THE DOMESTIC APPLICATIONS OF COALS AND THEIR HEALTH IMPLICATIONS BASED ON THE TRACE ELEMENTS CONTENT: CASE STUDY OF OKABA COAL

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Abstract
A total of 10 coal samples were collected from Okaba coal mine and analysed for their trace elements constitution and concentration. This is with a view to determine the coal's suitability for domestic uses or otherwise based on the type and concentrations of trace elements present in the coal and their effects on animals and human beings when applied domestically. This paper discusses the various possible effects of the analysed trace elements constituents of coal samples from Okaba mine. Analysis of the coal samples indicated average concentrations of 2.77% Fe, 0.06%Mn, 1.3ppm Cd, 0.013ppm Co, 1.22ppm Zn, 0.65ppm Pb, 1.29ppm Cr, 0.85ppm V, 0.65ppm Mo and 1.022ppm Ni. Copper was not detected in all the coal samples. The concentrations of most of the elements analysed fall within tolerable limits and will not pose any health hazard when the coal is used domestically. It is however recommended that the mined coal be subjected to washing using a Luitable Heavy Liquid Medium (HLM) e.g kerosene. This is expected to reduce the concentrations of the trace elements through the elimination of the fine coal dust and fly ashes. Diseases usually associated with intake of the analysed trace elements include pulmonary oedema, muscle cramps, kidney inflammation, liver darrliage, anaemia, bronchitis, dermatitis, lung carcinoma, transitory fever, mental impairment, renal failure etc.

Introduction

Nigeria is almost a leading giant in terms of fossil fuels endowment in Africa and ranking 6th on the list of world major producers (Whiteman, 1982). Coal is one of such fossil fuels.

Nigeria is blessed with at least 5 major coal fields and all grouped together to have a proven reserve of 639.0 million tones and unproven reserve of 905.0 million tones. Okaba coal deposit represents 73.0 million tones or 11.4% of the proven reserve while it accounts for 250.0 million tones or 27.6% of the unproven reserve. In the light of it's (Okaba) proximate and altimate characteristics which are non - coking compliant as determined by several researchers e.g (Afonja, 1974, 1977, 1996; Akintilerewa, 2000; Aderonpe, 1996; Mkpadi, 1996; Ogunbajo, 1998; Wessiepe, 1992 and Onoduku, 2003), Okaba coal have been proved to be non - coking. The coal deposit can however find uses in severql other applications, one of which is domestic uses in terms of house warning and cooking in place of fire woods. Each of these domestic applications can result into mild and at times serious treat to animal and human health depending on the quantity of the trace elements in the coal.

