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MINERAL POTENTIAL MAPPING AROUND UDEGE USING REMOTE SENSING AND GIS

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ABSTRACT: *Udege is located in Nasarawa State – Central Nigeria. Remote sensing and GIS was used to explore for potential sites for mineralization and alteration zones associated with mineral deposits. Satellite images as well as digital elevation models to study hydrothermal alteration associated with mineral deposits were used. Image processing techniques such as band rationing, principal component analysis as Ls-ft techniques were used for this study. Results reveal clearly areas of hydrothermal altered deposits of clays, iron oxides and ferric oxides around the study area. The principal component analysis using the Crosta technique also enabled the representation of the altered hydroxyl and iron oxide mineral deposits of the area. Spatial distribution of goethite, haematite and clay minerals were successfully mapped.*

KEYWORD: Mineral Potential, Remote Sensing, GIS, Mapping, Band Rationing, Principal Component

INTRODUCTION

Mineral resources occur on or in the earth according to predictable geological principles and must first be found using technical knowhow and appropriate technology and later under favourable conditions, economically developed, exploited, processed and used. The nation's development and prosperity is measured by assessing the extent to which the country has been able to explore, exploit and utilize its natural resources. Remote sensing and GIS (Geographic Information System) can be a very good tool for regional exploration of mineral resources. This tool was used in this work to explore for mineral potential in Udege and its' environs.

The studied area is located in Nasarawa State, Central Nigeria. It lies between longitudes $7^{0}45^{1}$ E to $8^{0}00^{1}$ E and latitudes $8^{0}15^{1}$ N to $8^{0}30^{1}$ N covering a total area of about 522 km^{2}. This falls within topographic sheet 229 Udege NE. The area is accessible through The main road from Akwanga to Keffi via Mararaba Agwada road and also through Nasarawa Loko via Mararaba Udege road. The annual range of rainfall is between 1100 – 1500mm. The temperature of the area is generally warm throughout the year with maximum temperature of 32^{0}c and minimum temperature of 26^{0}c. (Osu, 2011).

Regional Geology of the Area

Based on age and petrology, the geology of Nigeria can be subdivided into three major units. (Ogezi, 1988). They are the Precambrian to lower Palaeozoic rocks of the crystalline Basement Complex occupying approximately 50% of the total surface area of Nigeria, the Jurassic

Younger Granite and Tertiary to Quaternary volcanic rocks occupying less than 10% and the Cretaceous to recent Sedimentary Basins occupying about 45% of the total area (Fig 1).

