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Assessment of As and Cr Concentration in Gold Bearing Soil using Instrumental Neutron Activation Analysis (INAA)

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ABSTRACT

The concentration of Cr and As in gold bearing soil mine from Brinin Gwari Artisanal Gold mine was investigated using instrumental neutron activation analysis (INAA) techniques. The results showed that Cr has a mean concentration of 105.75 ±16.53mg/kg in range between 11.0 ± 0.04-235.0 ± 5.0mg/Kg while As has a mean concentration of 526.38 ± 26.29 mg/kg in range between 44.0 ± 0.4 - 29090 ± 6.0mg/kg. The values for Cr are within the world average values and within the tolerate limit while the values of As concentrations obtained in the work are by far more than the world average values and tolerable limit which implies that the miners and surrounding communities are at risk due to the high concentration of As in the area.

Keyword: *Concentration Cr, As neutron activation analysis.*

I. INTRODUCTION

Mining is a global industry undertaken for its economic benefits of wealthy creation and employment. In African commercial scale mining provides important benefits in terms of exports/foreign exchange earnings and tax receipt to nineteen African countries (Hayumbu, and Mulenga, 2004).

Beside the socio-economic benefits of the mining industry in the developing countries such as Nigeria, the industry may be faced with three potential negative effects. The first one is the socio-economic dislocation all ill-prepared mining communities go through at mine closure, which arise from exploitation of a non-regenerative resources (Hayumbuand Mulenga, 2004). The second and third undesirable aspects arise when non-optimal management of mining operations results in environmental degradation and /or negative health impacts on miners and mining communities (Zakari *et al*, 2013). Principal health problems among miners and mining communities from various countries that have been cited by the literature include respiratory disease, neoplasm/cancer, chronic hypertension, mental health and genetic impact (WHO, 1999) The major cause of these disease can be attributed to the heavy metal contamination and naturally occurring radioactive materials (ICRP, 1994).

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 (Ayodele and Muhammed, 2011, Kabala and Singh, 2001). 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 (Chiroma *et al*, 2012, Abdullahi *et al*, 2013). 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. (Boamposem *et al.*, 2010).

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 Zamfara State that kills more than 400 children. (Weekly Trust,, 2011).
In this work the concentrations of As and Cr were determine in a Gold ones mine from Brinin Gwari Artisanal Gold mine of Kaduna State Nigeria using instrumental neutron activation analysis techniques.

II. MATERIALS AND METHODS

Twelve samples were collected from 12 gold pits at different depth of 2.5 m to 43.0 m in the study area which comprised of the following artisanal gold mining sites: Kakini Farinruwa and Tsohowar Gwari. Global Position System (GPS) was used to determine the location of each pit and a tape rule was used to

determine the depth of each pit. Table 1 shows the location, depth and elevation of each pit where samples were collected.

Table 1: Sample locations

PLACE	SAMPLE CODE	DEPTH IN m	LOCATION N	LOCATION E	ELEVATION IN m
KAKINI	BG1	2.70	11^0.10" 25'	06^0 58" 0'	663
	BG2	4.30	11^0 10" 23'	06^0 59" 15'	685
F/RUWA	BG3	7.00	11^0 04" 14'	06^0 47" 34'	595
	BG4	7.50	11^0 04" 16'	06^0 47" 33	594
TSBG KANO	BG5	19.00	10^0 59" 45'	06^0 48" 27'	560
	BG6	43.00	10^0 59" 37'	06^0 48" 25'	562
TSBG JINEER					
	BG7	28.00	11^0 00" 43'	06^0 48" 28'	547
TS.BG KATSINA	BG8	26.00	11^0 00" 37	06^0 48" 23'	542
	BG9	24.00	11^0 01" 14'		550
TS.BG ABUJA	BG10	28.00	11^0 01" 10'	06^0 48" 20' 06^0 48" 21'	546
	BG11	10.20	10^0 59" 19'		558
	BG12	8.50	10^0 59" 17'	06^0 48" 31' 06^0 48" 32'	559

Sample preparation: The samples collected were taken to the Laboratory of Mineral Resources Engineering Department of Kaduna Polytechnic where they were crushed and sieved to tiny bits of 38 µm (Kogo *et al*., 2009). The crushed samples were dried at about 100°C to a constant weight. The samples were then taken to Centre for Energy Research and Training Ahmadu Bello University Zaria, Nigeria for Neutron Activation Analysis. Between 0.150g -0.180g of the powdered samples were wrapped in a polyethylene then placed in 7 cm3. Rabbit capsules. The polyethylene and rabbit capsules containing the samples were cleaned by soaking in 1:1 HNO3 (Nitric acid) and then washed with de-ionised water in order to eliminate every contamination prior to sample irradiation (El-Taher *et al*., 2003).

