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ASSESSING THE VIABILITY OF ARTISANAL MINING FOR ALLUVIAL GOLD DEPOSIT IN AFEKI AREA, SOUTHWESTERN NIGERIA

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ABSTRACT

Alluvial deposits are the commonest and often the richest type of placer gold. They contain pieces of gold that have been washed away from the seam through the force of water, and deposited in sediment in or near watercourses or former watercourses. Consequently, viability of artisanal mining was explored for alluvial gold deposit in this study. This study was carried out in Afeki area of Opa, Ile-Ife, Osun State, Nigeria. Panning and sluicing processing methods were employed. Six pits were dug with a varied horizontal distances, ranging between 15-20 m apart. The numbers of panning done from each pit were selected randomly, and an average of seven panning was done from each pit. From the results, the measured thickness of overburden and gold bed of each hole were in the range 0.3 to 1.2 m and 0.7 m to 2 m respectively. Also, the corresponding concentrates from the pits 2, 4 and 6 were 0.64 g/m^3, 0.74 g/m^3 and 0.88 g/m^3.

KEYWORDS: Alluvial, Panning, Sluicing, Gold and Mining.

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INTRODUCTION

In the metal category, gold has been acclaimed globally as the most important economic metal (WHO, 2016), and according to McCracken *et al.* (2018) gold is a high unit valued mineral. Gold is found in alluvial/eluvial placers and primary veins in Nigeria (Government of Nigeria capstone workshop report, 2019), and according to Oramah *et al.* (2015) they are from several parts of supracrustal (schist) belts in the Northwest and Southwest of Nigeria. Notably, gold deposits in Nigeria occur in the Maru, Anka, Malele, Malendo, Sofon Birnin Gwari-Kwaga, Gurrara, Bin Yauri, Okolom-Dogondaji, Ijero - Ekiti and Iperindo areas (Fig. 1). Also, smaller occurrences are found beyond these major areas (Ministry of mines and steel development, 2010).

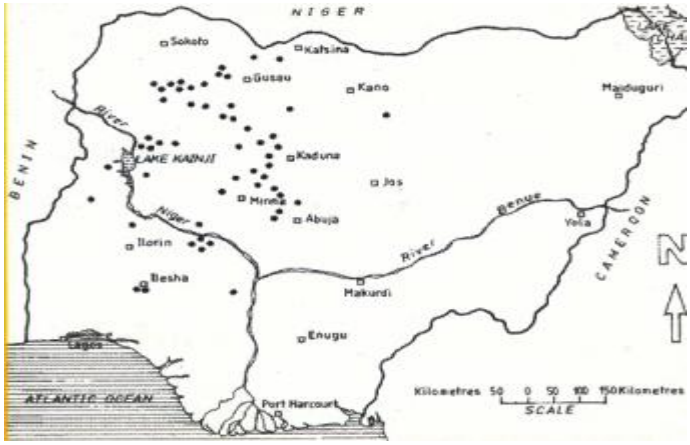

Fig. 1: Location of Gold Occurrences in Nigeria
Source: Ministry of Mines and Steels Development (MMSD), 2010

The major areas of gold mineralization in Nigeria as revealed by the Nigeria geological survey agency report of 2010 are shown in Fig. 2, and from the report, most of the primary gold mineralization in schist belt were found to occur in quartz veins within several lithologies. In addition, all the producing areas are in the western part of the basement where schist belts are well developed. Basically, four gold fields have been outlined, including Ilesha-Egbe, Minna-Birnin Gwari, Sokoto and Yelwa (NGSA, 2010).

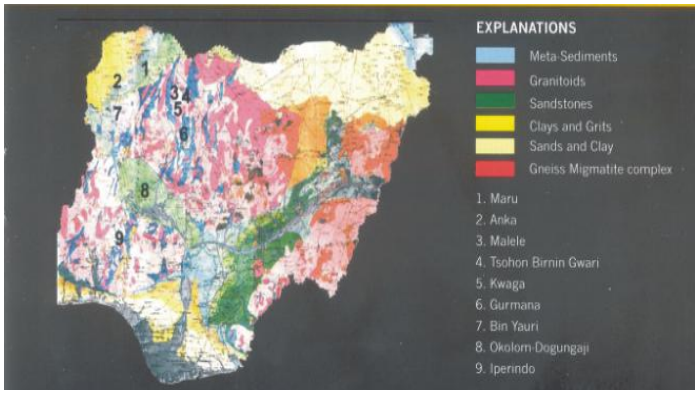

Fig. 2: Major Areas of Gold Mineralization in Nigeria
Source: Nigeria geological survey agency (NGSA), 2010

