

■ NIGERIA

**Sediment Analysis of a
500-year Old Archaeological
Deposit in Central
Yorubaland, Southwest
Nigeria**

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Introduction

Sediments are formed through the process of continuous and gradual accumulation of detritus materials over a period of time. This accumulation may result from human/animal actions, gravity (e.g., collapse of structures) or by other natural means (e.g., wind, water, ice). During the process of accumulation of the detritus materials, archaeological/biological materials are incorporated into the sediment matrix resulting in the formation of archaeological deposits. The sediment matrix acts as an embedding milieu for the artefacts/biological materials and defines their immediate physical and chemical environment (Dincauze 2002). At the early stage of the sediment deposition, the detritus materials are unconsolidated but over time, through the process of compaction, cementation and recrystallization (Hassan 1978), the incorporated archaeo-biological materials are locked up into stratigraphic units to form a consolidated mass which occurs in the form of a mound. In the absence of surface indicators (e.g., kitchen waste, potsherds), sometimes archaeologists are faced with

the problem of identifying the type of deposit at first sight, be it a mound formed from refuse dump or a collapsed mud structure. This is very common with old archaeological deposits which have undergone a series of degradation processes leading to the amalgamation of the deposit to a unified whole.

Bearing in mind that sediments register signatures of factors that may have influenced their deposition, granulometric and chemical analysis of a 500-year old archaeological deposit (*ca.* AD 1450-1640 Beta-403755) in Orile-Owu situated in Osun State, southwest Nigeria was carried out. This method of approach to the study was targeted at providing possible glimpses of the immediate environment at the time of the sediment deposition and an attempt at understanding the factor(s) responsible for the formation of the archaeological sediment in Orile-Owu. Considering the paucity of research in Nigeria using granulometric and chemical data in understanding archaeological sediment formation processes, this paper aims at providing Nigerian archaeologists with better insights into understanding their archaeological deposits in the light of the pattern of sediment deposition and factors responsible for it, and differentiating a refuse mound from a collapsed mud structure. The focus of this paper is to highlight the significance of sediment analysis in archaeological research in Orile-Owu through deductions made from the piecing together of physical and chemical data retrieved from the stratigraphic units. It should be noted that this paper is a product of the author's field experience at Orile-Owu and the results presented here were indicators used in deciphering the nature of archaeological deposit at Orile-Owu.

Environmental Setting

Orile-Owu is situated in Ayedaade Local Government Area of Osun state, Central Yorubaland in southwest Nigeria (Figure 1). It lies within the geographical coordinates of latitude N7°14' and 7° 16' and longitude E4°18' and 4° 22'. Orile-Owu is bounded to the south by Ijebu-Igbo in Ogun state, to the east by Ife South Local Government Area, to the north by Gbongan and to the west by Isokan Lo-