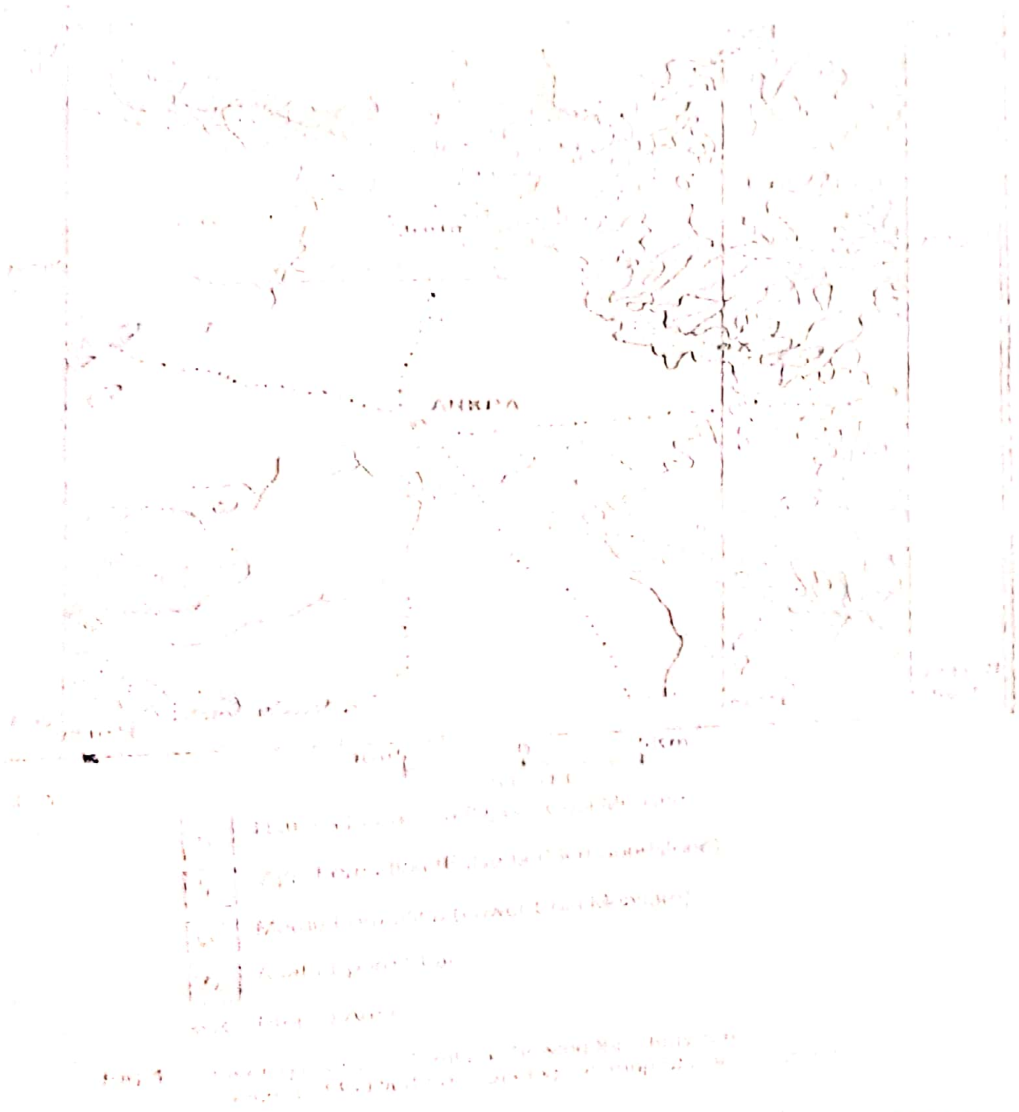
Many factors contribute to coal users negligence of ascertaining a coal's trace elements constitution before applying them domestically e.g ignorance, finance require for analysis and the cheap availability of the substance. It is none the less very important to know the trace elements status of a coal deposit before it is put to any domestic use in order to evolve a meaningful remediation or risk management, as required by environmental regulations.

This paper discusses the analysis of coal samples from Okaba deposit for their trace elements constitution and elucidate on the possible health risk posed by the presence of those trace elements on man and his biological environment.

Study Area

Okaba coal deposit is located at 16thkm North - East of Ankpa in Kogi State and accessible through the Ankpa - Makurdi Trunk A Road. The area lies between longitudes 7° and 8° 15'E and latitudes 6° and 7° 15'N (Fig. 1).

Geologically, Okaba coal deposit forms part of the Upper Cretaceous Formation within the Benue trough and belongs to the Lower Coal Measures (Adeleye, 1975). The coal measure is covered by false - bedded sandstone while it is bottom supported by the Enugu shades.



The average thickness of the coal seams is over 2.4 metres. Coal samples uS(3d for analysis were collected from the run - off - mine stocked by both the Nigerian

Coal Corporation (NCC) and Nordic Mining company and some exposed seams at the mine face.

Methodology

A total of ten (10) coal samples were collected from the Okaba coal deposit according to German standard of sampling (BB 22021). The BB 22021 standard involves sampling from run - off - mine. The analysis was carried out at the National Metallurgical Development Centre, Jos. The coal samples" each weighing 1kg were crushed to powder form. Portions of the powder were then ashed and digested with nitric acid. The whole solution was then filtered and the filtrates used for the various trace elements determinations using the Atomic Absorption Spectrometer (AAS). In the AAS analysis, part of the sample solution (filtrate) was aspirated into a flame and atomized. A light beam is circulated through the flame into a monochromator and onto a detector that measures the amount of light absorbed by the atomized element in the flame. Since each element has it's own characteristics absorption wave length, a source lamp which is composed of individual element tq. be analysed is usually used. This makes the method relatively free from spectral or radiation interferences. Thus the amount of energy absorbed in the flame is proportional to the concentration of the element in the sample. All the analysed trace element were calculated in parts per million (ppm) except for Fe and Mn which were calculated in percentages (%).

