

# PETROGRAPHICAL STUDIES OF AMATE AREA, AFIKPO BASIN SOUTHERN BENUE TROUGH

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**Abstract** Petrographic analyses were carried out on rock samples obtained from Amate and environs, in Afikpo Area of South Benue Trough, Nigeria. The Area is located within latitudes  $5^{\circ} 50' N$  and  $6^{\circ} 00' N$  and longitudes  $7^{\circ} 55' E$  and  $7^{\circ} 57' 30'' E$  in the region of Benue Trough graben with sediment infilling which had suffered deformations (NE-SW trending axis) and extensive magmatic activities. Petrography analysis indicated the presence of prolific exsolved, globular, texture in the arkosic sandstone and siltstone, confirming their metamorphosed nature as quartzo-feldspathic hornfels. The texture is partially relict, which indicates retention of original pre-metamorphic sedimentary features which have not been obliterated by metamorphism, in addition to textures with progressive nucleation and formation of exsolved globules which coalesce or segregate within shifting boundaries, then form polygonal granoblastic clusters or mineral crystals and eventually interlocking crystals.

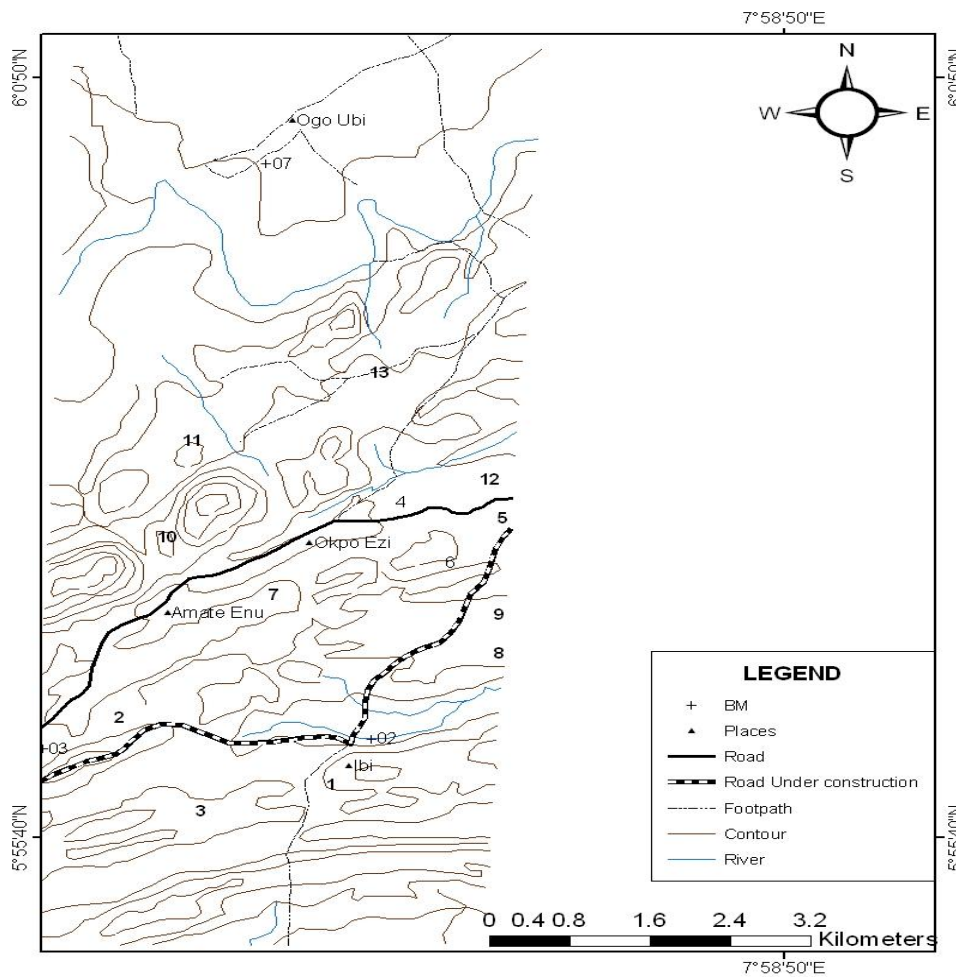
**Keywords:** Petrography, Benue Trough, Amate Area, Afikpo Basin, Metamorphism.

