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APCBEE Procedia 10 (2014) 54 – 58

Procedia APCBEE

www.elsevier.com/locate/procedia

ICESD 2014: February 19-21, Singapore

Radiological Monitoring of Borehole in Dei-Dei, Abuja, North Central Nigeria

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Abstract

Inhabitants in Dei-Dei area of Abuja consume groundwater that recharges from different lithologic units of subsurface structures due to inadequate public water supply.The water is consumed untreated and during drilling, it cuts across so many rock formations, to extents constitute radioactive elements which are to be evaluated. Vertical Electric Sounding and Shuttle Radar Topography mission was used to determine the structure of electric conductivity and map lineaments.Hydrogeologically motivated borehole with geophysical log data was drilled. Activity concentrations were analysed using high resolution co-axial HPGe gamma spectrometer system. The activity concentrations ranges from 45± 2 to 98 ± 6 Bq kg^{-1} for ^{232}Th, 18 ± 2 to 37 ± 4 Bq kg^{-1} for ^{238}U and 236 ± 32 Bq kg^{-1} to 1195±151 Bq kg^{-1} for ^{40}K. Structurally, fractured interconnectivity attributed to low levels in some layers. Activity levels are within the limits, requires research within groundwater activity levels and rock geochemistry.

Selection and peer review under responsibility of Asia-Pacific Chemical, Biological & Environmental Engineering Society

Keywords: Abuja, Borehole, Vertical Electrical Sounding (VES), Shuttle Radar Topography Mission (SRTM), Natural Occurring Radionuclides Materials (NORM)

1. Introduction

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Selection and peer review under responsibility of Asia-Pacific Chemical, Biological & Environmental Engineering Society
doi:10.1016/j.apcbee.2014.10.015

Natural radioactivity (^{238}U, ^{232}Th and ^{40}K) from the ground surface relate to the primary mineralogy and lithological compositions of vertical profiles, and the secondary weathered materials. The environmental radiation are related to the geological composition of each lithologically separated area, and to the content in ^{238}U, ^{232}Th and ^{40}K of the rock from which soils originate in each area, [1-2]. Naturally occurring radioactive materials (NORM) are found throughout the earth's crust, and they form part of the natural background radiation to which all humans are exposed,[3]. The presence of these (NORM) in soil, rocks, water, and air, along with cosmic radiation result in continuous and unavoidable internal and external radiation exposures of all humans. In Abuja, the case for conjunctive use of surface and groundwater supply, where available, to meet the ever increasing demand cannot be over-emphasized. Since the city growth is not in phase with the public water supply (waterboard), to defray the deficit, people look for alternative source (Borehole) to argument the demand for water which is inadequate. In the cause of drilling processes, it cuts across so many rock formations; to some extents, these rocks constitute radioactive elements especially granitic rocks found in basement terrain areas like Abuja. The water is being consumed without treatment. The objective of this study, therefore, is to determine the activity concentration of ^{238}U, ^{232}Th and ^{40}K in sequential lithological units to the groundwater-bearing rocks (aquifer) of varying depths, 70m in Dei-Dei. The coordinates of Dei-Dei borehole site is Lat: 9^o 6'52"N and Log: 7^o 15'39"E (Dei-Dei).

2. Geology and hydrogeology of the Study Area

The area of study forms part of the Basement Complex of northcentral Nigeria; with lithologic units falling under three main categories, which include (1) Undifferentiated migmatite complex of Proterozoic to Archean origin, (2) Metavolcano-Sedimentary rocks of Late Proterozoic age and (3) Older Granite Complex of Late Precambrian - Lower Paleozoic age, also known as Pan-African Granites. All these rocks have been affected and deformed by the Pan-African thermotectonic events. Detailed reports of the lithological description, age, history, structure and geochemistry of the Basement Complex of Nigeria are given in [4-5]. The geologic map of the study area is discussed elsewhere, [5].

2.1. Method of Vertical Electrical Sounding (VES) and Shuttle Radar Topography Mission (SRTM)

The Schlumberger configuration in vertical electrical sounding (VES) was used to determine the structure of the electric conductivity. Vertical electrical sounding probes the vertical variation in resistivity of the subsurface, thereby indicating the presence of fluid and ionic concentration in the subsurface materials, degree of fracturing of the bedrock; all of which would help in making the choice for a feasible site for constructing a successful borehole. The Shuttle Radar Topography Mission (SRTM), a single pass interferometry mission flown in February 2000, generated elevation data at 90m resolution for 80% of the Earth's surface in C-band. The SRTM-DEM data was subjected to hillshading procedure using Idrisi 32 software to enhance linear features that could be major regional fractures, [5]

2.2. Interpretation of VES and SRTM in the Study Area

Geophysical investigation was conducted to locate the suitable sites for drilling, also structures that control the aquifer and depth to the basement terrain groundwater. One sounding was made in the study areas to choose the dense populated zone.Vertical Electrical Sounding (VES) was carried out at the location of the study area and the results obtained were integrated with structural data generated from hill shaded Shuttle Radar Topographic Mission (SRTM) data [5]. The VES plot profile is reported elsewhere, Figure 8, [6]. The interpretation of the data obtained from the sounding revealed that six aquiferous geoelectrical layers overlie