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Relating Geology and Geological Structures with Regional Episodes: Implication for Groundwater Exploration and Development around Kwal-Kanke Area, Jos Plateau

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***Abstract*- The study addressed the Geology and geological structures around Kwal-Kanke area around the Jos plateau. Three (3) rock types namely; Quaternary dolerite/basic rocks, aplo-pegmatitic granite gneiss and migmatite-gneiss were delineated. The quaternary dolerites and the aplo-pegmatitic granite are emplaced in form of dykes with lateral extent greater than 3km trending NW-SE and conforms to the trend of the fractures around Jiver area at the vicinity of the Sara-Fier Complex, implying that these dykes intruded pre-existing fractures and are most likely affected by similar tectonic episode. Geological studies around the central area of the study using the 40 vertical electrical soundings (VES) were carried out to determine the sub surface geology and its groundwater implications. From the study, weathered overburden of variable thickness of between 3-27m thick and major fractures which are of hydrogeological significance were intercepted on VES P28, P34, P35 and P38. The sub surface structures as depicted by the VES conform to the general NW-SE surface structural trend.**

Keywords: Geology, Geological structures, tectonic episode, VES, Hydrogeological implication

INTRODUCTION

The study area (Kwal-Kanke) falls within Federal Survey Sheet Wase 191 NW and is bounded by longitudes 9.60.10 and 9.6375^0E and latitudes 9.3928 and 9.3643^0N and covers an areal extend of 24 km^2. It is accessible by Pankshin-Langtang trunk A road. The area falls within the immediate transition zone of the Jos Plateau uplifted area and the low land area in the eastern part of Plateau State. The area is generally ugged and dominated by relief with elevations ranging from 500-700m above mean sea level. Most of the tributing rivers/streams that forms the River Wase which empties in to the River Benue rises from this flaunt of the Jos Plateau. This paper concerns the geology and structural geology around Kwal-Kanke area and its relationship with regional episodes around the Jos Plateau. Also, geophysical survey by vertical electrical soundings (VES) was carried out to determine the sub surface geological units and implication.

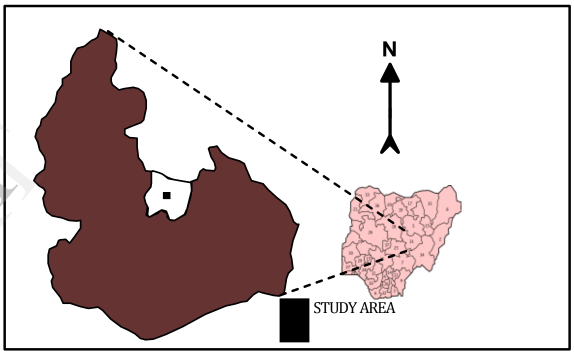


Fig.1: Map of Plateau State Showing approximate position of the Study area.

GEOLOGY

The geologic setting of Kanke is typical of the Precambrian to lower Paleozoic Basement Complex Rahaman 1988, and Goki et al (2010) described the general geology of Kanke area as being predominantly underlain by banded gneiss. The Pan-African undeformed Older Granite intrude the basement and have a gradational contact around the western flanks while the weakly foliated granite gneiss appear to be undifferentiated from the banded gneisses.

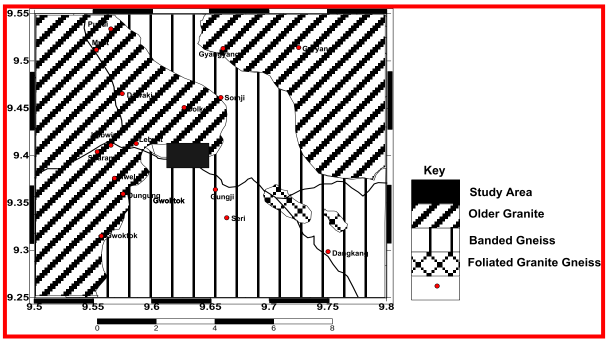


Fig.2: Geological Map of Kanke showing the Study area. Modified after Goki N.G. et al (2010)

