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Geochemical characteristics of unexplored mine tailings in Ijero Ekiti, Nigeria

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Abstract

Waste materials from mining tailings, often contain significant amounts of potentially valuable minerals. This study aimed at unearthing the valuable minerals in Ijero Ekiti mine tailings. The tailing samples were randomly collected in five locations of the study area. The samples were analyzed for selected physico-chemical parameters: pH values, electrical conductivity, chloride, organic matter and X-Ray Fluorescence Spectrometry (XRF) using standard analytical techniques. The physico-chemical parameters of tailings range in different concentration. The x-ray fluorescence spectroscopy analysis of the samples shows that the samples contain high concentrations of SiO_2, Al_2O_3, Fe_2O_3, and other trace compounds. The results of this study established that the tailings valuable minerals.

Keywords: Waste; Mining; Tailings; Valuable; Analyzed; Spectroscopy

1. Introduction

Mineral resources are abundant in Nigeria and their spread is across the 36 states of the federation. Its exploitation is aimed at meeting the demand for metals and develop infrastructure in order to improve the quality of life. However, the management of residues (gauge, mine drains, mine falling, waste rock and slag) which are generated by mining operations is of special concern environmentally and presents an undesired financial burden on investors [1]. Consequently, surface mining has been a major cause of environmental damage and in most cases replaces existing ecosystem with unwanted materials.

Since industrial revolution started in the mid-1800s, the biogeochemical cycle of inorganic substances (e.g. metals and minerals) naturally present in the environment has been greatly accelerated by human activities.

The mining industry is one of the causes of environmental pollution because it produces waste material of variable nature and extent. Mining processing include grinding of mineral, beneficiation, ore refining and solid and liquid waste disposal which can be a source of contamination to the environment [2]. The mining and smelting of non-ferrous metals has caused soil pollution, metal dusts emanation, water, effluents and seepage [3].

Mining of metals generates considerably amounts of waste materials. These generally have very little economic value, making their exploitation not profitable, though they often have the potential to pose a long-term threat and cause damage to the environment. Mining and smelting operations are important sources of heavy metal contamination in the environment due to activities such as mineral excavation, ore transportation, ore processing, smelting and refining [4]. Also, wastewater, waste gas and tailings (solid waste) generated in the process of mining and smelting activities will lead to the release and migration of heavy metals contamination of soils in the vicinity of mining areas and this has been regarded as a great environmental concern [5; 6;7].

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The mining is focused on the recovery by flotation processes and smelting. Large volumes tailings material are deposited in ponds and the resulting mine drainage typically has a neutral pH due to a high neutralization capacity of the parent rocks and liming prior to tailings deposition.

The aim of this study is to geochemically identify the distribution of minerals in the tailings of Ijero Ekiti tailings physicochemical characteristics and X-Ray Flourescence spectrometry.

2. Tailings sampling

A total of 24 tailing samples were collected from different locations in Ijero Ekiti, Ekiti state, Nigeria. It is located 7.82 latitude and 5.07 longitude, elevation of 491m above sea level and the 3rd biggest city which is situated in the northeast part of Ekiti state. The samples were kept in air tight polyethylene bags. In the laboratory, all the samples were air-dried at room temperature, pulverized and passed through a 0.8 mm sieve.

2.1. Sample Preparation

The tailing samples were pulverized to size less than 125 nm. Then, drop of toluene acid (binder) was then added to 0.5g of the powdered sample and crushing continued until the mixture was returned to fine powder again. Then, the crushed sample was compressed under a hydraulic press machine at 10-tone pressure and converted from fine powder to pellet form. The pellet were carefully labeled, covered with mila and stored in partitioned sample storage plastic container for analysis.

2.2. Sample Analysis

The pH, electrical conductivity, particle size, total organic matter and chloride was determined using method put forth by Carter and Ciregorich (1994) [8] and Yobouet *et al.,*(2010) [9].

Geochemical oxide concentration was evaluated using x-ray flourescence (XRF) techniques. The XRF offers qualitative and quantitative non-destructive method of analysis for trace and major elements in geological, environmental and biological sample.

3. Results and discussion

3.1. Tailings Physicochemical Characteristics

The results of some physicochemical parameter which can greatly determine the interconnectivity between the tailing environments are presented in Table 1. The pH value of the tailing samples ranged from 7.09 - 8.09 with a mean value of 7.51. These values are an indication that heavy metals maybe slightly immobile [10]. The electrical conductivity of the top soil (upper layer) in sample A and B is greater than that of the lower layer except for sample C, where the lower layer is greater than the upper layer. Electrical conductivity is a measure of salinity; excessively high salinity can affect plants such that higher osmotic pressure around the root prevents an elicit water absorption by the plant [11]. The concentration of chloride in the lower layer of the soil sample is greater than the upper layer of the sample. High concentration of chloride can cause toxicity problems in crops and yield. Organic matter promotes good soil Structure, thereby improving aeration and retention of moisture and increasing buffering and exchange capacity of soils, however, the total organic matter ranged from 0.12-7.34% which means there are low microbial activities in the tailings.