## I. INTRODUCTION

Metamorphic process have been considered largely in terms of mineralogical and chemical changes involving experimental synthesis, determination of the physical conditions under which minerals and mineral assemblages are stable to the extent that the significance of rock textures have been overlooked. Even when textures are considered comprehensive evaluation on of texture forming process are scarce. Both texture and mineral assemblage is essential to understanding metamorphic rocks and these information are available in literature. This study illustrates metamorphic textures and the fundamental process involved in textural development. The understanding of texture is based on the fact that metamorphism is regarded as a series of structural transformations rather than as chemical-reactions. Rocks (sediments and volcanics) which have been deeply buried but not appreciably deformed may undergo mineralogical changes at comparatively low temperatures. These changes belong to a group involving cementation, lithification diagenesis and incipient metamorphism. Burial metamorphism has been observed to produce mineral assemblages ascribed to the zeolite facies, greenschist facies and the glaucophane schist facies [1,3]. Many slates and slightly sheared greywackes mark transitions from the products of burial metamorphism to those of regional metamorphism. The retention of abundant original grains and textures and also of complex mineral assemblages suggests that equilibrium, both chemical and textural has not been achieved generally, although it may have been achieved in limited regions of matrix or cement. The textures are dominated by palimpsest (igneous and sedimentary) features which have been little studied.

## II. LOCATION AND ACCESSIBILITY:

The study area is located at Amate in Afikpo local government Area of Ebonyi State, Nigeria It lies between latitude  $5^{\circ} 50' N$  and  $6^{\circ} 00'$  and longitude  $7^{\circ} 55' E$  and  $7^{\circ} 57' 30'' E$ . It covers the entire town and comprises of villages namely Ibi, Ubi, Okpo-Ozi. See figure 1



**Figure 1** Location Map of The Study Area ( with names of towns where samples were collected)

**III. AIM AND OBJECTIVE:**

The aim and objective of this research work is to ascertain metamorphic texture and textural development of Amate and its Environs vis-a-vis field work which include, observation of field characteristics of rocks, collecting of samples, measuring the strike and dips of the out crop present, and also noting minerals as well as Petrographic analysis of the Samples..

*A. Literature Review*

Several authors have studied the geology of the Benue Trough and the sub basin within it, these authors have come to some conclusion that have been used in this field report. Adighe, Ajayi and Ajakaiye have described the Benue Trough as a narrow unique rift feature in the African continent. The Benue Trough is made up of the Anambra basin, Afikpo syncline and Abakaliki anticlinorium [1]. Investigation on the geology of Afikpo syncline was first carried out by Shell BP, a geologist in the early 1950's. some other known contributors to the geology of the Afikpo syncline include the work of Simpson, De Swardt and Casey, Reyment, Murat and Nwachukwu[2,3]. The Amasiri sandstone outcrops topographically as common ridges which extend from Afikpo through Ugep. The Abakaliki shale contains poorly sorted bedded sandy shales with sandstone and limestone lenses. It attains a thickness of about 30m. The sediments are folded in a NE-SW trend. It has been assigned to mid-Albian age based on ammonite evidence [ 5,6,7].

*B. Geology of the Lower Benue Trough:*

The Benue Trough of Nigeria is formed as a result of series of tectonism and repetitive sedimentation in the Cretaceous time when South America separated from Africa. The lower Benue Trough comprises of the Anambra Basin, Abakaliki anticlinorium and the Afikpo Basin (See figure 2). The lower Benue Trough is underlain by a thick sedimentary sequence deposited in the Cretaceous period the rocks belong to seven geologic formations they are Nsukka Formation Maastrichtian Ajali sandstone, Maastrichtian-Mamu Formation-Maastrichtian Nkporo Formation-Late Santonian, Agwu Formation-Cenomanian, Eze-Aku formation-Turonian, Asu- River Group-Albian, The Benue Trough is filled with sediments that range in age from middle Cretaceous to early Tertiary documenting alternating transgression and

regression . The Albian Asu river group comprises of bluish-black shale with minor sandstone units. The shale are typically fractured and weathered to needle shape bodies at the surface. Sand horizons are minor in extreme-south but tend to increase northward. Around Gboko and Aliade, the sandstone unit appears to be more pronounced. The shales also include important limestone intercalation in the Yandev quarry. Around Abakiliki, the shales are associated with pyroclastic rocks. However, the stratigraphic relationship between the pyroclastic and the Asu river group is subjected to several controversies.

