AN EVALUATION OF THE APPLICATION OF SCIENTIFIC METHODS IN POTTERY STUDIES

BAKINDE C. O.
Department of Archaeology
Ahmadu Bello University, Zaria
omobakinde@gmail.com

Abstract
Archaeologists study pottery as a result of the number of inferences that could be made from them. Pottery could be studied through visual identification; a method that could reveal the various techniques applied in pottery manufacture and the unique patterns of pottery manufacture associated with particular regions of the world. However there is a limit to the amount of information one could garner by solely depending on visual identification for pottery study. Therefore, when specialist information about the provenance of pottery is required by archaeologists, scientific methods are employed. This paper looks at the application of scientific methods in determining the probable antiquity and provenance of pottery discovered in archaeological context. The paper concluded that the use of these scientific methods is of paramount importance in pottery studies as it is a means of obtaining data for discussing the dynamics of intergroup relations in preliterate societies.

Introduction
One of the great pastimes of archaeological research is the study of pottery. This is because it is one of the abundant cultural materials recoverable from most archaeological sites. This perhaps might not be unconnected with the unique nature of pottery. Clay once hardened by heating beyond 500^0C has its chemical composition rearranged in such a way that it becomes impermeable and indestructible (Laurie Primmer, 1974). Of course at that stage it could be broken into tiny bits and pieces but its chemical composition cannot be destroyed. At that level fire cannot affect it and it is insulated from fire for as long as the temperature of the fire is below the temperature at which the vessel was fired at the first instance. Apart from fire, water cannot also adversely affect it because it has become impermeable. As a consequence of the attributes above, pottery becomes a very good utilitarian vessels in all human societies the world over in the prehistoric period. Because of its nature, that is, its inability to be destroyed physically, it becomes the most commonly encountered cultural material in most archaeological sites.

Importantly, pottery is of primary interest to archaeologists because it is an evidence of human conscious effort to create cultural material from the natural environment. Pottery therefore serves as cultural indicator in any environment where there has been the presence of man in the past. Consequently, it could be used as site indicator. Also, the study of pottery can help to provide insight into past cultures. Thus, when combined with other evidences, the study of pottery is helpful in the development of theories on the organisation, economic condition and the cultural development of the societies that produced or acquired them (Orton, Tyers & Vince 1993). The study of pottery may also allow inferences to be drawn about a culture's daily life, religion, social relationships and attitude towards neighbours, attitudes to their own world and even the way the culture understood the universe.

Apart from all the above, pottery shows the archaeologists aspects of the environment

that the potter lived in as well as some of their cultural practices. Thus we find archaeologists devoting considerable length of time studying this ubiquitous object as a process for the reconstruction of the culture history of the society that produced them. In studying pottery, archaeologists employ two broad techniques; visual identification and the scientific methods. The adoption of any of the two methods for archaeological investigation will depend to a great extent on the type of research question being pursued as each of these approaches address different research problems. However, in order to have a rounded view of the culture and traditions of the society being studied, it is always better to use both approaches in conjunction with one another. Since the two approaches offer distinctive results, it is important to look at these two interrelated approaches holistically starting with visual identification.

Pottery Studies through Visual Identification

Visual identification, which means the ability of archaeologists to study pottery based on what they could see with their naked eyes without the use of scientific devices is the first and primary approach in studying pottery. Thus, even before the use of scientific methods, archaeologists must physically evaluate their ceramic assemblage; this enables them to ascertain those vessels that need to be scientifically studied or otherwise. It is important to note that most studies on pottery in archaeology ends at this level as a lot could be learnt from the potsherds by merely looking at them.

For instance, in most traditional societies, the potters after producing their wares always leave some marks on them. These marks are called decorations. In traditional setting, the potters lack standard templates for making these decorations. These decorations served as the signature of the potter. As such each potter tend to have their signature on their pots based on the type of decorations applied. There are various types of instruments used in the past for the application of decorations on pottery. One of the earliest materials used are fibres which are knotted together to form a string. The string like material is rolled along the surface of the clay while at the leather hard stage, thus producing a type of decoration called roulette (Haour, et al, 2010). Apart from being in the string form, roulette could also come in various shades depending on the available natural material to the potter. In an environment where the people were farmers cultivating crops such as corn, the cob of the corn could be rolled along the surface of the vessel while at the leather hard stage. The type of roulette produced by this means is called corn cob roulette. Thus by this it is established that the makers and probably the users of the vessel were sedentary people who planted crops such as corn. Another inference from this is that the date for the production of such vessel might not be earlier than the 16th century AD, being the date of the introduction of maize from the New World to West Africa (Willett, 1962). Another form of roulette which is restricted to Africa is the carved wooden roulette. Unlike the fibre roulette, carved wooden roulette are depicted on wood and then rolled on the surface of the vessel while at the leather hard stage.

