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# The assay of tailings and vegetable plants samples for lead (Pb) from mining sites using PIXE technique from Kebbi State of Nigeria

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**ABSTRACT**
The number of reported stunted children admitted into health facilities and traditional care are on the increase in and around Kebbi State. This epidemic is believed to be caused by the unregulated mining activities been undertaken by artisans. Tailings and vegetables samples were collected where mining activities are been undertaken. The choice technique of assay was Proton induced X-ray emission (PIXE) because it is non-destructive, simultaneous trace multi-element analytical technique. Results obtained indicated that Pb concentration is way high above recommended value of 400 ppm. The highest and lowest value of Pb concentration from the survey area are 3826 – 106 ppm respectively. High concentration of Pb is rife in this area of survey indicating children and animals living around such area are at risk of health challenge. Medical science has proven that cumulative intake of Pb causes stunted growth in children.
**Key words**: Kebbi State, Stunted Children and Pb.

## I. INTRODUCTION

Pb poisoning has become rife in the North-Western and central Nigeria lately. This epidemic is believed to be caused by the unregulated mining activities been undertaken by artisans. These miners are in this vocation because of the immediate reward but ignorant of the attendant consequences. Illnesses allegedly associated with mining are superstitiously attributed as act of God. These strange illnesses was first localized in Zamfara State of Nigeria (Nov, 2011), though discovered in March 2010. Reconnaissance survey are carried out by the experienced artisans, thereafter miners go into mining at sites believed to be promising. They excavate, chiseled the ore into boulders and transported to their living quarters. They then pulverized the boulder to extract the gold. The aforesaid narration is been replicated all over North and Central Nigeria. In one of such States is Kebbi: Geological samples and vegetable plants were collected from communities that mining was on-going. Proton induced X-ray emission (PIXE) was used to interrogate the samples. The history of Pb use is quite extensive. Object made of lead have been excavated and dated around 6500 B.C. Pb is present in food, water, air, soil, paint, and other materials with which the general population comes in contact. Each are potential pathways for human Pb exposure via inhalation or ingestion (Samaila, 2019).

PIXE technique of assay is a powerful yet non-destructive, simultaneous trace multi-element analytical technique. This technique bombards the collected sample with ions. Bombardment with ions of sufficient energy (usually MeV protons) produced by an ion accelerator, will cause inner shell ionization of atoms in a specimen. Outer shell electrons drop down to replace inner shell vacancies, however only certain transitions are allowed. X-rays of a characteristic energy of the element are emitted.

In the PIXE technique the energy of the characteristic X-rays identifies the element, and the number of emitted X-rays with characteristic energy peak is a measure of elemental concentration for specific element. In this technique, accelerated ions beam like alpha particles, protons and other heavy ions have many applications for the analysis in different research fields like archaeological, environmental, biological, geological etc. In PIXE technique, the accelerated proton beam is used due to its low bremsstrahlung radiations, high fluorescence yield

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and X-rays production cross-section, Johansson, S. A. E., et al (1995). The standardization of PIXE is a process in which materials of already known composition and concentration (Standard Reference Materials (SRM's)) are analysed for finding the elemental concentration and then compared with the SRM data. For this process it is necessary to set up a reliable calibration of analytical system. The trace elements are those whose concentration are in the parts per billion (ppb) or tenth of parts per million (ppm) in a sample. For standardization of trace elements, accurate knowledge of beam parameters (energy, current and collected charge) and calibration parameters (fluorescence yield, sensitivity, ionization cross section, background radiation and absorption attenuation etc.) are required. The assumption of this research work is that there may be Lead (Pb) poisoning in the areas where minerals are been extracted (from crushed boulders) via washing; sometimes even the use of mercury to remove desired elements from crushed ore matrix tend to contaminate and poison sources of drinking water. Also to find out concentration of lead in plant (vegetables) grown within that vicinity.

## II. MATERIAL AND METHOD

### 2.1 Materials

1. Six rock samples and two biological samples
2. Global Positioning System (GPS)
3. Hillquist thin section machine
4. Chemflex TM
5. GUPIX Software

### 2.2 Method

Eight samples were collected from Site which is Located at approximately latitudes 007008.690□E and longitudes 090 34□ 224□ □ N of North Eastern Nigeria. Of the eight samples collected two were biological (samples 1 and 2). The samples collected were taken to Centre for Energy Research and Development (CERD), Obafemi Awolowo University, Ile-Ife. Osun State, Nigeria. Each bulk sample was crushed and grinded into powdered form and then labelled separately to avoid contamination.

After thorough mixing of the powdered materials with some binding agent such as chemflex TM, pellets are prepared with a hydraulic press. Eight pellets are made and thereafter fastened to the specimen holder (special ladder akin to a slide projector, which enables the analysis of many (100) in sequence). The aluminium foil paper was placed behind the pellets before it was fastened to the special ladder to avoid the masking tape sticking to the pellets. It was then meticulously lowered in to the specimen chamber. Once the specimen was securely placed in the specimen chamber, the chamber is made vacuous by a special vacuum pump affixed to the chamber.

#### 2.2.1 PIXE Calculation

The formula for calculating concentration [Y (Z)] in PIXE is given as:

$$Y(Z) = \frac{N_{av}\omega_Z b_Z t_Z \epsilon}{A_Z} N_P C_Z \quad 2.1$$

Where Np is the number of protons, Nav Avogadro's number, and $\sigma z$ (E) the K-shell ionization cross section for the proton energy E corresponding to depth x. The number of K X-rays in a particular spectral line is then obtained via the fluorescence yield ωk,z and line intensity fraction bk,z.

$$\frac{CZ\ (SP)}{CZ\ (ST)} = \frac{Y_Z\ (SP)}{Y_Z\ (SP)} = \frac{I_{Z_{ST}}}{I_Z\ (ST)} \quad 2.2$$

Standards are usually single elements or very simple compounds containing the elements of interest or their near neighbours in the chart of nuclides. The merit of this ratio process is its cancellation of instrumental factors such as solid angle, efficiency, and calibration factors for charge integration Aunget al., (2002). This is important given the practical difficulties in obtaining accurate knowledge of the detector's line shape and intrinsic efficiency at the low X-ray energies characteristic of the light elements that are so often the major elements in environmental specimens Sven et al., (1995).

