Structural Analysis of the Tigyit Area, Pinlaung Townhsip, Shan State (South)

Soe Khaing Linn[1], Saw Ngwe Khaing[2] and Hein Min Htet[3]

Abstract

The study area and its environs is structurally bounded by Shan Scarp Fault in the west. It is also geomorphologically bounded in the east by Ingyi Ingaung Fault. The remarkable topographic trend is NNW-SSE trending in the research area. The NNW-SSE (about N 20W) trending Panlaung fault zone, Ingyi Ingaung fault zone and related fracture systems are nearly parallel to the prominent regional topographic trend. Describing the observed structural elements and tectonic features of the study area, the structural data have been collected during the periods of geological mapping and field investigation and under the microscopic study. The structural data analysis is described as (1) Attitude of beds, (2) Folds, (3) Faults, (4) Joints and other fractures and (5) Lineation and other linear structures.

Key words; Attitude of beds, Folds, Faults, Joints

INTRODUCTION

The southern Shan State is situated on the eastern part of Myanmar, as part of the Shan Plateau, which rises up to the general elevation of 1219m (4000ft) above the sea level. The present research area is located at the western part of the Shan State (south) or western margin of the eastern highland which is made up of Mesozoic and Cenozoic units. Six lithostratigraphic units are exported in the research area. They are Tigyit Formation (Tertiary), Kalaw Red Beds (Cretaceous), Loi-an Group (Jurassic), Nwabangyi Dolomite Formation (Permian-Early Triassic). Generally the rock units are running in nearly NNW-SSE trend. The research area and its environs is largely dominated by NNW-SSE structural trend and generally inclined toward the SW direction. However, local NE inclination is some is due to the NW-SE trending discontinuous or continuous series of asymmetrical anticlinal and synclinal folds, perhaps related to the Ingyi-Ingaung Fault and Shan Scarp Fault.

Location

The southern Shan State is situated in the eastern part of Myanmar, as part of the Shan Plateau, which rises up to the general elevation of 1219 m (4000 ft.) above sea level. The present work is located at the western portion of the southern Shan State (Fig.1). Most of the Cenozoic, Mesozoic and Paleozoic units are well exposed in the Tigyit area, about 22.4 km north of Pinlaung Township and about 27.2km south of Aungpan Township. It is demarcated between vertical grid 51 to 69 and horizontal grid 52 to 60 on one-inch topographic map numbers 93D/11 and 93D/15. The area is bounded by latitudes 20º 20´N to 20º 26´ N and longitudes 96º 35' E to 96º 47' E. The total converges is about 144 square kilometers.

Physiography

Generally, the elevation is about1219m (4000ft.) above the sea level and the topographic trends are nearly N-S direction in the study area. Three different topographic units can be classified in the area from west to east on the basic of the shape and configuration of the contours. The eastern portion, which a general elevation between 1342 m and 1555 m (4400-5100ft.), is dominated highly mountain ranges regions. The central

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portion, which a general elevation about1250 m (4100ft.), is dominated by low lying plain, and the western portion which a general elevation around 1463m (4800ft.), is dominated by rugged to moderately steep slope regions. Myatheintan range is about 1600m (5250ft), which is the highest point in the eastern part of the study area and Thandaung, is about 1517m (4977ft.) that is the highest point in the western part of the study area. In these three different areas, generally most of the ranges and valleys are running in NNW-SSE direction.

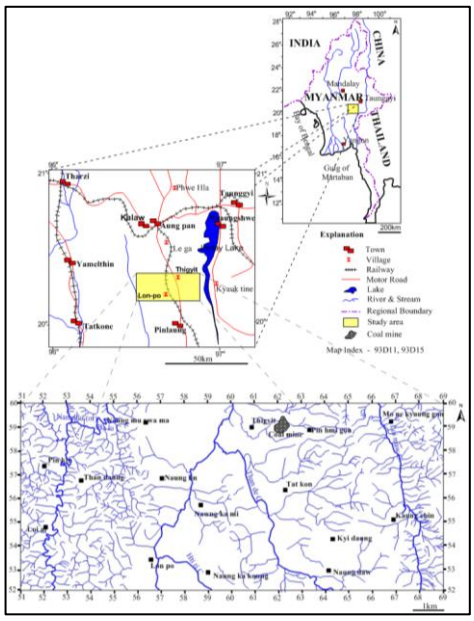


Figure (1). Location map of study area.

Methods of Study

Initially, desktop study is based on previous reports for literature survey. The lineation, general physiographic features, and different lithologic unit are studied on the aerial photos and satellite image interpretation. General traverse to know lithological units, general trend and to observed and measure main outcrop with distinct structures. In the bedding, lineation and structural features also study in these traverses.

The structural analysis is also mainly based on the interpretation of satellite TM-images and black and white aerial photographs on the scale of 1:25,000. The structural data analysis was made by using Schmidt's net stereographic projections.