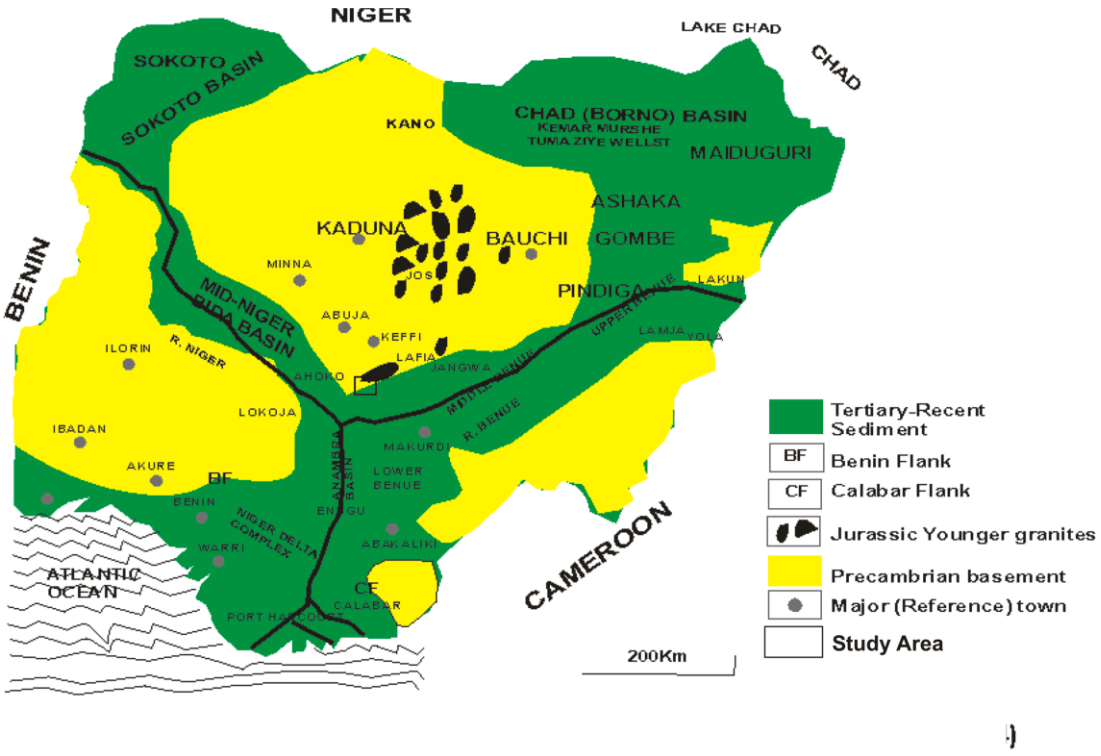

Fig.1: Sketch Geological Map of Nigeria Showing the Three Main Units of the Subdivision of Geology of Nigeria *(Taken from Obaje et al.,2004).*

The Basement Complex is made up of the oldest rocks and forms a part of the Pan African Mobile belt. It is intruded by the Mesozoic alkaline to peralkaline ring complexes (Younger Granites) and is unconformably overlain by Cretaceous and Younger sediments.

There are four lithological units within the Basement Complex of Nigeria (Rahaman, 1988) namely: The Migmatite – gneisses complex, the Schist belt (or Metasedimetary and meta volcanic rocks), the Older Granites (Pan-African granites) and Undeformed Acid and Basic dykes. The Nigerian Basement was affected by the 600Ma Pan – African Orogeny and occupies the reactivated region which resulted from plate collision between the passive continental margin of the West African Craton and the active Pherusian continental margin (Burke and Dewey, 1972, Dada, 2006).

Ring Complexes of Jurassic age (Younger Granite) intrude the late Precambrian to lower Palaeozoic Basement rocks of northern Nigerian in a N-S zone which continues northwards to the Air region of Niger Republic. The emplacement of the Younger Granites is completely unrelated to Orogenic activity (Jacobson et al., 1964; Van Breeman and Bowden, 1973).

However, its emplacement was associated with epeirogenic uplift. Black (1965) has put forward the idea that the Younger Granite magmatism may have been caused by rising convection currents in the mantle belonging to a sub Gondwanaland system.

Rocks comprising the sedimentary series have been deposited in seven basins. Five of them, the Niger delta, Dahomey, Bida, Benue and Anambra basins appear to have been initiated during the Cretaceous and are related to the opening of the Gulf of Guinea. Two of the basins, Sokoto and Borno are part of Illumedden and Chad basins respectively and occur mainly outside Nigeria. They have histories dating back to the Palaeozoic. The study area is part of the Benue Trough and is a rift or aulacogen basin which was formed during the Cretaceous, either by distension resulting in graben bounded by normal faults or by localised tension caused by large scale transcurrent faults (Benkelil,1989).

Udege is made up of high level anorogenic granites mainly biotite granites and minor quartz-feldspar porphyries emplaced within the Precambrian to Palaeozoic Basement gneisses, metasediments and older granites.

Methods

Remote sensing was used to identify potential sites for mineralization through mapping and identification of alteration zones associated with mineral deposits. Several methods were used for the alteration mapping. This remote sensing analysis was carried out using satellite images as well as digital elevation models. Image processing techniques such as band rationing, principal component analysis as Ls-ft techniques were used to study hydrothermal alterations in the area associated with mineral deposits. This study was employed with the aid of softwares such as envi, Arc Gis, pci Geometica and Rock works.