The study delineated three (3) rock types namely; quaternary dolerite/basic rock, aplo-pegmatitic granite gneiss and migmatite-gneiss. The quaternary dolerites/basic rocks and the aplo-pegmatitic granite gneiss are emplaced in form of dykes trending NW-SE (Fig.3)

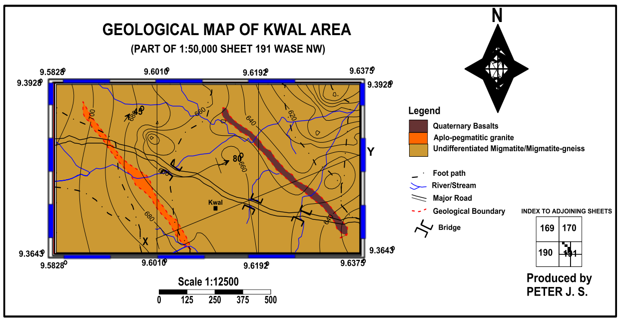


Fig.3: Geological Map of the Study Area

METHODOLOGY

Geological mapping of the study area was carried out using:

1. Base maps extracted from Topographical sheet Wase 191 NW.
2. Compass-Clinometer for mapping strike and dip of outcrops/structures. These data were used for producing the structural rose plots.
3. Hammer for breaking of rocks for field identification and sampling.
4. Global positioning system for determining co-ordinates of the geophysical soundings (VES) locations etc.
5. Geophysical survey by vertical electrical soundings for determining the sub surface geo-electrical layers/units. This was carried out using Allied Ohmega resistivity meter with AB/2 or current electrode expanding from 1.5 to 125m. The VES were interpreted using an iterative quantitative program, WinResist (Vander Velpen, 1988, 2004). The processed geophysical data provided resistivity ranges for the rocks identified in the area as well as the geo-electric models of the sub surface structures below the soundings stations

RESULTS AND DISCUSSION

Result of the mapping exercise identified and mapped out three with types-1. aplo-pegmatitic granite dykes, 2. basic dykes and 3. Migmatite-gneiss (Fig.3). The dykes and most of the minor fractures encountered on the migmatite-gneiss assume a NW-SE trend (Fig.4 and 5)

