seems however that sculptors and ceramists (traditional and modern) that have had to rely on the use of clay from the Isheagu deposit; as is the case with may plastic art practitioners in Delta State; do not seem to consider this necessity in their sourcing of clay for their practice.

This study, therefore, examined samples from one notable centre of clay-use (Isheagu) in Delta State of Nigeria and proffers suggestions for retaining plasticity in the clay while at the same time making it more suitable for modelling activities and durable finished products by formulating clay bodies that combine the two qualities of plasticity and high maturing temperature.

.

MAP OF DELTA STATE SHOWING IKA NORTH - EAST

MAP SHOWING IKA NORTH - EAST

Classification of Clays

Clays are generally classified into two categories: primary and secondary. The parameters for this classification are usually the properties that exist in the clays. The primary clays are formed on the site of their parent rocks and are found in irregular pockets because they have not been transported, either by water, wind or glacier. The primary clays are not plastic because of the coarse nature of their particles and rock fragments. As a result of this, primary clays are not directly suitable for modeling. However, when they are cleared of rock fragments and non-clay minerals contaminations theytend towards being pure.

On the other hand, secondary clays are those clays that have been transported from site of the parent rock by water (which is the major agent of transportation) and also by wind or glacier action. This category of clay varies widely in composition.This is largely due to contact with oxides, and accumulation of other substances in the process of transportation. Secondary clays are usually more plastic because their particles are finer.

In spite of the fact that secondary clays are generally plastic, the degree of plasticity still varies from deposit to deposit. This variation is determined by the quantity of inorganic substances that are embedded in the process of formation. As a result of the accumulation of these inorganic substances, many of the clay deposits found in the sedimentary beds of Delta State yield clay that has high degree of plasticity but are low in maturing temperature. The consequence of this is that the ceramic and sculpture object produced from this medium in the region have reduced durability.

The significance of fired clay objects with respect to durability is probably exemplified in its accidental discovery. According to Glenn (1960:2), the accidental burning of clay coated baskets which turned out to be harder in strength and more durable than un-burnt ones revolutionized the tradition of producing objects from clay. It was the survival of this technology that occasioned the production of the fired clay object that was discovered in the process of mining tin mines in the village of Nok in north-central Nigeria in 1936. This object – the head of a monkey –from a civilization that is dated as having existed between 600 BC and 200 BC provide further evidence that baked clay have higher chances of longevity than those that are not fired. All of the fore-going however still depends of the maturing temperature of the clay body with which the object was produced.In this study, a number of clay bodies were formulated by the addition of earthy materials such as ball clay, fired clay, flints, feldspar, and bentonite.

The Chemical Composition of Isheagu Clay Deposit:

Before the formulation of clay bodiesfrom the Isheagu clay depositthe chemical constituent and component was determined. The chemical components of the Isheagu clay were also tested using the Direct Reading 4000u Spectrophotometer (DRS) method. This was to analyze the clay natural content. The table below shows the constituent of the clay.

Constituents	Percentages
Silicon dioxide	50.37
Aluminum	07.36
Iron oxide	14.16
Calcium	06.59
Sodium oxide	**05.80**
Potassium oxide	10.69
Quartz	05.03
Total =	100%

Plasticity Test

After the chemical constituents and components of the Isheagu clay deposit have been known, a sample of the clay was tested to find the degree of plasticity. To do this, coils were prepared from the clay and they were wound around a finger and left to dry and no cracks were found. Thereafter the coils were fired to a temperature of 1020^{oc} to find out again if there will be cracks but cracks were also not found. Another test was carried out using a pyramid. This process was made by pinching and placing some of the clay over another until the pyramid is formed. The essence is to find out if the pyramid will retain its shape within duration of twenty four hour. The result of this test was that pinches of the clay that formed the pyramid did not separate or fall apart. After these tests ceramic and sculptural forms were produced from the sample. The produced ceramic and sculptural forms were exposed to accelerate drying by their being left in the open air. This was to determine their resilience and to establish the plasticity of the clay.

