# Geological Structures and Petroleum Occurrences in Minhla Area, Magway Region

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**Abstract**

The main scope of this research is to establish a modified structural map and to correlate it with petroleum occurrences of Minhla area. To complete the need, geomorphologic studies and marking structural features such as folding, faulting and jointings were carefully done. Furthermore, a detail field study was carried out to locate the actual places where petroleum is accumulated and a few interviews with both local and government petroleum explorers. As a result, the modified structural geology map has completed and it could also be interpreted that the occurrences of petroleum is significantly related to the major structural features of the research area. The research area can said to be influenced by a counter-clockwise rotational compressive stress of NW-SE direction to nearly ENE-WSW direction. Secondly, a detail lithologic study was done to investigate the stratigraphy of the area. The research area mainly consists of Tertiary sedimemtary rocks where of Oligocene-Miocene units of Pegu Group and Pliocene Irrawaddy Formation. A modified geological map was also updated.

**Kyewords:** petroleum occurrences, structural features, stratigraphy, Tertiary sedimemtary

## Introduction

### Location and Size

Tagaing-Nyaung Waing area is located in the Minhla Township, Magway Division, at about 4 miles southwest of Minhla Township. The study area lies within one inch topographic map sheet No. 85 M/1 and 85 I/13. This area is located between North Latitude (19° 45' 00") to (19˚ 55' 00") and East Longitude (94° 55' 00") to (95˚ 05' 30").

The length at the area is (17) kilometers and the width is (16) kilometers and the total area coverage is about (272) square kilometers. The area is easily accessible by car throughout the year. The location map of the study area is show in figure (1).

### Drainage and Topography

One third of the whole area is occupied by hilly regions, including Laung Tahle Taung (189m), Pa Di Taung (321m), Sin Ma Taung (350m) and Ta Man San Taung (359m). These ranges are trending NNW-SSE along the area. Parts of the area alongside of the hilly regions, near Daung Bok Village, Gyin Ye Myaung Village and Sit Sano Village are lowland terrain and slump regions. They are formed by either erosion or the detachment of the hilly regions. The study area mainly consists of Dendritic Drainage pattern.

Local parallel draingae patterns and rectangular pattern are also found. Padichaung, flowing west to east in direction, is the main drive of the study area, occupying two-third of the area by its tributaries and channels. The medium to fine dendritic pattern well developed in western part of the area that can be interpreted as shaly sedimentary units of area. The coarse dendritic unit can be interpreted as sandy units of the area. The drainage map is shown in figure (2).

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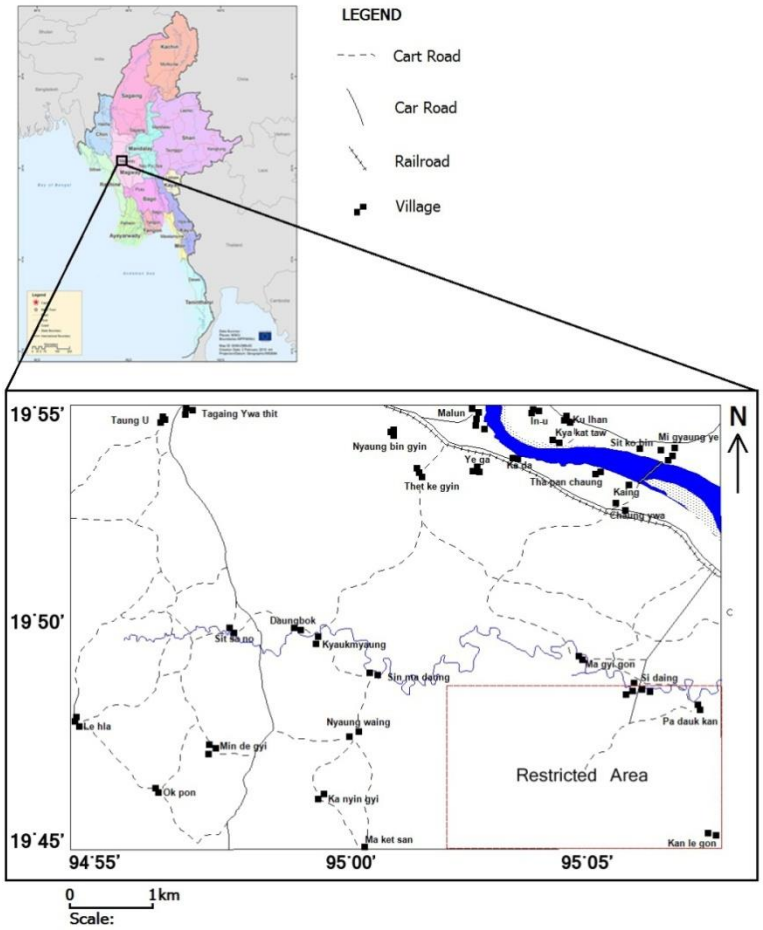


Figure (1) Location map of the study area.

