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Short Communication

TRACE METAL TOXICITY IN OUR ENVIRONMENT: CASE STUDIES OF INFLUX OF METALS IN SOILS, CROPS, WATERS AND AIR IN EBONYI STATE

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ABSTRACT
Ebonyi State is very rich in solid minerals and this has contributed to high metal contents of crops, waters and air near the deposits. Anthropogenic activities in the State have also resulted in increasing the metal contents of the crops, waters and air. This paper provides a critical review of the possible toxicity of Pb, Zn, Cd, As, Cr, Mn, Fe, Al and Cu in our environment using Ebonyi State as the case study. The potentials sources of the metals, their mobility and bioavailability are also reviewed.

KEY WORDS: Trace metal, anthropogenic activity, bioavailability, solid minerals etc.

INTRODUCTION

Metals are potential environmental contaminants that can result to various human health problems, if they are excess in the food, water and in the air (Salama and Radwan, 2005; Itumoh *et al*., 2011; Omaka *et al*., 2012; Omaka, 2012). They are given special attention throughout the world due to their toxic effects even at very low concentrations (Salama and Radwan, 2005) or at high concentrations (Stevović, *et al*., 2010). Today, several cases of human diseases, disorders, malfunction and malformation of organs due to metal toxicity have been reported (ATSDR, 2008; Omaka, 2008; Angelin-Brown *et al*., 1995; Itumoh *et al*., 2011; Salama and Radwan, 2005; Stoica, 1999). The geology and the geochemistry of Ebonyi State have made the State prone to influx of various metals in its soil, crops, water and air. There are scientific reports suggesting high levels of metals (Pb, Zn, Fe, As, Cd, Mn, Cr, Al, Cu) in crops, soils, water and air analyzed in various parts of the State (see Table 1).

TABLE 1: Concentrations of various metals of interest analyzed in Ebonyi State

Metal	Range conc. (mg/l)	Environmental matrix	Location	Ref.
As	0.04 – 0.28	Food grinding stones	Nkalagu	Ehiri *et al*., 2010
Cd	0.006 – 0.5134	Tuber crops	Izzi, Ezzamgbo	Omaka *et al*., 2012
Mn	6.419 – 11.4138	Soil samples	Abakaliki, Idembia, Apojo	Omaka *et al.,* 2011
Pb	0.00 – 1.7	Water & soil samples	Abakaliki	Omaka, 2012
Fe	0.00 – 4.20	Food grinding stones	Nkalagu	Ehiri *et al*., 2010
Cr	0.0035 – 3.5720	Tuber crops	Izzi, Ezzamgbo	Omaka *et al*., 2012
Al	19.85 – 41.24	Dust samples	Abakaliki	Omaka, 2012
Cu	29.0 – 107.67	Dust samples	Abakaliki	Omaka, 2012
Zn	0.0 – 12.1147	Soil & food grinding stones	Nkalagu, Abakaliki, Idembia, Apojo	Ehiri *et al*., 2011; Omaka *et al.,* 2010

Background of the study area

Ebonyi State is an inland state of 5,530 square kilometres. It is a part of the Benue Trough in the South-Eastern Nigeria (Fig. 1) (Omaka *et al*., 2011; Orazulike, 2002). Geologically, it is believed that the volcanic rocks which constitute the earliest phase of cretaceous volcanism in the Benue Trough are best exposed in the study area (Olade, 1979) which is characterized by black, carbonaceous shale with nodules of calcerous matter (Hutchison and Meema 1987). The area falls within the climatic region of Southern Eastern Nigeria where the rainy season spans from April to October and the dry season from October to

April (Ezeh and Ugwu 2007; Omaka *et al*., 2011). The average annual rainfall of the study area is about 1500 mm with actual surface temperature (seasonal temperature) of between 24-36^{0}C during dry season and about 18^{0}C during the rainy season (Ezeh and Ugwu 2007; Collins-Longman 1981). The study area is of high leached red soils of tropical forest areas. The main study area around Abakaliki is one of the well known lead-zinc mineralized districts in Africa where soil and streams have developed from naturally enriched parent materials, including black shales, hydrothermally mineralized rocks and mine dumps (Hutchison, and Meema (Eds.), 1987; Omaka *et al*., 2011). The vegetation is dominated by grasses, shrubs and trees e.g. palm trees, coconut, mango, and orange trees). The areas are leading producers of rice, yam, potatoes, cocoyam, maize, plantain and cassava.