Sample analysis: The concentrations of elements of interest from the collected and prepared samples were investigated using Neutron Activation Analysis technique (NAA) with the Nigeria Research Reactor 1 (NRR1) No NRR1/DS/JC/09/16 at the Centre for Energy Research and Training, Ahmadu Bello University Zaria, Nigeria.

III. RESULTS AND DISCUSSIONS

Gold bearing soil collected from 12 sampling locations were analyzed using instrumental neutron activation analysis (INAA) technique it was found out that the concentrations of the elements varied from one location to another inferential statistics was used to compare the concentrations of Cr and As across the 12 sampling locations. The one way ANOVA at the 5% level of significance was applied for the analysis. The mean concentrations of Cr and As is as shown in table- 2.

Table 2 concentration of AS and Cr in mg/kg

S/No	Sample Code	Concentration in mg/kg Cr	As
1	BG 1	50 ± 3	2909 ± 6
2	BG2	235 ± 5	110 ± 1
3	BG3	43 ± 3	1817 ± 4
4	BG4	81 ± 3	147 ± 1
5	BG5	113 ± 3	610 ± 2
6	BG6	11 ± 0.4	187 ± 1
7	BG7	138 ± 4	79.5± 0.4
8	BG8	117 ± 4	151.0 ± 1.00

9	BG9	103 ±4	64.1 ± 0.4
10	BG10	116 ± 3	67.8 ± 0.4
11	BG11	139 ± 3	76.1 ± 0.5
12	BG12	123 ± 3	44.0 ± 0.4
	Mean	**105.75 ± 16.53**	**526.92 ±26.29**

Chromium (Cr)

From the results of the analysis the mean concentration of Cr is 105.75 ± 16.53 mg/kg in range between 11.0 ± 0.04 to 235.0 ± 5.0. with the highest concentration in BG2 as shown in figure-1, the values obtained in this study for Cr are comparable with those reported for world average and range values of 100 mg/kg and 1 – 100 mg/kg respectively reported by USEPA 1992.