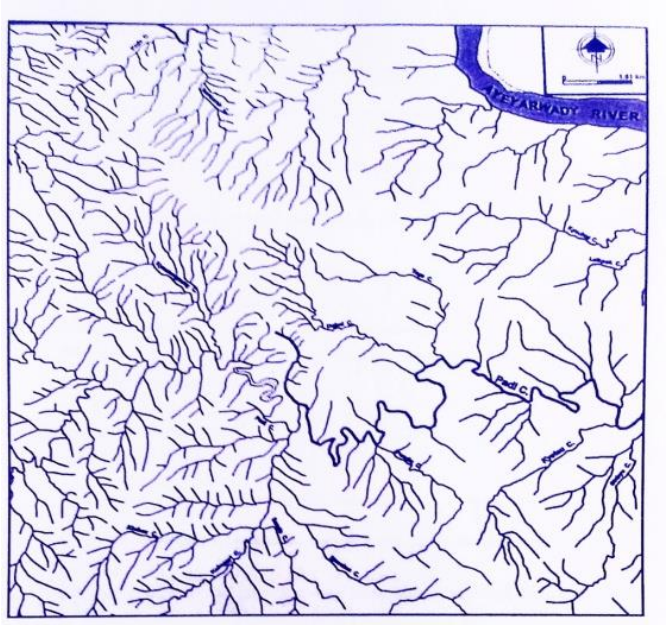


Figure (2) Drainge map of the study area.

**Previous works**

E, Procter (1917) described the Geology of Tagaing Area and southern part of Mindegyi Area.

J.D. Jardine (1930) worked on the Geology of Tagaing-Minbu and described the structural and stratigraphical relationships between the Tagaing and Peppi structures.

In 1964, Sir E.H Pascoe divided the Pegu Series of Lower Myanmar, Pyay and Kanma area and further modified the stratigraphy of Pegu and Irrawaddy formations and mentioned the discovery of unconformity between two systems.

## Regional Geologic Setting

The research area is located in the Central Myanmar Basin and mainly composed by Tertiary Sedimentary rocks. It is located in Pyay Sub-basin divided by MOGE after 20°N Uplift (Jardine, J.D, 1930).Western part from the area is Rakhine Costal region where Triassic to Eocene formations is found. Northern part from the study area is regionally sedimentary rocks of tertiary age, containing of Salin Sub-basin and Chindwin Basin. Eastern part from the study area is Central Volcanic Line where massive granite and other igneous rocks are found. These eastern Central Volcanic Line and western uplift of Rakhine Yoma provide a large central basin where petroleum can accumulate. Series of NW-SE trending thrust faults are located in and around the area. And nearly E-W trending normal faults are found (Everett, J. R, et. all., 1990). Sagaing Dextral Strike-slip fault is passed through from the east of the area. Salin syncline is located at the north of the stydy area and, Gwegyo Thrust and Gabaw Thrust Faults Zone are main structural factor of the study area. Central Myanmar Basin contains many thrust sheets, oblique strike-slip faults and series of normal fault systems (Stoneley, R., 1974). There are four main parts of the structural trends in the Central Myanmar Basin known as Western Outcrops, Basin Center thrust sheet, southeastern uplift and the 20° uplift (Fig.3).