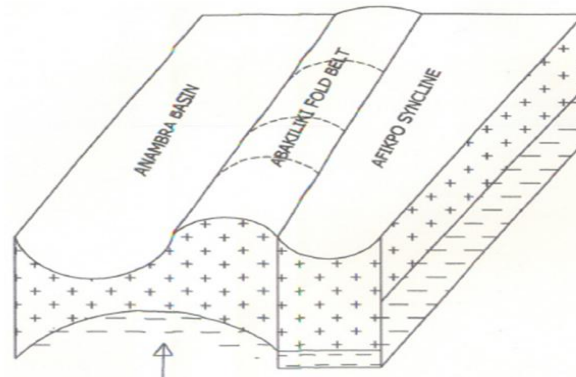


Fig. 2: Formation of Afikpo Syncline.

#### IV. MATERIAL AND METHODOLOGY

The method adopted during the investigation of rocks includes field techniques and laboratory analysis.

##### A. Field Techniques

This traverse mapping method was adopted due to limited accessibility in the area and scare exposure of outcrops. This method involves trekking along main roads, bush paths and pathways used by the local populace. With the use of this method of mapping, an appreciable area was covered and mapped. Before the commencement of each day's work a traverse route is chosen, work is carried out along a chosen route. When any feature of importance is encountered, such information is recorded in the field notebook. The exact location of outcrops, the dip and strike values and outcrops with their respective directions new roads river channels were also recorded. The information on the field map is usually transferred to the base map at the end of each day. Also, possible outcrops are delineated as the mapping exercise progresses.

##### B. Laboratory Analysis

This method involves the examination of rocks and minerals in the microscope using the samples collected from the study area. A chip of the rock is made and smoothed by the use of carborundum powder when the flat cut chip of rock is finally smoothed, a glass slip of about 3 inches is taken and a small amount of Canada balsam is placed at the center and heated gently until sufficient turpentine or tyel has been driven off, to cause the balsam to become hard and compact when cool. When the balsam has been sufficiently heated, the chip of rock is then placed on the slip with a flattened surface in contact with the balsam and glass. By pressing the chip, air bubbles are removed from the film of balsam between the chip and glass. When cool the chip will firmly cemented to the glass slip. The next process is grinding the thick chip from coarse to fine powder. After grinding, the section is carefully washed. Some fresh balsam is then rubbed on the slide properly, and a very thin sheet of glass is carefully placed over the rock and then pressed down so that no air bubble is then present. The whole specimen is heated until it dries. Any balsam round the cover slip is removed by menthylated spirit or acetone. The specimen is washed with water and left to dry, and a thin slide is produced. Then a photomicrograph of the slide is taken for studies. Then the slide is mounted on a petrographic microscope for studies See plate A-C.

#### V. RESULT AND INTERPRETATION

The mineral Assemblage of sandstone unit of Amete and its environs consist predominantly of quartz and feldspar and mica. This indicates the occurrence of intrusive and extensive igneous rocks in late cretaceous strata in the Benue trough has been reported by Ferrington . Wright attributed it to volcanism and basin intrusions to the initial rifting during the initiation of the basin as well as during the two deformational episode. Ferrington and Nwachukwu believed that intrusive rocks are mostly abundant in Albian and Turonian sediments and less common in post turonian sediments. The poor to moderate sorting and angular to subrounded nature of the minerals supports high energy environment and short history of transportation. It also indicates that some of the sedimentary rocks of the area has been affected by contact metamorphism.