There are several other types of decorations employed in the past. In some instances anthropogenic and zoomorphic images were depicted on the vessels (Fatunsi 1992). The types of animals depicted to a great extent shows the nature of the fauna prevalent at the location from where the vessels were unearth as at the time the people were living in that environment. In Eastern and Western Nigeria for instance vessels with snake and goat impression has been discovered respectfully (Ibeanu 1992, Fatunsi 1992). This suggests that these types of animals were available at those locations hence their being depicted on the vessels.

The natural environment to a great extent influences the type of decoration applied by potters in the olden days. Therefore a study of the decorations on the pots might be to an extent a partial study of the environmental condition of the makers of the vessel. In eastern Nigeria, there is a popular decoration called Mat impression (Ibeanu 1992). This decoration takes a pattern like mat when depicted on the vessel. This type of impression is limited only to the eastern part of Nigeria as well as central Nigeria most especially the Tiv speaking area (Ndera 2006). Thus with a careful study of the decorations on the vessels one could begin to talk about group identity (Bakinde 2007).

Each cultural group have their unique mode of decorating their vessels. If the Tiv type of decoration for instance is discovered among the Yoruba, it implies someone from Tivland must have taken it there. There are various agencies through which this could happen; through trade or relocation. The transfer of traditional knowledge through relocation occurs for instance when a Tiv person relocates from a Tiv town to a Yoruba town. In the process of relocation the fellow went along with his pottery making knowledge and started making that type of pottery in the new location. The second agency is trade which is the commonest means. Trade in pottery arise as a result of the fact that it is not every society that has the knowledge of pottery making; those without the knowledge of pottery making have to buy their pottery from those that could produce them. In a recent research on the Jos plateau among the people of Mahurum, Maram (2014) discovered a lot of pottery in their abandoned site. His oral informants maintained that the *Mahurum* people were never potters but that they always obtain their ceramics wares from the *Magawul* people who happen to be their neighbours.

Apart from decorative motifs, archaeologists are interested in studying the shape of the vessels they are analysing. This is very important as the function a vessel is meant to serve in most cases influence the type of vessel produced by the potter. The functions of pottery could be precipitated by three important criteria. First is the cultural practice of the maker or producer of the vessel. In traditional setting pottery served important functions culturally. In some instances pottery are used for ritual or medicinal purposes. Among the Yoruba especially the Okun area there are specialized bowls called *Awodin* used for *agbo* – herbal preparations – for treating infant diseases such as stomach disorder and those having teething problems (Bakinde 2004). Again, *awodin* could be used for ritual purpose. When used for ritual purposes, as vessels for conveying sacrificial substances to the spot for sacrifice, they are deposited at crossroads within the town after a lot of concoctions would have been prepared and stored in them. Some sacrifices could be placed at road intercession or at T – junctions, on hilltops or near a groove. Once the *awodin*, has been laden with the sacrificial materials the vessel is deposited at the site of sacrifice, as specified by the chief priest normally at the dead of the night (see plate 1). Generally, *Awodin* are usually small bowl of about 5cm to 10cm in diameter and 5cm to 10cm in height with a very narrow restricted neck (Bakinde 2014).

Pottery also plays active role in cultural festivities such as marriage ceremony or chieftaincy title celebration among Okun people. During these festivals *Ogaa* is used to convey the liquor used for the celebration. *Ogaa* is a pot of about 1.2m in height with a rim diameter of about 30cm. A typical *ogaa* will normally hold about two gallons or eight litres of *Sekete* or *emu. Sekete* is local liquor manufactured from sorghum while *emu* is the local palm wine. *Ogaa* always have a narrow neck and a very small lip, the orifice of which in most cases are about 5cm. The eldest person in each lineage in the village normally keeps the *ogaa* on behalf of his lineage and can only bring it out when there is a special occasion that demands the supply of local alcoholic drinks (Bakinde 2014).

Additionally pottery could be used as a storage facility. Two types of pots – *Agba* and *Odu* – are used for this purpose by the Okun people. *Agba* is used for storing alcoholic drinks during periods of festivities in which the whole community are gathered. *Agba* could contain up to 200 litres of liquor. *Odu* on the other hand is used for storing agricultural goods such as grains after harvest. *Odu* could also be used for other peculiar purposes as the situation demands (Bakinde 2004).