STRUCTURAL ANALYSIS

The structural study is mainly based in the interpretation of satellite TM-images. And then preparations of the lineament map of the study area were made consequently (Fig.2). Then, describing the observed structural elements and tectonic features of the study area, the structural data have been collected during the periods of geological mapping and field investigation and under the microscopic study. The structural data analysis is described as; (1) Attitude of beds, (2) Folds, (3) Faults, (4) Joints and other fractures and (5) Lineation and other linear structures.

Attitudes of Beds

Field measurements indicate that, the rocks exposed in the study area and its environs can be organized into three different categories, according to the attitude of beds.

(1) Moderate to steep inclination, which are generally dip amount more than 45º, (2) gentle to moderate inclination, which are generally between the 15º-45º and (3) gentle inclination is generally below 15º. The Loi-an Group unit represents the first category and their beds generally indicate NNW-SSE in strike-position with moderate to steep inclination towards NE, and dip amount generally 75º (Fig.3). Some exceptions show SW inclination of bed due to the local folding. Nwabangyi Dolomite and Kalaw Red Beds represent the second category. These formations commonly occurs NNW-SSE in strike position with moderate to gentle bed inclination towards NE (Fig.4). Tigyit Formation represents the third category and their rock unit generally indicated NNW-SSE in strike position with gentle bed inclination towards NE (Fig.5).

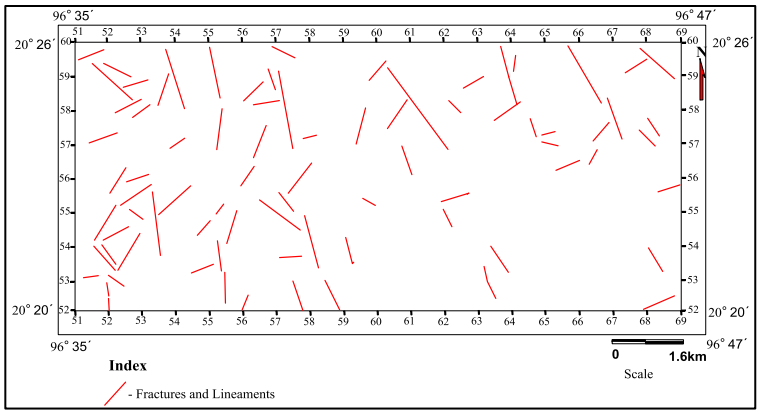


Figure (2). Image interpretation of the lineament features base on the satellite image of the study area.

Figure(3). Loi-an Group showing moderate to steep beds at the west of the Naungmu Village (20° 23' 50.1"N, 96º 39' 20.8"E) Photo Facing - 345º

Figure (4). Moderate to gentle beds of conglomerate unit of the Kalaw Red Beds (20° 22' 14.0"N, 96º 39' 06.5"E) Photo Facing - 85º

Figure (5). Gentle beds of coaly clay unit of the Tigyit Formation (20° 25' 00.3"N, 96º 42' 47.8"E) Photo Facing - SE

Folds

Folding is the most common form of distortion of the earth's crust. Folds are visually the most spectacular of Earth's structures. They are extraordinary displays of strain, conspicuous natural images of how the original shapes of rock bodies can be changed during deformation. Four lithostratigraphic units are exposed in the study area. Field investigation indicates that Loi-an Group and Tigyit Formation of the study area are highly deformed by the intense shear-folding processes. The local folds in the area are described as follows.

Nearly N-S oriented upright asymmetrical anticline fold is represented at the Tigyit coal mine (20° 25' 00.3"N, 96º 42' 47.8"E) eastern part of the Tigyit Village, by a medium to thick bedded coaly clay and coal unit of the Tigyit Formation. Direct measurement of the limbs indicates that the western limb is 63ºinclinations and directed toward 235º and the eastern limb is 25ºinclinations and directed toward 70º. Stereo plot analysis of the β diagram indicates that the fold axis is nearly N-S and plunging toward 17º and 18º dip angle (Fig.6). Another asymmetrical fold is observed in thin to medium bedded sandstone and shale interbedded unit of Loi-an Group (20° 25' 04.8"N, 96º 38' 01.5"E). Direct measurement of the fold limbs indicates that the NW limb is 70º inclinations and directed toward 310º and SE limb is 15º inclinations and directed toward 110º. The fold axis nearly NE-SW trending with southeastern limb is steeper than the northwestern limb. Stereo plot analysis of the β diagram indicates that the fold is plunging toward 39º and 5º dip angle (Fig.7).

An overturned fold is observed in the coaly clay unit of the Tigyit Formation exposed at the east of Tigyit Village. Direct measurement of the fold limbs indicates that the NE limb is 87ºinclinations and directed toward 64º and SW limb is 20ºinclinations and directed toward 160º. Stereo plot analysis of the β diagram indicates that the fold axis is SE-NW and plunging toward 150º and 20º dip angle (Fig.8).

