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ENVIRONMENTAL IMPACT OF HEAVY METALS CONCENTRATION IN PARTS OF KOKONA/NASARAWA L.G.A(S), NASARAWA STATE, NORTH CENTRAL NIGERIA

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ABSTRACT: *Geochemical survey was carried out in the soils, mine dump and water of Afu Younger Granite Complex, Nasarawa State. The aim of the study is to assess the level of trace element distribution in the three (3) media sampled as mentioned above. Objectives are to produce geochemical information of the area and the likely effects of the trace elements with remedies. Identify possible source of the trace elements. Atomic absorption, spectrometer (AAS) was used for analysis for seven trace metals – Cd, Cr, Co, Cu, Fe, Pb and Ni. The result revealed soil average metal concentration in the following order of decrease. Fe 286.163 > Pb, 0.648 > Co, 0.133 > Cu, 0.080 > Cd, 0.054, > Ni, 0.029 > Ci, 0.017. Mine dump reads as follows in the diminishing order. Fe, 185.590 > Pb, 0.607 > Cu, 0.122 > Co, 0.049 > Ni, 0.031 > Cd, 0.022 > Cr, 0.011 in ppm. Water in the same order reveals; Fe, 1.942 > Co, 0.630 > Pb, 0.512 > Cu 0.043 > Cr, 0.030 = Cd, 0.030 > Ni, 0.003. All the average soil samples of the individual elements are greater than that of mine dumps except for Ni and Cu. All the average trace elements in soil and mine dumps are less than the World Soil Mean (WSM) and Average Concentration of Granitic Rocks (ACGR). In water, Cd, Co, Fe, Ni and Pb are above World Health Organization (WHO) Standard, World River Mean (WRM), Cr and Cu are lower.*

KEYWORDS: Environmental Impact, Heavy Metals, Soils, Mine Dump, Water, Nigeria

INTRODUCTION

The world is desirous of comfort in all ramifications like health, accommodation, infrastructure, wealth, to mention but a few. Not many think of the source. It is worthy to note that all these and many more come from mother earth.

The primary purpose of geochemistry on one hand is to determine the composition of the earth and its parts and on the other hand, to discover the laws which controls the distribution of individual elements. The geological setting of the Afu Younger Granite Complex of Nigeria is the study area. Based on the distribution pattern, elements are classified as (i) Major (ii) Minor (iii) Trace and (iv) Rare Earth Element (REE).

Our point of focus is trace elements. Mining areas are characterized by high concentration of potentially harmful elements in soil, mine dumps and water. The primary magmatic composition of Afu Younger Granite and the secondary component of same emanating from weathering and mining activities may redistribute these trace elements. Some of these are equally important to our body systems as well as industrial sector. Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb) and Nickel (Ni) are the elements considered in this research. Afu Younger Granite Complex is one of the Nigerian younger

granite complexes that generated a lot of revenue to Nigeria through the mining of columbite deposit (NbO_2) and cassiterite (SnO_2). The Nb metal and Sn derived from these ores played a great role in the economy of this country. It is another ripe time for Nigerians to go back to the solid minerals sector, as petroleum is losing its pride in the comity of natural resources.

Location and Accessibility

The study area constitutes integral parts of sheets 208(Keffi SE) and 209(Akwanga SW) on a scale of 1:50,000 which covers Nasarawa and Kokona L.G.A(s) of Nasarawa state in North Central Nigeria (fig 1).