Results and Discussion

The result of the analysis is presented in table 1. Two soft wares; Minitab and excel were used to analyse the results as represented in figures 2 - 12. Fig. 2 shows the pie chart of mean concentration of the trace elements. From the figure Fe appears largest while Co is minimum quantitatively. Figures 3 represent the bar chart of mean concentration of the trace elements while figures 4 - 12 show the variation of concentrations of the trace elements. There was attempt to explain the results quantitatively and the various illustrated analyses are as attached.

Cadmium

Cadmium is very toxic to animals and human being and has been reported to be the cause of sterility in male human beings. Major possible effects of exposure to cadmium include pulmonary oedema, muscle cramps, acute inflammation of the kidney, mild liver damage and anemia. It's concentrations in the coal samples ranges from 0.12ppm to 0.15ppm as shown in fig 6, with highest value for sample 4 with an average of 0.13ppm. This value is considered not risky to animals and human beings since it's concentration in the coal is permissible as compared to it's usual average crustal value of 0.1 mgkg-1 and an alarming value of about 500mgkg-1 in soils around major mines and smelters.

Chromium

This is a transition metal with relative density of 7.2. It has crustal average concentration of 100mgkg-1 in felsic rocks and 3400mgkg-1 in mafic and ultramafic rocks. Chromium is toxic to animals and humans. The hexavalent Cr form is known to be a human carcinogen. Other health effects posed by chromiLlm that include bronchitis and dermatitis. The value of this element ranges fn`m 1.25ppm to 1.32ppm and averaging 1.29ppm in the coal samples. This figure falls within the permissible intake level for most animals and human beings. Thus it's content in the coal will not pose any health treat to the animals and humans alike and as such the coal can be employed for any domestic uses.

Copper

This element is considered as one of the essential elements required by living organisms. It has a specific gravity of 8.9 and melting/boiling points of 10890C/25670C respectively. It has average crustal value of 24-55mgkg-1 and 20-30mgkg-1 for soils.

Sources of copper pollution include fly ash from combustion of coals and others. Exposure to high concentrations of coppers can cause serious health ailments such as pulmonary oedema, lung carcinoma and transitory fever. This element is however not detected in all the coal samples analysed.

Lead

Lead is one element which is not known to have any beneficial value to plants and animals. It occurs in eight isotopic forms (4 stable and 4 unstable or radioactive). It is very common components of most sulphides and has average crustal concentration of 16mgkg-1 while it ranges from 15-25mgkg-1 in soils. Lead may be absorbed into the body by direct ingestion, inhalation and through the skin. It can cause death in human beings if much of it is taken. Its mixture with human blood turns the blood claret red which is an indication of deoxygenation and when circulated through the human body can result into death. Its abnormal intake by children can cause mental impairment which is a serious insanity in human beings. The concentrations of the element in the coal samples ranges from 0.001 ppm to 1.3ppm, averaging 0.65ppm as shown in Fig 9. This vall;1 is considered safe for the domestic usage of the coals and may not constitute any serious treat to human and animal health. Combustion of the coal during domestic should however take place in an open place to avoid congestion. These coals may not be burnt for house warming without proper cross ventilation.

Nickel

Nickel has crustal abundance of 75mgkg-1 and ranges between <50mgkg-1 to 100mgkg-1 in soil. Nickel can be disseminated within the environment through coal combustion. The element is known to be carcinogenic and becomes more toxic in the carbonyl form [Ni (CO)4] even in very low concentrations.

Plants seem to be more sensitive to toxicity than animals. Its concentrations in the coal s :mples ranges from 1.01 ppm to 1.03ppm with average value of 1.02ppm a5 shown in Fig 12. This value is equally not considered risky to human b' In IS and animals.

