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THE STRUCTURAL CONTROL OF BARITE MINERALIZATION IN GOMBE INLIER WITHIN GONGOLA BASIN UPPER BENUE TROUGH, NIGERIA

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ABSTRACT

Structural elements have important role in the Barite mineralization and exhumation of ore bearing host rocks. Field investigation has shown that the development of Barite veins have close Relationship with the fractures orientation and distributions in the study area. The accommodation of Barite veins and their trends were finally established and compared with the trending directions of the major deformational structures in the area. Field observation, micro and Macro structural analyses were also used to distinguish between the mechanisms of fracture development in the area. The fractures served as permeable zones for hydrothermal fluid circulation and play a critical role in Barite Mineralization in the area. The Gombe inlier where Barite mineralization occurred within Gongola Basin can be considered as a geological epitome of the basin as it clearly displays general stratigraphic and structural styles within a relatively small, easily accessible area. The structural plots has indicate the presence of two type of trend of veins (the NE-SW and the ENE-WSW trend) that are Structurally controlled conforming with the direction of the two major deformational Structures that affect the area (NE-SW trending Gombe fault and N-S trending Wuro-Ladde-Wuro Dole fault that truncate Liji hill at the Northeastern part forming ENE-WSW trend).

Key: Structure, Deformation, Mineralization and Control,

INTRODUCTION

Structural elements have important role in the Barite mineralization and exhumation of ore bearing host rocks. The Gombe inlier where Barite mineralization occurred within Gongola Basin can be considered as a geological epitome of the basin as it clearly displays general stratigraphic and structural styles within a relatively small, easily accessible area. The Basement Rocks and the lithostratigraphic sequence of the Gombe inlier have been affected by sinistral strike-slip faults; the Gombe and Wuro Ladde-Wurin Dole faults which lead to the formation of series of tectonic signatures like fractures, Joints, folds and faults. Most of the studies that looked in to tectonic structures in the area tend to be regional in nature often neglect the small scale structural details (Byemi et al.2015). The aim of this paper is to conduct a field investigation in order to determine the spatial distribution of the major Tectonic structures that affected the study area and also to determine the actual distribution of the Mineralized and non-Mineralized Veins with respect to these major deformational structures that affected the area.

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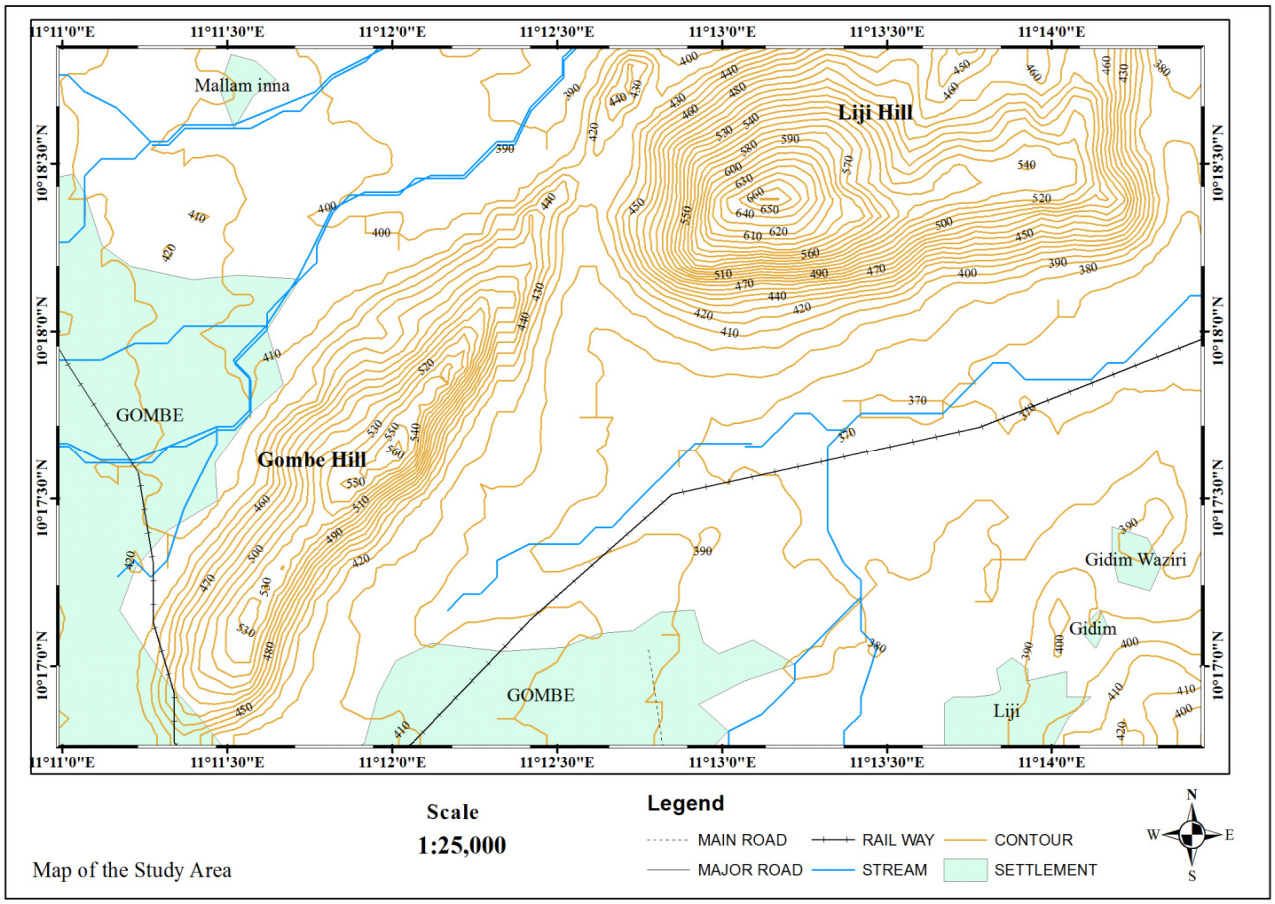