TABLE I : LITHOSTRATIGRAPHY

Location No	Location Name	Lithology	Lithologic Description
1	Ibi	Sandstone carbonaceous, dish structure outlined with carbonaceous streaks	Arenite (ferruginized hornfels tightly polygonal granoblastic texture Interlocking, poorly sorted, mosaic of feldspar,biotite and quartz Grains, no authigenic cement, but a concentration of opaque,glassy material along some grain boundaries,grains elongated parallel to bedding plane. metamorphic texture, cuspic –texture,with clouded grains of feldspar and surface of prolific rods,threads and of exsolved texture
2	Ibi	Sandstone highly carbonaceous with dish structure	Hornfel,patchy,clotted,granoblastic, polycrystalline aggregates of quartz feldspar and biotite in addition to ore mica,hornblende with dispersed oolitic globular inclusion of exsolution textur, medium grained larger than Location 1 sample showing some exsolved phases separated and forming intergranular phase, and some cusate inclusions. Crystals elongate,lenticular with preferred alignment boundaries wavy and interlocking
3a	Ibi	Calcite in sandstone quarry	mortar texture and deformational twinning in calcite of marble, fine grains, granoblastic, separate biotite/muscovite lineation and adjacent coarse calcite interlocking grains. Calcite showing euhedral crystals
3b	Ibi	Shale body with distinct contact	Slate/shale-quartz/clay grains, lenticular, even grained, finely divided. Greywacke (bioclastic limestone) unsorted poorly sorted consisting of shell fragments, quartz, feldspar. prolific shells (macroshells) coarse coquina composed of subangular molluscan shell fragments and detrital quartz grains, partially cemented by fine grained calcite. Shells consist of original fibrous calcite and aragonite.
3c	Ibi	Calclitic sandstone	hornfel-buchite. With Web texture, grains of quartz, perthite exsolution texture.Poorly sorted coarse angular,sub angular and subrounded grains of quartz feldspar and brachiopod shell fragment.
4a	Okpo-Ezi	Sandstone, mottled with carbonaceous streak.	Pelitic hornfels,Buchite with web texture and patchy,clotted crystals and partial granoblastic, polygonal and cusate texture of quartz and biotite with prolific oolitic, black and nodular inclusion of exsolution aggregate dispersed on surface and along grain boundaries, Grains angular and elongate matrix of clay crystallization crysatalizing into finer crystals which surround large minerals or phenocryst. Crystallized quartz feldspar melt
4b	Okpo-Ezi	Sandstone, mottled carbonaceous streak.	Hornfels-pelletic-argillaceous microcrystalline,partly granoblastic minerals in aligned preferred orientation. Finely crystalline clay aggregate with quartz and dispersed black, oolitic nodular exsolved inclusions. Retention of sediments abundant of original grains and complex mineral assemblage of Quartzo-feldspathic hornfels.
5	Dolerite	Calcareous/calclitic Sandstone or Dolerite pebble/shell entrapped in sandstone probably affected by magmatic fluid	Hornfel-Argillaceous-buchite web texture with grains of quartz, biotite, oolitic, black, nodular, inclusions,exsolution grains in glass matrix,feldspar clouded with prolific black nodules,rods,of exsolved textures.Grains elongate,lenticular,angular,sub-angular aligned in preferred orientation.
6	Amate- Enu	Sandstone, fine, reddish brown with thin carbonaceous layer.	Buchite with web texture and cryptocrystalline mass,elongate interlocking crystals of quartz,biotite,feldspar crystallizing into quartzo-feldspartic graphic intergrowth with exsolution inclusions.Texture with patchy clotted,cloudy feldspar boudry wavy-.