TABLE I

TRACE ELEMENT ANALYSIS OF OKABA COAL DEPOSIT

ELEMENT	Fe	Mn	Cu	Cd	I	Co	:	Zn	I	I--'b	I		
SAMPLE NO I	(ppm)	(ppm)	(ppm)	(Pp (ppm)	¨pm)								
		1	2.80	0.06	NO	0.12 . 0.01	I 1.23 0.001	1.32	0.86 I				
		2	2.81	0.06	NO	0.13	I	0.01	1.22	0.001	1.29	0.86	I
		3	2.78	0.07	NO	0.12	!	0.02	1.23	0.002	1.28	0.83	I
		4	2.60	0.05	NO	0.15		0.01	1.20	0.001	1.27	0.83 I	I
		5	2.78	0.06	NO	0.13	i	0.02 I	1.23	0.002 I	1.28	0.83	I
		6	2.60	0.05	NO	0.15		0.01 I	1.20	0.001	1.27	0.83	
. 7	2.78	0.06	NO	0.13		0.02		1.20	0.002	1.28 I	0.85		
- 8	2.68	0.05	NO	0.13		0.02		1.20	1.280	1.28	0.85		
I		9	2.80	0.06	NO	0.14		0.01	1.23	1.300	1.30	0.86 I	
r		10	2.80	0.06	NO	0.12		0.01	1.21	1.300	1.30	0.86	
RANGE	2.81	2.60 - 0.7	0.05 - NO	0.15	0.12 -	0.02	0.01 -	1.23	1.20 - 1.3	I 0.001 - 1.32	1.27- 10.86	10.83 - i O.	10.
MEAN		2.74	0.06	0.00	0.13		0.01	1.22	0.389	1.29	0.85		

NO = not detected

Zinc
This is an essential, lent to both plants and animals, human beings inclusive. Sphalerite (ZnS) ai j Nurtzite are the major sources of zinc. The major health concern of zinc is in deficiency rather than its abundance to constitute toxicity. However, the main Diem associated with it abundance is its inhibitory effect to the uptake of Copper and this is considered safe to animals and human beings since Copper intake 1 cause serious health problems. The zinc content of the coal samples rang') "am 1.20ppm to 1.23pprn with average value of 1.22ppm as indicated in Fi! 8. However, acute zinc intoxication, leading to nausea, vomiting and seveie memia have been reported. Zinc chloride injestion have also be known to causeenal failure in animals.

Iron
The intake of this elr: lent could either be harmful or not to human pady depending on the quantity, intake. It is an established fact that its over dosage as well as under dosage can result into neck goiter. Therefore a required optimum quantity is only safe for human intake. Thus the analysed average value of 2.77% in the coals could negatively or positively affect human beings depending on the person's Iron level status. The concentration of iron appears to be highest in all the coal sample analysed as shown in Fig 3.

Manganese, Cobalt, Vanadium and Molybdenum
The concentration of all these elements are considered safe for animals and human beings in terms of the coal usage. Their values are generally lower than the usual crustal abundance and are therefore regarded as non potential health hazard to man and animals as for as tea coal usage is concern. The variation in their concentration are indicated in Fig 5,7, 10 and 11 respectively.

Acknowledgement
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REFERENCES

Aderonpe, W. I. A. (1996). Coal blending - Application to Nigerian coals for the Iron and Steel industries. In: C. O. Harry and C. M. Okolo (Eds), Nigerian Coal: A Resource for Energy and Investments. pp 125 -133.

Afonja, A. A. (1974). Chemical, petrographic and coking studies of Enugu coal. Nigeria. Abstracts. 10th Annual conference held at University of Ile-Ife, pp 40 - 42.

Afonja. A. A. (1977). Washability charts for Nigerian coals. J. of mining Geology 14(2). pp 47 - 49.

Afonja. A. A. (1996). Production of metallurgical coke from non-coking coals. In C. O. Harry and C. M. Okofo (Eds). Nigerian Coals: A Resource for Energy and Investments, pp 89 - 97.

Akintilerewa R. O. (2000). Maceral analysis and Vitrinite reflectance measurements of Okaba coal, Kogi State. Unpublished B.Tech. Thesis, Federal University of Technology, Minna. pp 16 - 34

Arthur. Whiteman (1982). Nigeria: Its petroleum geology resources and potentii˜1. Vol. 1, pp 74-82.

Mkpadi. M. C. (1996). Development of formed coke in Nigeria. In C. O. Harry and C. M. Okolo (Eds). Nigeria Coals: A Resource for Energy and Investment, pp 113 - 119.