Fig.1. Fired at 950^{oc}

Fig.2. Fired at 970^{oc}

Water of Plasticity Test

Test for water of plasticity was also carried out in order to measure the amount of water needed to be added to fixed quantity of dry clay (4kg) of Isheagu to make the clay plastic. To determine this, this formula was used.

$$\frac{\text{Weight of water added}}{\text{Weight of dry clay}} \times \frac{100}{1}$$

$$\frac{\text{1 kg of water added}}{\text{4kg of dry clay}} \times \frac{100}{1}$$

$$\frac{1}{4} \times \frac{100}{1} = \frac{100}{4} = 25\%$$

This test proves that the water of plasticity is 25% of 4kg of dry clay.

Shrinkage Test

Shrinkage test was also carried out. A clay slab was produced from Isheagu clay and line measuring 10cm was drawn on the slab. The slab was allowed to dry. After this, the slab was bisque fired, and the measurement of the line reduced to 7.2cm. This decrease in length of the line was calculated to establish as follows: WL = wet length and FL =fired length

$$\frac{WL-FL}{WL} = \frac{10-7.2cm}{10cm} = \frac{2.8}{10} = \times \frac{100}{1} = 28\%$$

The length of shrinkage was 2.8cm which translate in percentage of 28%.

Absorption Test

Another test was carried out to determine the degree of absorption. The same slab used for testing shrinkage was used for the testing of rate of absorption. The slab was immersed into water in a pot and the pot was covered with a lid and allowed boil for an hour. Before the slab, weight was also recorded. The weight of the dry slab was deducted from the boiled weight.

To calculate absorption rate, the formula:

$$\frac{\text{Boiled Weight - fired weight}}{\text{Fired dry weight}} \times \frac{100}{1}$$

12.7 gram – 10.6 gram = 2.1gram.

Difference in weight = 2.1 gram.

$$\frac{2.1}{12.7} \times \frac{100}{1} = \frac{210}{12.7} = 16.5\ \%$$

Therefore, the rate of absorption = 16.5%

Maturing Temperature Test

Also, test for maturing temperature was carried out, and the Isheagu clay sample tested could not stand cone 10 (1,288^{o}c). Even at cone 05 (1,177^{o}c), it turned darkest brown and showed signs of burning off. Another firing was done again in which the slab was allowed to fire between 03 and 04 (950 and 1020). At these points the slabs were able to show brownish brown colour and there were some traces of burning off such dark brown colour.

Functions of the Varied Additives:

It is important that before addition of additives to enhance the formulation of clay bodies from the Isheagu deposit it of necessity to understand the functions of the additives that one wants to make use of. However, two constituents were varied in these compositions to achieve the desired objectives of enhanced plasticity and enhanced maturing temperature. These constituents were Ball clay and Fired clay. Ball clay is of very high iron content. It is very fusible plastic. Ball clay is really complementary in character and is often combined in clay bodies to adjust the mixture toward a practical, workable body. It also has the quality of firing to between 1000˚C and 1350˚C. On the other hand, fired clay has high resistance to high temperature and can attain 1600˚C. When this is combined with less fusible clay bodies, the resultant product usually lends itself to higher temperature resistance.

Formulated Clay Bodies From Isheagu Clay Deposit

Abubakar, Kawahya, Umar (2014:37) opined that it is necessary to take samples before formulating bodies (batches) for the production. This is usually done byseparating the rawmaterials and weighingaccurately before mixing them together and then converted into batches.This advice was adhered to in the formulation of the bodies for attaining the best sample.

The clay bodies formulated for enhancing the level of plasticity from the secondary clay of the site under study were composed of uniform volumes of red clay, fired clay, flint, feldspar, and bentonite. To investigate the plasticity potential of the clay from the site, the volume of fired clay added to the fore-going constituents varied in the six bodies produced and used for the production of Figures 1-6. The following observations were made:

Figure 1 was produced from a clay body composed of 5 kilograms of red clay, 1 kilograms of ball clay, 500 grams of fired clay, 500 grams of flint, 500 grams of feldspar, and 500 grams of bentonite. This clay body was only barely plastic. The non-plasticity was evident in the fired work. The figure produced had a very low shrinkage loss of only 0.11cm; the object having shrank from 15cm in height to 14.89cm.

Five kilograms of red clay, 2 kilograms of ball clay, 500 grams of fired clay, 500 grams of flint, 500 grams of feldspar, and 500 grams of bentonite were constituted into a clay body. This constitution turned out to be very low in plasticity as very visible crack resulted from a finger test. This reflected in the fired work. A low shrinkage loss of 0.93cm was however observed as Figure 2 that was 15cm in height at the bone-dried state shrank to only 14.07cm after firing.

