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Analysis of Zr, Pb and Zn in Soil and Cereal Grown Around Birnin Gwari Artisanal Goldmine, Kaduna State- Nigeria

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ABSTRACT: *Energy Dispersive X-ray Fluorescence technique was used to Analysis the concentration of Zr, Pb and Zn in soil an cereal grown in farm lands around Birnin Gwari Artisanal Goldmine. The mean concentrations of Zr, Pb and Zn in soil are 446.33±5.94mg/kg, 20.83±3.31mg/kg and 61.82±4.88mg/kg respectively while the mean concentrations in maize are 6.51±0.69mg/kg, 11.61±1.14mg/kg and 102.34±3.94mg/kg for Zr, Pb and Zn respectively. The concentration of Zr in soil is higher across all sampling locations while for Pb and Zn the concentration is higher in soil in some locations and higher in maize in other locations. The results indicated that Pb and Zn have elevated concentration in maize which may cause health problem.*

KEYWORDS*: Soil, maize, X-ray fluorescence, concentration Zr, Pb and Zn.*

I. INTRODUCTION

In many developing countries like Nigeria, soils are affected by mine waste disposal, acid deposition, sewage sludge and other anthropogenic and agricultural activities. Heavy metal contamination of arable soils through industrial and anthropogenic activities is a serious problem in Nigeria. The impact of contamination on the environment should be of scientific concern in order to minimize the threat of soil and ground water contamination[1]. Studies have shown that the heavy metals are potentially toxic to crops, animals and humans when contaminated soils are used for crop production[2]. For example, Lead (Pb) affects every organ system in the body. It is absorbed into the body and distributed to the body soft tissue and bones. The central nervous system is the most vulnerable to lead toxicity particularly in developing children [3,4]. A case study is the lead poisoning that killed over 400 children in Zamfara State as a result of illegal mining activities[5]. The total heavy metal content in the soils provide a convenient means of expressing a measure of pollution.

Mining and industrial processing are among the main sources of heavy metal contamination in the environment. Mining activities, through milling operations coupled with grinding, concentrating ores and disposal of tailings, along with mill wastewater provide obvious sources of heavy metal contamination of the environment [6,7]. It is, therefore, not surprising that the degree and extent of heavy-metal pollution as a result of human activities has been one of the main topics studied in environmental geochemistry. Heavy metals can cause health problems at higher exposures and destroy aquatic organism when leached into water bodies [8,9]. Metals contamination in aquatic environmental has received huge concern due to their toxicity, abundance and persistence in the environmental and subsequent accumulation in the aquatic habitats [10] . Heavy metal residues in contaminated habitats may accumulate in microorganisms, aquatic flora and fauna, which in turn may enter the human food chain and result in health problems like the lead poisoning problems In this research, the concentration of heavy metals in cereals and soil samples were determined using Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometric technique. The relation between the cereal and soil metal contents was also investigated.

II. MATERIALS AND METHOD

Sampling Location : A total of 80 samples were collected comprising of 40 soil samples and 40 maize samples from 3 mining communities of the study area which comprised of Kakani, Farin Ruwa and Tsoho Gwari. Global Positioning System (GPS) was used to determine the location of each farm where samples were collected. The position of each farm is shown in table 1 below.

Table 1: Sampling Coodinate

S.No	Place	No. sample	No.sample	N	E
1	Kakani				
	a.BG1	4	4		
	b.BG2	4	4	$11^0\ 11^{11}\ 23^1$	$06^0\ 59^{11}\ 15^1$
	c.BG3	4	4		
	d.BG4	4	4		
2	Farin Ruwa				
	Farin Ruwa1	4	4		
	BG5	4	4		
	Farin Ruwa2	4	4		
	BG6	4	4	$11^0\ 04^{11}\ 14^1$	$06^0\ 47^{11}\ 34^1$
	Farin Ruwa 3BG7				
	Farin Ruwa 4BG8				
3	Abuja				
	Abuja 1BG9	4	4	$10^0\ 59^{11}\ 19^1$	$06^0\ 48^{11}\ 31^1$
	Abuja 2BG10	4	4		

Samples Preparations : The soil samples collected were taken to the Laboratory of Mineral Resources Engineering Department of Kaduna Polytechnic where they were crushed and sieved separately to a tiny bits of 38µm (Kogo *et al.*, 2009). The crushed samples were then oven dried at about 100^0C to a constant weight. While the maize samples were taken to chemistry laboratory Kaduna Polytechnic where they were oven dried at 50^0C and also crushed to tiny bits. All the prepared samples were then taken to Nigerian Institute of Mining and Geosciences Jos Plateau State for XRF analysis using FXL-83358 model of XRF machine.