Nuhu, M. W.; (2004). Data collection, comparison and Analysis of the Detection of Heavy metal using three different pieces of electrochemical equipmentincluding an in - situ sensor. An unpublished M.Sc Thesis. The Rober Gordon University, Aberdeen. pp 7 -13.

Ogunbajo, M. I. (1998). Nigerian Coals - A neglected vital raw material. Abstracts, 51h National Engineering Conference, Kaduna, Vol. 5, NO.1. pp 93 - 98.

Onoduku, U. S. (2002). The Geochemical Evaluation of Okaba Coal Deposit, Lower Benue Trough, Nigeria. Unpublished M.Tech Thesis, FUT, Minna. pp 36, 42, 54 - 55.

Onoduku, U. S. Ogunbajo, M. I. Jonah, S. A; Kolo, M. T: and Crow, I. E. (2005). Trace Elements Analysis of Okaba Coal and their Environmental Implication. 1 sl Annual SSSE Conference book of Proceedings, Vol. I pp 227 - 279.

Richards, H. J. and Buchanan, M. S. (1958). The Okaba Coal, Igala division, Kabba Province. Rec. SUN. Nig. (1955). pp 17 -19.

Wessiepe, K. (1992). Present coke making capacities worldwide, Coke Making International. Vol. 4 (Germany), pp 11.