Local Geology

The study area is underlain by Basement Complex rocks, Younger granites and the sedimentary rocks of the Middle Benue Trough (Fig. 2). The Basement in the area consist mainly biotite Schist (mica schist), granites of the older granite suites and quartz-feldspar porphyries. The Younger granites(Afu) consist of microgranites, diorites and biotite granites. The southern part of the study area is underlain by Lafia formation which is cretaceous sedimentary rock of the Middle Benue Trough made up of loose sands, sandstones and mud.

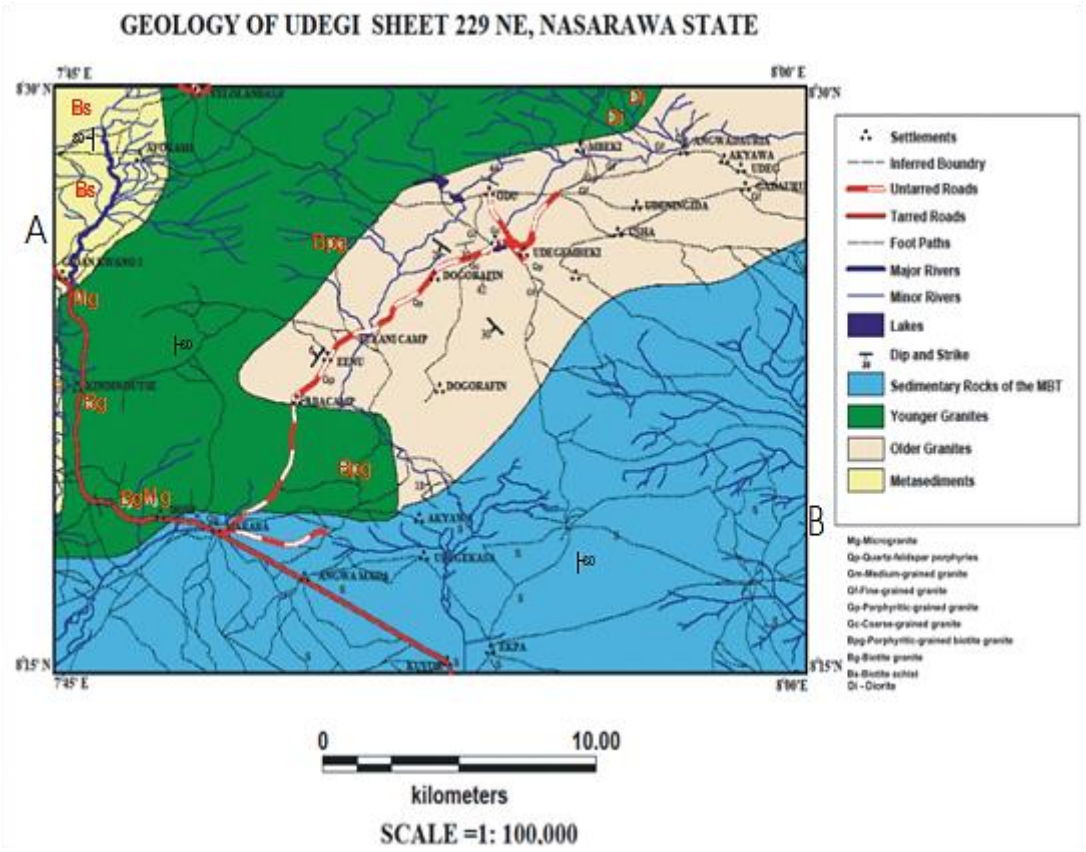

Fig.2: Geology Map and Cross Section of the Study Area

RESULTS AND DISCUSSION

Remote Sensing and GIS Analysis

Remote sensing was used to identify potential sites for mineralization through mapping and identification of alteration zones associated with mineral deposits. Several methods were used for the alteration mapping.

Band Ratio

Band ratio is a technique used for many years in remote sensing to display spectral variations effectively (Goetz et al 1983). It is based on highlighting the spectral differences that are unique to the materials being mapped. In this research, different band ratios were used.