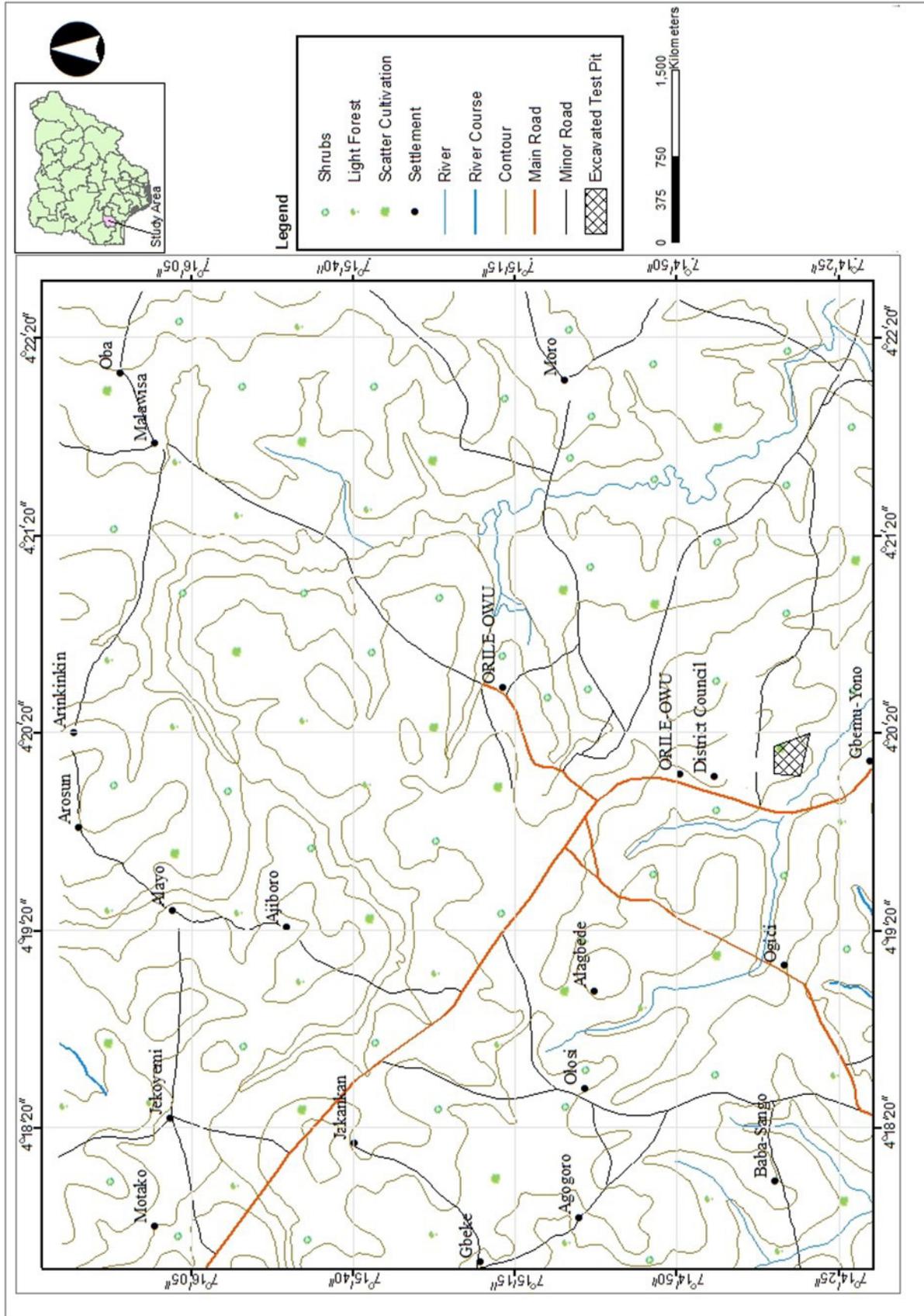


Figure 1: Map of Orile-Owu and its environs (adapted from Federal Survey, Nigeria 1966).

cal Government Area (Ogundele and Ebonine 2010). Orile-Owu experiences typical tropical temperature, vegetation and rainfall patterns. Mean annual temperature for Orile-Owu is about 26.6°C, while the average rainfall is 1414mm per annum with double maxima in June and September (en.climate-data.org/location/389998/). Physiognomy of the present-day vegetation in Orile-Owu is typical of secondary forest. This is clearly reflected in the composition of the vegetation of the area with particular reference to:

- agricultural activities characterised by farmlands and fallow lands. Examples of cultivated plants in the area include plantain (*Musa paradisiaca*), banana (*Musa sapientum*), African star apple (*Chrysophyllum albidum*), sweet orange (*Citrus sinensis*), maize (*Zea mays*), yam (*Dioscorea* sp.), chili pepper (*Capsicum frutescens*), kola (*Cola gigantea*) and cocoyam (*Colocasia esculenta*);
- abundance of oil palm (*Elaeis guineensis*), which is known to thrive in open forest; and
- occurrence of forest regrowth and plants characteristic of secondary forest such as African border tree (*Newbouldia laevis*), alum plant (*Cnetis ferruginea*) and west African albizia (*Albizia zygia*).

Sample Collection and Analysis

Three natural stratigraphic layers were delineated based on soil colour (partly dependent on organic matter content) and texture (Figure 2) for an 80cm depth excavated pit at Orile-Owu (Figure 3). Soil samples were collected from the exposed stratigraphy of the excavated test pit with the aid of a hand trowel. Two samples were collected from the first layer at levels 0-2cm, 4-6cm, four samples from the second layer at levels 8-12cm, 24-26cm, 38-42cm, and 48-52cm, while one sample from the last layer at level 68-72cm. The resulting seven soil samples were subjected to granulometric, chemical and colour analyses. This was with a view to derive optimum information from the sediment matrix since no single technique can provide a conclusive answer (Hassan 1978).