The clay body used for the production of Figure 3 was composed of 5 kilograms of red clay, 3 kilograms of ball clay, 500 grams of fired clay, 500 grams of flint, 500 grams of feldspar, and 500 grams of bentonite. This clay body was only just plastic as noticeable crack appeared when subjected to finger test. This was also evident in the fired work (Figure 3),1.18cm shrinkage was also experienced; the figure having shrunk from 15cm to 13.82cm.

A body composed of 5 kilograms of red clay, 4 kilograms of ball clay, 500 grams of fired clay, 500 grams of flint, 500 grams of feldspar, and 500 grams of bentonite yielded only average plasticity a finger test of the clay showed a network of cracks. A shrinkage loss of 1.97cm was also observed in the fired object (originally 15cm at bone-dried state) produced from this body (

The clay body composed from 5 kilograms of red clay, 5 kilograms of ball clay, 500 grams of fired clay, 500 grams of flint, 500 grams of feldspar, and 500 grams of bentonite went through a finger plasticity test without cracks. A shrinkage loss of 2.83cm was also observed in the object produced from this body (Figure 5) as the bone-dried figure shrank from 15cm to 12.17cm.

It was observed that the body composed of 5 kilograms of red clay, 6 kilograms of ball clay, 500 grams of fired clay, 500 grams of flint, 500 grams of feldspar, and 500 grams bentonite had improved plasticity as was evident through a coil test. It was also observed that there was 2.94cm shrinkage after firing; Figure 6 having been 15cm in height at its bone-dried state and 12.06cm after firing.

Formulation Of Clay Bodies For Enhanced Maturing Temperature:

For the purpose of enhancing the maturing temperature of the clay from the study site, varying quantities of the earthy materials listed above were added to equal quantities of the red clay from the site. The clay body for the production of Figure 7consisted of 5 kilograms of red clay, 500 gramsof ball clay, 6 kilograms of fired clay,500 grams of flint, 500 grams of feldspar and 500 grams of bentonite to make a total mass weight of 13 kilograms.

It was observed that Fig. 7 was able to withstand a temperature of about 1270^{o}C. Figure 8 was produced from a clay body constituted from 5 kilograms of red clay, 500 grams of ball clay, 5 kilograms of fired clay,500 grams of flint, 500 grams of feldspar, and 500 grams of bentonite. The object produced from this composition had a high maturing temperature of 1260 ^{o}C.

The body for the production of Figure 9 was made up of 5 kilograms of red clay, 500 grams of ball clay, 4 kilograms of ball clay, 500 grams of flint, 500 grams of feldspar, and 500 grams of bentonite. This composition fired at a high temperature of 1220 ^{o}C.

Fig.1. Tiers embrace, Clay, 25cmx 18cm

Fig.2.Draft, Clay, 34cmx28cm

Fig. 3. Crown. Clay.
22cm x 17 cm

Fig.4. Union, Clay,
19cm x 12cm

Fig. 5. Flower Vase, Clay,
30cm x 26cm

Fig. 6: Utogre vase
18cm x 12 cm

Fig. 7. Woman, clay.
25cm x 12 cm

Fig. 8. Dog clay.
26 cm x 15 cm

Fig. 9. Casting mould.
clay. 14cm x 13 cm

Fig. 10. Abstracted bird.
14 cm x 9 cm

Fig. 11. Lampshade, clay
32 cm x 18 cm

Fig. 12. Oshe vase, clay
34 cm x 19 cm

The constituents of the body for the production of Figure 10 included 5 kilograms of red clay, 500 grams of ball clay, 3 kilograms of fired clay, 500 grams of flint, 500 grams of feldspar and 500 grams of bentonite. This object fired successfully at a temperature of 1190 °C.

Figure 11 was produced from a clay body that consisted of 5 kilograms of red clay, 500 grams of ball clay, 2 kilograms of fired clay, 500 grams of flint, 500 grams of feldspar, and 500 grams of bentonite. This object fired at a temperature of 1060°C.Tables 1 and 2 below show the total weight of the clay body samples used for the determination of plasticity and maturing temperature. The composition of the clay body for the production of Figure 12 comprised 5 kilograms of red clay, 500 grams of ball clay, 1 kilogram of fired clay, 500 grams of flint, 500 grams of feldspar, and 500 grams of bentonite. This body fired at 980°C. Tables 1 and 2 below show the total weight of the clay body samples used for the determination of plasticity and maturing temperature.