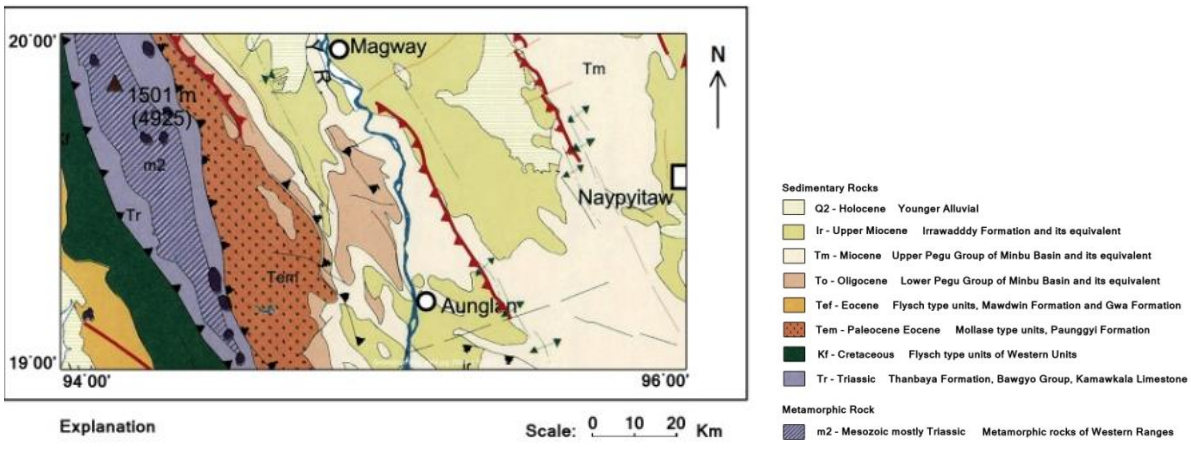


Figure (3) Regional geological map of the research area (Myanmar Geosciences Society, 2014).

## Geology of the study area

The investigated area is a portion of the Northwestern part of the Salin Sub-basin of Central Myanmar. The area is composed of clastic sedimentary rocks of Terstiary aged Pegu Group and Quaternary units. The Lower Oligocene Formations overlies the Upper Eocene Formations with a distinct unconformity (Day Wa Aung, 1993) (Table.1).

Table (1) Stratigraphic units of the study area.

| **Age** | **Formation** |
|---|---|
| Quaternary | Alluvial |
| | ^^^^^^^^^^^^^^ |
| Pliocene | Irrawaddy |
| | ^^^^^^^^^^^^^^ |
| Late Miocene | Obogon Formation |
| Middle Miocene | Kyaukkok Formation |
| Early Miocene | Pyawbwe Formation |
| | ^^^^^^^^^^^^^^ |
| Late Oligocene | Okhmintaung Formation |
| Middle Oligocene | Padaung Formation |

## Structural geology

### General Statements

The research area can be divided into eastern part and western part. In this area, Chaungtha thrust fault, extending about 8.5 km, divides eastern part and western part. Eastern part of the study area is the hanging wall and the western part of the area is the footwall of Chaungtha thrust fault (Pivnik, D.A, *et.al.*, 1998).

Padaung Formation and Okhmintaung Formation of Lower Pegu group, and Pyawbwe Formation and Obogon Formation of Upper Pegu group are exposed at the hanging wall of Chaungtha thrust. There are no evidences of the exposures of Kyaukkok Formation at the eastern part of the area that is the hanging wall of Chaungtha thrust fault. Okhmintaung Formation of the Lower Pegu group, Pyawbwe Formation and Kyaukkok Formation of the Upper Pegu group and Irrawaddy Formation are exposed at the footwall of the Chaungtha thrust fault (Fig.4). There are no evidences of the occurrences of Obogon Formation at the footwall of the thrust (Htun Naing Zaw, 2010).

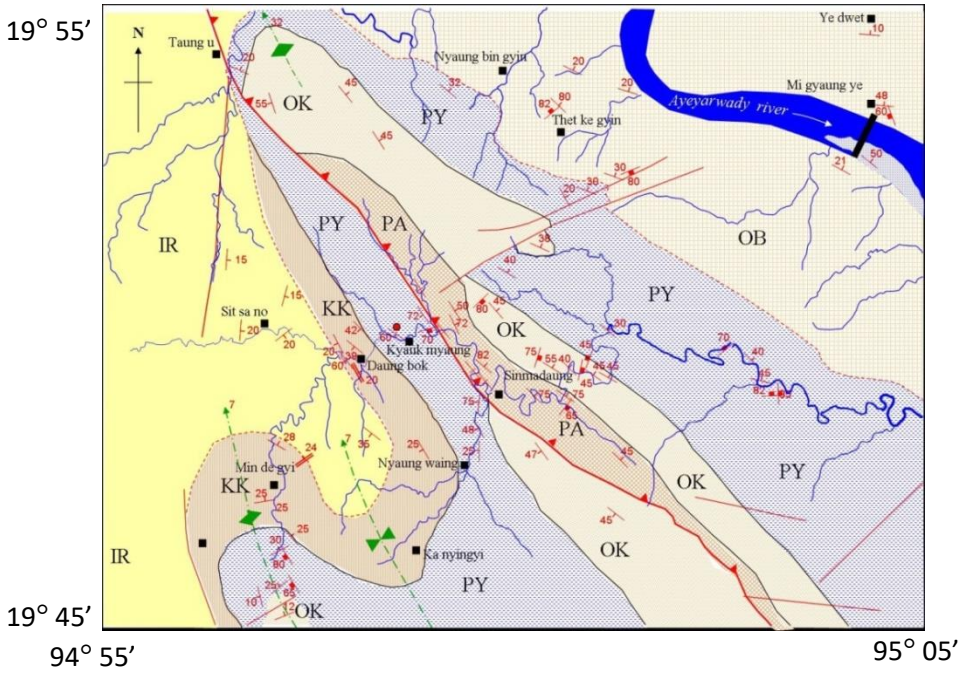


Figure (4) Geological map of the study area.