Granulometric Analysis

The objective of this analysis was to have a clear view of the different particle size classes that make up the sediment, the pattern in which the different layers of sediment were deposited and the wetness/dryness of the environment at the time of

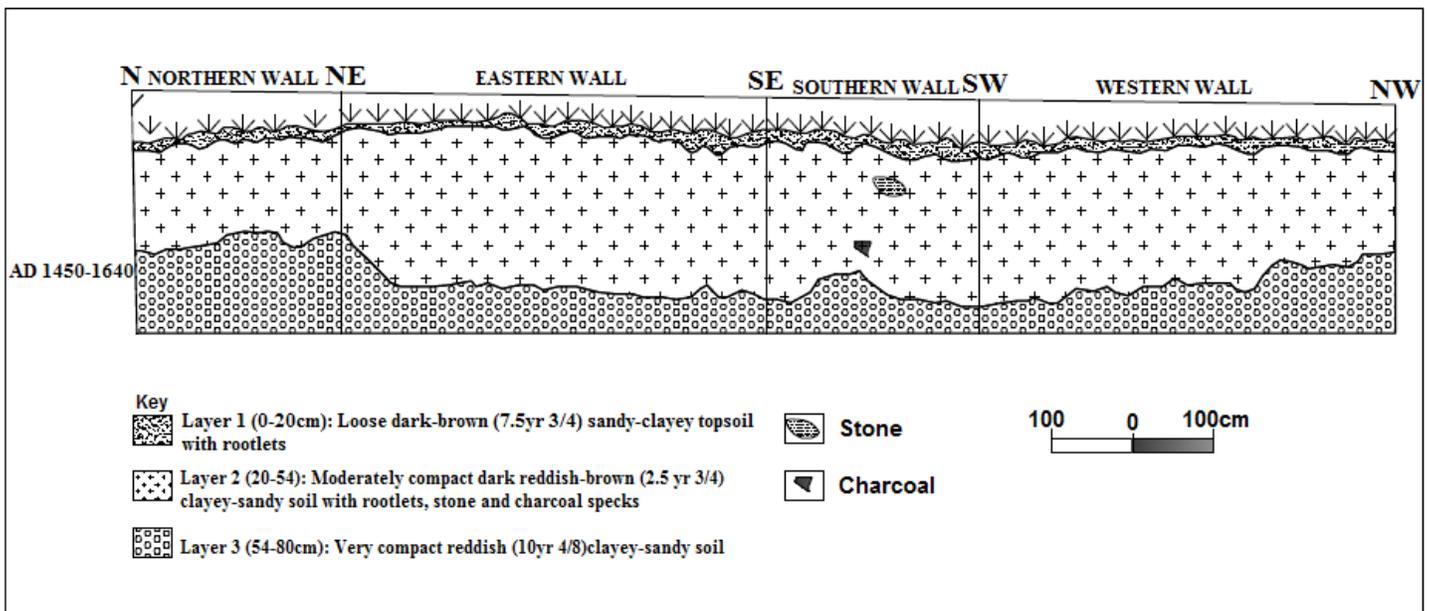


Figure 2: Stratigraphy of Orile-Owu TP1.



Figure 3: Excavated pit, Orile-Owu TP1.

the sediment deposition. It is generally opined that soils rich in gravel and sand are considered to have been deposited under wet conditions because of the strong surface runoff (water) required for their deposition. On the other hand, soils rich in silt and clay are deposited under dryer conditions and they will require a weaker surface run-off (wind) for their deposition. However, in applying this rule in the interpretation of archaeological deposits, caution should not be thrown to the wind since some archaeological deposits could be products of human activities. This is because archaeological deposits that are products of human activities have not been deposited by any of the natural factors such as wind or water and so cannot provide insight to wetness or dryness of the environment.

The procedure employed in the sediment preparation involved the use of the settling and dry-sieving techniques. Forty grams each of the soil samples were weighed, except for sample from level 68-72cm that weighed 28.5g due to the available sample from that level. The samples were placed in 800ml beakers and 50% Hydrogen Peroxide (H_2O_2) was added to digest the organic matter present. This caused effervescence and the reaction was allowed to continue for four days during which the organic matter content was expected to have dissolved. At the end of the fourth day, the H_2O_2 treated sample was diluted with distilled water, agitated and sieved in a less than $63\mu m$ mesh filter into another clean 800ml beaker. This was done so as to separate clay and silt from quartz-grained sediment. The wet quartz-grained sediment was allowed to dry in an evaporating dish which was later subjected to dry sieving technique while the filtrate obtained from the less than $63\mu m$ was subjected to settling technique.