Abrahams Ratio

Abraham ratio was used to study alterations by assigning band ratio 5/7, 3/2,4/5 in the red, green and blue channel (Fig.3).

Kauffmann Ratio

Using the Kauffmann ratio, band 7/4, 4/3, 5/7 was assign to the red, green and blue channels (Fig4).

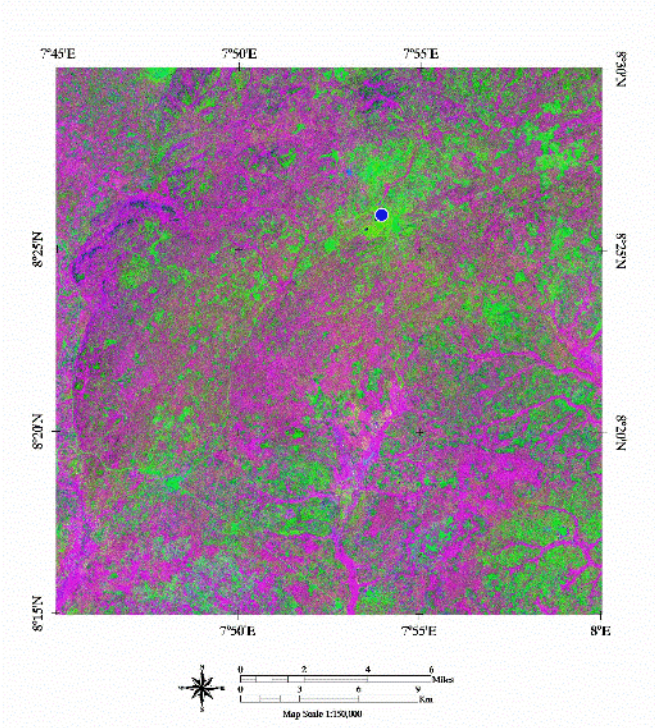

Fig.3 : Abrahams Ratio Image for the Study Area *(Iron as green, clay as red)*

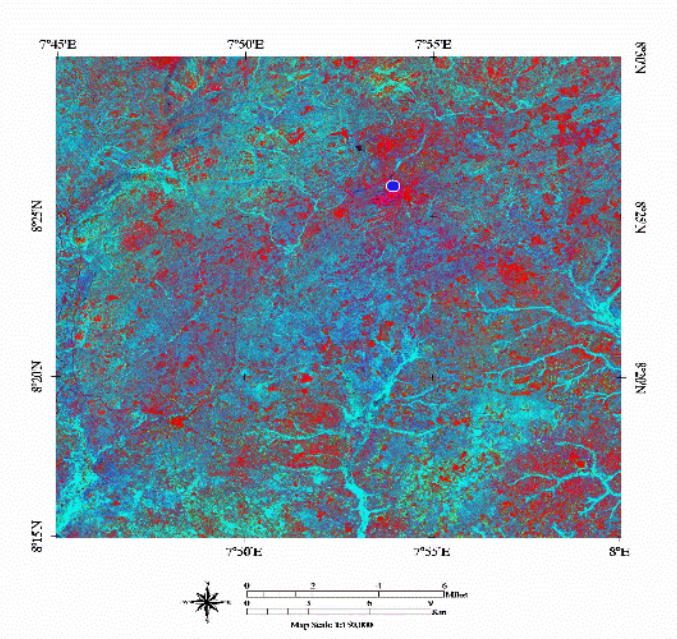

Fig.4 : Kauffmann Ratio Image for the Study Area *(iron as red, vegetated zone as green and hydroxyl mineral as blue)*

ChicaOlma Ratio

For Chica-Olma ratio, band ratio 5/7, 5/4, 3/1 was assigned to the red, green and blue channels respectively. The image is displayed in Fig.5.

Principal Component Analysis (Crosta Technique)

Selective principal component analysis was used as a method of data compression by which most information contained in the original image was transformed into the first few components. Crosta technique was used to study hydrothermal alteration within the study area.The results are shown in Figures 6 to 8 which are termed H image, F image and H+F image respectively. The H image, H+F image and F Image was then assign into the red, green and blue channel to display a Crosta image showing hydrothermal alteration(Fig.9).

