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Assessment of radionuclides content of lead-zinc mines in Abakaliki area, Lower Benue Trough, Southeastern Nigeria

There are several hundreds of mines within the six(6) cluster lodes of the lead-zinc mineralization belt trending NE-SW similar to the Benue Trough trend in Abakaliki area, southeastern Nigeria. Thousands of artisanal mine workers involved in the exploitation are exposed Type 1 and Type 2 Naturally Occurring Radioactive Materials (NORM). The study aim to determine the health risk due to the radiation exposure of these workers to radionuclides: ^{40}K , ^{238}U and ^{232}Th during extraction and processing of the metallic ores. Airborne Radiometry data were interpreted and twenty (20) water samples from mine pits were taken. Also, RS-230 Spectrometer was used to take more than one hundred and sixty (160) readings within the mines in the cluster lodes in the area covering about one hundred (100) kilometer. The airborne data shows significant distribution of the radionuclides content more within the sedimentary rocks than the basement rocks. The hydrogeochemical analysis for lead in the water samples from the mine pits viz: $6200\mu\text{g/l}$, $7900\mu\text{g/l}$, $9300\mu\text{g/l}$, $4400\mu\text{g/l}$, $3800\mu\text{g/l}$, $7300\mu\text{g/l}$, $1200\mu\text{g/l}$, $2300\mu\text{g/l}$, $6800\mu\text{g/l}$, $3000\mu\text{g/l}$, $4500\mu\text{g/l}$, $6300\mu\text{g/l}$, $3600\mu\text{g/l}$, $4900\mu\text{g/l}$, $9100\mu\text{g/l}$, $3900\mu\text{g/l}$, $900\mu\text{g/l}$, $8100\mu\text{g/l}$, $2800\mu\text{g/l}$ and $5200\mu\text{g/l}$. All these values are higher than the 1993 World Health Organization and 1998 European Union drinking water standards respectively. This poses a lot of health hazard. The ground spectrometer revealed the radionuclides content $\text{K} > \text{Th} > \text{U}$. The radiation hazard data vis-à-vis the air absorbed dose has an upper and lower limits of 38.0 to 325.7 nGyh⁻¹ respectively, higher than the world average value of 55 nGyh⁻¹ (United Nations Scientific Committee on the Effects of Atomic Radiation, UNSCEAR). Annual Effective Dose Equivalent (AEDE) of the upper and lower limits in the cluster lodes revealed-Izzi(0.2-0.7mSvy⁻¹); Nkaliki(0.2-0.6mSvy⁻¹); Enyingba(0.3-0.6mSvy⁻¹); Ameri-ikwo(0.2-0.6mSvy⁻¹); Uburu(0.1-0.6mSvy⁻¹) and Ishiagu(0.1-0.7mSvy⁻¹). The AEDE results in all the mines are lower than the allowable maximum limits of 1mSvy⁻¹(Public), 20mSvy⁻¹(Occupational of 18years above) and 6mSvy⁻¹(Occupational of 16-18years) based on 2014 IAEA and International basic safety standards. Although, the result obtained show that there are no radiological health hazards. However, many of the mines in the area have been active for more than twenty five (25) years. The long term cumulative effect could pose radiation health hazard to both the public and the mine workers

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