In the dry sieving technique, the quartz grained sediment was subjected to dry sieving by means of a set of standard British sieves of various mesh sizes ranging from $5,600\mu m$ to less than $63\mu m$. For the settling technique, the filtrate was allowed to stand for about a week so as to permit the settling of the silt and clay particles. When it was observed that the sediments had clearly separated leaving a clear

solution on top of it, the clear solution was carefully decanted. The residue containing silt and clay was then dried. After drying, the samples were weighed with the aid of an electronic balance. It should be noted that at the completion of the granulometric analysis, a percentage loss in weight of the samples was observed due to the loss of their organic matter content and other losses recorded during the sieving process.

Chemical Analysis

The soil samples were also subjected to pH and phosphate analysis. The pH analysis revealed the degree of acidity or alkalinity of the samples. From this, inferences were made about the climatic conditions of the area because humid climate tend to produce more acidic soils than do arid climate (Reed *et al.* 2000). The pH test was carried out on the filtrate of a solution of 15g of soil sample in 30ml of distilled water after sieving with a $120\mu m$ sieve. This test was performed with the aid of a Jenway 3520 electronic pH meter.

Furthermore, phosphate analysis of the soil samples entailed subjecting three grams of the air dry soil sample to Mehlich-3 extraction procedure. The resultant solution was then subjected to the spectrophotometric method in obtaining the phosphate content of the samples. This was instrumental to our understanding of the intensity of human activity in the area. Anthropogenic additions of phosphorus to the soil come from human activities: waste, burials, products of animal husbandry in barns, pens and on livestock paths or intentional enrichment with soil fertilizer (Holliday and Gartner 2007).

Soil Colour

The colours of the samples were determined with the aid of the Munsell soil colour chart. Apart from providing clues in relation to the organic matter content of the soil, the conditions of drainage were also deciphered from the soil colour. Well drained and aerated soils are usually conducive to the development

of reddish and yellowish colours as a result of oxidation, while poorly drained soils are characterised by mottled greyish, brownish and yellowish colours (Hassan 1978).

Results

Granulometric, chemical and soil colour analyses. Summarised results of the granulometric, chemical and soil colour analyses are presented in Table 1, showing the physical and chemical characteristics of the archaeological sediment from Orile-Owu TP1. Results showed high percentages of sand at the two topmost levels (0-2cm and 4-6cm) compared to mud (silt and clay). However, from level 8-12cm to the bottom level 68-72cm, a higher percentage of mud was recorded in relation to sand. Also, pH analysis indicated that the deposit is acidic occurring within a range of 5.5-6.6. The samples were low in phosphate content, having a concentration within the range of 3.6-21.22mg/kg P and no phosphate content was recorded for level 4-6cm. The reason for the absence of phosphate content at level 4-6cm could not be explained. Furthermore, comparing the samples with the Munsell colour chart showed that the topmost 2cm of the deposit was dark reddish in colour. From the second level (4-6cm) to the penultimate level (48-52cm) dark reddish colour was recorded for the samples while red colour was recorded for the bottom level (68-72cm).

Discussion and Conclusion

Sediments contain imprints of environmental data, which when studied, provide information with regard to conditions responsible for their formation. The sediment analysis of an archaeological deposit in Orile-Owu has provided clues in making some environmental deductions about the nature of environmental factors that may have influenced the process of deposit formation.

Granulometric analysis showed the dominance of sand over silt and clay (mud) at the topmost levels (0-2cm and 4-6cm) and the dominance of mud

over sand from level 8-12cm to the bottom level 68-72cm (Table 1). The pattern of occurrence of high amounts of sand particles at the topmost levels and high concentration of mud particles at the lower levels is deciphered to have been caused by humid conditions. This is because humid conditions may have initiated the action of strong surface runoff (water) responsible for the downward leaching of mud particles from the surface levels and their accumulation in the successive lower layers. In addition, it has been noted that humid conditions favour the production of acidic soils (Reed *et al.* 2000). In this case, humid conditions deciphered at the topmost levels is corroborated by relatively stronger acidity pH values of 5.5 and 6.0 recorded at levels 0-2cm and 4-6cm respectively, compared to the other successive lower levels whose pH occurred between 6.2 and 6.6. The increasing pH values downward the stratigraphic column as noted in Table 1, probably may be a reflection of increasing drier conditions.