## Beddings

Firstly, in the eastern most part (or the hanging wall side) of the study area, sand and shale alternations of the Obogon Formation are found and they are dipping towards East and Northeast with gentle angle. The average dip amount is about 20° to 30°. The bedding of the rock layers of Pyawbwe Formation and Okhmintaung Formation are in Northeast direction with 40° to 50°. The beddings of Padaung Formation along the Padichaung are of vertically dipped.

Pyawbwe Formation exposing at the footwall of the Chaungtha thrust fault is dipping towards Southwest with the amount of 45° to 75°. And the Kyaukkok Formation exposed near the Daungbok village and along the Padichaung is dipping towards Southwest with the amount of 20° to 40°. Irrawaddy Formation is found at the western most part of the study area. The beddings are in turn, dipping towards east with the amount of 20° to 30°.

Stereo Plot Analysis (Lower Hemisphere, Schmidt Net) of the average beddings of the rock units exposed at the eastern part and western part of the study area is shown in figure (5). The average bedding of the rock units of the eastern part of the study area is 28°/020° and

the average bedding of the western part is 30°/033°. The average beddings of these units show that there are not much different dipping between the hanging wall and footwall of Chaungtha thrust.

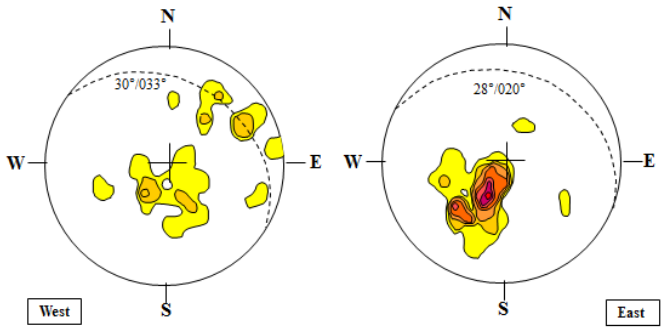


Figure (5) Stereo Plot Analysis (Lower Hemisphere, Schmidt Net) of the average beddings of the rock units exposed at the eastern part and western part of the study area.

## Folds

There are three major folds in the study area. The fold axes of these major folds are in NNW-SSE direction. These folds are Dahatpin Fold, Kanyingi Fold and Tagaing Fold. Analysis of folding including average dip amounts, plunge directions and plunge amounts are shown in table (2). Stereographic analysis of β-fold axis of each fold is shown in figure (6).

Table (2) Analysis of foldings in the area.

| Name | E.limb (Average) | W.limb (Average) | Plunge Direction | Plunge Amount | Type of fold |
|---|---|---|---|---|---|
| Dahatpin Fold | 21°/049° | 43°/265° | 344° (NNW) | 7° | Anticline |
| Kanyingi Fold | 50°/260° | 21°/049° | 343° (NNW) | 7° | Syncline |
| Tagaing Fold | 52°/047° | 60°/066° | 346° (NNW) | 32 | Overturned Fold |

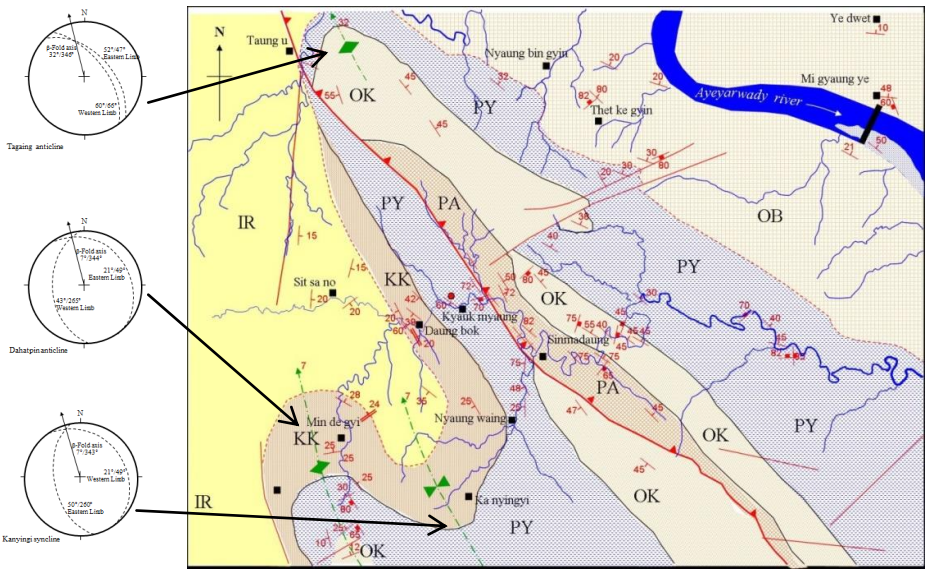


Figure (6) Stereographic analysis of β-fold axes of folds in the study area.