Table 1 – Composition for Plasticity

	Sample A	Sample B	Sample C	Sample D	sample E	Sample F
Clay body consti-Tuents	weight of constituent of fig. 1	Weight of constituent of Fig. 2	Weight of constituent of Fig. 3	Weight of constituent of Fig. 4	Weight of constituent of Fig. 5	Weight of constituent of Fig. 6
Red Clay	5kg	5kg	5kg	5kg	5kg	5kg
Ball Clay	1kg	2kg	3kg	4kg	5kg	6kg
Fired Clay	0.5 kg	0.5 kg	0.5 kg	0.5 kg	0.5 kg	0.5 kg
Flint	0.5 kg	0.5 kg	0.5 kg	0.5 kg	0.5 kg	0.5 kg
Feldspar	0.5 kg	0.5 kg	0.5 kg	0.5 kg	0.5 kg	0.5 kg
Bentonite	0.5 kg	0.5 kg	0.5 kg	0.5 kg	0.5 kg	0.5 kg
Shrinkage	0.11cm	0.93cm	1.18cm	1.97cm	2.89cm	2.94cm

]Table 2 – Compositions for Maturing Temperature

	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
Clay Body Constituents	Weight of constituent of Fig. 7	Weight of constituent of Fig. 8	Weight of constituent of Fig. 8	Weight of constituent of Fig. 10	Weight of constituent of Fig. 11	Weight of constituent of Fig. 12
Red Clay	5kg	5kg	5kg	5kg	5kg	5kg
Ball Clay	500g	500g	500g	500g	500g	500g
Fired Clay	6kg	5kg	4kg	3kg	2kg	1kg
Flint	500g	500g	500g	500g	500g	500g
Feldspar	500g	500g	500g	500g	500g	500g
Bentonite	500g	500g	500g	500g	500g	500g
Maturing Temp.	1270°C	1260 °C	1220 °C	1190 °C	1060 °C	980 °C

CONCLUSION

The investigation carried in this study shows that the lack of survival of pottery-related objects from the area of study can be associated with the relative low maturing temperature of the clay used in pottery tradition practiced in the area. This may also have been accounted for the near total absence of any archaeological data in Isheagu study area. The clay from this source needs to the addition of earthy materials in order to make the objects produced from this source more durable.

RECOMMENDATION

Given the fact that many of the pottery and mud-sculpture producing communities of the Niger Delta rely on the secondary clay of the zone for their art objects, and given the established fact here that the secondary clay on its own is neither plastic enough nor does it have sufficiently high maturing temperature, it would be necessary to carry out studies in other clay deposits in the zone in order to ascertain what could be done to stimulate and continue the "clay art" traditions of the region.

REFERENCES

Abubakar, E., kawahya P.D., UMAR, A.(2014). "Developing Pyrometric Cones Silicates Obtained in Nigeria". in Ashakwu Journal of Ceramics, ceRAN, Ahamad Bello University, ZariaVol. 11. P.37.

Ahuwan, A.M. (2014). Towards A Search for Nigeria Ceramics Identity: The

Hunkuyi- Experiment in Ashakwu Journal of Ceramics, ceRAN, Ahamad Bello University, ZariaVol. 11. P.1.

Ali, V. (2001) "Igbo Traditional Pottery Types, Forms, and Function" Uso Nigerian Journal of Art Vol. No. 1&2.

Andrews, A.F. (1966) Sculpture and Ideas. New Jersey Prentice-Hall Inc.

Barley, Nigel (1994) Smashing Feasts of Clay from Africa Pots: London: British Museum Press.

Glenn, C.N. (1984): Ceramics Potter's Handbook, New-York; C.B.S. College Publishing.

Murray, J & Woody, (1978). Handbuilding Ceramic Forms: Great Britain John Murray Publishers Ltd.

Peter, D. J. (1988).' Clay Modelling for Everyone. (ed) Peter,D. J.Great Britain, Search Press Ltd.

Rada, P. (1989). Ceramic Techniques. London: Hamlyn Publishing Group.

Rhode, D. (1972). Clay and Glaze for the Potter. London: Chiton Book Company.

Roger, L.R. (1969). The Appreciation of the Arts/2 Sculpture. London: Oxford University Press.