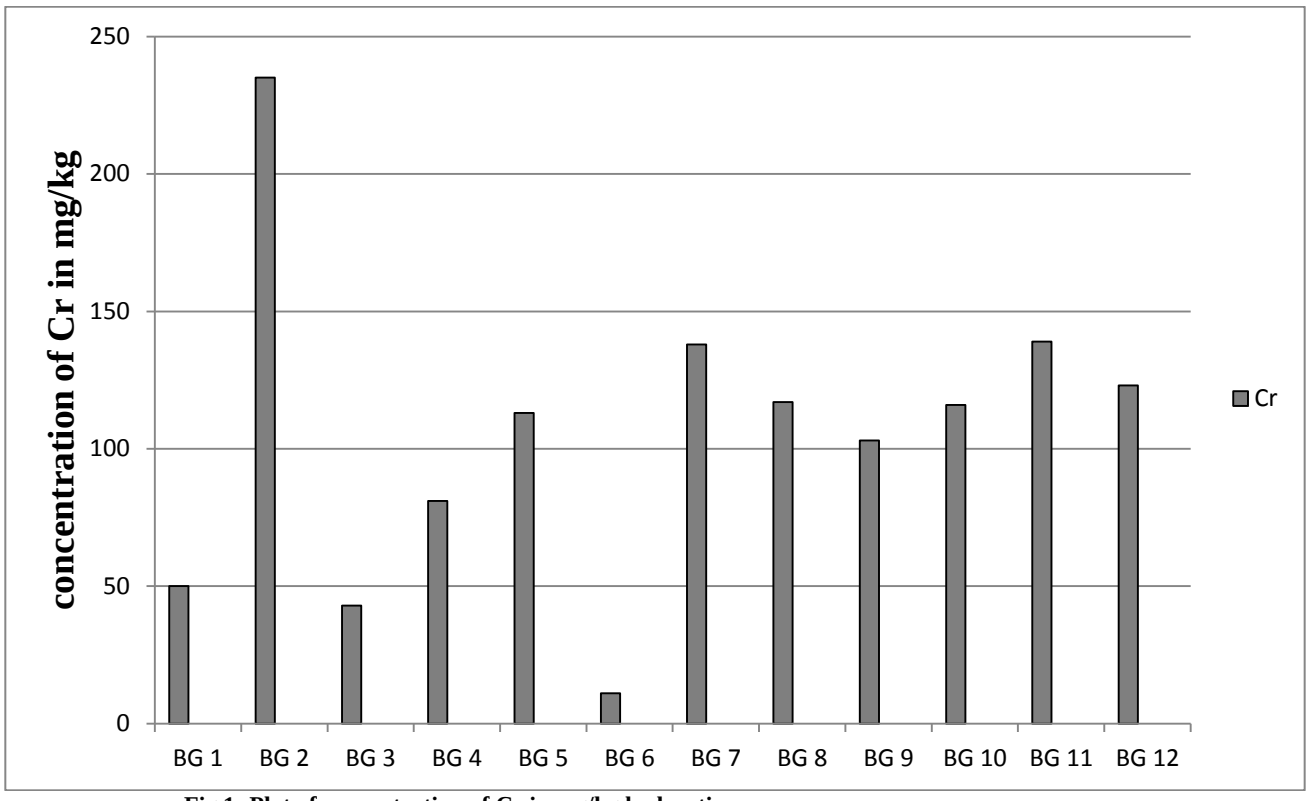

Fig.1: Plot of concentration of Cr in mg/kg by location

Arsenic (As)

The mean concentration of As is 526.38 ± 26.29 mg/kg in range between 44.0 ± 0.4 – 2909 ± 6.0 mg/kg. The highest value was abstained from BG1 as shown in figure- 2.. The values of As in this study are by far more than 5 mg/kg average and range 1-50 mg/kg reported by USEPA 1992.

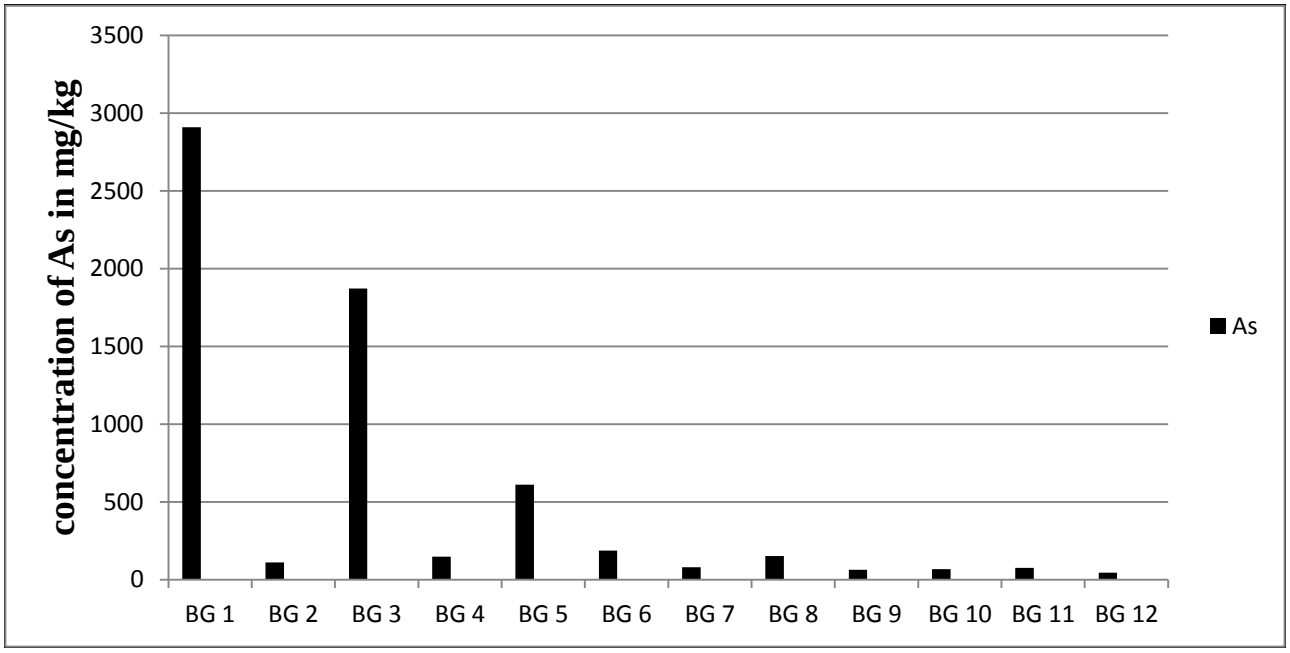

Fig.2: Plot of concentration of As in mg/kg by location

The ANOVA (0.00070.05) showed that there is a significant difference in the relative abundance of As and Cr in the sampling locations. In other words in some locations Cr is more than As while in some As is more than Cr as shown in Fig- 3.

