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PROXIMATE AND ELEMENTAL ANALYSIS OF SOME NIGERIAN COAL DEPOSITS

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ABSTRACT: *Studies were carried out on the proximate and elemental contents of coal deposits in three Nigerian States (Enugu, Benue and Delta) employing standard laboratory procedures and instrumentation. The fixed carbon and ash contents of Benue and Enugu coal samples deposits were found higher than Delta coal deposits. Heavy metals like arsenic, lead and cadmium were present at higher concentrations in Delta coal sample deposits than in the other coal sample deposits studied. Trace mineral contents of Enugu coal deposits were found to be higher than others implying that it is of higher economic value.*

KEYWORDS: Heavy Metals, Trace Metals, Coal Deposits.

INTRODUCTION

Throughout history, coal has been used as an energy source, primarily burned for the production of electricity and or heat and is also used for industrial purposes, such as refining metals (Colorado Geological Survey, 2005). Coal is the largest source of energy for the generation of electricity worldwide, as well as one of the largest worldwide anthropogenic sources of carbondioxide releases. The extraction of coal, its use in energy production and its by products are all associated with environmental and health effects including climate change (Ward, 1984).

The rank of coal is based on the degree to which the original plant material has been transformed into carbon and can be seen as a rough indication of how the coal is: the older the coal, the higher the carbon content. The coal with the highest carbon content is the best and cleanest type of coal to use. As one move down the coal rank the heat given out decreases and dirtiness of the fuel and moisture content increases (Gabbard, 2008). Coal is extracted from the ground by coal mining. Coal contains diverse amounts of trace elements in their overall composition (Thomas, 1992).Certain trace elements such as lead, arsenic, cadmium, chromium and mercury if present in high amount could preclude the coal from being used in environmentally sensitive situations (Ward 1984). Over the past few decades, the world has become increasingly wary of coal combustion emissions because of concern about trace, minor and major metal releases into the environment (Pacyma and Pacyma, 2001). Several Studies on trace and major elemental composition of coal have been reported in literature. The modes of occurrence and concentration of trace elements in coal have been reported in previous works (Zhang *et al.,* 2002).

Trace and heavy metal emissions have been reported to be higher in coal and sediments than in fuel oil (Paiva *et al*., 1990; Srinivasa *et al.*, 2005). According to the reports issued by environmental groups in 2004 and world Health organization in 2008, coal particulates pollution are estimated to shorten approximately 1,000,000 lives annually worldwide (World Coal Institute, 2008). The aim of this study is to carry out a proximate analysis and also identify

the trace and heavy metals present in some Nigerian coal deposits with view to determining their quality and economic value.

MATERIALS AND METHODS

The coal samples were collected from deposits in three Nigerian States namely; Enugu, Benue and Delta. Utmost care and precaution was applied in the sample collection and preparation in order to avoid impurities/extraneous materials from interfering in the final results in accordance with established standard procedures.

The proximate analysis and digestion of the coal samples followed the established operational guidelines (AOAC, 2006).

The chemicals used were of the highest quality and purity and of analar grade. The digest were aspirated into the atomic absorption spectrometer for metal analysis in accordance with the beer-Lambert's law.

RESULTS AND DISCUSSION

Table 1: Proximate Analysis of the coal samples in Percentage Dry Matter

Parameter	Enugu coal	Delta coal	Benue coal
Total moisture content (TM)	23.70	35.61	26.60
Ash content (AC)	14.30	12.00	13.91
volatile matter content (VC)	41.30	59.50	43.10
Fixed carbon content (F.C.C	69.80	65.90	68.10

Table 1 shows that the percentage fixed carbon and ash contents of Nigerian coals decreased in the following order: Enugu coal >Benue coal > Delta coal.The percentage moisture and volatile matter contents in the coal samples decreased as follows: Delta coal >Benue coal>Enugu coal.

Proximate analysis of the coal samples showed that Enugu and Benue coal deposits fall within the rank of sub-bituminous coal while Delta is brown coal (Low, 1963). The economic value of sub-bituminous coal over brown coal have been well documented (Thomas, 1992).

Table 2: Mean Concentrations of Trace and Heavy Metals in Enugu Coal sample deposits (ppm)

Elements	**Mean concentration (ppm)**
Potassium	55.24 ±3.11
Sodium	28.57± 0.83
Calcium	37.72±4.07
Magnesium	107.50±6.24
Lead	9.54±1.83
Cadmium	0.141± 0.06
Chromium	10.32±0.95
Cobalt	1.78±0.16
Zinc	27.83±2.22
Copper	10.69±1.14
Manganese	10.63±1.03
Nickel	4.55±0.82
Iron	2190.00±10.63
Arsenic	0.49±0.05

Table 3: Mean Concentration of Trace and Heavy Metals in Delta Coal sample deposits (ppm)

Elements	**Mean concentration (ppm)**
Potassium	17.60± 1.43
Sodium	19.08±3.44
Calcium	7.41±1.62
Magnesium	17.50±2.22
Lead	271±0.66
Cadmium	1.922± 0.30
Chromium	5.88±0.77
Cobalt	4.64±091
Zinc	16.89±1.44
Copper	6.63±1.12
Manganese	6.74±1.80
Nickel	15.45±2.13
Iron	1100±7.54
Arsenic	1.99±0.14

Table 4: Mean Concentration of Trace and Heavy Metals in Benue Coal sample deposits (ppm)

Elements	**Mean concentration (ppm)**
Potassium	45.67±2.88
Sodium	22.27±1.43
Calcium	14.44±2.81
Magnesium	86.74±5.30

Lead	0.545±0.07
Cadmium	0.33±0.08
Chromium	9.68±1.73
Cobalt	2.50±0.20
Zinc	17.93±181
Copper	9.67±0.88
Manganese	9.68±0.92
Nickel	2.73±0.05
Iron	1879.6±6.76
Arsenic	0.33±0.09

Tables 2, 3 and 4 shows that heavy metals like lead, cadmium and arsenic were present in the coal samples. The mean concentrations of the heavy metals in the coal samples decreased in the following order: Delta coal > Benue coal > Enugu coal. The mean concentrations of the heavy metals in the delta coal deposits were present at levels that are of public health concern. Hence the gassification of Delta coal deposits industrially in generation of electricity suggests emission of these heavy metals to the environment above world established limits. Table 2, 3 and 4 shows that mean concentrations of trace elements in the coal samples decreased in the following order: Enugu coal > Benue coal > Delta coal. The mean concentrations of the trace elements in the coal samples shows that Benue and Enugu coals are in the rank of sub-bituminous coal while Delta coal belong to the lignite or brown coal.

This elemental analysis shows that Enugu and Benue coal deposits are of higher economic value that Delta coal deposit.

The elemental analysis suggests that Benue and Enugu Coal will have a higher caloric value and a better source of electricity generation than Delta coal occasioned by their iron contents e.t.c. The results obtained in this study was in agreement with what was reported on the presence of heavy and trace metals in Nigeria coal deposits (Adaikpo et al., 2005).

CONCLUSION

Samples of coal deposits from Enugu and Benue were classified as sub-bituminous coal while that from Delta were classified as lignite or brown coal from the proximate and elemental analysis. Coal samples from Enugu and Benue respectively indicated higher economic value than that from Delta based on their rich mineral and carbon contents respectively.

The rich mineral contents in Enugu and Benue coal samples buttressed their wide use and application in electricity generation and steel manufacturing. The heavy metal contents of Enugu and Benue coal sample deposits were found lower than Delta coal sample deposits which implies that they could be used in environmentally sensitive situations.

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