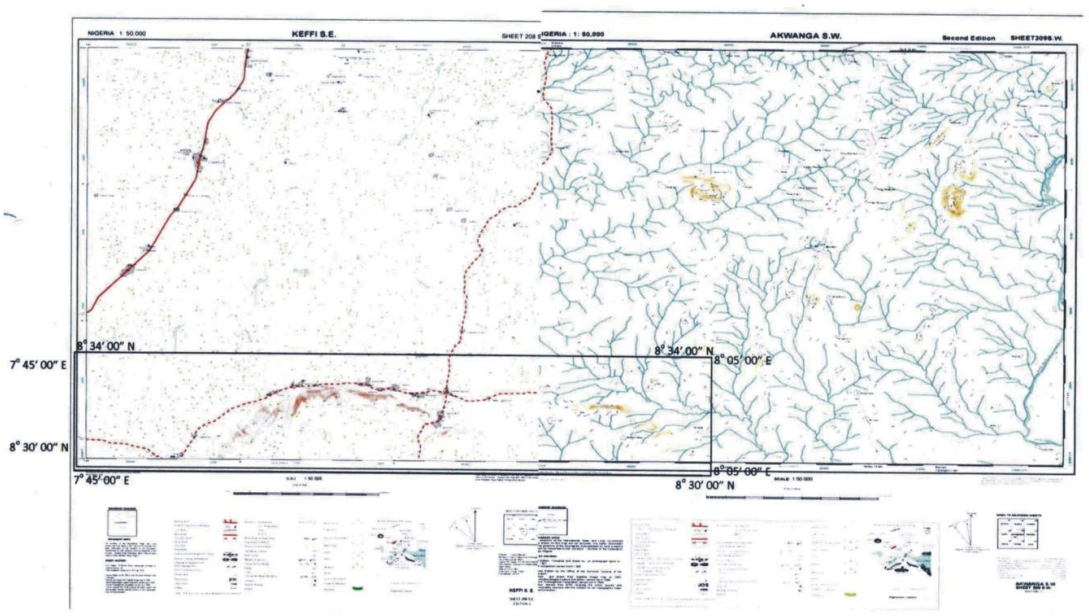

Fig. 1 Location Map of the Study Area (Office of the Surveyor General Federation Abuja, Nigeria, 2008)

Geology

Afu Younger Granite is about 141±2ma (Bowden etal, 1973). Afu Younger Granite is the youngest in Nigeria (Obaje, 2009), it is located at the North Central Nigeria. The rock types here include: alkali feldspars granite, rhyolites, minor gabbro and syenites (Wright et al, 1985). Biotite granites-the host of columbite and the associated mineral ore deposites like galena, pyrite, sphalarite, chalcopyrite, pyrochlore are found.

MATERIAL AND METHOD

The research enjoyed two steps-(i) Field work and (ii) laboratory investigation. Each of the two has two stages.

(i) Field work- Reconnaissance survey and detailed field mapping.
(ii) Laboratory investigation- Sample preparation and sample analysis.

Three media sampled; soil, mine dump and water were analysed. Atomic Absorption Spectrometer (AAS) buck scientific: VG210 model with are acetylene burner was used. Cheap relativity, can analyse up to 40 elements depending on the availability of lambs (Levinson, 1980)

RESULTS

Table 1: Result Trace Element Concentration in the soil of the study Area in ppm

S/N	Sample No	Description of Location	Cd	Cr	Co	Cu	Fe	Pb	Ni
1	S1	Omadegye	0.058	0.005	0.061	0.150	434.516	0.178	0.032
2	S2	Odamu	0.044	0.027	0.042	0.190	553.275	0.085	0.052
3	S3	Rafin Gabas	0.013	0.020	0.061	0.030	92.055	2.885	0.025
4	S4	Bajari	0.028	0.010	0.090	0.110	307.940	0.031	0.027
5	S5	Bajari	0.021	0.014	0.102	0.050	22.133	0.695	0.006
6	S6	Jenta	0.078	0.012	0.134	0.010	182.277	0.590	0.014
7	S7	Jenta	0.008	0.017	0.002	0.020	164.302	2.571	0.007
8	S8	Igwo	0.128	0.048	0.231	0.080	323.208	0.016	0.048
9	S9	Igwo	0.022	0.002	0.201	0.110	199.426	0.001	0.007
10	S10	Igwo	0.142	0.019	0.407	0.050	582.500	0.425	0.076
		Minimum	0.008	0.002	0.002	0.010	22.055	0.001	0.006
		Maximum	0.142	0.048	0.407	0.190	582.500	2.885	0.076
		Average	0.054	0.017	0.133	0.080	286.163	0.648	0.029
		World Soil Mean(WSM)	1	50	10	20	20	20	30
		Average Concentration of Granitic Rocks(ACGR)	0.15	20	5	15	14.000-30,000	18	8

WSM= World Soil Mean= Compiled from A.A Levinson (1980)
ACGR= Average Concentration of Granitic Rocks

Table 1: talked about the average concentration of elements in the soil of the study area. The average concentration of the samples (Cd, Cr, Co, Cu, Pb and Ni) are all less than the World Soil Mean (WSM) and Average Concentration of Granitic Rocks (ACGR).

Table 2: Comparism of Average Trace Element in soil of the Study Area with WSM, ACGR and clays in ppm.

S/N	Media	Element	Average	WRM	ACGR	Clays
1	Soil	Cd	0.054	1	0.15	1.4
2	Soil	Cr	0.017	50	20	120
3	Soil	Co	0.133	10	5	20
4	Soil	Cu	0.080	20	15	50
5	Soil	Fe	286.163	35000	14000-	47000
6	Soil	Pb	0.648	20	30000	20
7	Soil	Ni	0.029	30	18	68
					8	

WSM= World Soil Mean
ACGR= Average Concentration of Granitic Rocks

Table 2: explains how the values are also less than average clay values.