The second criterion is economic or technological factor. Here the predetermine function of the pots will influence the type of vessel to manufacture. The Okun people have a bowl type called *Agbagba* which is used for industrial purposes. *Agbagba* is spherical and not usually more than 5cm deep with a diameter ranging from about 60cm to 80cm and a thickness of about 7mm. This vessel is used for making *Garri*. The importance of this type of pottery ware lies in the fact that the people are mainly agriculturalists, as such, the people depends greatly on the availability of *agbagba* in processing agricultural produce such as in processing cassava into *Garri* (Bakinde 2014).

The third criterion is trading activities. Right from the earliest period since pottery production was invented; trade has been a recurring decimal in societies that have ability to produce the ware. This is borne out of the fact that not everyone in the society has the ability to produce pottery. Therefore those lacking pottery making ability have to procure their needed wares from those that could produce them. It should be noted that the cultural as well as the technological or economic factor also have a bearing on the type of materials produced for sale. When archaeologists are interested in establishing trade and trading contacts from pottery studies, they apply the scientific methods.

The scientific methods

The ranges of inferences attainable with visual identification is limited and in most cases are based on the researcher's knowledge about the cultural practices of the extant society inhabiting the geographical niche from where archaeological materials have been recovered. The inferences adducible to the society from which the cultural materials were collected are primarily based on the principle of cultural analogy. A principle most suitable for cultures where there is a proven cultural continuity between the extinct and extant societies. In situations where the intention is to obtain chronometric dates for pottery retrieved from particular geographical niche or wherein the intention is to establish the provenance of the archaeological pottery, the scientific methods are best employed.

Five chronometric methods – each with a lot of variants – are available for use to the archaeologist. These methods are; sidereal, isotopic, chemical and biological, radiogenic and lastly geomorphic methods. Not all these chronometric methods are useful for ceramic analysis. For instance the sidereal method which contains such techniques as historical records and dendrochronology cannot be used for ceramics material. The isotopic method is also not useful for ceramics. The best methods available for ceramics analysis are the radiogenic and chemical and biological methods. The discussion that follows is devoted to two of these scientific methods in use for archaeological study of pottery: thermoluminescence dating and chemical analysis. The thermoluminescence method belongs to the isotopic group with others such as radiocarbon dating technique.

Thermoluminescence Dating

It is impossible to know the date a potsherd was manufactured, used or discarded by visual identification alone. Thus, in order to establish the date of any ceramic material it has to be dated. Available are an array of dating methods for pottery, however the most important of these is thermoluminescence method because it can date pottery directly. This method is based on the principle that almost all natural minerals are thermoluminescent to some extent. It works by measuring the light emitted when a sample is heated to over 250^0C. The light emitted comes from the release of trapped electrons that are held in the crystal structure of quartz, feldspar, and calcite when these minerals are heated. Therefore it is possible to empty electrons traps by the application of heat. This method is used for dating rocks, minerals and pottery (Balme & Peterson 2006).

The method may also be used on minerals which have had their electron traps set to zero by exposure to high temperature prior to burial. When the material is heated, the crystal lattice vibrations become sufficiently violent such that the trapped electrons are released and recombine with lattice atoms. In this process they emit light; the emitted light is related to the dose by calibration with known doses of beta and alpha or gamma rays. The amount of light released is proportional to the dose of radiation absorbed by the sample material since it was last heated. Therefore, the older the material, the greater the amount of thermoluminescene will be produced. Thus, through this method, the appropriate age of pottery could be determined in calendric dates. Needful to note however that the dates produced by this technique can only give the range of dates within which the material was made, used or discarded (Balme & Peterson 2006).

Chemical analysis

Chemical analysis is a well-established procedure for the provenancing of archaeological ceramics. There are various techniques under this procedure; this includes but not limited to the following analytical methods; Neutron activation analysis (NAA), X – ray fluorescence analysis (XRF) and X –

ray Diffraction (XRD). All these methods follow the same basic principle. For our purpose we shall focus on X – Ray Fluorescence. This technique was chosen because of its high precision. It can accurately identify about eighty elements present in a sample on the basis of major, minor or trace qualities (Rice, 2005). It is also highly efficient for elements that are not analyzable by neutron activation analysis for example magnesium and titanium. Moreover, for elements such as potassium and calcium, it could be more efficient than other methods (Rice, 2005)

The chemical properties of ceramic materials are normally discussed in terms of major, minor or trace constituents. Major constituents usually include SiO_2, Al_2O_3 and FeO_3. Minor and trace elements usually occur in combinations and amounts that are distinctive of individual clays or clay/temper combinations. The samples for analysis are grounded into powder and palletized, the palette is irradiated with beams of X – Ray. This method works by shooting an X – ray beam onto a piece of palletized pottery causing the electrons in the pottery to become excited and emit fluorescent X – ray energies. Because different trace elements emit different levels of energy; the analyst can measure the spectra of energy emitted from the pottery and from this determine the proportion of each trace element present. Comparing the sample's trace element composition statistically with all known sources allows analysts to find the best match and presumably the geological source of an artefact.