## Faults

Rocks in this area are not only folded but also faulted. Where there are four major faultings in this area namely Chaungtha thrust fault, Thet-ke-gyin fault, Dahat-Chaung fault and Mindegyi fault, the most prominent fault in this area is Chaungtha thrust fault (Fig. 7 & 8).

Table (3) Analysis of faults in the area.

| Name | Fault trace location | Slip plane | Pitch angle | Stress positions | Shear sense |
|---|---|---|---|---|---|
| Chaungtha thrust fault | 0.2km N of Kyaukmyaungvillage, inKyaukmyaungChaung | 12°/70° | 80°W | σ1-06°/037°<br>σ2-02°/306°<br>σ3-84°/169° | Thrust |
| | N 19° 51' 34.7" E 94° 59' 27.4" | 64°/278° | 5°N | σ1-21°/032°<br>σ2-62°/256°<br>σ3-16°/130° | Dextral Strike Slip |
| | N 19° 50' 26.6" E 94° 57' 43.3" | 64°/278° | 10°N | σ1-21°/340°<br>σ2-62°/195°<br>σ3-18°/064° | Dextral Strike Slip |
| Thet-ke-gyin fault | N 19° 53' 20.0" E 95° 04' 26.2" | 82°/282° | 10°W | σ1-11°/282°<br>σ2-79°/099°<br>σ3-02°/202° | Dextral Strike Slip |
| | N 19° 53' 20.0" E 95° 04' 26.2" | 83°/280° | 5°W | σ1-22°/152°<br>σ2-60°/019°<br>σ3-18°/250° | Dextral Strike Slip |
| | N 19° 53' 20.0" E 95° 04' 26.2" | 25°/210° | 85° S | σ1-56°/216°<br>σ2-02°/124°<br>σ3-34°/032° | Normal |
| Dahat-Chaung fault | N 19° 50' 08.4" E 95° 01' 37.3" | 62°/040° | 10°S | σ1-22°/152°<br>σ2-60°/019°<br>σ3-18°/250° | Dextral |
| Mindegyi fault | 0.8 km NW of Sit-sa-no village | 72°/110° | 5°NE | σ1-12°/228°<br>σ2-72°/096°<br>σ3-10°/321° | Dextral |