Table 3: Result Trace Elements concentration in the mine-dumps of the study Area in ppm

S/N	Sample No	Description of Location	Trace Elements Cd	Cr	Co	Cu	Fe	Pb	Ni
1	D1	Dogon Daji	0.025	0.008	0.028	0.100	458.280	1.172	0.016
2	D2	Dogon Daji	0.014	0.015	0.051	0.070	168.394	1.713	0.011
3	D3	Main Padlock	0.018	0.003	0.034	0.100	166.111	1.260	0.036
4	D4	Main Padlock	0.012	0.024	0.018	0.320	50.314	0.788	0.051
5	D5	Agbalande	0.004	0.004	0.027	0.040	504.948	0.005	0.050
6	D6	Agbalande	0.011	0.015	0.014	0.140	139.251	0.598	0.011
7	D7	Agbalande	0.048	0.013	0.022	0.200	1.115	0.011	0.080
8	D8	Agbalande	0.002	0.004	0.081	0.002	111.071	0.127	0.007
9	D9	Agbalande	0.054	0.017	0.109	0.190	142.985	0.266	0.019
10	D10	Agbalande	0.032	0.005	0.110	0.060	116.435	0.126	0.033
		Minimum	0.002	0.003	0.014	0.002	1.115	0.005	0.007
		Maximum	0.054	0.024	0.110	0.320	504.948	1.713	0.080
		Average	0.022	0.011	0.122	0.122	185.890	0.607	0.031
		World soil Mean (WSM) Average Concentration of Granitic rock (ACGR)	1	50	10	20	20	20	30
			0.15		5	15	14.000-30,000	18	8

Table 3: Again clearly shows the average concentration in the mine dumps of the indicated elements to be all less to the normal concentration in the various media except for Fe. But the value of Iron (Fe) in the soil is greater than the value in the dumps (286.163 against 185.890 ppp). (ACGR, WSM).

Table 4: Comparism of Average Trace Elements in Mine dump of the Study Area with WSM, ACGR and clays in ppm.

S/N	Media	Element	Average	WRM	ACGR	Clays
1	Mine	Cd	0.022	1	0.15	1.4
2	dump	Cr	0.11	50	20	120
3	Mine	Co	0.049	10	5	20
4	dump	Cu	0.122	20	15	50
5	Mine	Fe	185.890	35000	14000-	47000
6	dump	Pb	0.607	20	30000	68
7	Mine	Ni	0.031	30	18	
	dump				8	
	Mine					
	dump					
	Mine					
	dump					
	Mine					
	dump					

Table 4: explains how the value is a normal clay value.

Table 5: Result: of chemical Analysis of Water.

Sample	Description of Location	Cd	Trace Elements Cr	Co	Cu	Fe	Pb	Ni
W1	Udege	0.110	0.022	0.142	0.260	0.293	1.429	0.008
W2	Mbeki							
	Udege	0.002	0.146	0.314	0.060	3.3385	0.340	0.002
W3	Mbeki(L)							
	Udege	0.011	0.015	0.110	0.010	0.173	0.001	0.022
W4	Mbeki(L)							
	Udege	0.000	0.003	1.251	0.080	2.033	0.033	0.020
W5	Mbeki(L)	0.014	0.030	1.061	0.090	0.619	0.008	0.034
W6	Dogon daji	0.031	0.056	1.210	0.020	0.399	1.154	0.014
W7	Dogon daji							
	Main	0.056	0.025	0.341	0.100	2.477	1.853	0.007
W8	Paddock							
	Main	0.031	0.020	0.621	0.110	1.182	0.031	0.024
W9	Paddock	0.051	0.044	0.814	0.140	2.493	1.296	0.020
W10	Odu (L)	0.022	0.034	1.260	0.050	1.592	1.495	0.020
W11	Odu (L)	0.011	0.017	0.211	0.000	6.569	0.075	0.010