Figure 1: Topographic Map of the study Area

Drainage and Topography

The Relief of the Area is generally defined by the Gentle Steep Slopes of the prominent Inlier and the undulating Cretaceous Sedimentary successions surrounding it. The major River that drains the Area is the River magaria and its Tributaries. The tributaries are perennial and usually overflow their Banks at the peak of the Rains (Maryam, 2011).

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Field Description of Strike-Slip Faults of the Gombe Inlier

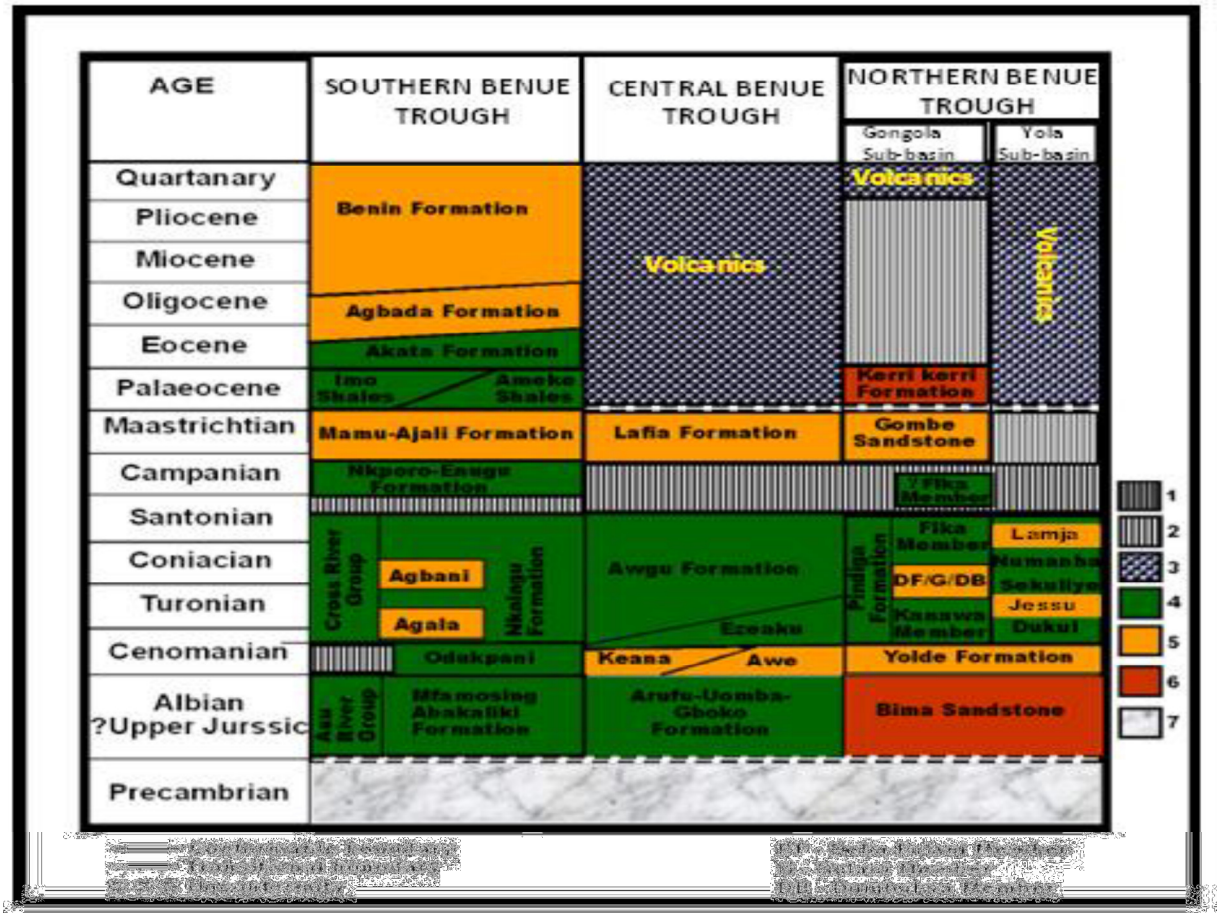

Fig. 2: The stratigraphy of the Benue Trough (modified from Obaje *et al.,* 1999).1-Hiatus, 2-Santonian and Cenomanian tectonism, 3-Basalt, 4-Marine sediments, 5-Transitional-marine sediments,6 Continental sediments ,7-Basement complex

