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RESEARCH ARTICLE

EVALUATION OF SOME RADIOACTIVE ELEMENTS (RUBIDIUM, STRONTIUM, YTTRIUM, NIOBIUM AND ZIRCONIUM) IN SOILS IN PARTS OF JOS PLATEAU, NORTH CENTRAL NIGERIA

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ABSTRACT

The Jos Plateau is situated in the central part of Northern Nigeria, on a rugged terrain of low lands at the edge of the Plateau surface (Hyde, 1986). It is the principal centre of tin and colum bite mineralization, which forms the focal area of Younger Granites (Macleod et al., 1971). A total of thirty soil samples from Rayfield, Bukuru and environs on the Jos Plateau were analysed for Rubidium (Rb), Strontium (Sr), Yttrium (Y), Niobium (Nb) and Zirconium (Zr) using the X-ray fluorescence (XRF) analytical method, with the aim of determining the extent to which the long history of mining, and other surficial geological processes have affected the soils of the study area. The distribution of the analysed elements (Rb, Sr, Y, Nb, Zr) were evaluated to monitor potential threats to human health and the natural ecosystem by comparing the determined concentrations of these elements (Rb, Sr, Y, Nb, Zr) with concentrations in uncultivated and unmined areas as controls. Mean concentrations of 133.11ppm was obtained for Rb, 83.7ppm for Sr, 66.97ppm for Y, 77.35ppm for Nb and 425.53 for Zr as against 35ppm, 67ppm 27ppm, 15ppm and 270 for Rb,Sr, Y, Nb andZr, respectively in unmined and uncultivated soils. A calculation of anthropogenic factor (AF) and Index of geo-accumulation (Igeo) indicated Rb, Sr, Y, Nb and Z recontaminations (Rb, Sr, Y, Zr low contamination, Nb moderate contamination) in soils of the study area. These values can be used as guidelines for ensuring the preservation of environmental integrity of the study area.

INTRODUCTION

A lot of mining activities have been taking place in Jos area, for several decades, with extensive commercial mining and processing starting in 1930's (Onuoba, 1992). Monazite, zircon Sphalerite, galena, pyrite, colum bite and most of the radioactive elements like U, Th, Rb, Y are reported to be associated with the tin bearing granites in the Younger Granite Province. The production of tin in these areas has necessarily led to the release of these radioactive elements into the environment and hence the negative impact on health status of the immediate environment. Radioactive materials that decay spontaneously produce ionizing radiation, which has sufficient energy to strip away electrons from atoms (creating two charged ions) or to break some chemical bonds. Any living tissue in the human body can be damaged by ionizing radiation in a unique manner. The body attempts to repair the damage, but sometimes the damage is of a nature that cannot be repaired or it is too severe or widespread to be repaired. Also mistakes made in the natural repair process can lead to cancerous cells. The most common forms of ionizing radiation are alpha and beta particles, or gamma and X-rays. The Younger Granites of the Jos Plateau are a petrologically distinctive series of alkali feldspar granites associated with rhyolites and minor gabbros and syenites. They occur in sub volcanic intrusive complexes as ring dykes and related annular cylindrical intrusions. Falconer, (1911) recognized the Younger Granite to be host of tin and other associated metals (Pb, Zn, Cu, As, Zr) on the Jos Plateau. This study is similar to the works of Jibiri et al 2007, Ademola 2008, Mangset and Sheyin 2009, Jwanbot et al 2012, Jwanbot et al 2013and Ademola 2014. Weathering and sedimentation are considered as the geochemical processes of great importance to man since they provide man with basic economic resources in the soil, Mason (1976). Man depends on the soil on daily basis for survival. Typical of the Jos populace is the use of soil for construction, cultivation and also the fact that the soil serves as the pathway through which infiltrating surface water gets to the groundwater which of course is the major alternative source of water supply to the people, some even use the soil to fry groundnuts for human consumption. One major characteristic of soil is the division of its constituents and properties into horizons A, B, and C. Minor and trace elements are frequently enriched in the B-horizon (Mitchel, 1965) and is therefore known as the zone of accumulation. For this reason samples for analysis were collected from the B-horizon. Soils are direct product of weathered rocks; therefore the composition of soil to a great extent depends on the