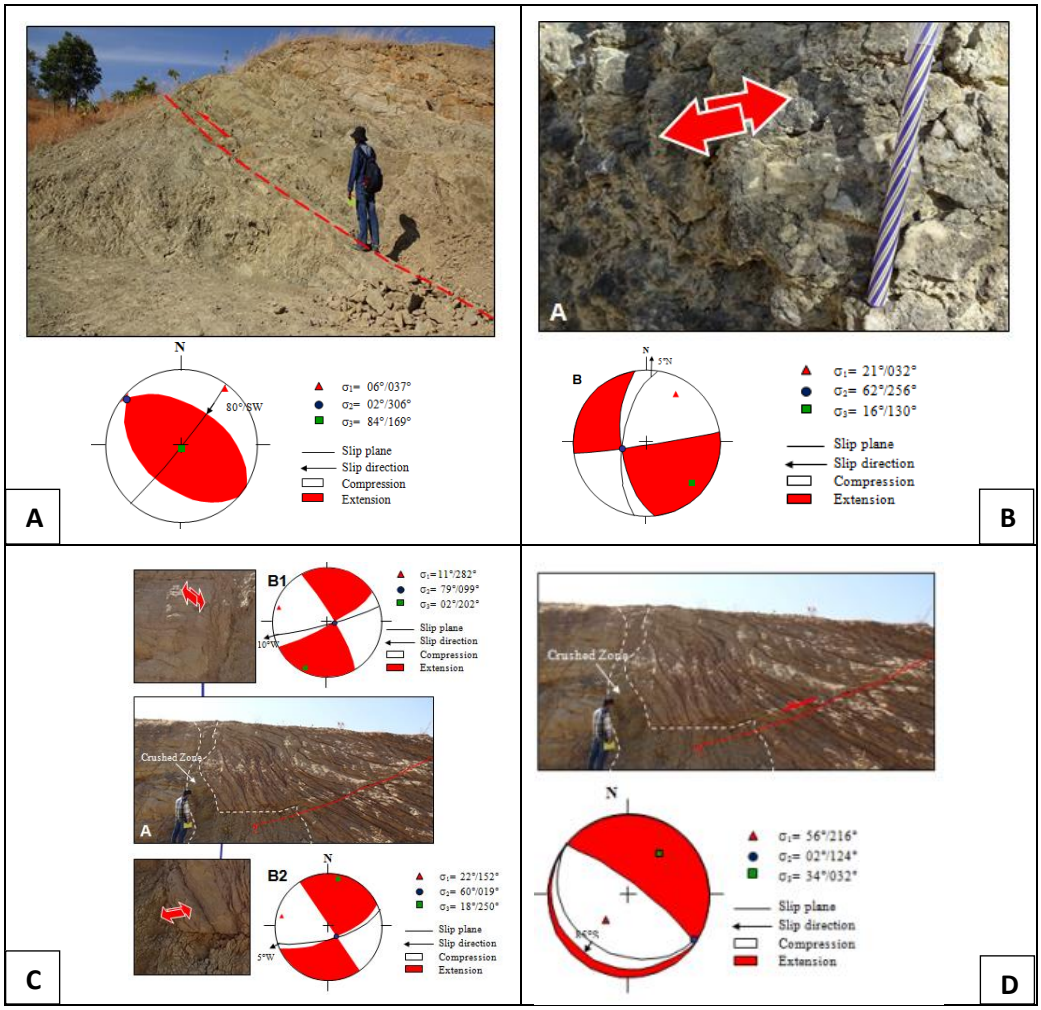


Figure (7) (A) Thrust slip planes of Chaungtha Thrust Fault, Facing- N (N of Kyaukmyaung village),

(B) Dextral slip plane of Chaungtha Thrust Fault, Facing- 70° (N 19° 51′ 34.7″, E 94° 59′ 27.4″)

(C) Dextral slip planes of Thet-ke-gyin fault, Facing- 030°. (N 19° 53′ 20.0″, E 95° 04′ 25.1″),

(D) Normal slip plane of Thet-ke-gyin fault, Photo facing- 030°. (N 19° 53′ 20.0″, E 95° 04′ 25.1″, Southeast of Thet ke gyin village)

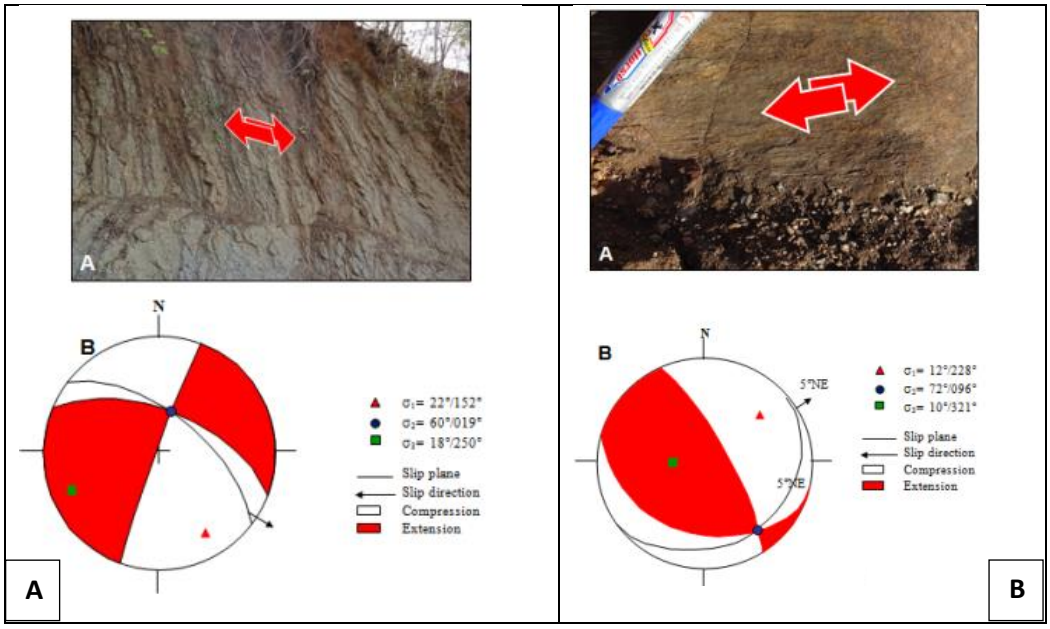


Figure (8) (A) Dextral slip plane of Dahat-Chaung fault, Facing- 220°. (N 19° 50′ 08.4″, E 95° 01′ 37.3″, East of Kyaukmyaung village)