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Today, gold is a high ranked valuable resources in Nigeria, and due to its social-economic effect on nations' development, the importance of gold mining industry is becoming increasingly appreciated in Nigeria. Artisanal and small-scale gold mining (ASGM) has been a long time venture in Nigeria, and gold mining accounts for an extensive amount of artisanal mining activities (Idris-Nda *et al.,* 2018; Adeoye, 2015; Makinde *et al.,* 2013). The large deposits of gold in the north-west and south-west of Nigeria, and smaller deposits in some others locations within the country have been made possible to a certain extent by artisanal miners' inquisitiveness. Although artisanal mining is associated with negative environment impact (unsafe), low productivity labor intensive (Oramah *et al.,* 2015; Adeoye *et al.,* 2015; Idris-Nda *et al.,* 2013; Makinde *et al.,* 2013; Adeyinka *et al.,* 2011), however, it is a relatively simple and less expensive approach (Idris-Nda *et al.,* 2018; Bamba *et al.,* 2002).

In Nigeria, about 90% of the total gold production is from alluvial deposits (Chapman *et al.,* 2001), and they are derived from primary gold mineralization in the basement rocks (United Nation Office on Drug and Crime, 2018). Alluvial gold deposits are characterized by loosed materials, and they are formed when materials are eroded from the upper reaches of rivers are carried downstream and deposited in the lower reaches. This usually occurs on a flood plain where the rate of flow becomes slow and the load of sediment cannot be transported further, thus building up in thickness over time (Alan and lan, 2003; McCraken *et al.,* 2018). Generally, alluvial mining is used for precious gold deposits in alluvial deposits (sand and gravel of the river/stream beds (Basque, 1999; Chirico *et al.,* 2013). Gold placers are related either to present drainage systems or to paleo channels having complete histories of environmental changes (Macdonal, 1983; Chapman *et al,* 2001). Recent deposits vary in form according to differences in the materials of the environment, geometry of the drainage system, the amount and distribution of energy, climatic variations and distances from the source (Adeyinka *et al.,* 2011; Royle, 1976, Bamba *et al.,* 2002).

Placer gold can be mined using a number of methods, both in terms of extraction from the ground and separation (Government of Nigeria capstone workshop report, 2019). Panning is a process involving the agitation of some mined gold ore and water that are placed in a large metal or plastic pan, during which, the gold particles, being of relative high density settle in the bottom of the pan and the gangue material (sand, mud and gravel) are washed over the side of the pan, while the gold is left behind. Rocker box is effective in terms volume of gold mined relative to panning, however, its effectiveness is still low as compared to the other placer mining methods (Hruschka *et al*., 2011; Dunning, 2004).

Other methods of placer mining are: sluice box, dry washing, trommel and gold dredge which of higher productivity (Basque, 1999; Dunning, 2004). Gold pans are designed to allow for the trapping of heavy materials during agitation and for their easy removal at the end of the process. Sluice box is a channel with a gate that controls the movement of water level within it. It has transverse riffles over a carpet, which traps the heavy minerals and gemstones. By this principle, black sands, gold, and other minerals from alluvial deposits are recovered during mining operations and concentrate is obtained.

Exploitation and the processing of alluvial deposit on land have been achieved with the aid of machines, including backhoes and bulldozers, and on water with dredges, elevators and pumps.

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Also, belt conveyor, rotary scrubber, trommel screen, shaking table, sluice box, vibrating sluice box, melting furnace and gold bar are some of the other equipment used (Chirico *et al.*, 2013).

Undoubtedly, Nigeria has a variety of minerals endowment. However, it is regrettable that the mining industry has not contributed significantly to the national economy. For instance, in 2008, the mining industry only accounted for 0.18% of the national GDP. Whereas, the contribution of mining industry to the national economy of countries such as Botswana, Ghana and South is much more significant (World Bank Report, 2013; Mitchell, 2006; Mutemeriand and Petersen, 2002). Consequently, efforts were made in this study to explore the viability of artisanal mining for alluvial gold deposit in Ifeki area of Southwestern Nigeria. This is expedient due to the near non - existence research information on this deposit in literature. Even, in spite of the increasing waves of artisanal mining activities in Nigeria.

GEOGRAPHICAL DESCRIPTION OF THE STUDY AREA

The study area is located within Afeki area Opa, Ile-Ife Osun State Nigeria (Fig. 3). Its geographical coordinates are 7^0 32' 17'' and 4^0 35' 56''. It is accessible through Ife-Ilesha express way; it covers a total area of 11km^2. The popular Opa river cut across this area, the Opa river basin is a tributary of river shasha (one of the main tributaries of river Osun).