The Gombe Fault

The Gombe fault is a NE – SW trending sinistral strikeslip fault (Benkhelil, 1989; Guiraud et al., 1989) that intersects the N – S trending Wuro Ladde – Wurin Dole fault in the northeast of the Gombe inlier (see Fig. 2). At this location, and along the fault the Yolde and Pindiga formations adjacent to the fault shows a dextral sense of movement in the field. Moving south along the fault, it splits into two sets of faults with lozenge-shaped geometries visible in plan-view. These lozenge-shaped faults are bounded by doubly plunging folds that are of limited extent; one to the south of Liji hill (approximately 1 km along-strike) and the other forming the Gombe hill (approximately 4 km along-strike). In these two anticlines basement rocks are exposed along their axes. At a quarry adjacent to Gombe hill and on the top of hil, the Bima sandstone can be seen directly in contact with the basement rocks. Here,

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the Bima sandstone is pebbly and very hard due to pervasive siliceous cements; which is also seen on the eastern limb of Liji hill anticline. This kind of cements often occur in rocks adjacent to major fault zones in the Gongola basin (Zaborski, 1998, 2003).

The Wuro Ladde – Wuro- Dole Fault

The Wuro Ladde – Wurin Dole fault is one of severalmajor N – S trending structure-building fractures in the Gongola basin (Zaborski et al., 1998), and can be traced for about 70 km. In the northwest of Fig.2 (location 9), a low discontinuous N – S oriented ridge was observed. This ridge can be traced for a few tens of meters along-strike of the fault and is comprised of silicified Gombe sandstone which marks the fault zone; and beds dip within the Gombe sandstone is up to 80° E at the fault zone (Fig. 2). Here, sinistral strike-slip movement can be discerned from slickensides and micro scarps that developed on some fracture surfaces. Guiraud et al. (1989) carried out microstructures analyses along the major strike-slip faults in the upper Benue trough (including the Gombe fault zone) and reported the presence of horizontal to low dipping slickensides on the walls of alternate cataclastic and brecciated bands associated with the deformation zones in basement rocks. Moreover, Guiraud (1990b, 1991) reported that these slickensides indicate successive normal, sinistral strike-slip and reverse reactivations of the faults. South along the fault trend, the Liji hill anticline, whose axis trends in a NEE – SWW direction is observed to have been truncated such that part of the hill is now bound to the west by the Gombe fault and to the east by the Wuro Ladde – Wurin Dole fault (Fig. 2). To the east across the Wuro Ladde – Wurin Dole fault, an anticline whose axis is marked by the exposed Pindiga Formation was observed and appears to be a continuation of the Liji hill anticline but with an axis trending in NE – SW direction. The juxtaposition of these two anticlines by the Wuro Ladde – Wurin Dole fault indicates a sinistral strike-slip movement (Fig.2).

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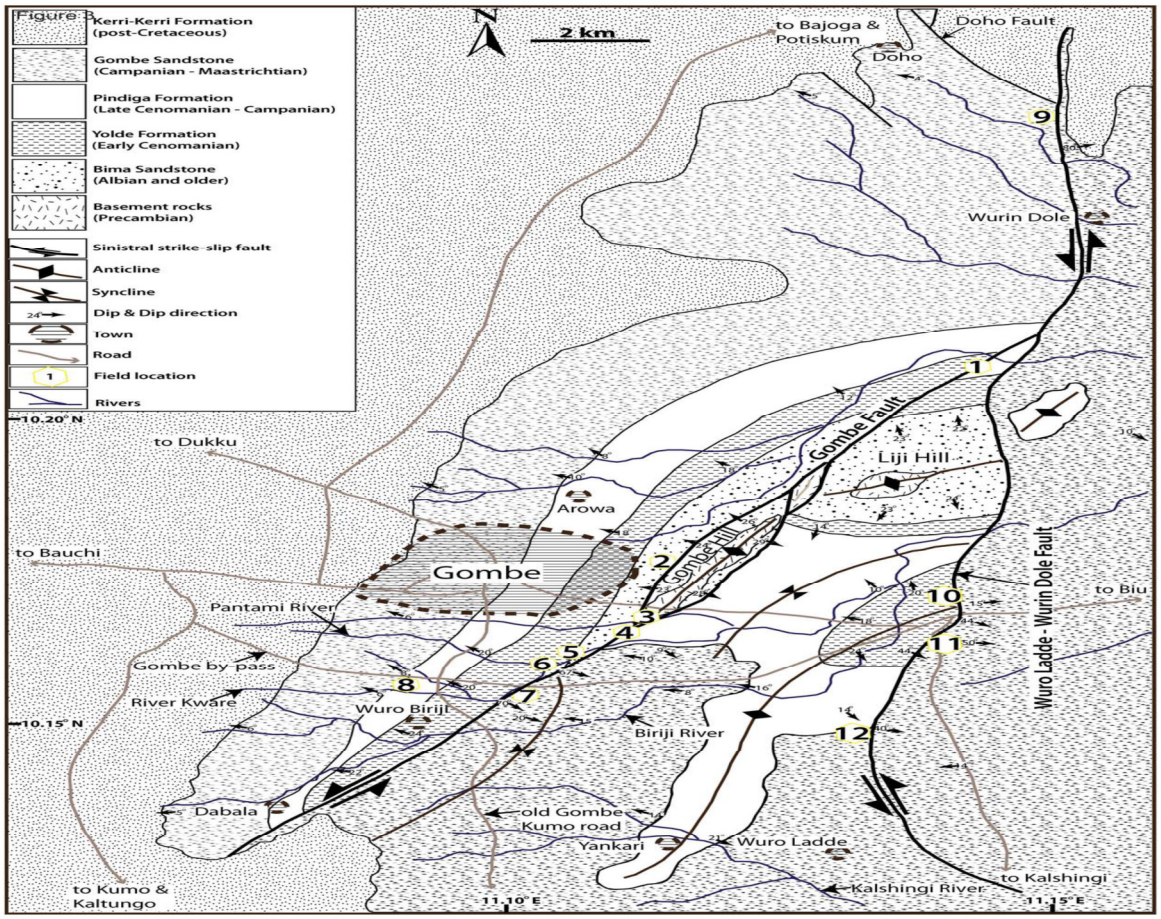