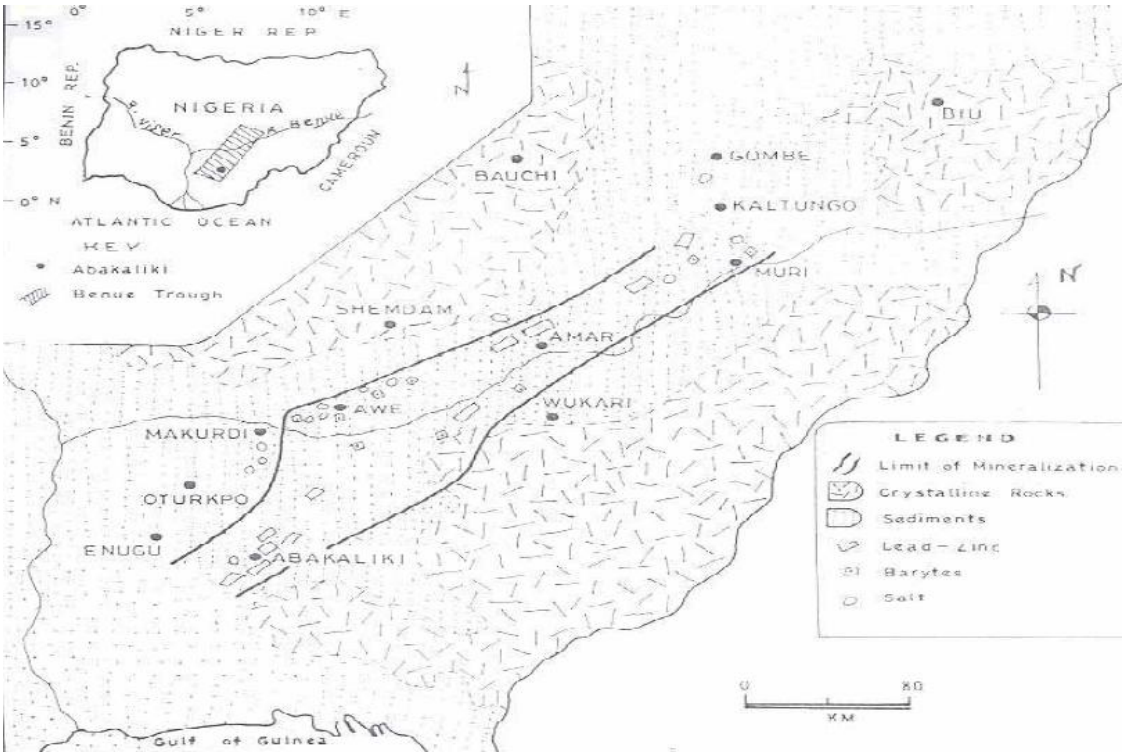

FIGURE 1: A map showing the mineralization of the Benue Trough including Abakaliki, the Capital of Ebonyi State.
Source: Orazulike, 2002.