III. RESULTS AND DISCUSSION

The result of X-ray fluorescence analysis showing the concentrations in mg/kg of Zr, Pb and Zn in both soil and cereal (maize) are indicated in table 2-4 below.

Table 2: Concentration of Zr in Soil and Maize Samples

S/N	Locations	Concentration in (mg/kg)	
		Zr	
		Soil	Maize
1	BG 1	1408.53± 7.40	5.97 ± 0.67
2	BG 2	1332.75± 7.48	5.04 ± 0.66
3	BG 3	903.08± 6.63	7.09 ± 0.68
4	BG 4	707.43 ±5.40	6.28 ± 0.67
5	BG 5	805.01 ± 5.48	5.41 ± 0.69
6	BG 6	906.66 ± 5.91	6.09 ± 0.67
7	BG 7	580.78 ± 4.54	6.63 ± 0.69
8	BG 8	1083.14 ± 5.79	7.84 ± 0.73
9	BG 9	444.50 ± 4.08	7.88 ± 0.70
10	BG 10	1291.44± 6.64	6.86 ± 0.70
	Mean	446.33±5.94	6.51±0.69

Table 3: Concentration of Pb in Soil and Maize Samples

S/N	Locations	Concentration in (mg/kg)	
		Pb	
		Soil	Maize
1	BG 1	19.68 ± 3.33	5.90 ± 1.32
2	BG 2	16.00 ± 3.40	11.65 ± 1.51
3	BG 3	29.05 ± 4.51	ND
4	BG 4	36.39 ± 4.09	2.61 ±1.21
5	BG 5	23.47 ± 3.37	40.18 ± 2.28

6	BG 6	16.68 ± 3.10	ND
7	BG 7	11.35 ± 2.64	5.85 ± 1.36
8	BG 8	11.83 ± 2.49	ND
9	BG 9	22.36 ± 3.11	10.46 ± 1.51
10	BG 10	21.45 ± 3.10	39.46 ± 2.25
	Mean	20.83±3.31	11.61±1.14

Table 4. Concentration of Zn in Soil and Maize Samples

S/N	Locations	Concentration in (mg/kg)	
		Zn	
		Soil	Maize
1	BG 1	57.79 ± 5.29	17.99 ± 3.96
2	BG 2	66.12 ± 5.75	109.43± 3.94
3	BG 3	117.02 ± 7.52	45.19 ± 2.89
4	BG 4	116.03 ± 6.84	82.51 ± 3.56
5	BG 5	52.33 ± 4.97	297.90 ± 6.24
6	BG 6	44.41 ± 4.81	54.74 ± 3.07
7	BG 7	25.06 ± 3.99	54.74 ± 3.07
8	BG 8	44.83 ± 4.29	90.07 ± 3.88
9	BG 9	46.78 ± 4.67	100.39 ± 3.93
10	BG 10	47.82 ± 4.67	170.42 ± 4.89
	Mean	61.82±4.88	102.34±3.94

Zirconium (Zr) : Zr is a transition metal and was found in both the soil and maize samples in all the locations. The mean concentration of Zr in soil is 946.33±5.94mg/kg while the mean concentration in maize is 6.15±0.69mg/kg. The 95% confidence interval for the mean concentration of Zr was between(444.50±4.08 to 1408.53±7.40)mg/kg in soil and was between (5.97±0.67 to 7.88±0.70)mg/kg in maize. The concentration of Zr is more in soil than in maize in all locations as shown in Fig.1.