Putting into consideration that climate and vegetation have a strong influence on the process of sediment formation (Hassan 1978), it can be inferred from the particle size distribution of the archaeological deposit in Orile-Owu that the area does not have a thick vegetation cover. This is because the leaching experienced at the top soil was not intense as deduced from the high concentration of mud that occurred at the topmost levels (42.50% and 35.25%, at 0-2cm and 4-6cm, respectively). Intense leaching at the top soil would have resulted in minimal concentration of mud particles in relation to sand and gravel particles at the top soil since much of it would have leached into successive lower layers. It is suspected that the partial thickness of the vegetation cover of the area must have allowed for the superficial leaching of the topmost 6cm of the deposit, unlike areas with totally exposed vegetation cover where leaching of the topsoil could have been more profound.

Low concentration of phosphate was recorded in all the soil samples as illustrated in Table 1, an indication of low human activities on the mound. This is for reason that human occupation and activities increase the amount of soil phosphorus in the areas occupied (Sjoberg 1976). In addition, soil colour

Depth(cm)	Particle size			pH	Phosphate Content (mg/kg)	Colour
	%Gravel	%Sand	%Silt&clay			
0-2	1.50	51.00	42.50	5.5	21.22	2.5YR 3/6 Dark Red
4-6	0.75	55.5	35.25	6.0	0.00	2.5YR 3/4 Dark Reddish Brown
8-12	4.75	38.50	54.25	6.2	3.96	2.5YR 2.5/4 Dark Reddish Brown
24-26	5.50	17.25	73.50	6.4	19.42	2.5YR 3/4 Dark Reddish Brown
38-42	15.00	31.75	49.75	6.5	7.55	2.5YR 2.5/4 Dark Reddish Brown
48-52	14.75	25.75	55.25	6.4	7.91	2.5YR 2.5/3 Dark Reddish Brown
68-72	2.80	29.40	49.67	6.6	3.60	10R 4/8 Red

Table 1: Physico-chemical characteristics of sediment from Orile-Owu TP1.

analysis indicated that the archaeological deposit possessed good drainage and aeration conditions as reflected in the reddish colours recorded for all the samples (Hassan 1978).

Piecing together information derived from the sediment analysis, with specific emphasis on the phosphate content, it was decoded that the archaeological deposit resembles a collapsed mud building more than a refuse mound. This inference was arrived at based on the following observations made. First, refuse mounds are usually characterised by high humus content with dark brown, black or grey colours (*cf.* Hassan 1978). On the contrary, the colour of the three natural stratigraphic layers beginning from the

top layer were dark red, dark reddish brown and red, all dominated by red. Mud houses in the southwestern part of Nigeria are usually built with mud, which is naturally reddish in colour. This reddish colour can also be seen from the colour of the mud buildings still standing in the area. Second, evidence from particle size analysis indicates that majority of the layers are dominated by mud (silt and clay) particles except for the topmost layers which understandably have undergone some form of leaching over the years leaving behind the heavier particles. The collapse of the mud building must have undergone compaction and cementation through the action of rain water to form the mound. Third, the deposit was poor in archaeological materials with potsherds dominating

the finds (details of inventory of finds is presented elsewhere). The presence of potsherds in the deposit was suspected to be either products of material inclusions in the making of the bricks as evidenced in mud buildings still standing in the area, or probably they were post deposited and gradually got incorporated during the process of the decay of the collapsed building. Fourth, results from phosphate content analysis showed poor phosphate content of the sediment which gradually reduced down the strata with no value recorded at level 4-6cm. High phosphate content on the other hand would have suggested human refuse and waste disposal. This showed that the mound was not a product of human activities. This to a greater extent dissociates the archaeological deposit from being described as a refuse mound.

In conclusion, the multifaceted analytical techniques applied in the study of the archaeological deposit at Orile-Owu has provided us with an insight that water played a major role in the process of gradual formation of the archaeological deposit. It is suggested here that there is a need for more studies to be conducted to provide standard parameters that can be used to differentiate refuse mounds from collapsed mud buildings especially when they are consolidated in a unified mass. Archaeological reconnaissance study conducted by this author has shown that sometimes refuse mounds can be difficult to differentiate from completely decayed mud buildings by mere surface view. This paper, while looking at the environmental inferences made from the sediment matrix, has also attempted to provide some notable distinguishing characteristics between refuse mound and collapsed mud building.

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