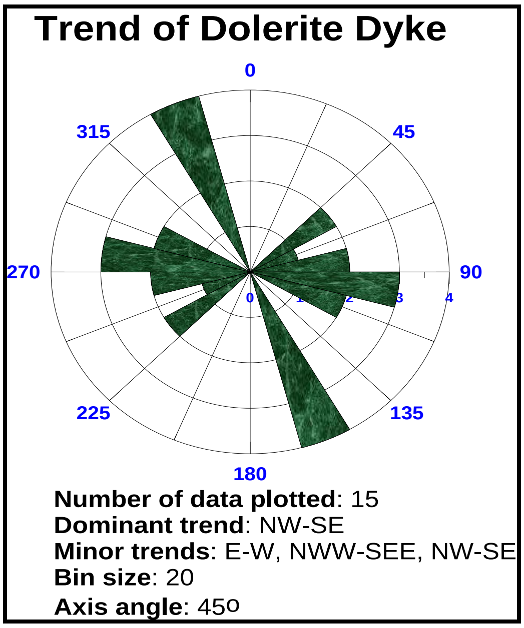


Fig. 4: Rose plot showing the trend on the dolerite dyke

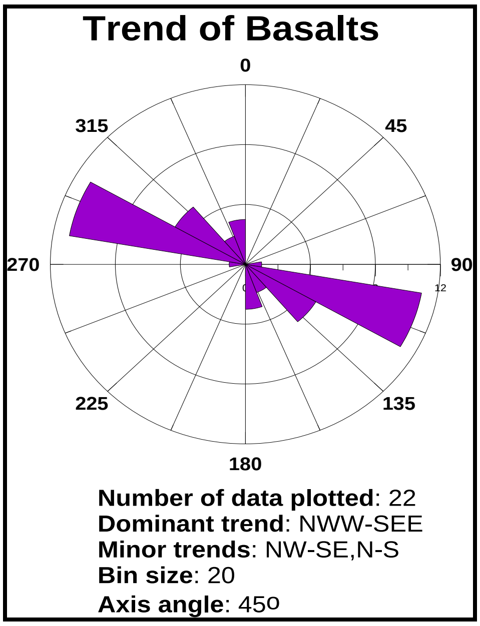


Fig. 5: Trend of Basaltic dyke

Ring faulting and cauldron subsidence are major tectonic control governing Younger Granite emplacement around the Jos Plateau which Sara-fier Complex is part (Macleod et al, 1971). A projection of the dolerite/basic dyke trending in NW-SE directions beyond the study area appears to intercept Centre 3 of the Sara-fier Complex which consists of basic rocks (Fig.6). The assumption is that since basalt/dolerite are basic rock, it is most likely that they might have the same composition with the one in the Complex and also with the trend of the fractures that emplaced the felsites at the vicinity of the Sara-fier complex (Fig.6). Therefore, it appears the geology and geological structures around Kwal are related to the initial volcanism that emplaced the Younger Granite rocks of the Sara-fier complex.

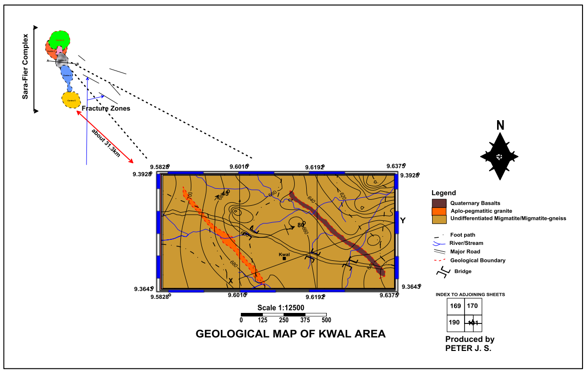


Fig.6: A schematic representation of the relationship of the Sara-Fier Complex with the Study Area

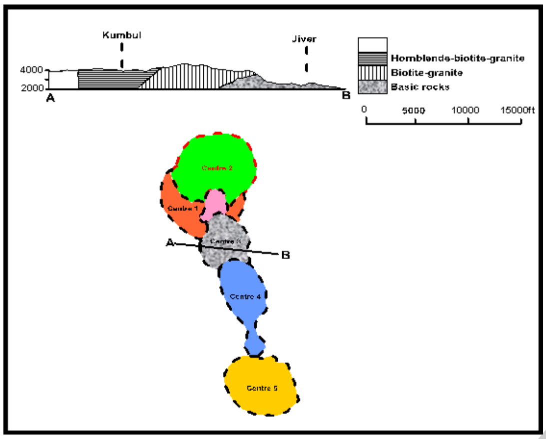


Fig.7: Schematic diagram showing Basic rocks associated with Centre three of the Sara-Fier Complex (modified after Maclead et'al, 1971).

GEOPHYSICAL INFERENCE

The geophysical survey using vertical electrical sounding method was carried out in profiles (Fig. 8) at intervals of 50 or 100m intervals. The VES were interpreted in terms of geo-electric sequence/lithologic units and geo-electric parameters correlated in profiles as geo-electric sections. The geo-electric sections revealed 4 major geo-electric layers- (1) Topsoil (2) weathered basement (3-27m) (3) slightly weathered basement and (4) fresh basement. The various geo-electric layers revealed variable thickness and resistivities and between 0-2.7m, 0.8-27m, 10-30m and ≥ 10m and characterized by resistivity of 27-243, 28-89, 77-4957 and 4603 ohm-m respectively. However, fractures were intercepted in profile No.4 and 5 on P28, P34, P35, P38 and trending in NW-SE direction (Fig. 8).