## III. RESULTS AND DISCUSSION

### 3.1Quality Control

Table 3.1 shows the results of irradiation carried out on standard (NIST) 278 (Obsidian Rock). The table contains the analyte, standard and certain values. The observation from the table reveals that the certain values of the analyte silicon (Si), potassium (K), iron (Fe) and rubidium (Rb) respectively are of the standard. Analyte chlorine (Cl), vanadium (V) and zirconium (Zr) respectively are below the standard. Observation shows that PIXE is efficient for the analysis.

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**Table 3.1 (NIST) 278 (Obsidian Rock)**

| ANALYTE | STANDARD | CERT. VALUES (ppm) |
|---|---|---|
| Si | 341397.3 ± 6281.71 | 341436 |
| Cl | 584.5 ± 88.03 | - |
| K | 34511.7 ± 106.99 | 34530 |
| Ca | 7020.8 ± 90.57 | 7026 |
| Ti | 1439.7 ± 22.75 | 1469 |
| V | 30.7 ± 15.76 | - |
| Mn | 401.2 ± 10.99 | 403 |
| Fe | 14275.1 ± 51.39 | 14268 |
| Cu | 6.8 ± 3.02 | 5.9 |
| Zn | 55.8 ± 5.96 | 55 |
| Rb | 127.5 ± 18.47 | 127.5 |
| Sr | 64.2 ± 13.67 | .5 |
| Zr | 375.8 ± 39.46 | - |
| Ba | 1222.2 ± 165.49 | 1140 |
| Ce | 67.1 ± 42.94 | 62.2 |

Below is table of the analyses of the eight samples collected from the mining sites in the field:

Table 3.2: Analyses of samples A through to H at part per million (PPM) concentrations

| ANALYTE | SAMPLES CONC. (PPM) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F (PL) | G (PL) | H |
| P | BD | 880 | BD | BD | 1178 | BD | BD | 664 |
| S | 6319 | 1135 | 4333 | 5513 | 1178 | 791 | 523 | BD |
| K | 10366 | 7808 | 21195 | 20605 | 1355 | 1910 | 1857 | 107 |
| Ca | 1439 | 522 | 376 | 249 | 20231 | 5987 | 6169 | 41904 |
| Ti | 1519 | 333 | 2148 | 703 | 1574 | 1642 | 2092 | 1664 |
| V | 48 | 1135 | BD | BD | 13570 | 56 | 69 | 1955 |
| Cr | 614 | 550 | 737 | 752 | 347 | 186 | 190 | 833 |
| Mn | 146 | 96 | BD | BD | 748 | 29 | 21 | 103 |
| Cu | 402 | 98 | 272 | 2452 | 408 | 20 | 17 | 13 |
| Zn | 40 | 25 | 30 | 33 | 408 | BD | 31 | 7 |
| Rb | 33 | 50 | 82 | 53 | 292 | 0.864 | BD | 52 |
| Sr | 81 | 63 | 128 | 57 | 122 | BD | 61 | 88 |
| Zr | 240 | 76 | 176 | 139 | 503 | BD | BD | 207 |
| Ba | BD | 382 | 625 | 608 | 206 | BD | BD | 480 |
| Pb | 2120 | 445 | 3279 | 943 | 3826 | 893 | 106 | BD |

Key to table 3.2: BD = below detection, PL = plant, ppm= part per million, Con. = concentration.

Of the eight samples only a sample (H) has lead (Pb) below detection level. Sample G is the only sample that has concentration below 400 ppm (above 400 ppm is believe to be inimical to human health). Outside these two samples, all the remaining have values above 400 ppm, particularly C and E are way high above this value. Sample of the vegetable plant H has a value of 893 ppm which suggests that the consumption of this plant will be hazardous to human health; But not only to humans but even the grazing animals that may feed on it will end on the food chain of the omnivorous (human beings etc).

The presence of other elements, possibly at commercial quantities was also observed. Take for example sample D has Cu concentration at 2452 ppm. This sample suggest that further feasibility study be carry out to investigate if copper's presence is widespread to elicit it mining in commercial quantity.

## IV. CONCLUSION

This research work concluded that because Pb presences were in excess of what was recommended in sites where this work was undertaken, the authorities in the concern areas should be notified. The Authority is to notify the populace around the Sites not to eat the vegetables growing around because of its high Pb concentration. They will then create consciousness of the imminent health hazard. The authority should make provisions to cleanse areas already affected and prevent the creation of new ones. Constituted authorities should enforced mining ethics and ensured that they are been observed strictly.

## REFERENCE

[1]. Johansson, S. A. E., Campbell, J. L., &Malmqvist, K. G. (1995). Particle Induced X-ray Emission pectrometry (PIXE) Wiley, Chichester, 3, 56-71.

[2]. Sven, A. E., John, L. C., Klaus, G. M. (1995). Particle-induced X-ray Emission Spectrometry (PIXE). Nuclear Science Application, 133, 65-78.

[3]. Samaila, B. (2019). Determination of Lead from Tailings of Gold Matrix using Proton Induced X-ray Emission. International Journal of Science and Research (IJSR), Volume 8 Issue 1, pp.110-113