Table 1 Results of physicochemical parameters analysis (n= 25)

Sample	**IJE1**	**IJE2**	**IJE3**	**IJE4**	**IJE5**
pH	8.09	8.03	7.90	7.69	7.41
Electrical Conductivity(µS/cm)	453	264	324	211	212
Chloride (mg/kg)	17.50	21.30	17.75	17.75	3.55
Organic Matter (%)	0.43	0.13	7.34	0.12	0.25

3.2. Geochemical oxide composition

The geochemical properties of tailings samples were established by X-ray fluorescence (XRF) spectroscopy and presented in Tables 2. The XRF analysis revealed the presence of 13 major oxides and traces in all the tailings samples. The major oxides commonly detected in all the samples were; SiO_2, Al_2O_3, Fe_2O_3, MgO, TiO_2, K_2O, CaO, Na_2O, P_2O_5, MnO, Cr_2O_3, CuO and ZnO. The presence of silicon oxide (SiO_2) and aluminium oxide (Al_2O_3) indicate the presence of quartz and alumina formed from the SiO_2– Al_2O_3 system [12;13]. Furthermore, iron oxide (Fe_2O_3) may be due to the presence of hematite, which is one of the most commonly detected minerals in soils and sedimentary rocks formed from weathering processes. The oxide of titanium (TiO_2) detected in the coal samples may be largely due to ilmenite (manaccanite, $FeTiO_3$) and the naturally occurring minerals including rutile and anatase [14;15]. According to Vassilev and Vassileva (1997) [16], TiO_2 could also originate from aragonite, brockite, calcite, iron sulphides, gypsum, mica, oxy-hydroxides and other organic or clay minerals.

Table 2 The Geochemical oxide composition (%) of tailings samples (n= 25)

Oxide	IJE1	IJE2	IJE3	IJE4	IJE5
SiO_2	58.10	62.16	63.60	70.00	69.10
Al_2O_3	23.10	24.10	20.10	25.00	26.05
Fe_2O_3	13.10	10.56	11.90	12.20	10.10
MgO	0.40	0.40	0.40	0.40	0.40
TiO_2	2.07	2.82	2.90	1.82	1.67
K_2O	0.26	0.25	0.30	0.35	0.40
CaO	0.16	0.10	0.15	0.22	0.30
Na_2O	0.08	0.03	0.05	0.08	0.06
P_2O_5	0.11	0.16	0.05	0.13	0.20
MnO	0.15	0.12	0.16	0.21	0.20
Cr_2O_3	0.04	0.04	0.01	0.31	0.04
CuO	0.05	0.03	0.02	0.35	0.05
ZnO	0.07	0.04	0.03	0.33	0.07

4. Conclusion

The geochemical study of major oxide of tailing shows their high abundance which indicates the presence of Quartz, alumina, hematite, ilmenite, rutile, gypsum and mica. The minerals identified are economically viable which their exploration can increase government earnings.

Compliance with ethical standards

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References

[1] European Union. Heavy metals in wastes, European commission on environment. 2002.

[2] Andriano DC, Wenzel WW. Vangronsveld J and Bolan N.S. Role of assisted natural remediation in environmental clean-up. *Geodema.* 2004; 122: 121-142.

[3] Alloway BJ. Contamination of soils in domestic gardens and allotments: a brief overview. *Land Contamination Reclamation*. 2013; 12(3): 179-187.

[4] Zhuang P, McBride MB, Xia H, Li H, Li Z. Heavy metal contamination in soils and food crops around Dabaoshan mine in Guangdong, China: implication for human health. *Environment Geochemical Health*. 2009; 31: 707-715.

[5] Navarro MC, Perez-Sirvent C, Martinez-Sanchez MJ, Vidal J, Tovar PJ, Bech J. Abandoned mine sites as a source of contamination by heavy metals: A case study in a semi-arid zone. *Journal of Geochemical. Exploration*. 2008; 96: 183-193.

[6] Singh AN, Zeng DH, Chen FS. Heavy metal concentrations in redeveloping soil of mine spoil under plantations of certain native woody species in drytropical environment, India. *Journal of Environmental Science.* 2005; 1: 168-174.

[7] Ekwue YA, Gbadebo AM, Arowolo TA, Adeosun JK. Assessment of met contamination in soil and plants from abandoned secondary, and primary goldmines in osun state, Nigeria. *Journal of soil science and environmental management*. 2012; 3(11): 262-274.

[8] Carter MR, Gregorich EG. Soil Sampling and Methods of Analysis, Second Edition. CRC Press, LLc, Boca Raton, FL. 2007; 1264.

[9] Yobouet YA, Adouby K, Trokourey A, Yao B. Cadmium, Copper, Lead and Zinc speciation in contaminated soils. International Journal of Engineering Science and Technology. 2010; 2(5): 802-812.

[10] Smith AH, Lingas EO, Rahman M. Contamination Of Drinking Water By Arsenic In Bangladesh: A Public Health Emergency. Bull, WHO. 2014; 78: 1104-1117.

[11] Bauer M, Hock G, Smith HA, de Jongste JC, Gerritsen J, Postma DS. Air Pollution and Development 1 Asthma Allergy and Infections in a Birth Cohort. European Society for Clinical Respiratory Physiology. 2007; 245: 879-888.

[12] Vassilev SV, Vassileva CG. Mineralogy of combustion wastes from coal-fired power stations Fuel Processing Technology. 1996; 47: 261-280.

[13] Dai S, Zhao L, Peng S, Chou C-L, Wang X, Zhang Y, Li D, Sun Y. Abundances and distribution of minerals and elements in high-alumina coal fly ash from the Jungar Power Plant, Inner Mongolia, China International Journal of Coal Geology. 2010; 81: 320-332.

[14] Zhang W, Zhu Z, Cheng CY. A literature review of titanium metallurgical processes Hydrometallurgy. 2011; 108: 177-188.

[15] Filippou D, Hudon G. Iron removal and recovery in the titanium dioxide feedstock and pigment industries JOM. 2009; 61: 36.

[16] Vassilev SV, Vassileva CG. Geochemistry of coals, coal ashes and combustion wastes from coal-fired power stations Fuel Processing Technology. 1997; 51: 19-45.