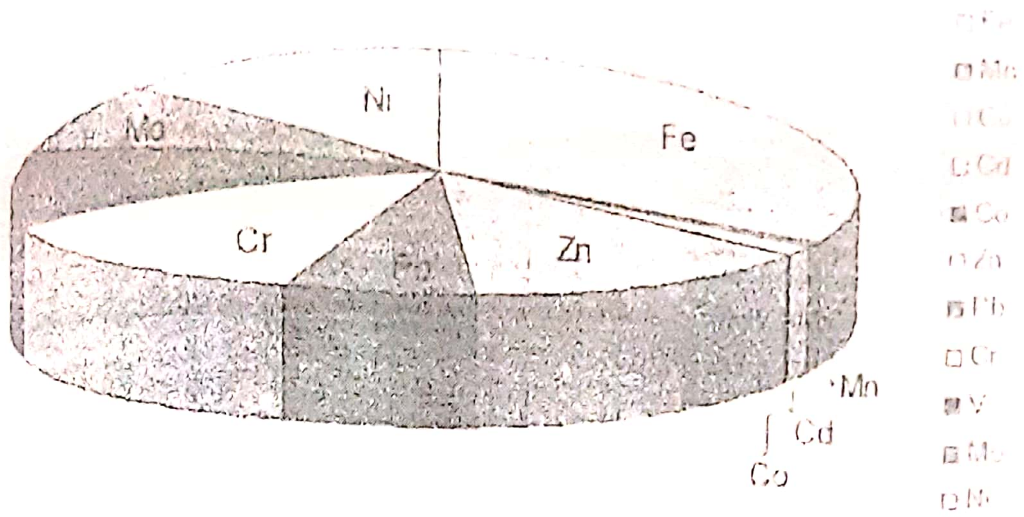

Fig. 2 Pie chart of mean concentration of trace elements in Okaba coal samples

Fig. 3 Barchart of mean concentration of trace elements in Okaba coal samples

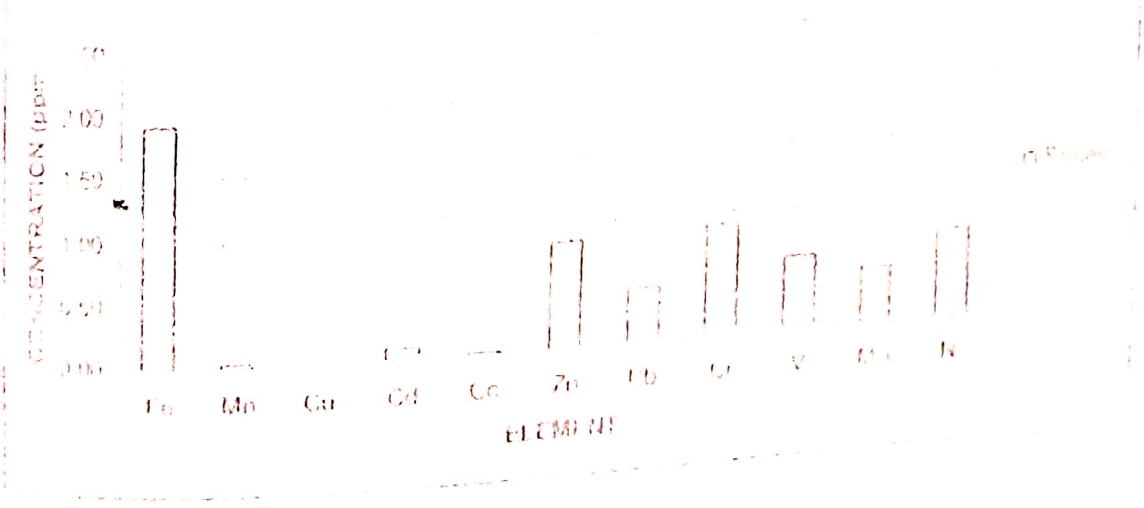

FIG. 4 Variation of concentration of Fe in coal samples

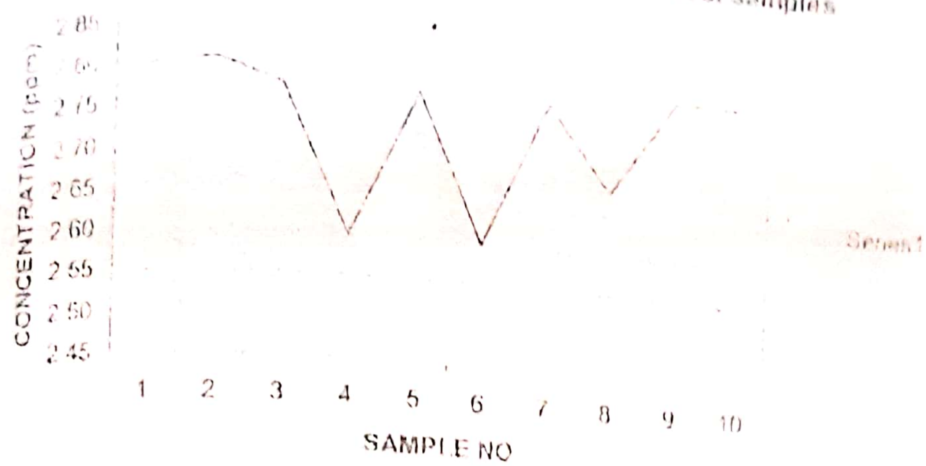

Fig. 5 Variation of concentration of Mn in Okaba coal samples

