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# Human exposure to lead and other potentially harmful elements associated with galena mining at New Zurak, central Nigeria

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ABSTRACT

Galena mining in New Zurak, central Nigeria is currently increasing in intensity, with widespread artisanal mining taking place alongside mechanised mining. These activities are causing immeasurable damage to the environment. The prolonged human exposure and ingestion of Pb and other potentially harmful elements (PHEs) such as U, Cd, Se, Zn and As that are released from ores during these (mining) activities is a cause of great concern to populations that live in the vicinity of these mine fields. Many of the communities make their living from subsistence farming, growing food from the surroundings, and obtaining drinking water from nearby surface and sub-surface water resources. An overall assessment of the degree of contamination or toxicity of Pb and other PHEs was carried out using the indices of geo-accumulation ($I_{geo}$) and contamination factors (CFs), in the different media sampled – farmland soils, uncultivated lands, mine tailings/dumps, natural waters and vegetables. Results reveal that the mine tailings and dumps are highly contaminated with Pb and other PHEs followed in decreasing degree of contamination by the uncultivated lands, farmlands and natural waters. These findings suggest that release of Pb and other PHEs from the galena mining activity has contributed significantly to the enrichment of these elements in the surrounding environment, including the natural water bodies, and are disposed to subsequent entry into the human body through the food chain. As such these PHE accumulations pose significant risks to the environment and human health, especially of children and pregnant women who are the most vulnerable groups in the area. In order to forestall a reoccurrence of the Zamfara Pb poisoning episode in northwestern Nigeria in 2010, where more than 400 children died, the authorities concerned should ensure that mining in New Zurak is done in a more environmentally friendly manner, ensuring the maintenance of an environmental quality adequate for good health and well-being of the surrounding mining communities.



## 1. Introduction

"This paper presents an assessment of environmental health impacts of galena mining at New Zurak in central Nigeria (Fig. 1). In general, communities in New Zurak practice subsistence agriculture, but many are also engaged in artisanal mining, in keeping with a long mining tradition that started in 1931, with peak operations attained between 1930 and 1937. Today, the region is besieged by widespread artisanal mining alongside large scale operations. Indiscriminate mining and manual processing of the ore is causing an environmental disaster – hampering agricultural productivity and the health of nearby residents and other ecosystem components.

Discharges from Pb–Zn mining have been shown to contain Pb and other potentially harmful elements (PHEs) (Alloway, 1995; Lar et al., 2000; Davies, 2010). Children play on the mine tailings and dumps. Some children are even engaged in processing the commodities. During these activities, children inhale Pb in the atmospheric dust or ingest it through hand to mouth contact. Other routes of exposure to Pb are through drinking water and food. Groundwater constitutes a major source of potable water for the mining communities.

A most devastating Pb poisoning episode occurred recently (June, 2010) in Zamfara, northwestern Nigeria, which drew worldwide attention. Ingestion of Pb released from gold mining activities caused the death of at least 400 people, mostly children between the ages of 5 and 11 years. Although the death toll from Pb poisoning in this episode is on the rise, the local miners continue to ignore advice from local environmental auditors. If Pb–Zn mining methods in New Zurak remain unchecked, we may be waiting for yet another calamity similar to the Zamfara one, in the near future.

The present study has assessed the degree of contamination or toxicity of Pb and other PHEs that have resulted from Pb–Zn mining activity in the New Zurak mining district, and considered the