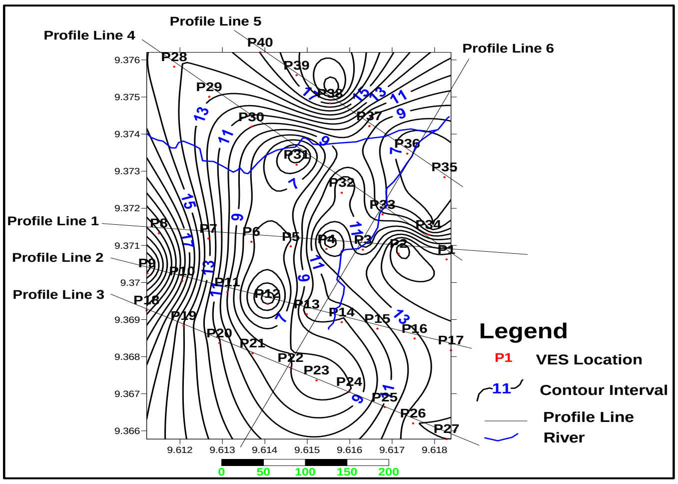


Fig 8: Map Showing the VES Locations and Profiles

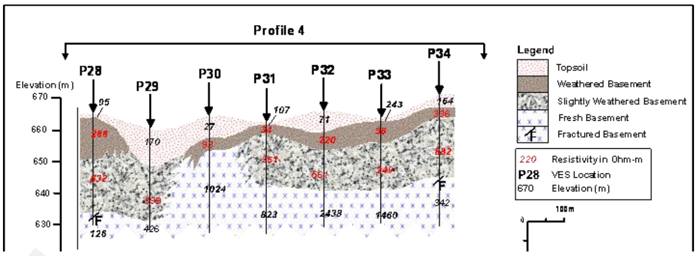


Fig. 9: Geo-electric section along profile 4

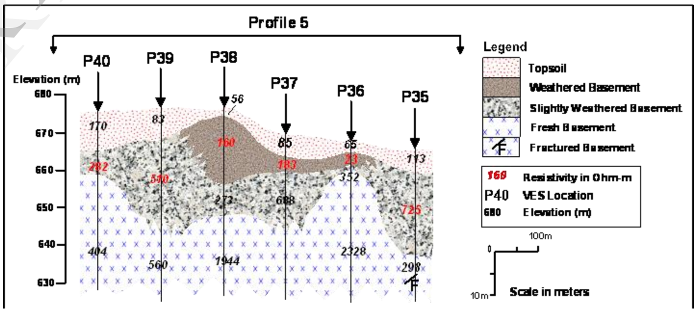


Fig. 10: Geo-electric section along profile 5.

Groundwater Resources Evaluation/Hydrogeological implications

It is pertinent to note that groundwater in basement is generally controlled by nature and thickness of the weathered overburden and concentration and pattern of fracture system (Aryo etal, 2003; Vanderberghe, 1982, Olurunfemi etal 2005a, Olorunfemi and Okhue 1992).

Deriving from the geology and geological structures from surface mapping and geophysical survey by vertical electrical soundings, the study established the following:-

(i) The general structural trend from dolerite/dykes, fractures etc is NW-SE.

(ii) Weathering thickness is very variable within the study area and characterized by very shallow average weathering thickness of 0-13metres. However, isolated overburden thicknesses of 17 to 27m were identified (Fig. 11).

From depth to basement map produced by contouring of the weathering depth on each of the VES locations, a groundwater potential map was evolved (Fig. 12).

Generally, the overburden is very shallow but thick overburden with significance groundwater potential is found in same isolated areas (Fig---).

The study area is highly rugged and characterised by seasonal streams only, the need to further explore the basement structures with regional perspective is advocated as the structures are locally regionally related and are significant in groundwater resources development.