By using this technique Bakinde (2013) was able to prove that the Okun people of Kogi state, Nigeria have been engaged in trading activities in pottery and related materials on a long distance basis from about the 16th century AD onwards. Secondly, he contended based on the result from the chemical analysis of Okun pottery that the various types of decorations encountered in all Okunland excavations are the same and that the traditions dates back to at least the 16th century AD. Apart from cultural homogeneity among the Okun people he asserted that there are many different types of interactions among the Okun people. These interactions were not limited to trading alone but it encompasses social and cultural interactions. Thus he posited that the polity within this culture area shares many cultural traits and traditions notably their pottery and metal working techniques from the precolonial period till the present era (Bakinde 2012).

Ceramic Petrography

This is a method used for tracing the movement of pottery and associated trade through provenance determination. This method is used to examine the mineralogical and microstructural composition of ceramics and other organic materials under the polarising light microscope in order to interpret aspects of the provenance and technology of the artefact. The principle of provenance ascription with ceramic petrography relies on the fact that the mineral and rock inclusions within a paste are a reflection of the geology of the source area of the ceramics. Provenance studies of pottery have provided archaeologists with important data about the differences between the material cultures of various societies (Balme & Peterson 2006).

Discussion

Archaeologists are engaged in pottery studies because of the many inferences they could make from them. In order to make these inferences, they use two principal methods; the scientific methods and visual identification. Visual identification is very important in pottery studies as there are a lot of things one could learn from just looking at the potsherds. For instance, it could reveal to the analyst the nature of the material in terms of their shape and size. Also, from a mere observation of the material the archaeologist might be able to determine the type of society that made or used the material. For instance, based on the type of decoration on the pottery the archaeologist may be able to reconstruct the economic pastime of the people that made them. In instances where there is corn cob roulette on the potsherds it might suggest that the people probably that manufactured the vessel probably cultivated and ate that crop.

Despite its usefulness in throwing light on the culture and tradition of the people that made and used ceramics materials through visual identification, it is highly limited. This is because there is a level at which physical examination of cultural materials becomes highly incapacitated. If, for instance, the

desire of the archaeologist is to obtain the provenance and age of the cultural material, then, the scientific method has to be adopted as visual identification will not be able to provide satisfactory age determination or provenance result. Thus the scientific methods are very important in the determination of the age of ceramic materials.

Even though the relative age of the cultural material could be recorded through a system called seriation – a system referred to as type series – in which artefact type A is said to be older than artefact type B, the result obtained through this means is still limited. Thus, it is only when absolute or chronometric dates are established that the archaeologist could discuss his cultural materials with confidence. There are a number of radiographic methods at the disposal of the archaeologist to do this of which the thermoluminescence method is the most ideal as it could date ceramics materials directly.

Another important dimension in which scientific methods have contributed greatly to pottery studies is in provenance studies. It is customary for archaeologists to discover pottery from societies that claims their progenitors never produce pottery. That was the experience of the researcher in a community called Ogidi in Kogi State, Nigeria (Bakinde 2013). The people of Ogidi migrated to their present location from an abandoned settlement called Ebere. An excavation conducted at Ebere produced a lot of potsherds. An ethnographic survey was conducted on the people of Ogidi and it was discovered that they had never produced pottery, as they normally procure their ceramics materials from another settlement called Erusu which lies in present day Ondo State according to oral informants (Bakinde 2013).

Provenance studies through chemical analysis were carried out on pottery from the excavated materials from Ebere and pots were purchased from the people of Erusu. The result of the chemical analysis shows that the pottery from the excavation and those from contemporary Erusu had their origin from the same rock formation. Thus the analysis proved that the pottery from these two locations is from the same source. As such the provenance studies validated the oral tradition of the people that they always procure their pottery from that particular location. (Bakinde 2010; Bakinde 2013).

At the third level, the researcher might be interested in knowing the nature of trade and trading patterns in the period gone by through ceramics. Here Ceramic Petrography comes in handy. Regional studies are carried out on the ceramics materials and the pattern they create is plotted in order to establish the movement of the various attributes discovered (Balme & Peterson 2006).

