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Combined High Resolution Aeromagnetic and Radiometric Mapping of Uranium Mineralization and Tectonic Settings in Northeastern Nigeria

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Geological lineaments, depths to the basement, uranium concentrations and remobilization in parts of the Upper Benue Trough, Northeastern Nigeria were mapped through the integration of high resolution aeromagnetic and radiometric data. This was with a view to identifying the potential zones of uranium deposition in the area.

High Resolution Aeromagnetic Data (HRAD) and airborne radiometric data (equivalent uranium and thorium data) of the study area, covering about 56 by 56 km^2 (bounded by latitudes $11°30' - 12°00'$N and longitudes $10°00' - 10°30'$E), were acquired from the Nigeria Geological Survey Agency (NGSA). The data were gridded at 100 m spacing using the minimum curvature gridding method. The HRAD was processed to accentuate anomalies of interest using reduction-to-equator and upward continuation filters. Thereafter, the depths to the basement were estimated from the HRAD using spectral analysis and Source Parameter Imaging (SPI) techniques, while the structural lineament map of the study area was inferred from the superposition of the Horizontal Gradient Magnitude (HGM), Analytical Signal Amplitude (ASA), First Vertical Derivative (FVD) and 3D Euler solutions of the HRAD.The equivalent Uranium (eU) and equivalent Thorium (eTh) distribution maps of the radiometric data were processed to obtain the eU^2/eTh, eU/eTh and eU − (eTh/3.5) ratio maps that were used to determine the concentrations and remobilization of uranium. Magnetic forward modelling of two profiles (P-P' and T-T') taken across the suspected uranium rich zones was carried out to provide 2D model representations of the basement blocks beneath the zones.

The results obtained show that the study area is dissected by several structures that trend ENE-WSW, NE-SW, E-W, NNE-SSW, WNW-ESE and NW-SE; among which the ENE-WSW and NE-SW trends dominate. The delineated lineament structures dip vertically, northeasterly, southwesterly, northwesterly and southeasterly. The depths to the basement range between 150 m and 1941 m. The uplifts and depressions on the map of the basement morphology coincide with the basement complex and the sedimentary terrains of the study area respectively. Results from the eU^2/eTh, eU/eTh and eU − (eTh/3.5) ratio analyses revealed that uranium ores in the study area were possibly remobilized epigenetically from the granitic rocks, and were later deposited into sedimentary rocks (Bima formation), and in fault and fracture zones to form uranium veinlet in the Basement Complex terrains. The northwesterly and southeasterly dipping faults dip in the same direction as the paleocurrent direction (direction of depositions of sediments), and trend in a direction perpendicular to the direction of uranium deposition. The Burashika Group (Bongna Hills) and Wawa area of the study area show vein type deposition, while the Anatectic migmatite in the northeastern region and the uranium rich Bima formations show both fault/fracture and contact types of deposition.

It is concluded from this study that the studied area possibly contains deposits of uranium ore, which are likely to be found in: the Bima sandstones of Wade, Shinga, Bima Hill, Wuyo, Teli, Bryel, Dali, Barkan, Gasi, Kunkun, Boragara, Deba, and Gberundi localities; the Anatectic migmatite at Kubuku, Whada and Hyama; and the Bongna hills and agglomerates around Burashika, Kawaba and Galu.