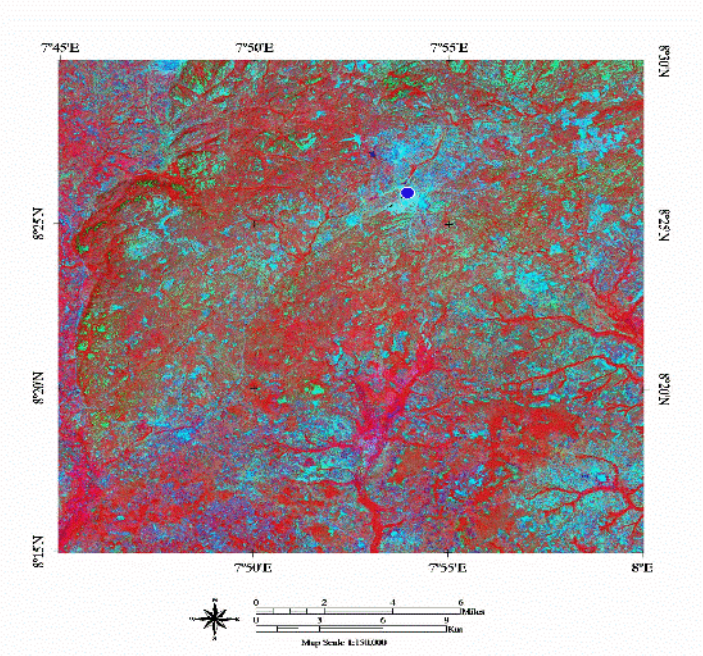

Fig.5: Chica Olma Ratio Image for the Study Area *(clay as red, ferric iron as green and ferrous iron as blue).*

