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Characterization and Determination of Liberation Size of Maitumbi Gold Ore

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Abstract: *The samples of gold ore used in this study were collected from Maitumbi, Chanchaga local government area, Niger state. 500g of the finely milled sample was sieved in a sieve set from 355µm to 63µm within an automatic sieve shaker. Samples from various sieve sizes were further pulverized to below 125µm and then subjected to x-ray analysis. The commercial mesh of grind of the sieve test was found to be 125 µm, 180 µm and 250 µm having retained 20.3%, 17.12% and 18.05% weight percent of the entire sample respectively. Upon x-ray analysis, gold was observed in trace amount having assayed 0.0251 %, 0.1083 %, 0.1212 % and 0.0882 %, with manganese, iron and copper being dominant. The liberated free gold was at -125 + 90 µm having 6.55g which is the highest degree of liberation for commercial viability.*

Keywords: *Gold, Ore, Sieve, X-ray, Mesh, Liberation*

INTRODUCTION

Nigeria is blessed with vast land of solid minerals. Their abundance, if harnessed will boost the gross domestic product (GDP) of the country through foreign investment, local job creation, technology-based research and training (Hilson, 2006; Aigbedon and Iyayi, 2007). Common mineral ores where gold is found are pyrite, sphalerite, magnetite, chalcopyrite, arsenopyrite, galena, pyrrhotite and the associated gangue mineral are tourmaline, chlorite, graphite, muscovite calcite, albite, feldspar and quartz (Mwanga, 2010; Samson *et al.*, 2014). Refractory ores of gold in solid solution or as nano-particulate form like auriferous sulphides and astellurides yield gold through complex processing route (Zhou and Martin, 2004; Kankara and Darma, 2016). Processing of gold ores entangled with carbonaceous compound like pyrite or graphite has shown to be difficult because the carbon easily adsorbs the gold which hinders the recovery of gold and boost cyanide consumption (Zhou and Martin 2004). There are other gold ores like krennerite, nagyagite, petzite sylvanide and calaverite that are rare and are difficult to process because they are chemically agglomerated (Garba 2003; Adelekan and Abegunde 2011). Most gold are in auriferous or quartz vein which is known as lode deposit.

However, they are recovered in appreciable amount (~20%) as bye products from beneficiation of other base metal ore, majorly copper deposits. Separation of gold from other minerals or gangues, otherwise known as communition is carried out on gold ores found in lode deposit unlike placer deposit, (Laplante, & Dunne 2002). Mined ores are concentrated in order to separate valuable particles or concentrate from the gangue or tailings, through dressing or milling. This is followed by communition which is the liberation of valuable minerals from gangue that is accomplished through crushing and grinding to fine particles (Wills, & Napier-Munn, 2006).

In communition, the ores are crushed, grinded and concentrated before recovery of valuable minerals. Efficient grinding determines the quality of liberation of valuable minerals at various particle sizes and in turn the effectiveness of the communition processes (Wong, & Arun, 2009). For any process design or beneficiation process, the degree of liberation of ore is very important. Therefore, the sole aim of this study is to determine the liberation size where gold is optimally separated from the associated gangues. Ozah, (2019) characterized crude ore and was confirmed to assay 4.10 ppm upon chemical analysis, the mesh of grind and the liberation size were established to be 250 um and 45 ums respectively. Waterman (2017) characterized gold ore after carrying out communition and discovered that the ore was associated with gangue minerals like pyrite, galena, chalcopyrite, sphalerite, and the liberation of 80% at particle size fraction of -200+270 um. Usaini, (2014) determined the liberation size of copper ore in Akiri, Nasarawa state Nigeria, after ore dressing, sieve and chemical analysis, attained a mesh of grind of 210 um and liberation size of 125 um with 11.9% copper. Extensive review of literatures revealed the presence of valuable minerals in Chanchaga leaving a gap in understanding the economic viability of particularly gold. This study aimed at bridging the gap by determining the liberation size of Maitumbi gold ore in Chanchaga.

MATERIALS AND METHODS

2.1 Location of Sample Sites

As shown in Fig.1 is the topographic map of Chanchaga area (Waheed *et al.*, 2017).