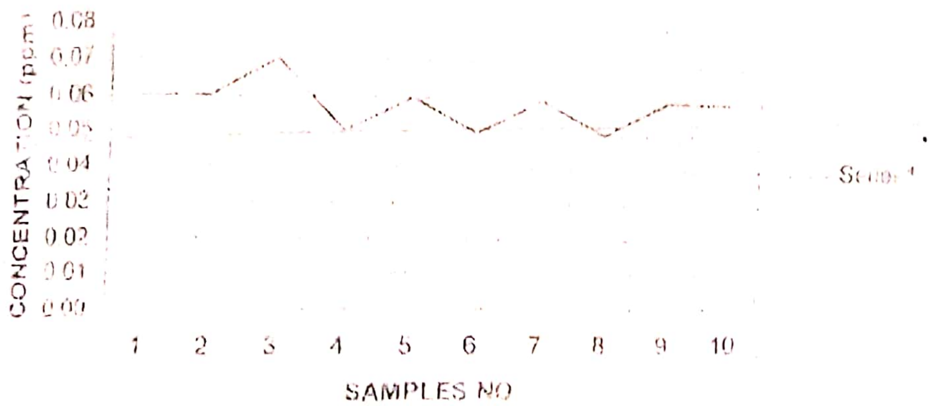

Fig. 6 Variation of concentration of Cd in Okaba coal samples

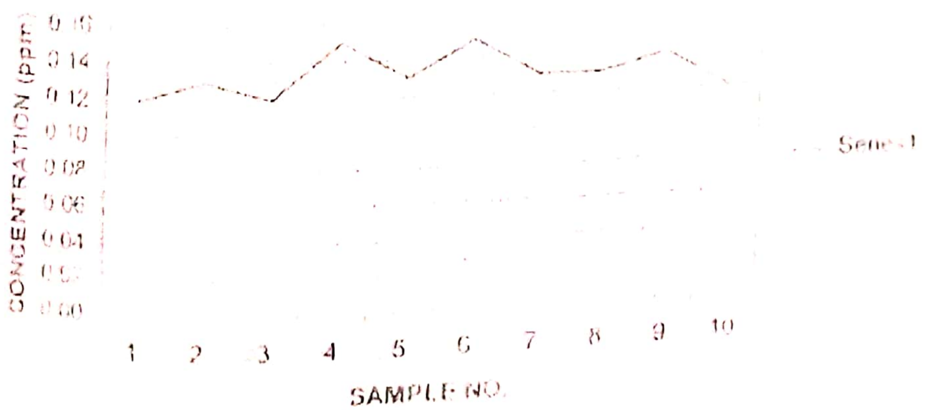

Fig. 7 Variation of concentration of Cobalt in Okaba coal samples

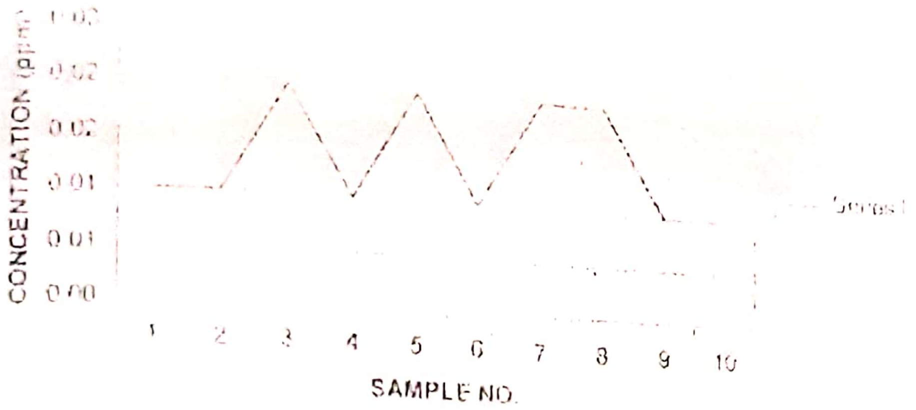

Fig. 8 Variation of concentration of Zn in Okaba coal samples

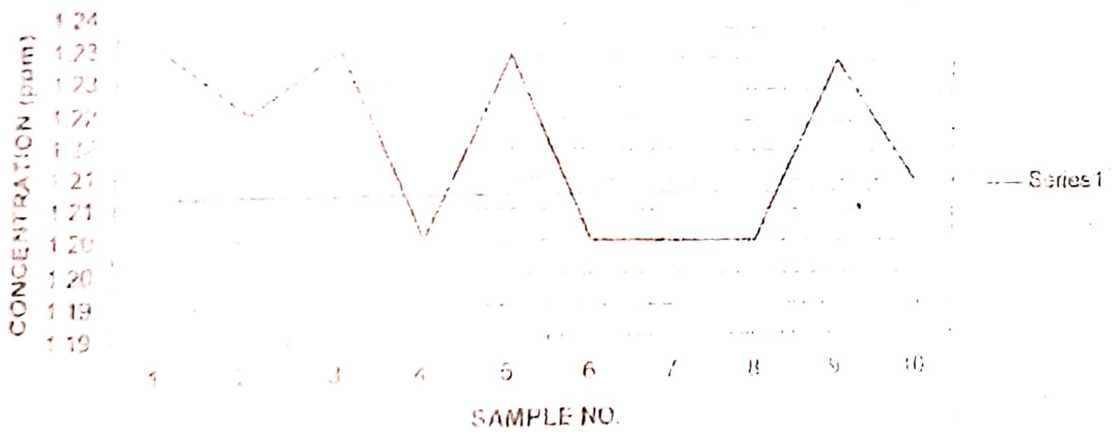