(B) Dextral slip plane of Mindegyi fault, Facing- 290°. (N 19° 50′ 34.6″, E 94° 56′ 40.4″, East of Sit sa no village)

**Joints**

Joints in the study area are different in both lithologically and formationally. In competent rocks, they are in well jointed nature and contain up to three joint sets. In incompetent rocks, there are poorly jointed natures. Figure 8 shows the joint strike-rose diagram of the combine joint data of the whole study area. By field observation, strike orientation of the first prominent joint set is NE-SW direction, strike orientation of the second prominent joint set is NW-SE direction and strike orientation of the third prominent joint set is ENE-WSW direction. By plotting the combine data on stereographic projection analysis (lower hemisphere, Schmidt Net projection), the mean joint plane expresses that 34°/105° (Fig. 9). This mean joint plane is more than 7.3% of the total joints.

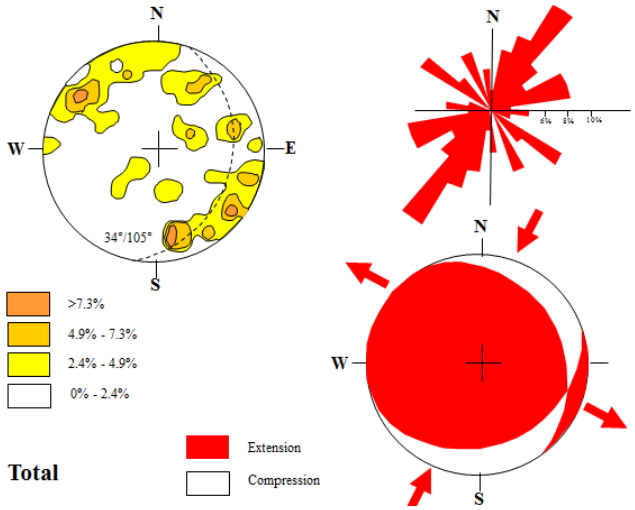


Figure (9) Stereographic projection analysis and joint strike-rose diagram of the combine joint data of the study area.

**Structural Interpretation of the study area**

The combine stress positions of the study area indicates two different prominent compressive direction nearly NE-SW and ENE-WSW which rotates nearly 30°. Systematic analysis of joints by their represented age pointed out that the stress field has counter-clockwise rotation. So, structural interpretation can be done that; Due to the early NE-SW compressive stress direction, folding of the soft rock units is formed. And when it exceeds to the elastic limits of the sedimentary rocks, thrust shearing comes along. Regional stratigraphy and dextral movement of Sagaing fault triggered the change of direction of stress position to ENE-WSW direction where weak plains of the shear surfaces reactivated as Normal and Dextral strike-slip shear movements, (MaungThein, *et.al.*, 1991).Combined stress position map is shown in figure (10).

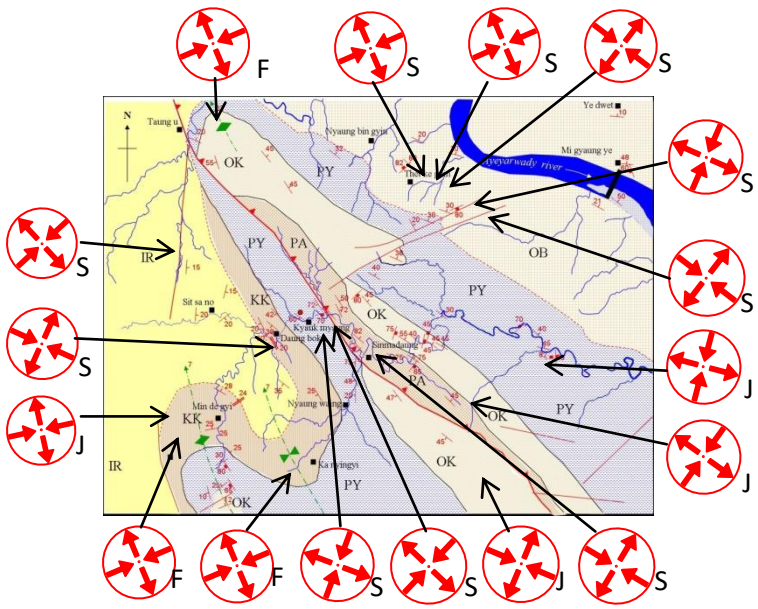


Figure (10) Combined stress field positions in the study area.

## Petroleum Occurrences

The study area is located in the Central Myanmar Basin where petroleum accumulation occurs. Many local handed wells are found in the area. The area produces over 350 gallons of petroleum per day. The areas of the accumulation of petroleum can be described in three main parts; near Tagaing village (N 19° 55' 30", E 94° 55' 00"), near Kyaukmyaung village (N 19° 50' 12", E 94° 57' 30"), near Dahat Pin Sakan (N 19° 47' 00", E 94° 57' 00") (Paw Tun, 1972). Figure (11) shows the location of petroleum sites in the study area.