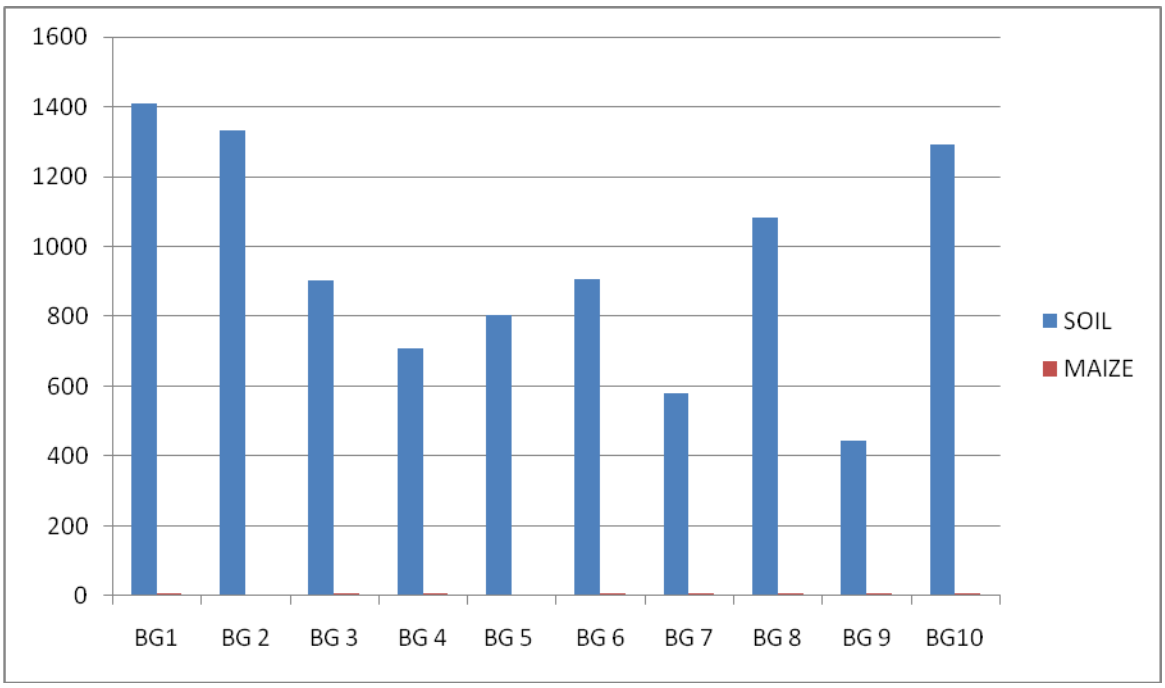

Fig 1 Plot of Concentration of Zr by location

Lead (Pb) : The result of analysis show that Pb is present in soil in all location while in 3 location Pb was not detected in maize. The mean concentration of Pb in soil sample is 20.83±3.31mg/kg while in maize the mean concentration is 11.61±1.14mg/kg. The 95% confidence interval indicated that the mean concentration of Pb in soil and maize lies between (11.35±2.64 to 36.39±4.09)mg/kg and(2.61±1.21 to39.46±2.25)mg/kg respectively. The concentration of Pb in soil is higher in8 locations while it is higher in maize in only 2 locations as shown in Fig.2.

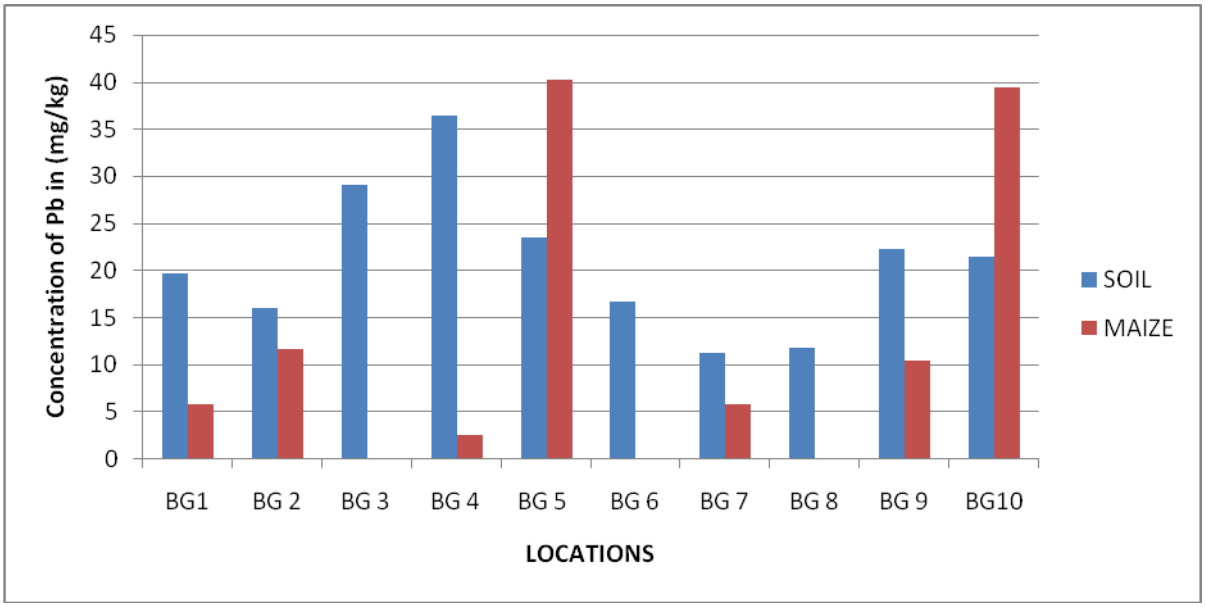

Fig 2 Plot of Concentration of Pb by location

Zinc (Zn)