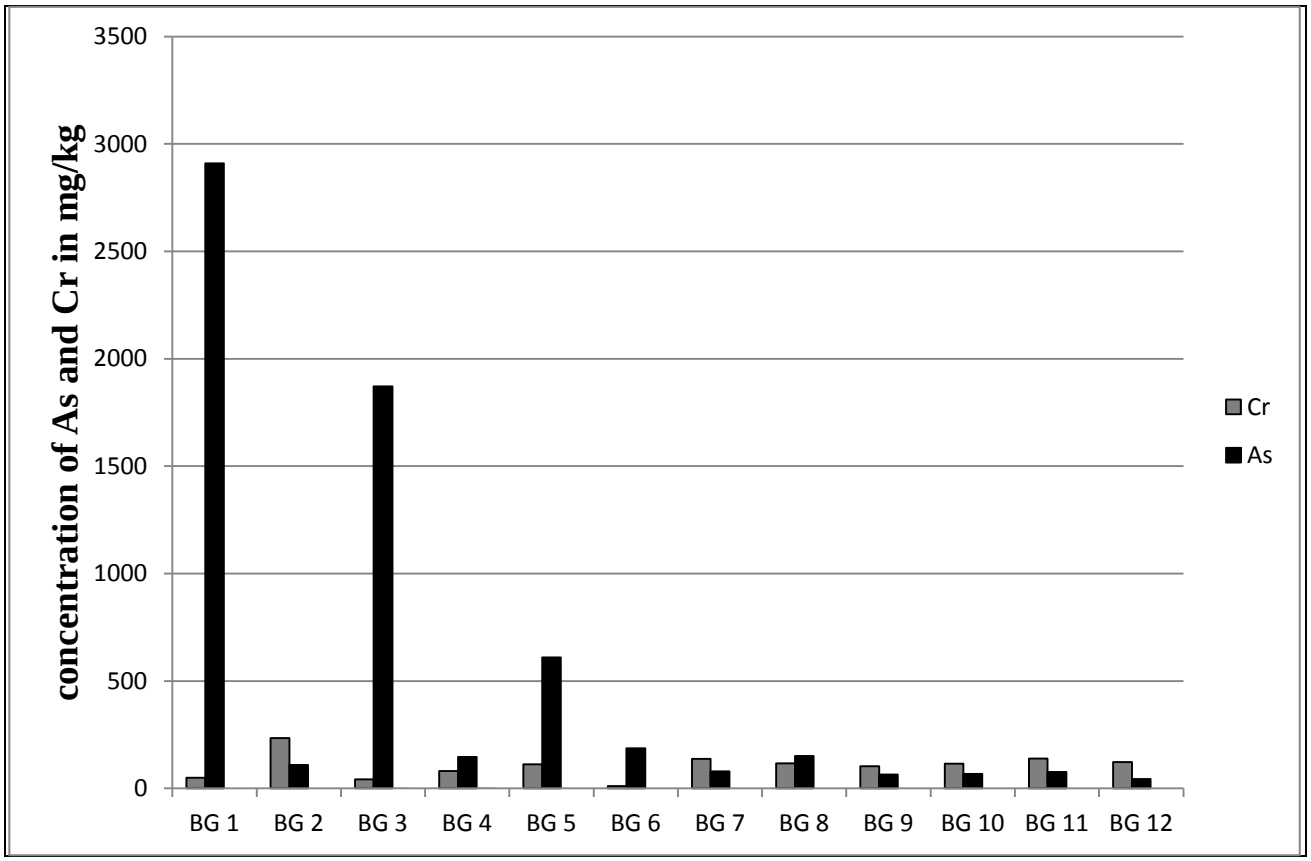

Fig.3: Plot of concentration of Cr and As in mg/kg by location

V. CONCLUSION

The concentration of As and Cr in gold bearing soils mine from Birnin Gwari Artisanal Gold mine Kaduna state were determine using instrumental neuron activation analysis techniques. The results showed that Cr has a mean concentration of 105.75 ± 16.53mg/kg whith minimum and maximum values between 11.0 ± 0.4 235.0 ± 5.0 mg/kg and As has mean concentration of 526.38 ± 26.29mg/kg with minimum and maximum values between 44.0 ± 0.4 – 2909 ± 6.0 mg/kg. The mean and range values of Cr compared well with the world mean and range and are within the tolerable limit.

The mean and range values of As from this study are by far more than the world mean and range values and the therefore more than the tolerable values, consequently the miner and the surrounding communities are at risk of being affected by the high concentration of As in the area.

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