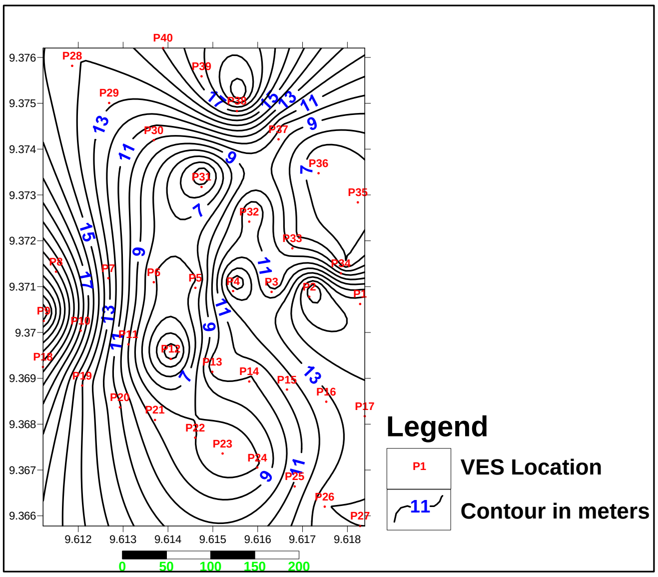


Fig. 11: Depth to Basement Map

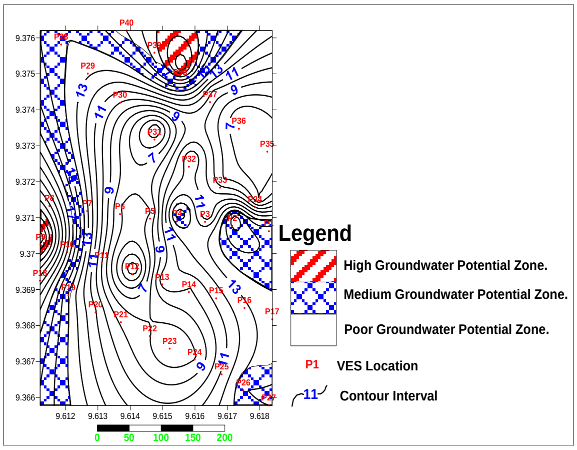
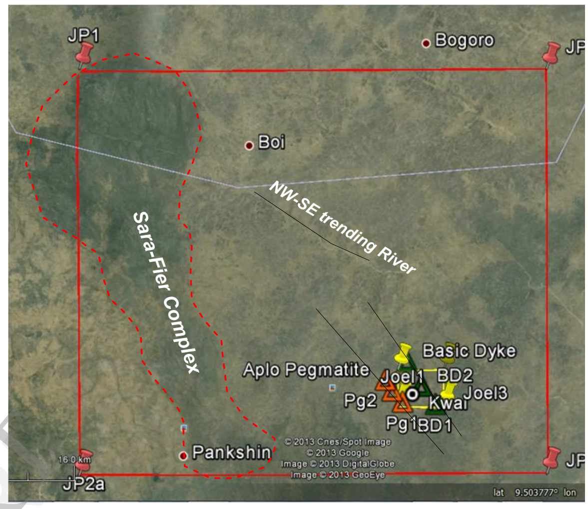


Fig.12: Groundwater Potential Map of the Study Area.

CONCLUSION

The NW-SE trending fractures /and dolerite/basic dykes, aplo-pegmatite granite and by geophysics are structurally controlled. The evidence of these structural control could be observed on the NW-SE flowing river on (Fig.9). A projection of the NW-SE general trend of the fractures/dolerite dykes/basic dykes with the Sara-Fier Complex within the study area conforms with the trend of the fractures that emplaced the felsite and basic rocks at the vicinity of the Sara-fier Complex and thus the hypothesis Fig. 9: A Satellite Map showing the relationship of NW-SE trending structures in the study area with the Sara-Fier complex. that it is most likely that the tectonic episode that led to the emplacement of the rocks of the Sara-fier Younger Granite Complex may be related to the one that emplaces the dykes. Geophysical survey to determine the geo-electrical sequence of the area revealed very shallow weathered overburden with isolated thick overburden in places. Local Geological structues were intercepted also on some of the VES locations and trends NW-SE direction exploring geological structures remains the best for groundwater development in the area. Thereefore, local and regional structural studies and groundwater implication in the area cannot be over emphasised.



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