W12	Odu (L)	0.067	0.029	0.341	0.110	1.441	0.117	0.009
W13	Odu (L)	0.034	0.025	0.902	0.170	8.398	0.765	0.014
W14	Omadegye	0.031	0.021	0.164	0.190	0.842	0.976	0.024
W15	Odamu	0.024	0.020	0.231	0.050	1.567	0.009	0.055
W16	Rafin Gabas	0.019	0.016	0.116	0.050	1.027	0.032	0.015
W17	Bajari	0.026	0.006	1.201	0.10	0.015	0.032	0.025
W18	Jenta (L)	.0021	0.028	1.251	0.070	0.893	0.196	0.001
W19	Agbalande	0.016	0.29	0.304	0.180	0.422	0.383	0.112
W20	Agbalande	0.012	0.003	0.681	0.040	3.063	0.032	0.020
	Igwo	0.000	0.003	0.110	0.000	0.015	0.001	0.001
	Minimum	0.110	0.146	1.260	0.260	8.398	1.853	0.112
World	Maximum	0.030	0.030	0.63	0.043	1.942	0.512	0.022
River	Average	0.0001	0.001	0.0002	0.007	0.500	0.003	0.0003
Mean								
WHO		0.003	0.05	0.01				
	(Drinking	0.0005-			1-2	0.3	0.01	0.02
	water)	0.005	0.05		0.006-			
	Limit for				0.03	0.1	0.02	0.01
	Salmonid in							
	fresh water							

L= Well, World River Mean after Hem, (1985) Turekian, (1969)
List for salmonid in fresh water after Dail, et al.., (1983) and Alaska (1983)

Table 5: the concentration, here, shows that all the elements are more than the World River Mean (WRM) except Fe that is less.

Table 6: Comparism of Average Trace Elements in water of the study Area with WRM, WHO, LSFM in ppm.

S/N	Media	Metal	Average	WRM	WHO	LSFP
1	Water	Cd	0.030	0.0001	0.003	0.0005-
2	Water	Cr	0.030	0.001	0.05	0.005
3	Water	Co	0.630	0.0002	0.01	0.0002
4	Water	Cu	0.043	0.003	1-2	0.006-0.30
5	Water	Fe	1.942	0.5	0.3	0.1
6	Water	Pb	0.512	0.003	0.01	0.02
7	Water	Ni	0.022	0.0003	0.02	0.1

LSFW=Limit for salmonid (fish) in fresh water after.

Table 7: Metal (Element) Species in a Natural Fresh Water.

S/N	Chemical Formular	Metal	Main Species	Proportion of free Ion
1	Cd	Cadmium (ii)	Cd^{2+} $CdCO_3$	0.5
2	Cr	Chromium Chrome (ii)	Cr	O_4^{2-}
3	Co	Cobalt (ii)	Co^{2+} $CoCO_3$	0.5
4	Cu	Copper (II)	$CuCO_3$ $CuC(OH)_2$	0.01
5	Fe	Iron (iii)	$Fe(OH)_2$	$2x10^{-11}$
6	Pb	Lead (II)	$PbCO_3$	0.05
7	Ni	Nickel (ii)	Ni^{2+} $NiCO_3$	0.4

Stumm and Morgan, (1996)