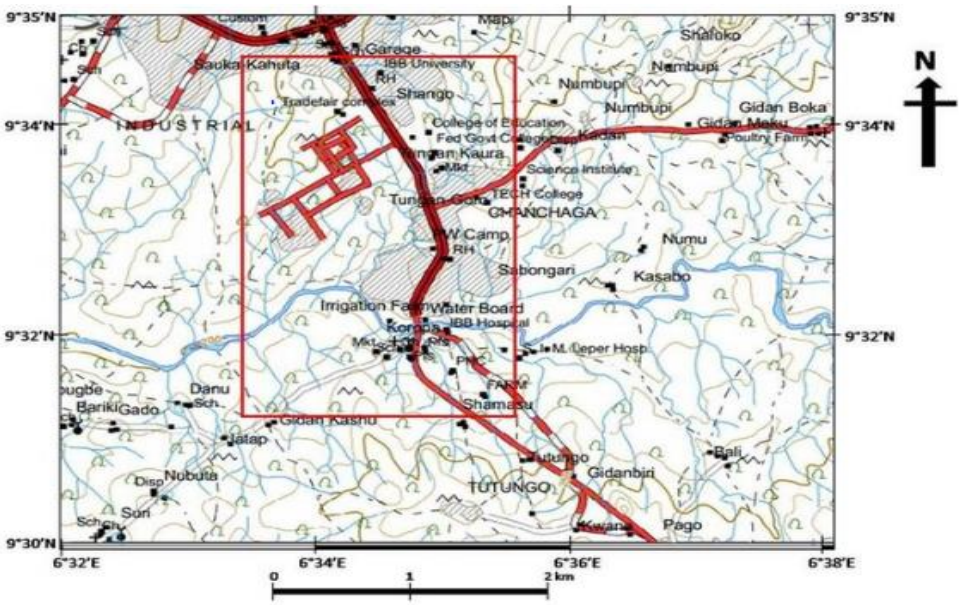

Fig.1. The topographic map of Chanchaga area (Waheed *et al.*, 2017)

Maitumbi is the site where samples of gold ore were collected. It is in Chanchaga local government, Niger State. It is on 9.530N and 6.530E latitude and longitude respectively. Gold deposits in Maitumbi are found in schist veins as a result of tectonic processes leading to rock formation in the basement. Due to high degree of weathering, the gold mineral become clayey in nature and hence the need for characterization and liberation processes (Yerima and Abdulrahman 2015).

2.2 Sample Collection and Preparation

Gold ore samples were collected at four different mining pits in maitumbi using grab sampling method-random sampling, with the support from mining artisans. The randomly taken sample were collected at about 15 metre radii from one another. The as-collected samples were broken to acceptable sizes with hammer before being fed into a Retsch steel jaw crusher. Crushed sample were then milled for about one hour repeatedly till the required amount was obtained, a procedure followed by Olatunji & Durotoye, (2010) and Olubambi & Potgieter (2005).

2.3 Sieve Analysis

Sieve sizes from the coarseness (355 µm) to the finest (63 µm) were stacked for proper separation into various sizes and shaking was carried out on the lid. With shaking, particle sizes less than the sieve size passed through successively till the least particle size is collected in the last tight-fitting pan beneath the sieve stack.

2.4 Chemical Analysis of Sieve Fractions

The chemical composition of each sieve fraction was conducted using energy dispersive x-ray fluorescence spectrometer which is designed to determine elements between sodium and uranium, the sieve samples were pulverised further to about 125 µm, mixed with drops of organic binder and pelletized using hydraulic press. The pellets were then subjected to x-ray fluorescence analysis.

RESULTS AND DISCUSSION

3.1 Particle Size/Assay Analysis

Table-1 Particle size analysis of Maitumbi gold ore

Sieves Ranges (µm)	Weight Retained (g)	Weight Retained (%)	Nominal Aperture Size(µm)	Cumulative Weight Retained (%)	Cumulative Weight passed (%)
+355	68.70	13.74	355	13.74	86.26
355+250	90.40	18.08	250	31.82	68.18
-250+180	85.60	17.12	180	48.94	51.06
-180+125	101.65	20.33	125	69.27	30.73
-125+90	60.50	12.10	90	81.37	18.68
-90+63	41.55	08.31	63	89.68	10.32
-63	51.60	10.32	-	100	0.00

From the result of particle size analysis in table 1, it was observed that appreciable amount of the ore was retained at 125 µm, 250 µm and 180 µm corresponding to 20.3%, 18.08%, and 17.12% respectively. Therefore, these are the optimum particle size for the sieve test and are the commercial mesh of grind for this operation, this is in alignment with the work of Ozah *et al.,* (2006), and Olasupo *et al.,* (2014).

From the graph of percentage cumulative weight retained/percentage cumulative weight passing against the particle size (Fig. 2), it can be deduced that the curves of percentage cumulative weight retained and passing intercepted at 50% and 180 µm particle size. This is in agreement with the work of Wills, (2006), where it is established that the point of intersection of the two curves connotes the median of the particle distribution, this implies that the 50% aggregates are smaller and the remaining 50% are larger than the sieve particle size at the midpoint of the curves. This sieve size, i.e., 180 µm is the economic liberation size of the Maitumbi gold ore.