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composition of the rocks from which they are formed. Other conditions that affect soil composition are biological activities, topography and time. The crustal abundances for Rb, Sr, Y, Nb and Zr are 150ppm, 300ppm, 50ppm, 20ppm, and 150ppm respectively (Green 1959, Taylor 1964, Wedepohl.1969-1978). Traces of Rb, Sr, Y,are found in the silicate material of many igneous rocks particularly granites. Zr occurs principally as accessory mineral in the granites within the study area while Nboccurs in association with the tin mineralization hosted by the Younger Granites. The presence of these elements in excess within the study area therefore is linked to the rock types, mineralization, and human activities like mining, processing and agricultural practices. The soils of the areas being investigated would be evaluated bearing these in mind, hence the concentrations found in the soils would be analysedvis a vis the intrinsic concentrations to highlight the anthropogenic additions and how they might affect the environmental health and ecosystem. This is the main aim of the investigations.

MATERIALS AND METHODS

Soil samples were collected from the B-horizon using a hand auger (Fig. 2). They were stored in clean polythene bags and labeled, after which they were oven dried, disaggregated, and sieved using minus 80 mesh screen size. The samples were further ground to grain size less than 125μm and pellets of 19mm diameter were prepared from 0.3 to 0.5g powder mixed with three drops of organic liquid binder and pressed at 10tons with a hydraulic press. The Energy Dispersive X-ray Fluorescence (EDXRF) was used for the analysis at Centre for Energy Research and Training, Zaria. Data from the analysis were further statistically tested for patterns using the index of geoaccumulation (Igeo), calculated from the formula below

$I_{geo}= \log_2 [C_m / (1.5*B_m)]$ The anthropogenic factor (AF), was calculated using the formula $AF=C_m/B_m$. Where C_m is the measured concentration in soil and B_m is the background concentration (value) of metal m, either from literature as average crustal abundance, 1.5 is a factor for possible variation in the background concentration due to lithologic differences. For this work, B_m is taken from literature (Rose et al., 1979 Table 3). Results and computed data are displayed in Table 2. The index of geoaccumulation gives a quantitative contamination class with respect to the quality of the medium analyzed.

It was observed that the concentration of Rb in the soil fell within low to moderate contamination, Sr, Y, and Zr show low to slightly moderate contamination, Niobium shows low to high contamination (Table 2 and 3). These levels of contamination could be very dangerous to the inhabitants. The fact remains that no amounts of radiations from radioactive sources like these are too small to cause harm to the human system. These elements get into the human system through inhalation, eating of radioactive vegetables, rice and meat, drinking of radioactive milk, teas and water with an enrichment of these elements. The health implications of radioactive elements are so serious that the public needs to be sensitized. Radiations from radioactive elements are the major cause of cancer (including leukemia which is a very deadly disease). Other health problems caused by these elements are severe nausea and diarrhea and bleeding, gene mutation, birth defects, new born with genetic diseases or carry abnormal genes for diseases like cystic fibrosis and diabetes or inborn errors of metabolism to be passed on to future offspring, mental disorder, premature aging or even death, hair fall out, skin burns or diminished organ function. (Carl and Edward 1994). The high concentrations of these elements are believed to have been caused by weathering of the surrounding granitic rocks which geochemically host large lithophile elements like zirconium, rubidium, strontium, niobium and yttrium which are incorporated in silicates during crystallization of parent rock. Human activities like mining accelerate the liberation and mobilization of trace elements in the environment. Agricultural practices involving the use of fertilizers and insecticides could also contribute to the release of trace elements in the soils.

Conclusion

This study shows that Rb, Sr, Y, Nb and Zr occur in soils of the study area in concentration above the background value in uncultivated soils (Fig 3). The presence of these elements in excess can, through the food chain interferes with normal metabolic processes in human causing dangerous human diseases. So far, studies carried out on the animals (some organs of slaughtered cattle for human consumption were analysed for effective dose due to ingestion of natural radio nuclides) by Ademola 2014 also revealed high doses of these radio nuclides. The effects of these contaminations shown by this study are largely dangerous and as such should be taken more seriously. This will go a long way to save both animal and human lives that are presently at jeopardy.

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