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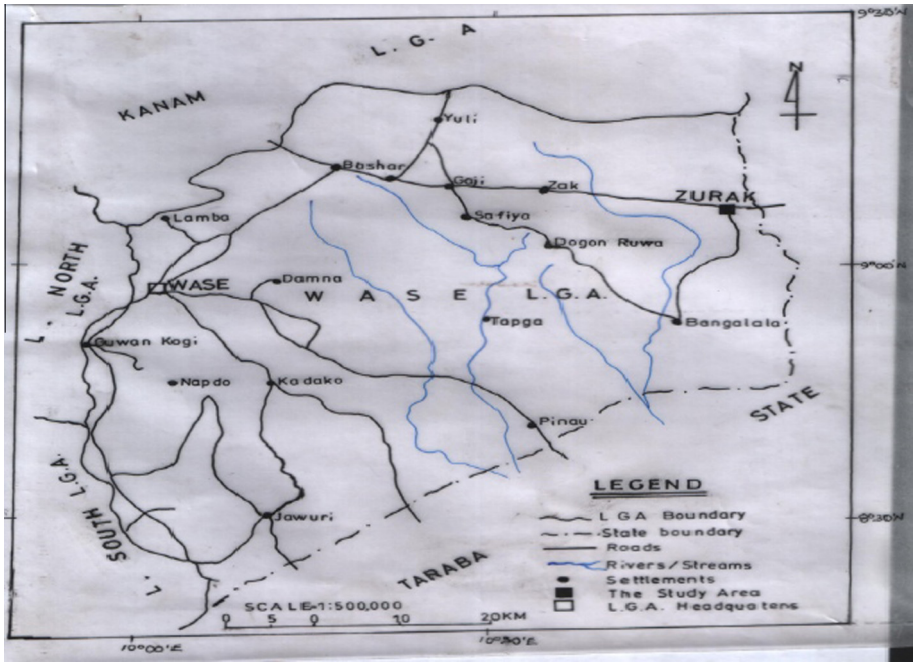


**Fig. 1.** Location map of the study area.

effects on human health. Remediation measures are proffered that would help to obviate negative effects on the human population. Strategies are outlined for creating public awareness on the risks of prolonged human exposure to Pb."

## 2. The study area

New-Zurak Pb–Zn Mining District is situated in central Nigeria (Fig 1), and lies between latitude 9° 12′ N–latitude 9° 17′ N; and longitude 10° 32′ E–longitude 10° 37′ E in the Middle Benue sedimentary basin (Benue Trough). The geology of the area comprises mainly of Cretaceous sediments with a few "igneous intrusions". The sedimentary sequence is represented by medium to fine grained sandstone of the Bima Formation (Upper Albian age) and Yolde Formation (Cenomanian age).

Pb–Zn mineralisation is hosted by hydrothermal veins in these sandstone beds following the major NS trending faults in the area (Olade, 1976; Fig. 2). Associated with these veins are a series of parallel fissure veins hosting minor ores such as limonite, hydrohaematite, cerusite and covallite (NECCO, 1976).

## 3. Materials and methods

Three representative sample types, namely, soils, water and vegetables were collected (Fig. 3). The soil samples were collected from the mining pits, mine and tailings dumps as well as farmlands and uncultivated lands using hand auger. Water samples from surface and underground water supplies were collected in 250 ml polyethylene bottles and acidified with one to three drops of Nitric acid. Samples of sweet potatoes, onions and spinach from farmlands, were also taken. Water samples are filtered using No. 42; 125 diameter ashless filter paper prior to analysis on ICP OES. Physical parameters of water, viz., pH and EC were taken in the field.

The soil samples were pulverized to pass through 0.067 mm mesh size. 100 mg of the powdered soil sample was weighed into a Teflon crucible and dissolved in aqua regia ($HCl + HNO_3 + HClO_4$

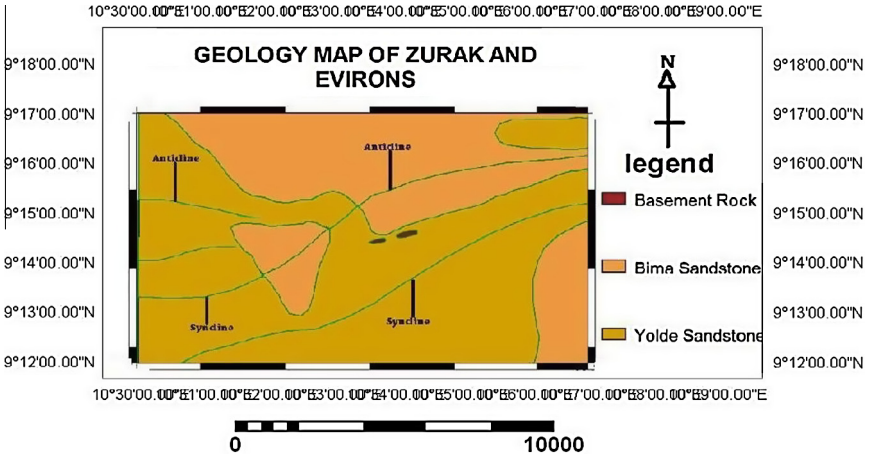


**Fig. 2.** Geological map of Zurak and Environs.