DISCUSSION

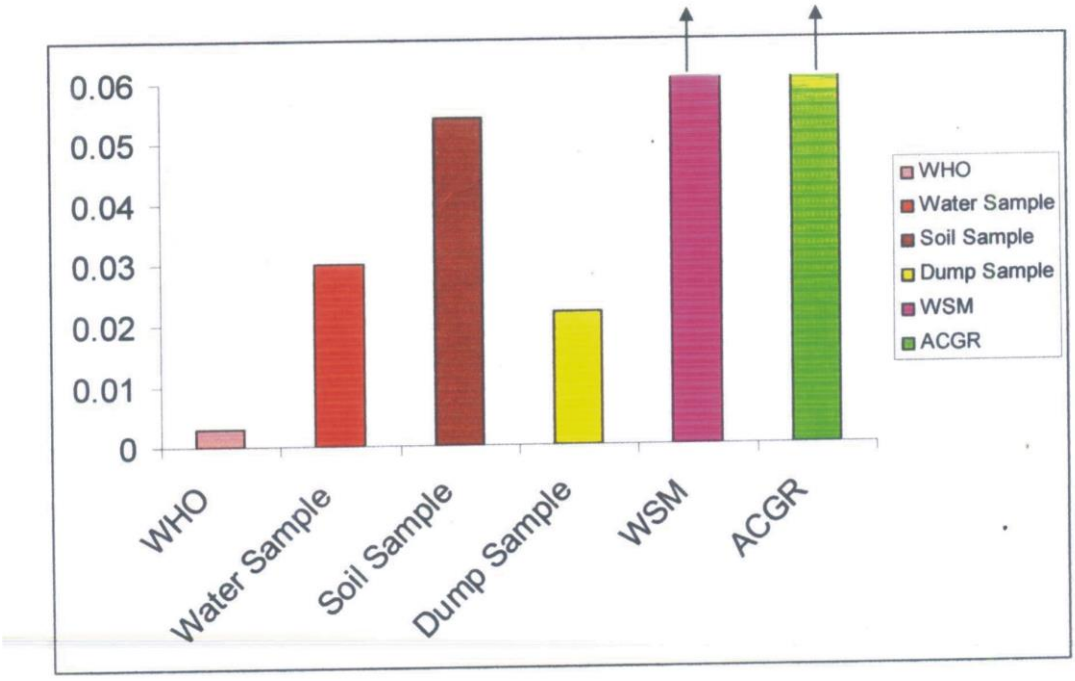

Fig. 2: Average Concentration of Cadmium (Cd) in Water Soil and Dump Samples (Present Work) against WHO Drinking Water Limit, World Soil Mean (WSM) and Average Concentration of Granitic Rocks.