Fig. 3: Geologic map of Gombe Inlier showing the major faults that affected the Area, together with field exposures (modified from Byami et al 2015)

MATERIAL AND METHOD

The research work started with extensive field mapping mainly by traverses purely on foot across the study area using a topographic map of Gombe Northwest sheet 152, on a scale map of 1:50000. Rock exposures were carefully observed and described. Samples were taking across veins and analyzed macroscopically in the field as hand specimen. Measurements were taking and recorded with the aid of Global positioning system (GPS), compass clinometer, and measuring tape. The readings were used for structural plots (stereo net, Rose and Contours plots) and Coordinate plots combine with the Satellite images and elevation data in order to determine their spatial distribution of the major tectonic deformational structures and veins distribution.

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Plate 1: taking attitude readings of Barite veins along Gombe Hill

Plate 2: field observation and traverse taking along Liji Hill

RESULT AND DISCUSSION

The Geologic map of the Inlier and adjacent areas shows the spatial distribution, and attitude of the stratigraphic units described earlier. The basement rock is exposed along the crest of Gombe and Liji hills anticlines and exposed as core through a rail way cutting at Gombe Hill. The Basement complex Rocks were surrounded by the Cretaceous Sedimentary sequences which encompasses ; Bima formation, Yolde formation, Pindiga formation, followed by Gombe formation. The predominant Rock type is Gneiss of medium to coarse

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grained textured and mesocratic in color. The alternations of light and dark colored bands of minerals are very obvious. The Inlier vividly exposed the stratigraphy of the area. It was observed toward the peak of the Inlier a highly indurated and metamorphosed sandstone while going down the Inlier the sandstone change to medium coarse grained sandstone interbedded with thin layer of grey purple clay.

