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## Method Article

## Radioactivity and radiological hazards from a kaolin mining field in Ifonyintedo, Nigeria

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## A B S T R A C T

The concentrations of the radionuclides in the subsurface formation (soils and rocks) solely depend on their geological origin, which enables its variation from point to point on the Crust. Construction materials can possess elevated concentrations of radioactivity if their byproducts are mined from contaminated radionuclide sources. In this article, results of in situ measurements of radioactivity concentrations of <sup>40</sup>K, <sup>232</sup>Th, and <sup>238</sup>U as well as gamma doses and radiological hazards from kaolin mining field were presented and evaluated. Eleven stations were randomly occupied in order to cover the upper axis of a kaolin mining field in Ifonyintedo. The radiometric survey was achieved using Super-Spec (RS-125), equipment capable of measuring activity concentrations and gamma doses. For each location, measurements were taken four times, while its mean and standard deviation values were estimated for better accuracy. The overall mean activity concentrations (for <sup>40</sup>K, <sup>232</sup>Th and <sup>238</sup>U) and gamma dose were estimated as 93.9 Bq kg<sup>-1</sup>, 65.1 Bq kg<sup>-1</sup>, 38.2 Bq kg<sup>-1</sup>, and 59.6 nGy h<sup>-1</sup> respectively. The estimated radiological hazards from the measured parameters showed that the overall mean concentrations of Radium Equivalent, External and Internal Hazards, Annual Effective Dose, Gamma and Alpha Indices, and Representative Level index are 138.5 Bq kg<sup>-1</sup>, 0.37, 0.48, 0.29 mSv yr<sup>-1</sup>, 0.48, 0.19, and 0.97 respectively. By comparing the mean values of the activity concentrations and their radiological risks with the several world standards from the literature, kaolin deposits in Ifonyintedo are highly rich in thorium.

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## A R T I C L E I N F O

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## Method details

Kaolin is one of the types of clay found in nature, with the chemical composition of  $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$  [1]. The name “kaolin” is derived from a Chinese word Gaoling, which literally mean “High Ridge”. The industrial usefulness of kaolinite clays can be found in paper industry [2], paint industry (as filler for paint), rubber and plastic industry [3], and construction industry [4]. They are used in the production of ceramics, cement, porcelain and bricks [5], toothpaste, food additive, and cosmetics [6]. Kaolinite clay also found its application in agricultural domain (production of spray that repel insects and avert sun burn) and medicine [6]. Recent study from Turkey showed that Kaolin clays are cost effect when used as pozzolanic additives in cement and concrete [7].

Ceramic raw materials are categorized into plastic and non-plastic ceramics. The former are materials that exhibit plasticity property when mixed with water, which include kaoline, bentonite and clay. The later are materials that are not plastic when mixed with water, which include feldspar, quartz, dolomite, limestone, magnesite, talc and calcium phosphate [8]. The main component in ceramic tile body is clay. Clay is a term for naturally occurring mineral aggregates consisting mainly of the hydrous silicate of alumina. Tile is a thin rectangular or square slab of baked clay used in overlapping rows for covering floor, wall column, or and roof. Geologically, kaolin is a result produced when feldspar crystals and feldspar are mixed together under the control of weathering [9]. As stated on the website of Ceramic Research Company [8], weathering is a wearing down of all exposed rock body that is frequently breaking down to sea level by actions such as water, glacial or wind. It is either a mechanical or physical process.

Globally, elevation of activity concentrations of radionuclide and its radiological consequences from buildings as well as building materials from geological origin have been reported by many researchers, among are: Lu et al. [10], Arabi et al. [11], Ge and Zhang [12], and Isinkaye et al. [13]. Recently, activity assessment and radiological risks associated with tiles made in Nigeria have been reported by Joel et al. [14] and Joel et al. [15]. Their results showed elevated concentrations of radionuclides in different tiles manufactured in Nigeria. Their outcome has facilitated this research in order to evaluate the radionuclide concentrations of one of the major kaolin deposits used for manufacturing of tiles in Nigeria. However, the aim of this research is to assess the concentrations of radioactivity on a kaolin mining field in Ifonyintedo, Nigeria and to estimate the radiological risks to human exposure.

## The study area and its geology

Kaolin is one of the mineral resources that are available in commercial quantity in Nigeria. Ifonyintedo, the study area is one of the several locations where kaolin clays are mined in Nigerian sedimentary Basins. The study area is bounded by longitude  $002^\circ 47.498'$  to  $002^\circ 47.570'$  E and latitude  $006^\circ 46.077'$  to  $002^\circ 46.126'$  N, located in the eastern arm of Dahomey Basin, Nigeria. The elevation above the sea level ranged from 86 to 91 m, with an average of 89 m. Fig. 1a is the representation of how the kaolin clays are mined in Ifonyintedo, Nigeria. Ifonyintedo is a town located in Idiroko local council development area, Ipokia local government area, Ogun state, SW Nigeria. The town has a population of approximately 10, 000. The residents along Ifonyintedo axis are into farming and cottage industry. The major cultivated crops in Ifonyintedo include: cassava, maize, vegetable, and cash crop such as palm tree. The major cottage industries are cassava and palm oil industries. Recently, the discovery of kaolin deposits in commercial quantity has attracted the miners to the town. Commercial activities in Ifonyintedo have been improved greatly, due to its propinquity to the Republic of Benin's border. Like other suburbs of the study area, Ifonyintedo has a tropical climate, with distinct two seasons: rainy and dry seasons. Averagely, the rainy season span from March to November, while the dry season fluctuates from November to March, except on some minor cases where the rainfall is scarcely experienced between December and January. The mean temperature of the study is  $26.5^\circ\text{C}$ . Additional information on Ifonyintedo is available on [1].

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