Potential sources of metals

Trace metal pollution is widely reported in literature as one of the profound alteration of our environment (Kabata and Dudka, 1990; Sodré *et al*., 2005; Toscano *et al*., 2005; Onyedika and Nwosu, 2008). One of the major sources of metals in Ebonyi State is the background geochemistry. The State is highly mineralized and deposits of Pb, Zn, etc are abundant (Omaka, 2008). However, anthropogenic activities like mining and other industrial activities are recognized as some of the sources of metals in the environment (Angelin-Brown *et al*., 195; Grytsyuk *et al*., 2006; Hutchison, and Meema (Eds.), 1987; Kosmus *et al*., 1990) and metals released to the atmosphere from such activities travel long distances and are deposited on the soil, vegetation and water. These metal ions, which are not degraded, persist and are retained in the ecosystem indefinitely (Monperrus *et al*., 2005; Stoica, 1999). The main sources of Pb in Ebonyi State, apart from its natural concentrations in soils, are through mining, processing and agriculture (Omaka, 2008; Yongming, *et al*., 2006) which releases inorganic lead compounds. Industrial activities (Omaka, 2008), commercial activities, high traffic flows and atmospheric inputs contribute to increased concentrations of Pb in the environment (Yongming *et al*., 2006, Thorton, 1990). Cadmium is highly dispersed by human activities and the mean range of concentrations of Cd in surface soils is 0.07-1.1 mg kg^{-1} with significant anthropogenic contributions (Kabata-Pendias and Dudka, 1990). Atmospheric depositions (Omaka, *et al*., 2011), agricultural activities and fuel combustion (Kabata-Pendias and Dudka, 1990) can contribute to the amount of Cd in the environment. The use of waste water for irrigation can increase the Cr content of agricultural soils in many areas and plants grown in these soils may accumulate them (Gill and Saggo, 2010). Potassium dichromate salt ($K_2Cr_2O_7$) which occurs naturally in soils as the rare mineral lopezite is a major source of Cr and atmospheric depositions could also contribute to increased levels of Cr (Omaka *et al*., 2012). Manganese occurs in rocks and soils and is widespread in the environment, (Krauskopf, and Bird, 1995). Hence, the sources of Mn concentrations in the State could be attributed to background soil geochemistry (Omaka *et al*., 2011). Traffic activities can contribute to Zn due to mechanical

abrasion of vehicles and also from Zn compounds used extensively as antioxidants (e.g., zinc carboxylate complexes and zinc sulphonates) as a detergent/dispersant improvers for lubricating oils (Yongming *et al*., 2006).

Toxicity Effects of Metals

Chronic intakes of metals have proven adverse effects on human beings and animals because there is no effective mechanism for their elimination from the body (Omaka *et al*., 2012). Pb is readily absorbed through the gastrointestinal tract, in which about 70-90% of Pb assimilated goes into the bones, liver and kidneys where it replaces calcium in the bones (Omaka, 2008). Pb toxicity can lead to anaemia and also impairment of haem biosynthesis, red blood cells; and depression of sperm count (Anglin-Brown *et al*., 1995). Its intoxication in the body may also lead to encephalopathies in the central nervous system (CNS) and disturbances in kidney and liver functions (Omaka *et al*., 2012). Organic forms of Pb compounds are dangerous to all forms of life as they cause injuries which may lead to mental development such as reduction of intelligence (especially in children), growth disturbances and spasticity (Omaka, 2008). Exposure to high concentration of Cr or its chronic low level intake has been implicated in adverse skin, respiratory tract, and gastrointestinal system, hematological, immunological and reproductive systems (ATSDR, 2008). Cadmium is a cumulative poison and reports indicate high intake may cause renal, postrate and ovarian cancers (Omaka *et al*., 2012). Other health effects of Cd exposure include proximal tubular disease and osteomalacia (Anglin-Brown, *et al*., 1995). In human body, metals, particularly Pb^{2+} and Cd^{2+} are sulphur-seeking and easily bind to S-CH_3 and S-H (Sulphydryl groups) in enzyme proteins. Such "immobilized" enzymes cannot function properly and the individual suffers (Okonkwo and Eboatu, 1999).

CONCLUSION

Determination of trace metals in natural environmental matrices is essential for understanding their biogeochemical cycles, roles in ecosystem and to monitor their toxicity levels in compliance to standard regulations. The geology, geochemistry and anthropogenic activities of man in Ebonyi State have resulted to influx of metals of various forms in soil, water, crops and air in the environment with potential toxicity. It is important therefore that activities that contribute to these metal pollution be checked to reduce their implications on health.

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