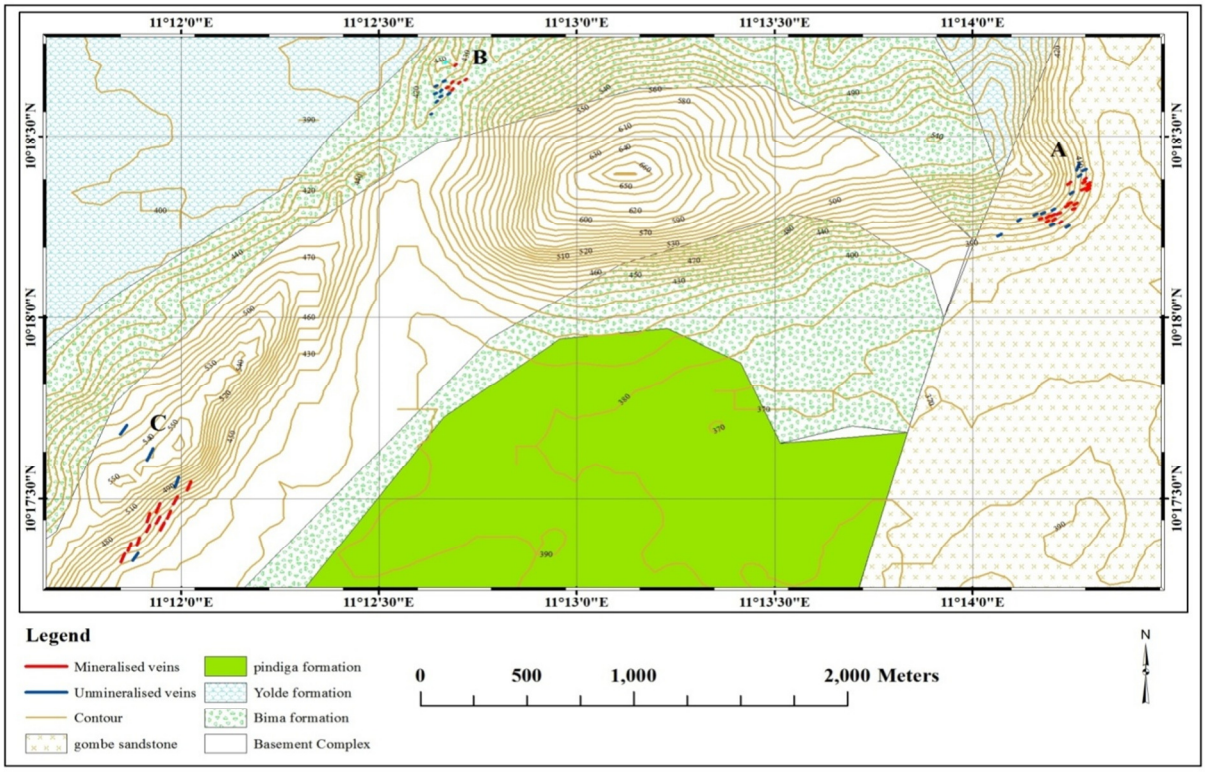

Fig. 4: Geologic map of the study area

Coordinate and Structural Plots

The result of coordinate and structural plots is presented in order show the major and minor trending directions of the structures hosting the Barite, and also to indicate the spatial distribution of veins with respect to the major Tectonic structures that affected the study area. Each of the location has been captured out to indicate the actual position of the Mineralized and non mineralized Veins.

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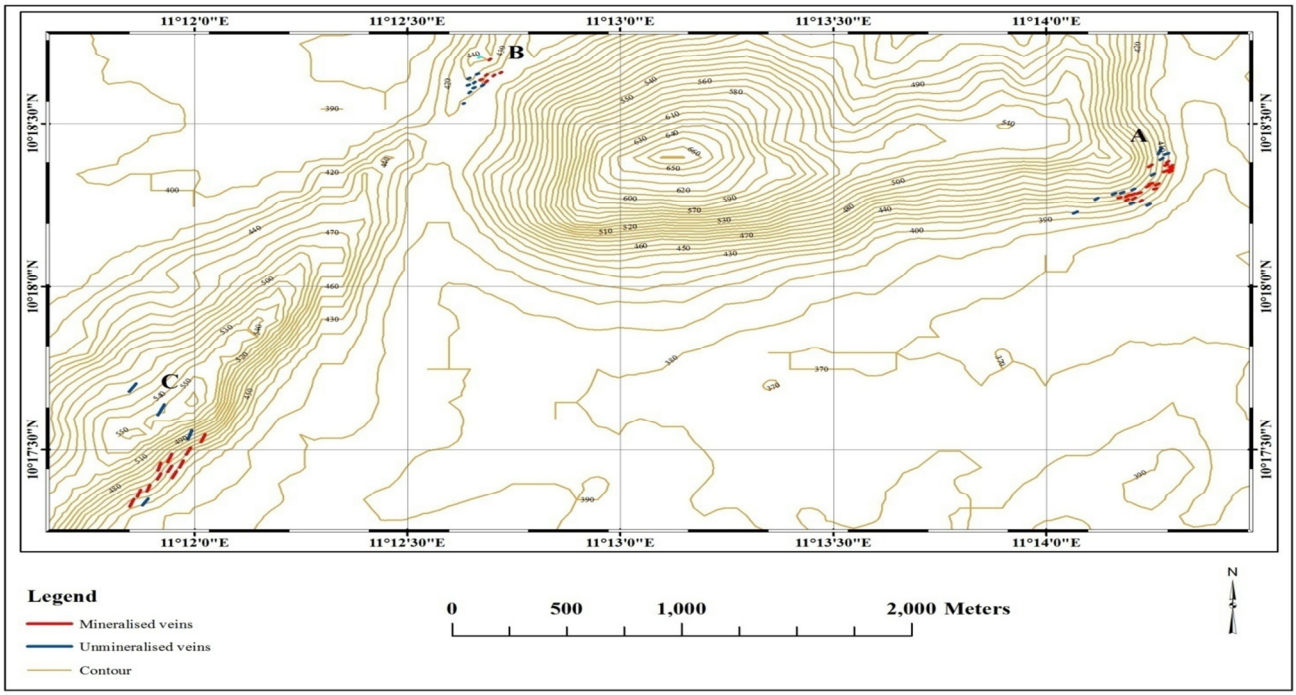

Figure 5: Map of coordinate plots showing the Mineralized and non mineralized Veins

Coordinate and structural plots for the captured location 'A'

The captured area is the north eastern part of the Liji Hill, the coordinate plot in figure 8 indicated the spatial distribution of the Mineralized and non Mineralized Veins in location 'A'. The area compare to the other locations, is the one that has large number of the Mineralized Veins. The mineralized Veins are the red linear structures while the non mineralized veins are the Blue linear structures. The Beta and Contours plots in figure 9 and 11 have indicated that the poles on the plot orienting them self from the center to different direction. Some are moving in N W N while others are moving in W N W directions. The Rose diagram in figure 10 has indicated the major trending direction of the structures in the location is East North East and West South West with some minor trends.