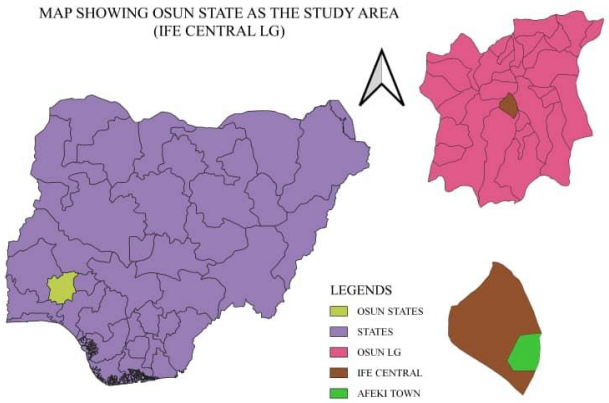

Fig. 3: Geological description of the study area

2. METHODOLOGY

2.1 Materials

The equipment used were digger, shovel, measuring tape, geographical positioning system (GPS), and pan and sluice box.

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2.2 Methods

The sampling technique adopted in this study is the pit test method (Roden and Smith, 2003) based on the Standard Operating Procedure (SOP) 9 v 12. Six pits were dug with varied horizontal distance, ranging between 15 to 20 m apart and the area of each was 50 cm by 50 cm. The measurement of the location of the holes was taken with the aid of global positioning system (GPS). Thickness of the overburden and the gold bed of each of the hole were measured and the readings were recorded. A number of panning was done from each pit, the pits were selected randomly, and an average of seven panning was done from each of the pit. Sluicing operation was carried out for pits 2, 4 and 6. 900kg of gravel from the pits was sluiced and the concentrate from the carpets was panned and weighed.

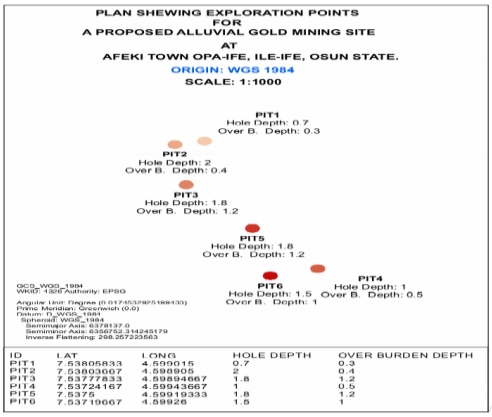

Fig. 4: Exploration plan of the sampled pits

3. RESULTS AND DISCUSSION

Figs. 5 and 6 are results of the overburden level and pit recorded during pitting, and Plates 1 to 6 are the products of the panning. While plate 7 is the combined result of the whole panning and Fig. 5 shows the results of sluicing for pits 2, 4 and 6. From the results, it is obvious that the overburden thickness varies from 0.3 to 1.2 m, and thickness of the gold belt ranges between 0.7 m and 2 m, thus making the total depth of this formation from the surface to the base lie between 1 and 3 m. With final depth of the deposit (3m), and loosed nature of the sediment, artisanal and small-scale alluvial mining method can be suitably used to dig and sift through mud, sand or gravel of the alluvial gold in Afeki (United Nation Office on Drug and Crime, 2018; Royle, 1976).

The results of panning and sluicing of pits 2, 3 and 4 of the alluvial gold deposit, which is depicted in Fig. 7 reveal concentrate values of 0.64 g/m^3, 0.74 g/m^3 and 0.88 g/m^3 respectively, indicating that gold is found within the sediment, and the reconnaissance signature permits for detailed exploration through which its source can be traced (Chirico *et al.*, 2013; Alan and Lan, 2003).

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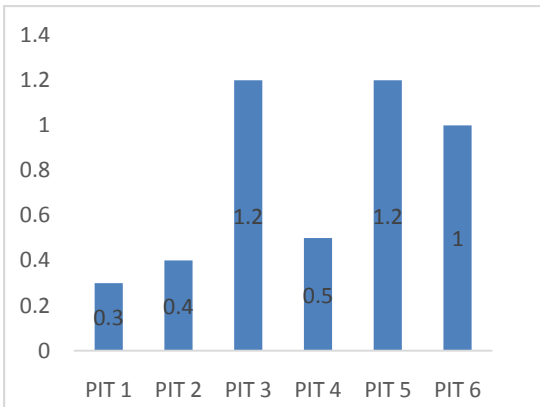


Fig. 5: Overburden thickness (m)