PLATE ONE



Fig.1

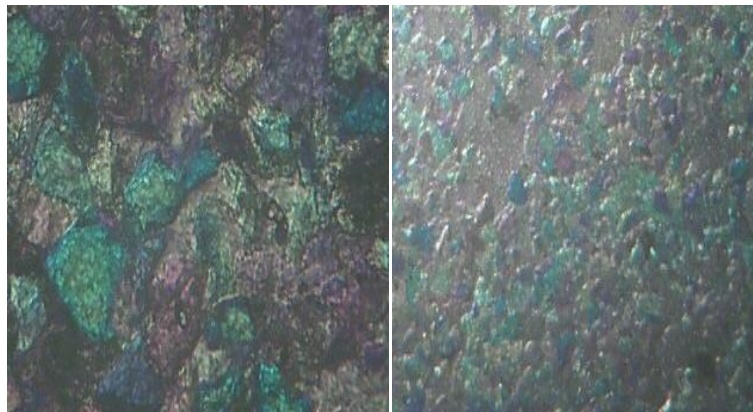


Fig 2

Fig 3

1. Hand specimen of pelitic hornfels from Ibi area of Afikpo 2. Thin section of pelitic hornfels grains 3. Thin section of pelitic hornfels showing shape of smaller grains

PLATE TWO



Fig 1

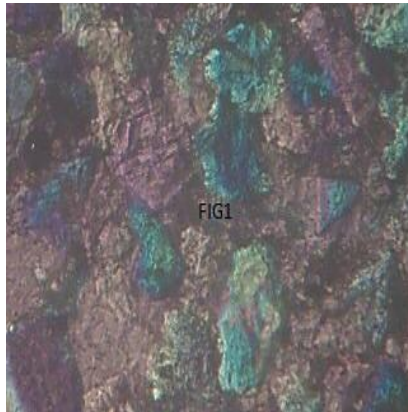


Fig 2

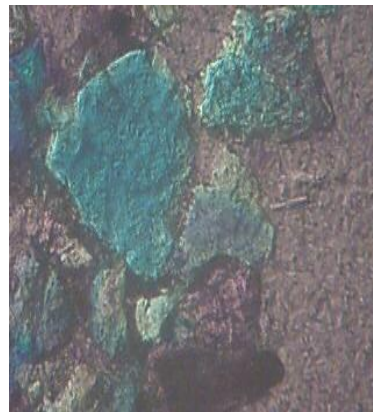


Fig 3

1. Hand specimen of quartzofeldspatic hornfel from Ibi area indurated. 2. Thin section of quartzofeldspatic hornfel showing matrix. 3. Thin section of quartzofeldspatic hornfel small and large grains.

**PLATE THREE**



Fig 1



Fig 2



Fig 3

1. Hand specimen of white calcite sample from Ibi area of Afikpo  
 2. Thin section of sample under plain polarized light  
 3. Thin section of calcite showing grains

## VI. DISCUSSION AND CONCLUSION

These sediments are part of the cretaceous successions in the lower and middle Benue Trough. They consist of over 5000 meters thick of sediments ranging from Aptian/Albian to Maastrichtian. The sediments constitute three unconformity bracketed sedimentary cycles ranging from Albian-Cenomanian, Turonian-Coniacian and Campanian-Maastrichtian. The oldest Albian-Cenomanian belonging to the Asu River Group, consists of arkosic sandstones, volcanic clastics, marine shales, siltstones and limestone, overlying the Precambrian to lower paleozoic crystalline basement rocks. The extensive weathering of the basement rock which were invaded by alkaline basaltic intrusives prior to the initial rapid marine flooding of the Albian times. This first Albian-Cenomanian successions are overlain by the Turonian-Santonian, Eze-Aku and Agwu formations consisting of predominantly marl shales, calcareous siltstones, limestones and marls. The pre-stentorian sediments have been tectonically deformed and intruded by magma resulting in folded, faulted and uplifted structures during the Santonian. This gave rise to the Abakaliki Anticlinorium. The sediments analyzed are part of the pre-stentorian and consist of dominantly arkosic sandstone and siltstone, arenites, shale, and limestone belonging to the Turonian-Stentorian, Amasiri Sandstone, Eze-Aku and Awgu shale. The rocks were obtained from various locations such as Ibi quarry, Okpo-Ezi and Amate-Enu. Other metamorphic textures observed include, pelitic hornfels with calcite, arenite hornfels with thin cement and elongate grains of cloudy fritted feldspar in preferred orientation, segregation/crystallization of patchy clots, exsolved perthite, poikiloblasts, reaction rims, outgrowth, recementation of clay matrix and porphyroclasts. These textures indicate state of inequilibrium.

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