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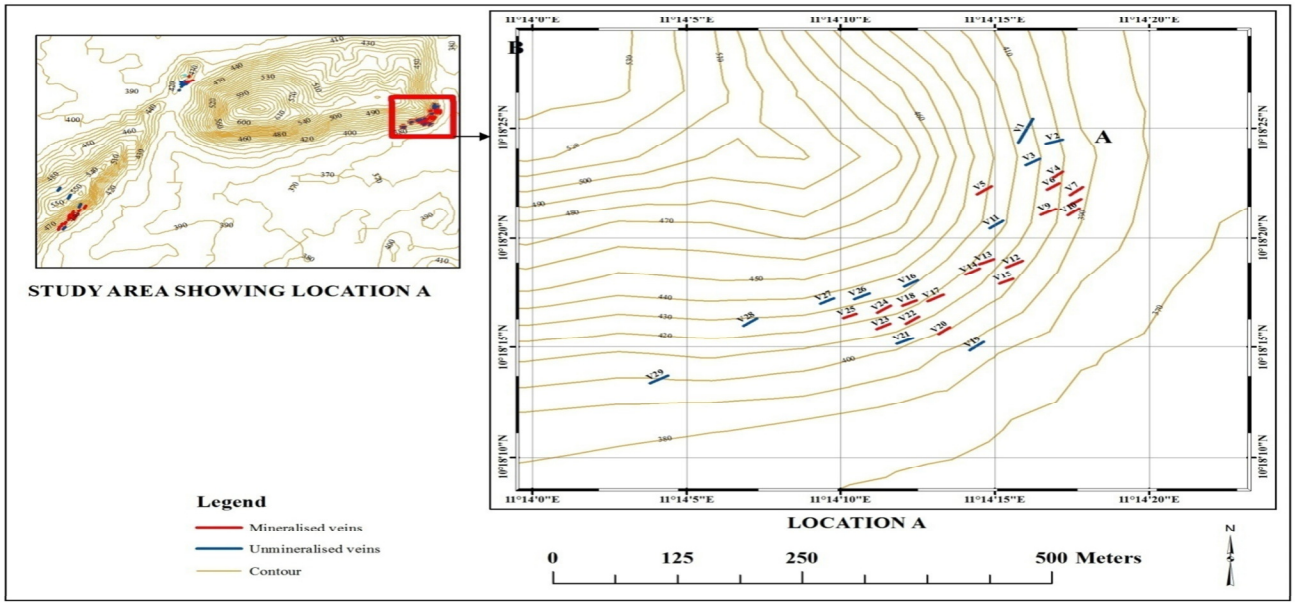
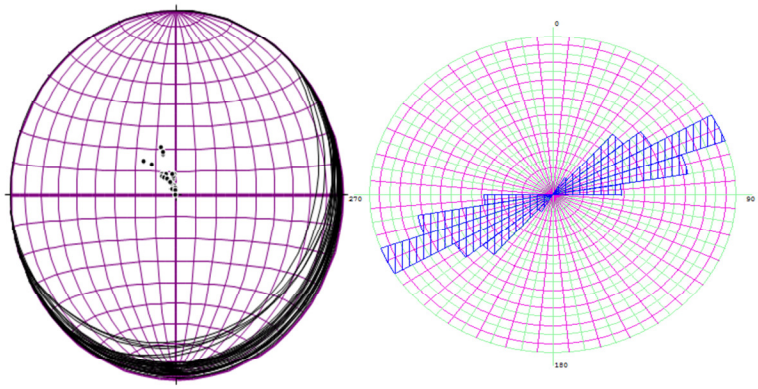


Figure 6: coordinate plot for the location 'A' showing the spatial distribution of the Veins



Dominant trend: E NE-WSW
Scale interval: 10 %
Mean direction: 70°-250°

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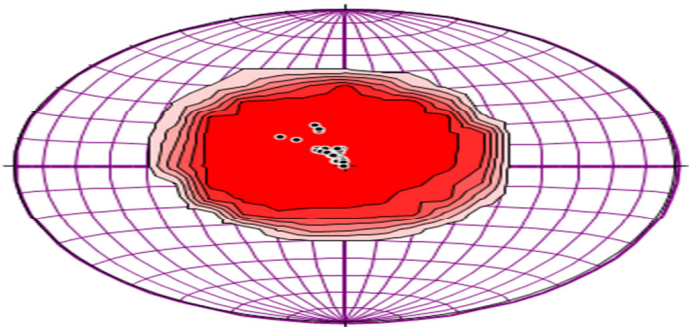

Figure 7: Rose diagram, Contours, Beta and S-pole plots for location 'A'

Coordinate and structural plots for the captured location 'B'

The captured area is the northern part of the Gombe Hill, the plot below indicated the spatial distribution of the Mineralized and non Mineralized Veins in the area. The Beta and Contours plots in figure 13 and 15 have indicated that the poles on the plot orienting them self from the center trending the same direction. The poles are moving toward Northern direction. The Rose diagram in figure 14 has indicated the major trending direction of the structures in the location is East North East and West South West with some minor trends.