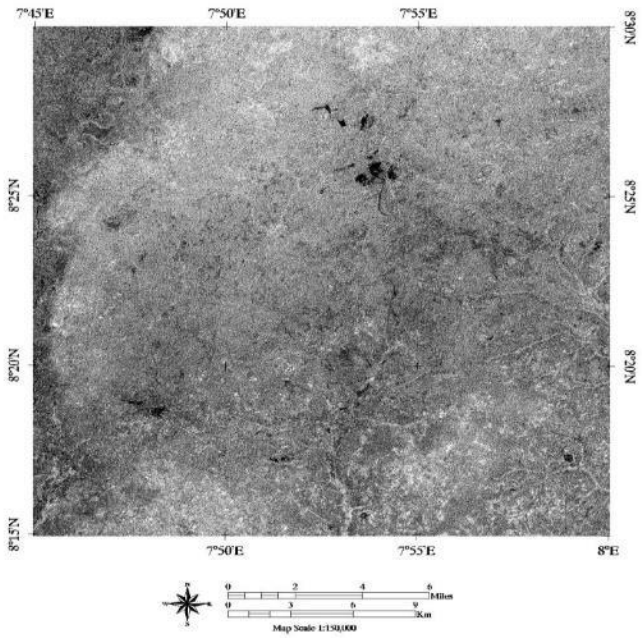

Fig.6: H Image Displaying areas of Clay Alteration as Light Tone

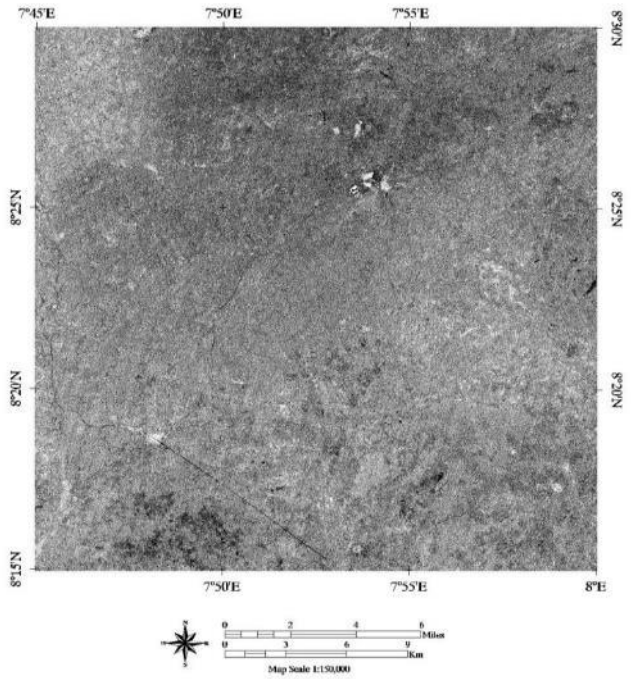

Fig.7: F Image for Study Area Displaying Iron Alteration as Light Tone.

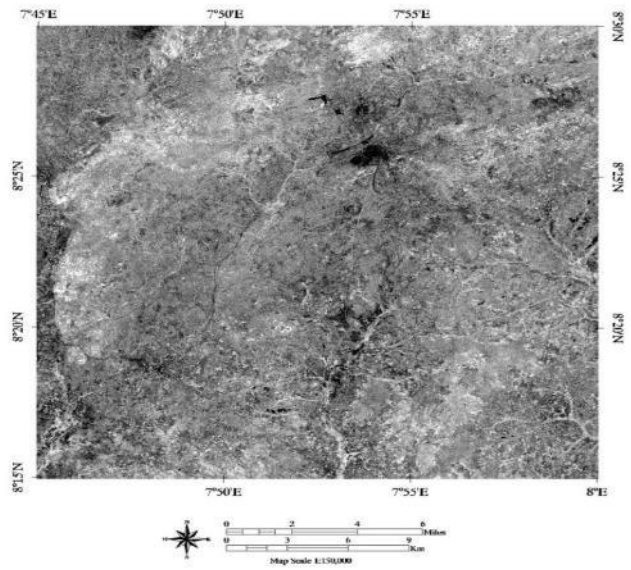

Fig.8: H+ F Image for the Study Area Displaying Both Clay and Iron Alteration as light Tone.

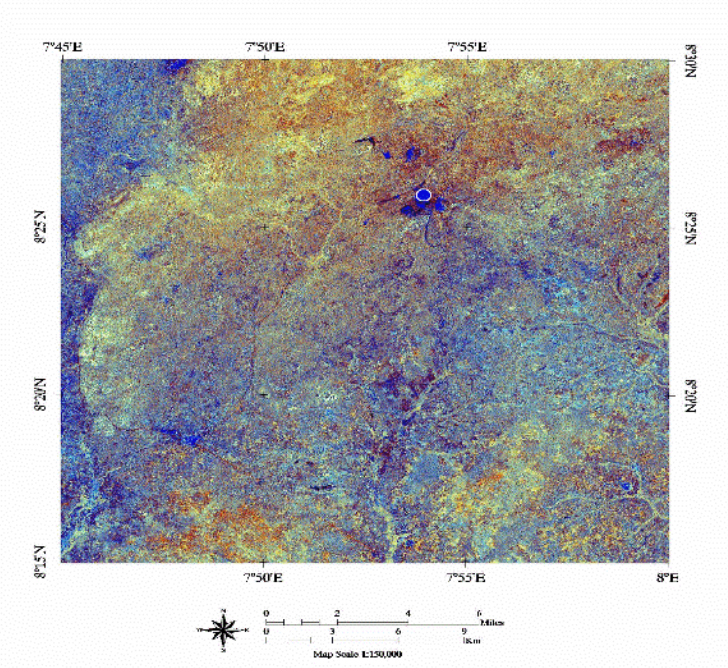

Fig.9 : Crosta Image for the Study Area (white =iron stain + argillized areas, bright reddish to orange = more argillized than iron stain and bright cyan to bluish = more iron stain than argillized zone *(Loughlin 1991)*

CONCLUSION

The spatial distribution of minerals like goethite, hematite and clay were mapped. There is prospect of these minerals in the area.

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