Fig. 9 Variation of concentration of Pb on Okaba coal samples

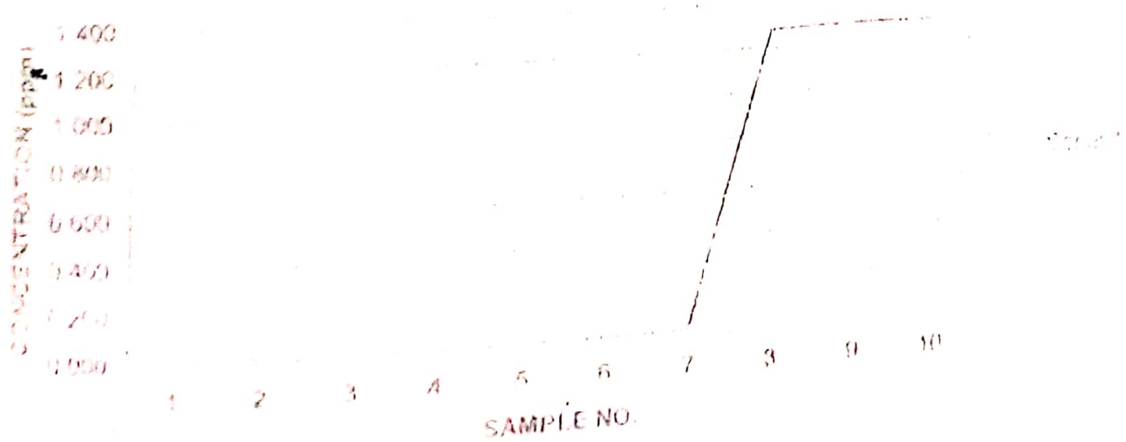

Fig. 10 Variation of concentration of vanadium in Okabo coal samples

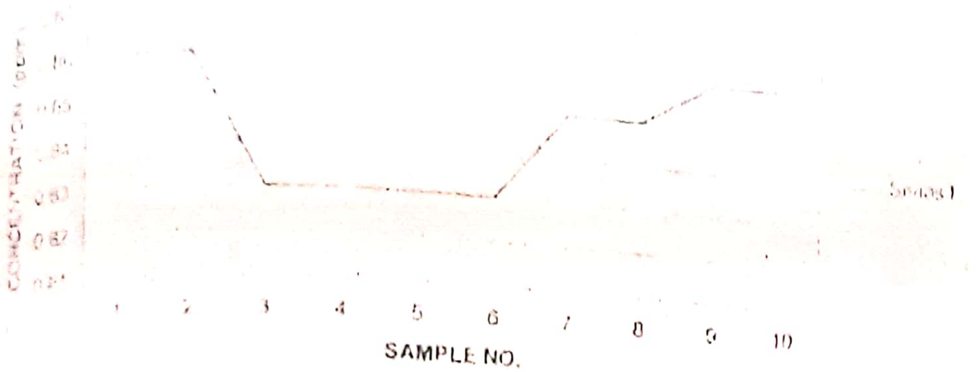

Fig. 11 Variation of concentration of Molybdenum in Okaba coal samples

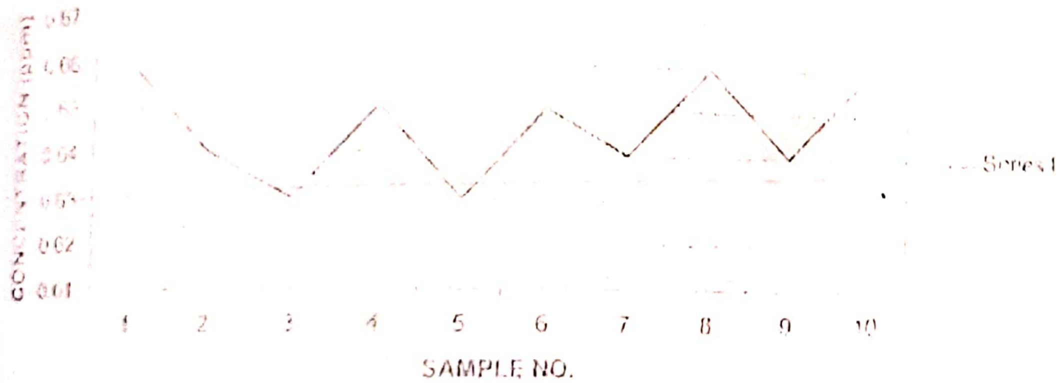

Fig. 12 Variation of concentration of Nickel in Okaba coal samples