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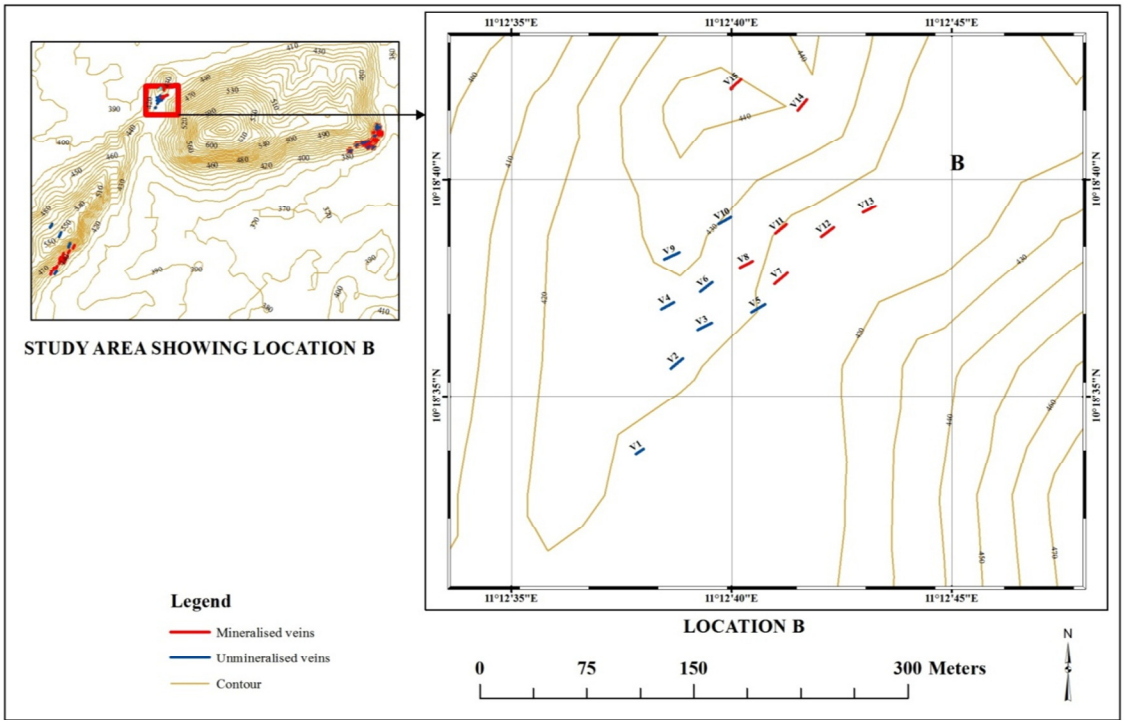
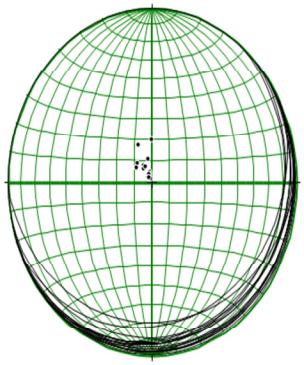
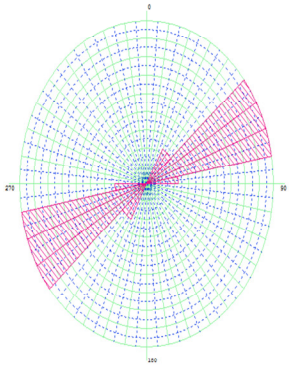


Fig. 8: Coordinate plots for the location 'B' showing the distribution of the Veins.





Dominant trend: ENE-WSW
Scale interval: 10 %
Mean direction: 80°-260°

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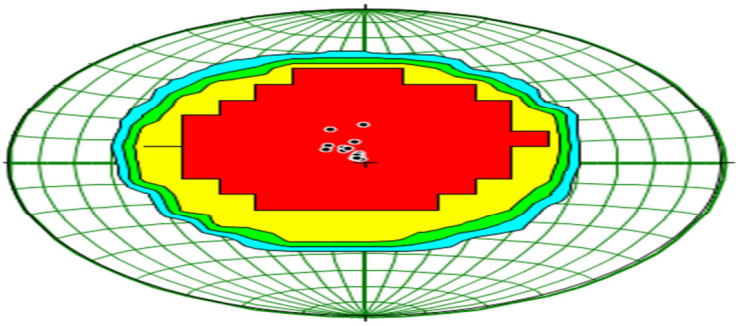

Fig.9: Rose diagram, Contours plot, and Beta and S-pole plots for location 'B'

The Coordinate and Structural Plots for Location 'C'

The captured area is the north Western part of the Gombe Hill, the coordinate plot below indicated the spatial distribution of the Mineralized and non Mineralized Veins in the area. The area compare to the other locations, is the second large in terms of the Mineralized Veins. The Beta and Contours plots in figure 17 and 19 have indicated that the poles on the plot orienting them self from the center trending in different directions. The poles are moving toward Northern direction. The Rose diagram in figure 18 has indicated the major trending direction is North East and South West with some minor trends.