The results show that Zn is present in both soil and maize. The mean concentration of Zn in soil is 61.82±4.88mg/kg while in maize the mean concentration is 102.34 ± 3.94mg/kg. The 95% confidence interval indicated that the mean concentration of Zn in soil and maize lies between (25.06±3.99 to 117.02±7.52mg/kg and (17.99 ± 3.96 to 297.90±6.24) mg/kg respectively. The concentration o Zn is higher in soil in only 3 locations while in the remaining 7 locations the concentration of Zn is higher in the maize samples as shown in Fig. 3.

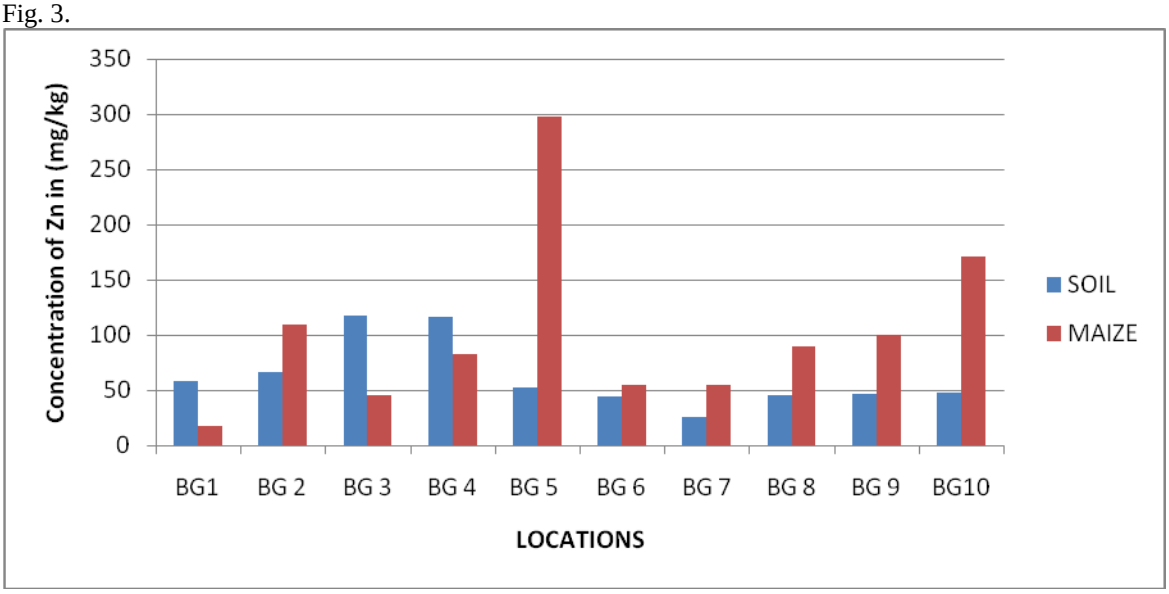

Fig. 3 Plot of Concentration of Zn by location

IV CONCLUSION

The concentration of Zr is higher in soil in all locations with mean values of 446.33±5.94mg/kg and 6.51±0.69mg/kg in soil an maize respectively. This shows that the accumulation of Zr by maize from the soil is only 1.45%. The mean concentration of Pb in soil and maize are 20.83±3.31mg/kg and 11.61±1.14mg/kg respectively with the concentration in soil being higher than in maize in 8 locations while the mean concentration of Zn in soil an maize are 61.82±4.88mg/kg an 102.34±3.94 mg/kg respectively unlike Zr and Pb the concentrations of Zn is higher in maize samples across 7 locations. The mean values obtained in this work for Zr is within the world average values in both soil and maize[11]. However, the mean values of Pb and Zn in soil are within the world average value but maize has elevated values of Pb and Zn which may cause health problem.

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