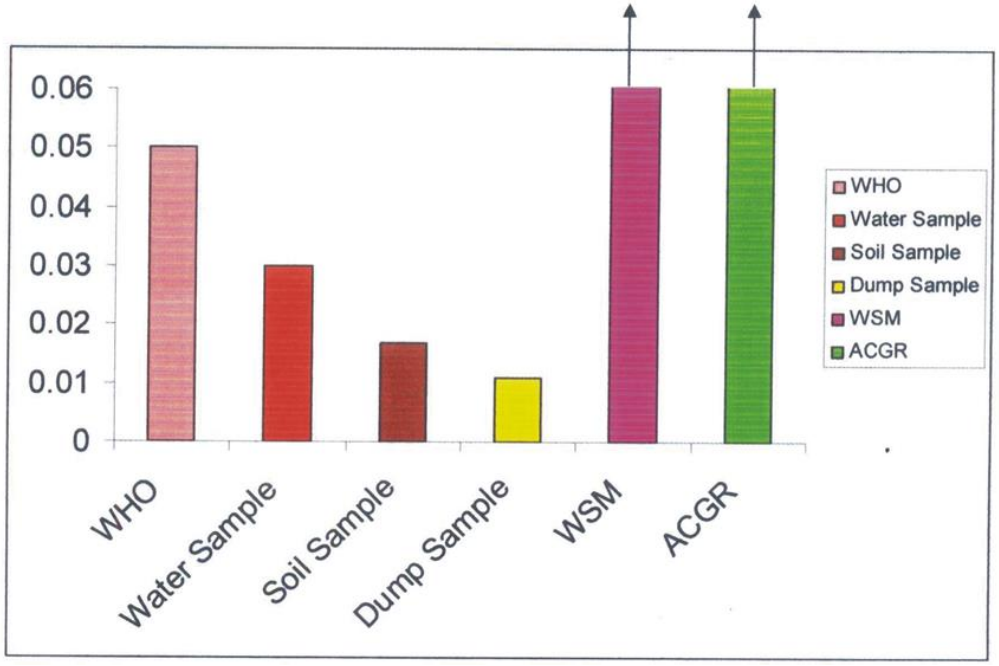

Fig. 3: Average Concentration of Chromuim (Cr) in Water, Soil and Dump Samples

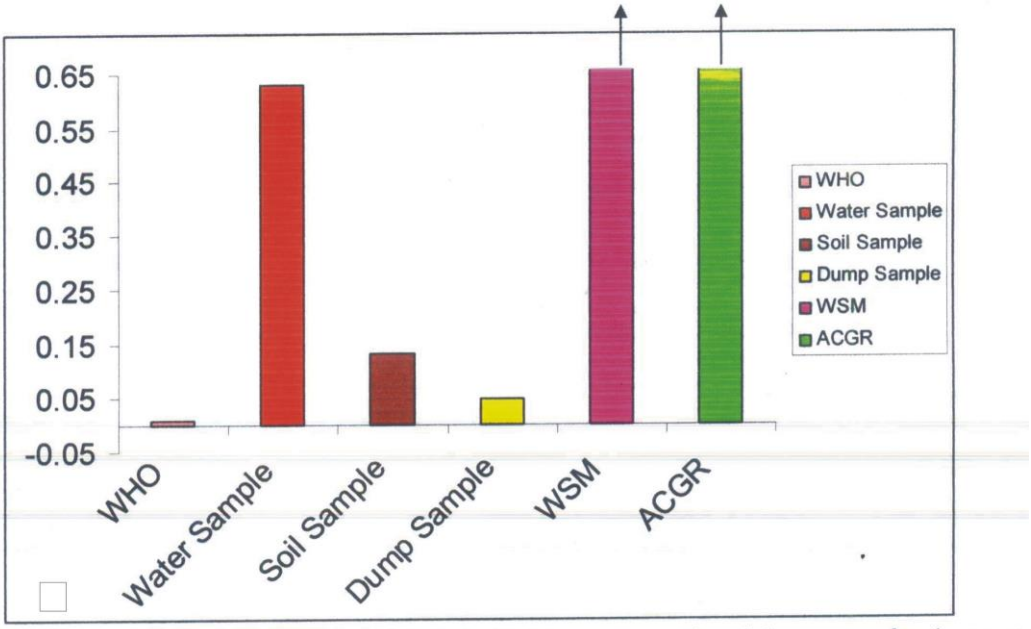

Fig. 4 *Average concentration of Cobalt (Co) in water, soil and dump samples (present work) against WHO drinking water limit, world soil mean (WSM) and average concentration of Granitic Rocks (ACGR)*

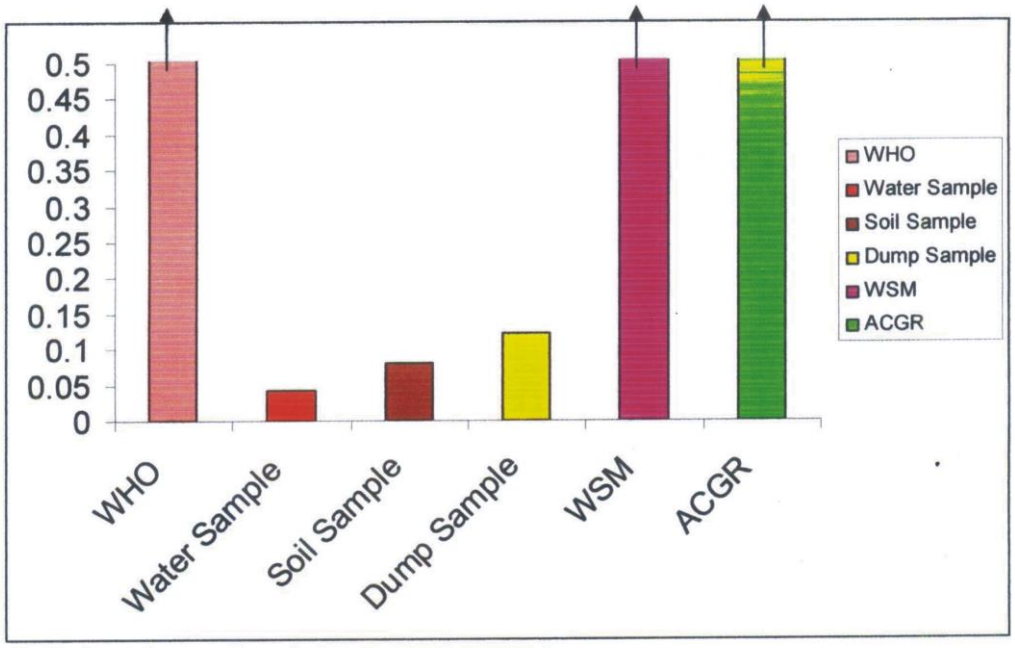

Fig. 5 *Average concentration of Copper (Cu) in water, soil and dump samples (present work) against WHO drinking water limit, world soil mean (WSM) and average concentration of Granitic Rocks (ACGR)*