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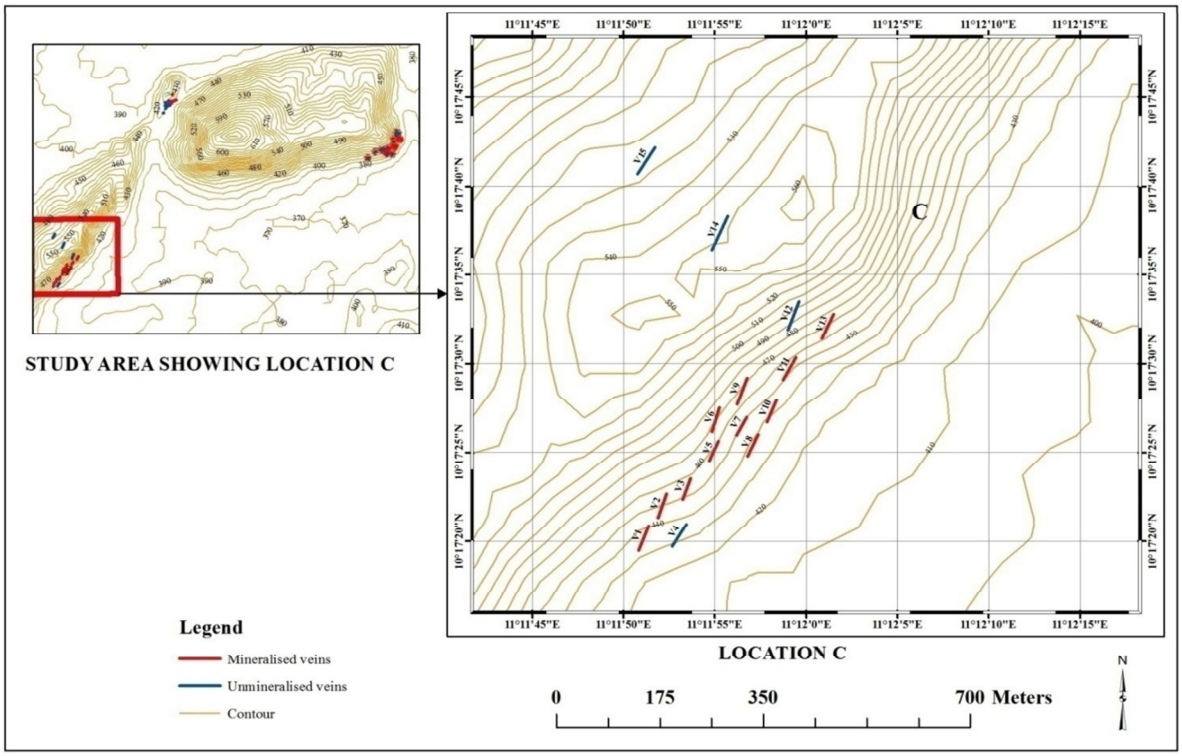
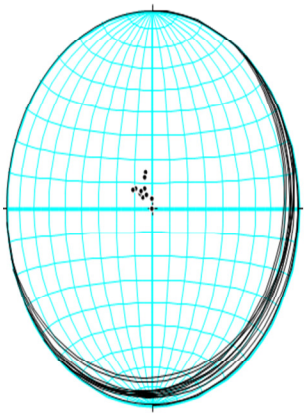
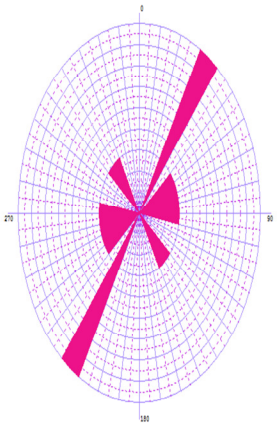


Figure 10: coordinate plot for the location 'C'





Dominant trend: NE-SW
Scale interval: 10%
Mean direction: 40°-220°

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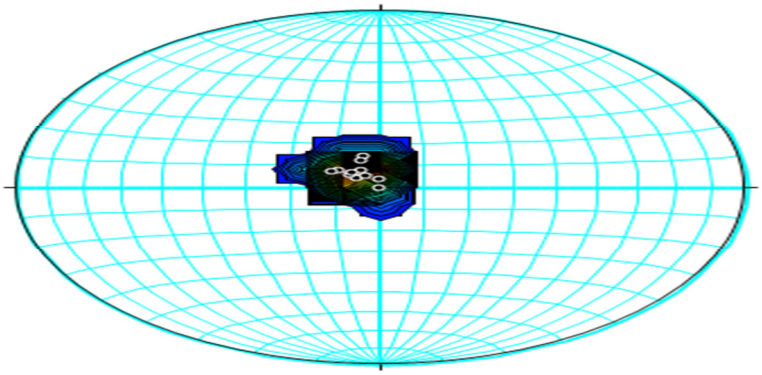

Fig.11: *Rose diagram, Contours, Beta and S-pole plots for location 'C'*

CONCLUSSION

Field investigation has shown that the development Barite veins have close Relationship with the fractures orientation and distributions in the study area. The accommodation of Barite veins and their trends were finally established and compared with the trending directions of the major deformational structures in the area. Field observation, micro and Macro structural analyses were also used to distinguish between the mechanisms of fracture development in the area. The fractures served as permeable zones for hydrothermal fluid circulation and play a critical role in Barite Mineralization in the area. The General trend of the faults planes are NE-SW with a SE dipping. The coordinate and structural plots indicated that the structural features that plays an important role in the localization of Barite mineralization in the study area are NE-SW trending Gombe fault and N-S trending Wuro Ladde-Wuro Dole fault that truncate Liji hill at the Northeastern part forming ENE-WSW trend. It was suggested that the subsequent Igneous and episodes of Tectonic activities that affected the area are responsible for path ways in which the mineralizing fluids are accumulated and consolidated within these structures .The extensive field studies of the structures hosting the mineralization have shown that some of the veins are mineralized while others are not

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