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Short Communication

Unsuspected Pollutants in Soils Around Mine-Site Vicinity

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Abstract

Our opinion is based on a study that utilizes two non-destructive analytical techniques (XRF and XRD), which proved effective in the mineralogical characterization of Columbite-Tin ore contaminated soils. Unsuspected contaminants of environmental and health concern were found to range from radio-nuclides to their stable nuclides of toxicity potentials.

Keywords: XRF; XRD; Soil; Minerals; Tin; Columbite; Mine site

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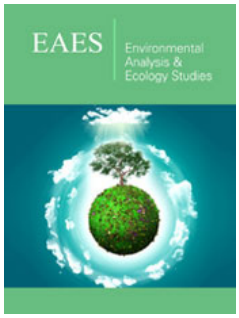

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Introduction

It is worthy of note that contamination of agricultural soils and depletion of the environment as a results of unregulated mining activities poses threats on the environment and on human. The basis of this research piece is the mineral characterization and dearth information on the toxicology of the elements and compounds that are exposed as a result of mining activities. The mining industry generates wastes which contain high concentrations of metals and metalloids which contaminates agricultural soils, air and water. These pollutants can be mobilized, resulting in leaching into ground and surface water. Most of these heavy metals are highly toxic and are not biodegradable [1].

Ecological Effects of Mining

There is the danger of neglecting the environmental externalities based on human-nature interactions linked with mining [2]. These ecological anomalies do not operate in a vacuum; This results partly from the fact that the mining industry is largely underdeveloped and dominated by informal miners scrubbing minerals to make ends meet with little or no regulatory measures to ensure conformance to operational standards [3]. Seeing the recurrent hazards from thousands of abandoned mines across the country especially in Jos Plateau, Nigeria and the other risks in the sector through inland sand mining and the effects of artisanal mining, the concentration of toxic residues from geological hazards and ecological disturbances of destruction of flora and fauna are major mining and post mining challenges [4,5].

Material and Methods

An appropriate method for soil sampling, pretreatment and analysis was reported elsewhere [6]. This was followed by the use of non-destructive analytical techniques for determination of contaminants in mine-site contaminated soils. From the early years of this century, the chemical analysis of mine site soils has been made with classical analytical methods in which elements are precipitated from the solution as successive group precipitates and then determined mainly with gravimetric methods. Today, characterization of minerals and soils are made on instruments capable of determining up to 30-40 elements simultaneously or in rapid succession. Among the techniques now in use are the X-Ray Fluorescence analysis (XRF) and XRD which are non-destructive techniques. Surface and structural morphologies are investigated with Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) while radionuclides in soils could be quantified using Neutron Activation Analysis [7].

Result and Discussion

XRF analytical results gave percentage elemental composition of the agricultural soil around mine site. Result shows the presence of elements in the following classifications:

Essential minerals (Ca, P,K,); Trace minerals (Cu, Fe and Mn); Heavy metals(Al, Cr, Mn, Fe, Ni and Cu); Radionuclides (Rb, Zr, Nb and Th), and noble element (Au) at a very low level depicting its name as a relatively rare element (Figure 1).

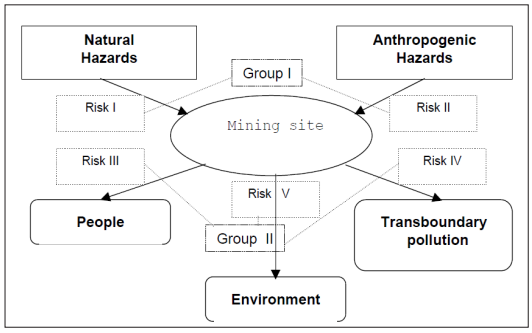

Figure 1: Classification of risks posed by natural and anthropogenic hazards from mining sites [5].

There are two types of essential minerals: major and trace minerals. Both types are equally important for health, but major minerals are present in larger quantities in your body than trace minerals. Pollution index results shows that the concentration of oxides of the major essential minerals are within the limits of 0.18-1.0mM contamination factors, hence not toxic [8]. Radionuclides and trace metals are detected in farmlands soils around Columbite-tin mining sites. The chemical characterization, using electron dispersive XRF revealed the presence of niobium mineral in various proportions and vary from deposit to deposit depending on the geochemical composition of the minerals that formed the parent rock of the area. The percentage elemental composition of soil around the mining vicinity determined by ED-XRF unveiled the presence of radionuclides K-40, rubidium and thorium at trace level in the soil. These could bio-accumulate and subsequently bio-amplify as threshold limits are exceeded.

Soil Mineralogy

The mineralogical components of the sample were carried out by X-ray diffraction technique. The main minerals found in the sample were Braunite, Cassiterite, Ilmenite, Quartz, and Zircon. Each of these compounds have a phase information from the XRD pattern obtained. Useful information on these combined minerals has been reported [8,9]. The main minerals linked to Tin in the sample were Cassiterite, Litharge and Magnetite respectively, with each of this compound having a phase information from the XRD pattern.

The principal minerals of commercial interest in the plateau mining sites are Titanium Minerals (rutile and Ilmenite), columbite (niobium and tantalum), Monazite, magnetite, litharge, and zircon. Cassiterite has been mined since 2,500 BC; its main use was in bronze alloy and as a component in low-melting solder with antimony and lead [10]. This research revealed high intensity 2θ values for cassiterite between 26.585, 33.871 and 51.768% respectively. It is noteworthy that broadening of reflections beyond 25% intensity due to instrumental factors could be predominantly attributed to crystallite size effects [9].

Conclusion

The percentage elemental composition of soil around the mining vicinity determined by the nondestructive techniques unveiled the presence of Radionuclides K-40, Rubidium and Thorium in the soil. This is of great concern considering the recurrent hazards from thousands of mines across the study area. Concentration of toxic residues from niobium, tantalum, tin and other geological hazards could cause ecological disturbances and destruction of flora and fauna are the major challenges from these mineral explorations.

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