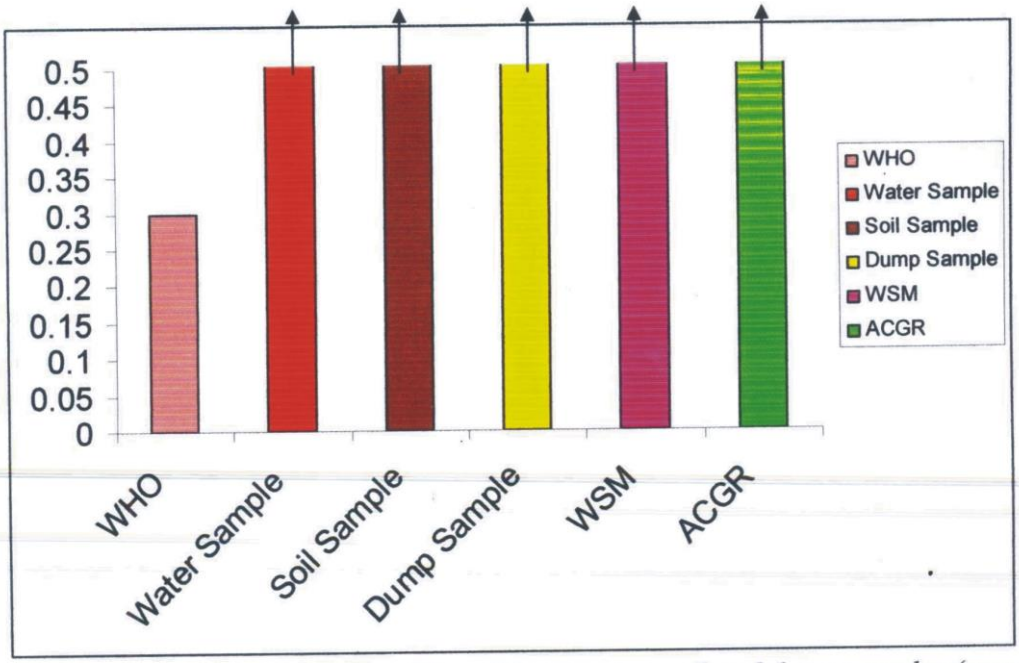

Fig. 6 *Average concentration of Iron (Fe) in water, soil and dump samples (present work) against WHO drinking water limit, world soil mean (WSM) and average concentration of Granitic Rocks (ACGR)*

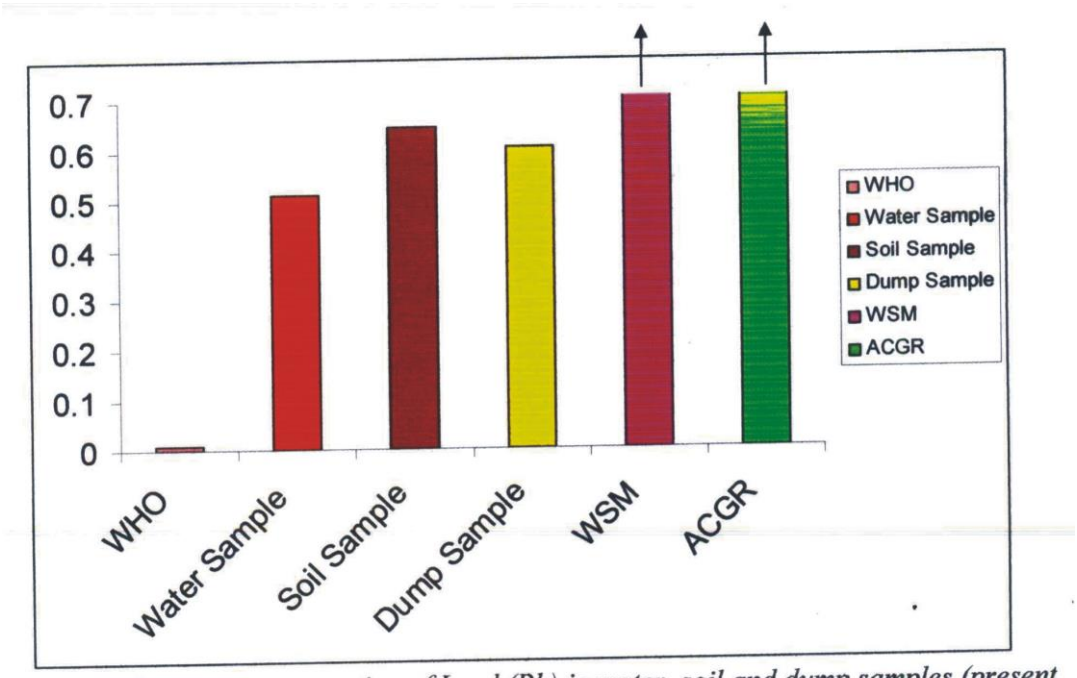

Fig. 7 Average concentration of Lead (Pb) in water, soil and dump samples (present work) against WHO drinking water limit, world soil mean (WSM) and average concentration of Granitic Rocks (ACGR)