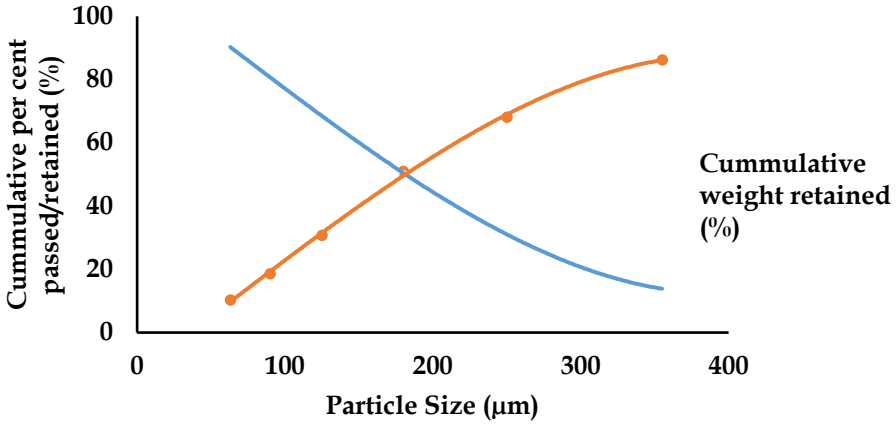

Fig.1 Graph of cumulative percent passed/retained against particle size

3.2 Ore Composition

Table-2 Chemical analysis of size fraction

Nominal Aperture Size(µm)	Au	Mn	Fe	Cu
355	0.0251	0.1532	14.1424	0.0685
250	0.0000	0.0888	10.3218	0.0774
180	0.0000	0.0839	10.6527	0.0806
125	0.0000	0.0973	11.1528	0.0705
90	0.1083	0.1126	12.6493	0.0752
63	0.1212	0.1422	11.6079	0.0686
-	0.0882	0.1529	14.6533	0.1693

Table-2 presents the elemental composition of the ore and their respective percentage value assayed at various sieve sizes. Apart from gold, which of course exist in trace amount with 0.12% being the highest, manganese, iron and copper are the most predominant elements in the ore as shown in Fig. 3, Iron is found to be in the range of 10-15% in the ore in all the samples prepared.

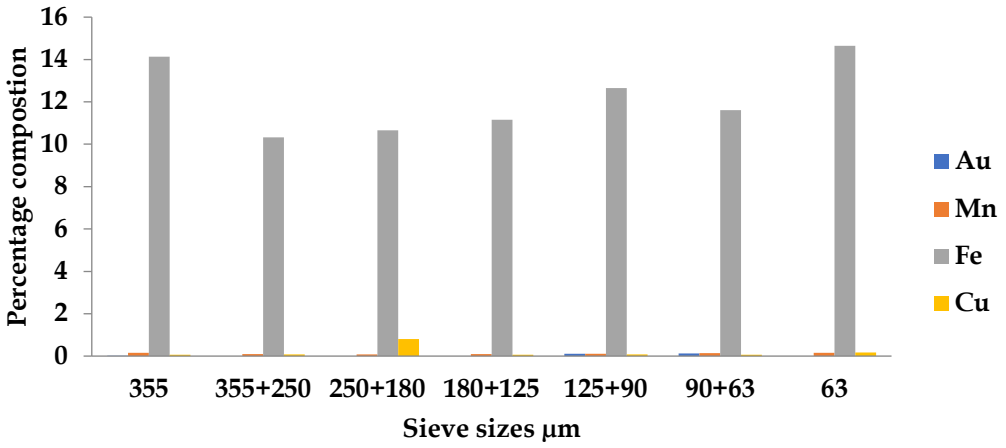

Fig. 3 Chart of predominant elements in various sieves

3.3 Liberation Size

Table 3: liberation size

Sieve Size Fraction (µm)	Gold Weight Content (%)	Weight Retained in Sieve (g)	Amount of Gold in Sieve Size
	0.0251		1.72437
+355		68.70	
	0.0000		0.0000
-355+250		90.40	
	0.0000		0.0000
-250+180		85.60	
	0.0000		0.0000
-180+125		101.65	
	0.1083		6.55215
-125+90		60.50	
	0.1212		5.03586
-90+63		41.55	
	0.0882		4.55112
-63		51.60	
	∑ =0.3428	∑ =500	∑ =16.3073

The percentage of free gold in each ore samples from various sieve sizes are presented in Table-3 such that the free gold particles relative to the ore is prevalent in sieve size 90 µm having 6.55g. this implies that the highest degree of liberation of the minerals of interest is at sieve size fraction of -125 + 90µm. The percentage composition of the ore constituents through x-ray analysis is not enough until it is found relative to the weight of the ore in each sieve as concluded in the column – 'amount of gold in sieve size' from Table-3.

CONCLUSION

This novel research into Maitumbi gold ore has shown through chemical analysis the presence of gold assaying 0.0251%,0.1083%, 0.1212% and 0.0882%, an evidence of gold existence in trace amount unlike copper, iron or manganese that are predominant. Furthermore, the economic mesh of grind and the highest degree of liberation were found to be 180 µm and -125 + 90 µm respectively

CONFLICT OF INTEREST

There is no conflict of interest for this research work.

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