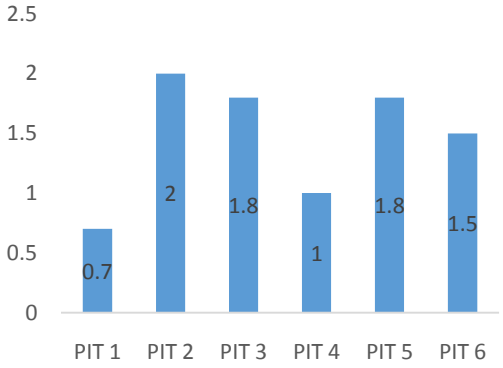


Fig. 6: Gold belt thickness (m)

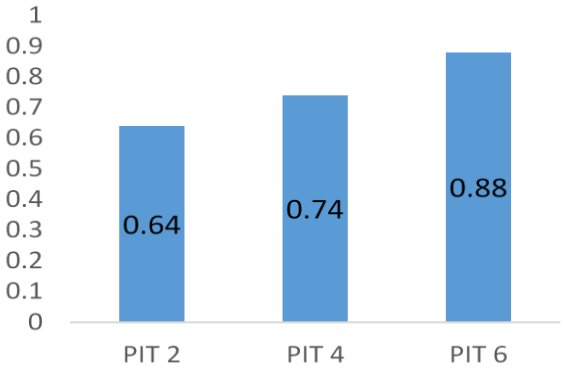
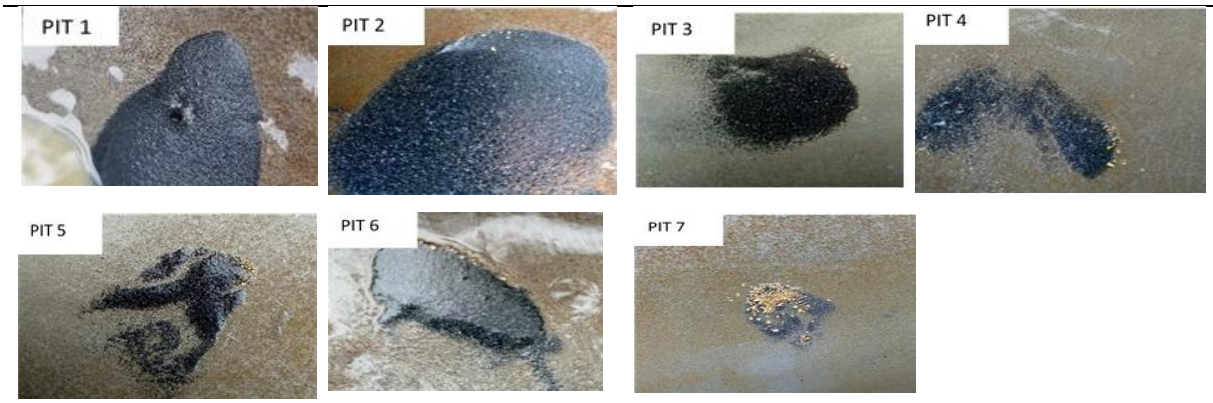


Fig. 7: Weight of the concentrate (g/m^3)

Table 2: Panning results for pits 1-6, and pit 7 is the result for the whole sampling



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4. CONCLUSIONS

From the results obtained, the following conclusions are drawn:

1. The final depth of Afeki alluvial gold deposit is 3 m. This is very important for the selection of the mining method.
2. The results of gold panning and sluicing from pits 2, 4 and 6 were 0.64 g/m^3, 0.74 g/m^3 and 0.88 g/m^3 respectively, which shows that gold is present within the sediment studied, and can be used to trace the source deposit.
3. Generally, the deposit is of loosed sediment, therefore the proposed artisanal alluvial is adequate, and it is relatively simple in practice and cheap to use.

5. RECOMMENDATIONS

Although artisanal mining is saddled with a lot of disadvantages, however, it is a simple and less expensive method. Therefore, if it is done based on government regulations, it shows to improve the local economy through employment generation for the populace, whereby many youths will be withdrawn from criminal activities and illicit trade. Hence, artisanal mining should be used for Afeki alluvial gold deposit under the following considerations:

1. All relevant regulatory agencies should ensure that Afeki alluvial gold deposit mining activities is done by the licensed individuals, and such individuals should be encouraged to engage more hands to increase production and profitability.

2. Government should encourage Artisanal mining of Afeki alluvial gold deposit in small scale through the employment of panning, rocker box, sluice box, dry washer or trommel screen.

3. For higher productivity, it is important that more subsidies should be extended to the association of licensed small scale miners (ALSSM) by government to allow for the purchase of modern equipment.

4. Environmental impact of the mining activities on the air, water, soil, fauna, flora, human being and landscape needs to be assessed so as to determine the negative impacts which should be prevented early and as such, the viability of the exploitation can be ascertained.

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