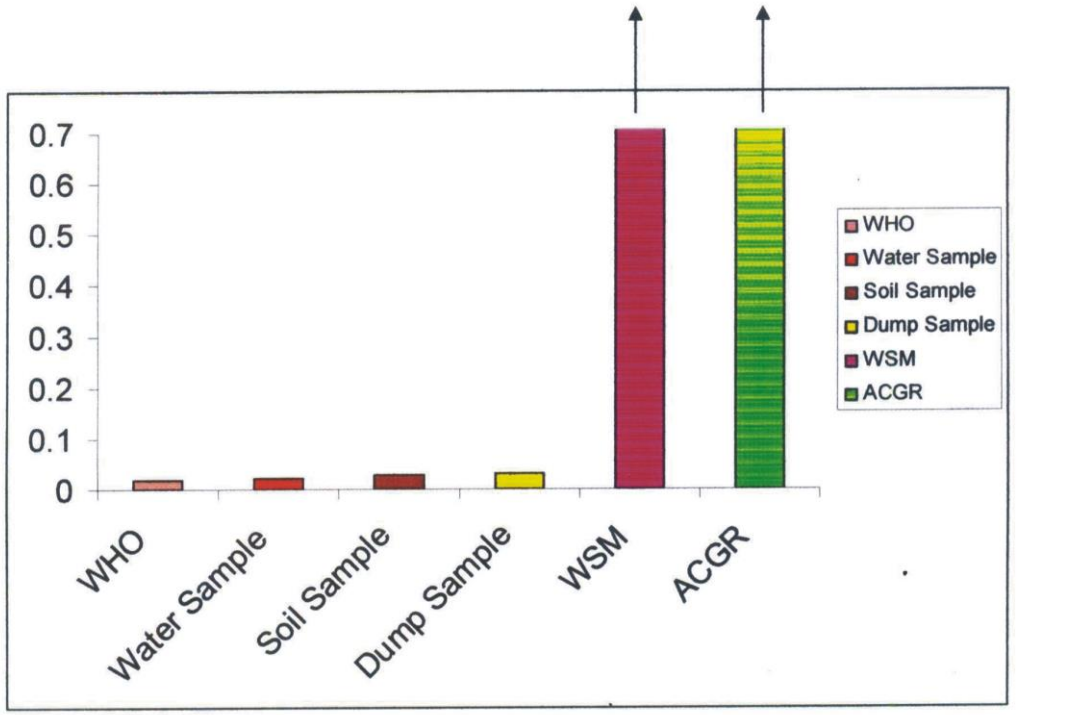

Fig. 8 Average concentration of Nickel (Ni) in water, soil and dump samples (present work) against WHO drinking water limit, world soil mean (WSM) and average concentration of Granitic Rocks (ACGR)

SUMMARY

The Bar chat practically shows Cd, Cr, Co, Cu, Fe and Ni are less than the normal requirement in the soil, clay and granitic rocks.

Also Cd, Co, Fe, Pb above the WHO requirement Cd, Co and Fe are far above WHO requirement Cd associates closely with sphacrite (Zns). Zns may weather into secondary cadmium mineral – Greenociate (Cds) Arite $CdCO_2$. Leaching of these minerals may release individual elements into the environment (Ashano, et al, 2004).

The presence of C_o in high concentration is due to the presence of Fe (Fleming, 1978). Fe is also high in the environment, this is due to the main ores like magnetite (Fe_3O_4 – 2.4%Fe) haematite (Fe_2O_3 70%Fe), geotite (FeOCOH) 68.5%Fe limonite (Feo.OH H_2O), sulhides like chalcopyrites $CaFeS_2$, Pyrite FeS_2. Even ilmenite (FeT_1O_3) columbite (Fe, Mn) Nb_2O_6) wolframite Fe, Mn Ta_2 O_6 and biotite, graniter is also a contribution of Fe in the environment.

The concept of labite metal must be given it place for determining the true toxicity value of trace elements i.e. the free ion and those that can disassociate from the colloid and complex. Aspirated metal and the free ions may be affected by pH.

CONCLUSION

Deficiencies of all the trace elements in soil call for caution, agricultural research and update the trace element – soil – plant match. For maximum output, advantage of Co should be taken for leguminous plants.

Amount of trace elements in mine dumps is less, could be accounted for by the fact that the mine dumps are loose and water easily percolates and washes elements to the soils, weathering is also an added factor.

Cd, Cu, Fe, Pb and Ni are higher in soil than in water except Cr and Co, Cd, Cr, Co are higher in water sample than in mine dump than in water.

Mine dumps – soil – water – life, generally constitute organic – inorganic web.

All the average metal values in soil, and mine dumps are below the mean value concentration in soil clay and granite. They are far above WHO tolerable limits, World River Mean (WRM) and limit for salminds in fresh water.

Human activities like mining and natural factor – weathering interplayed in the surface geochemistry of the region. Agro-geo-medicine is the solution.

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