### Near Tagaing Village

More than 150 handed wells are found at the area and the average depth of the exploration of the petroleum by local people is 30-40 meters. The possible lithology from which the petroleum is taken in sand lenses of Pyawbwe Formation.

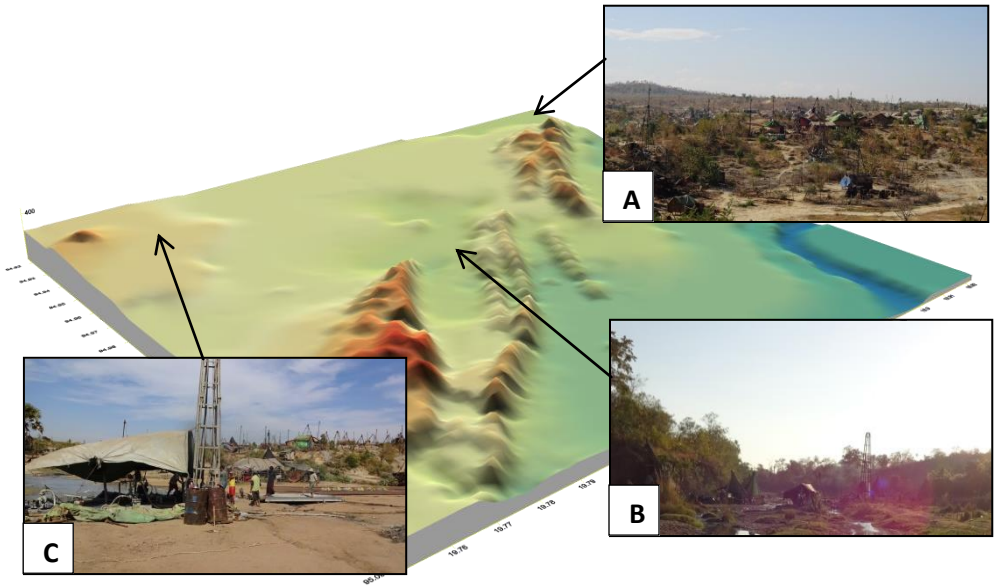


Figure (11) Location of petroleum exploration sites in the study area, (A) Near Tagaing village, (B) Near Kyaukmyaung Village, (C) Near Dahat Pin Sakan

### Near Kyaukmyaung Village

The exploration of petroleum by local people at the north of the Kyaukmyaung village is rather deep reaching nearly 60 meters from 3 of total 15 wells which are operating the extraction of petroleum. And the petroleum production rate is low; only produce nearly 50 gallons per day. The extraction of petroleum by locals in this area is from sand lenses of Pyawbwe Formation.

### Near Dahat Pin Sakan

This is the most productive site of the area producing average of nearly 240 gallons per day of petroleum. There are over 200 wells in the area and 165 wells are under operation

of the exploration of petroleum. Local people extract petroleum less than 50 meters from the ground and the possible lithology is Sandstones of Pyawbwe Formation. Two deep drilling wells are under operation and they expect to extract petroleum from deeper layers; possibly Okhmintaung Formation.

### Location of petroleum sites related to structural geology

Structural geology plays an important part in the accumulation of petroleum in this area. Chaungtha thrust is the main structural trap and Mindegyi anticline also is important trap. All three petroleum sites are found in these respective areas, producing thousands of gallons every month. Occurrence of petroleum accumulation near Tagaing village is located at the nose of the NNW – Plunging Tagaing Overturn Anticline. Petroleum site near Kyaukmyaung village can also be said to related with Chaungtha thrust fault. Moreover, the North West plunging Mindegyi anticline performs as a structural trap for accumulation of petroleum.(Yenne, K. A., 1988).

## Conclusion

The study area is made up of Tertiart and Quaternary sedimentary rocks. Both brittle and ductile deformation can be seen in this area. Foldings in this area give the same trending while trends of faultings and jointings are giving at least three directions. With detail studies both in the field and and the lab, as provided in the former chapters, there is a stress field rotation during Oligocene-Miocene and Pliocene, (Jarrard, R. D., 1986).These stress field rotation causes deformations in the stratigraphy which provide suitable traps for petroleum accumulation. The need of fossil fuel is in very much demand nowadays, so, further geophysical surveys such as seismic surveys and detail study of microforaminifera should be carried out to provide 3D columnar maps which are very useful in locating new petroleum accumulation sites.

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