Conclusion

In conclusion, the scientific method is very important in pottery studies. For instance, chronologies based on pottery are often essential for dating non-literate cultures and are often of help in the dating of historic cultures as well. Trace element analysis, mostly by neutron activation, X – ray diffraction and X – ray fluorescence, allows the sources of clay to be accurately identified and the thermoluminescence test can be used to provide an estimate of the date of last firing.

Plate 1: *Awodin*

Plate 2: *Ajere* from Iffe

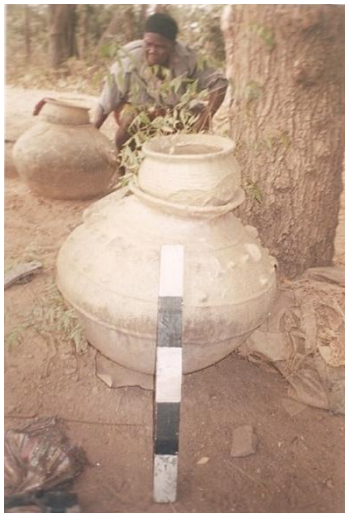

Plate 3: *Odu* from Ogga

Plate 4: *Agba* from Iffe

References

Bakinde, C. O. 2004. Ufe and her Potting Traditions. *Nigerian Traditional Crafts for Self - Reliance.* Proceedings of the 16th Conference of the Archaeological Association of Nigeria. pp. 101 – 109.

Bakinde, C. O. 2007. Traditional Pottery as a Channel of Group Identity. *ASHAKWU: Journal of Ceramics* Vol. 4 No. 1, 40 – 46.

Bakinde, C. O. 2010. Provenance Studies on Okun Pottery, Kogi State, Central Nigeria. A Paper Presented at the Joint PANAF/SAFA Conference held in UCAD- IFAN, Dakar Senegal, 1st – 7th November

Bakinde C. O. 2012. Pottery Traditions of Okun Speaking People of Central Nigeria. *ZAHIR: Zaria Historical Research*. Volume 4, Nos 1 – 4, June 2009 – June 2012, pp 274 – 290.

Bakinde, C. O. 2013. Aspects of Okunland Archaeological Investigation: Report from Ebere Hilltop Excavations. *African Notes: Humanistic Confluence. Essays from the African Humanities Program.* Journal of the Institute of African Studies. University of Ibadan, Nigeria. Vol. 37 Numbers 1 & 2, pp 169 – 188.

Bakinde C. O. 2014. Pottery Traditions of Okun Speaking People of Central Nigeria. *Case Studies in Heritage Management. The international Institute for Science, Technology & Education (IISTE)*, Hong Kong, 91 – 103.

Balme, J. & Paterson, A. 2006. *Archaeology in Practice: A Student Guide to Archaeological Analyses.* Oxford: Blackwell Publishing

Fatunsin A. K. 1992. *Yoruba Pottery*. NCMM Lagos.

Haour, A., Manning, K., Arazi, N., Gosselain, O., Gueye, N. S., Keita, D., Livingstone Smith, A., MacDonald, K., Mayor, A., McIntosh, S., and Vernet, R. 2010. *African Pottery Roulettes, Past and Present: Techniques, Identification and Distribution.* Oxbow Books, Oxford.

Ibeanu, A. M. 1992. Pottery Function: An Indispensable Criterion in Igbo Pottery Classification. *Imprints of West Africa's Past. Special Book issue of West African Journal of Archaeology*. vol. 22, 159 – 164.

Laurie Primmer, A. T. D. 1974. *Pottery Made Simple*. W. H. Allen, London.

Maram, M. M. 2014. An archaeological Study of Ancient Iron Working Sites in Mahurum, Bokkos Local Government Area, Plateau State, Nigeria.

Ndera, J. D. 2006. Pottery production in Tivland, Benue Valley of Nigeria: An Ethnoarchaeological Perspective. *Ethnoarchaeology: An Archaeological Perspective, Zaria Archaeological Papers,* Volume 10,112 – 119.

Orton, C., Tyers, P., Vince, A. 1993. *Pottery in Archaeology*. Cambridge: Cambridge University Press

Rice, P. M. 2005. *Pottery analysis: A source book.* Chicago: The University of Chicago press.

Thomas, D. H. & Kelly, R. L. 2006. *Archaeology*. Australia: Thomson Wadsworth

Willett, F. 1962. The Introduction of Maize into West Africa: An Assessment of Recent Evidence. *Africa: Journal of the International African Institute.* Volume 32 Issue 1, 1 – 13.