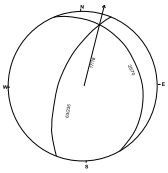


Figure (6). Asymmetrical anticline fold observed in the coal clay and coal unit of the Tigyit Formation at the Tigyit coal mine (20º 24' 50.3"N, 96º 42' 51.9"E) Photo Facing – S

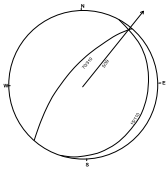


Figure (7). Thin to medium bedded sandstone and shale interbedded unit of the Loi-an Group observed as asymmetrical fold (20º 25' 04.8"N, 96º 38' 01.5"E) Photo facing - 25º

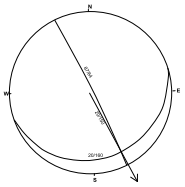


Figure (8). Coaly clay and coal unit of the Tigyit Formation represented by overturned fold observed in the Tigyit coal mine (20º 24' 50.3"N, 96º 42' 51.9"E) Photo Facing - 285º

Faults

The study area is situated in the southern part of the Kalaw-Pinlaung Basin which is a part of the Shan Plateau. The study area of regional structural trend is nearly NW-SE direction, being parallel to the general topographic trend. The upper Paleozoic and Mesozoic

strata are affected by faulting. These faults can be traced not only on the satellite TM-image, but also in the field investigation. The western part of the study area is highly deformed than the eastern part of the study area.

Measurement of structural data in the study area is based on the lineaments map which has been taken during field investigation. These study composed of attitudes of observed shear planes, including their dip amount and strike direction, and the direction and amount of pitch angle of striations or slicken lines on these shear planes. The orientation of principal stresses axes are determined on lower hemisphere, Schmidt projection to get the extensional quadrants the σ_1 axis and compressional quadrants that contain the σ_3 axis. Major fault was observed at the eastern part of the study area near the Pinhmigon Village. This fault is NNW-SSE trending normal fault, named here Pinhmigon fault. These fault strongly affected on the Kalaw Red Beds, Loi-an Group and Nwabangyi Dolomite. This shear zone is remarkably expressed by the fault breccias, fault gauge and slickenside on the fault plane (Fig.9). The direct measurement of the slickenside indicates about 80º inclinations and directed toward 260º. Stereo plot analysis of slicken plane indicates that the maximum stress σ_1 is 70º inclination and directed toward 59º. The intermediate stress σ_2 is 6º inclinations and directed toward 160º and minimum stress σ_3 is 18º inclinations and directed toward 251º. The criteria of minor faults are observed in the study area. They are described as follows.

Normal Fault

A normal fault criteria is observed in the sand-shale interbedded unit of the Loi-an Group at the south of Thandaung Monastery (20º 23' 50.1"N, 96º 39' 20.8"E). The direct measurement of the fault plane solution indicates about 75º inclination and directed toward 200º. Stereo plot analysis of slicken plane indicates that the maximum stress σ_1 is 75º inclination and directed toward 34º. The intermediate stress σ_2 is 4º inclinations and directed toward 288º and minimum stress σ_3 is 14 º inclinations and directed toward 168º (Fig.10).

A slicken plane is observed in the Loi-an Group at the west of Naunglin Village (20º 23' 50.1"N, 96º 39' 20.8"E). The direct measurement of the fault plane indicates about 55º inclination and directed toward 60º. This fault is layer parallel shear normal fault and strongly affected on the sandstone and shale units. Stereo plot analysis of the fault plane indicates that the maximum stress σ_1 is 80 º inclinations and directed toward 127º. The intermediate stress σ_2 is10ºinclination sand directed toward 335º and minimum stress σ_3 is 5º inclinations and directed toward 244º (Fig.11). Another normal fault is observed in the indurated sandstone unit of the Loi-an Group at the west of the Naungmu Village (20º 24' 58.9"N, 96º 38' 26.9"E). The direct measurement of the fault plane indicates about 50 inclinations and directed toward 120. The stereo plot analysis of the fault plane indicates that the maximum stress σ_1 is 77º inclinations and directed toward 78º. The intermediate stress σ_2 is 8º inclinations and directed toward 204º and minimum σ_3 is 10º inclinations and directed toward 295º (Fig.12).

Nearly N-S trending normal fault is observed in the indurated siltstone and sandstone unit of the Loi-an Group at the west of Naungmu Village (20º 25' 01.5"N, 96º 38' 57.6"E). The direct measurement of the fault plane indicates about 70º inclinations and directed toward 85º. Stereo plot analysis of the fault plane indicates that the maximum stress σ_1 is 59º inclinations and directed toward 202º. The intermediate stress σ_2 is 28º inclinations and directed toward 8º and minimum stress σ_3 is 6º inclinations and directed toward 101º (Fig.13).

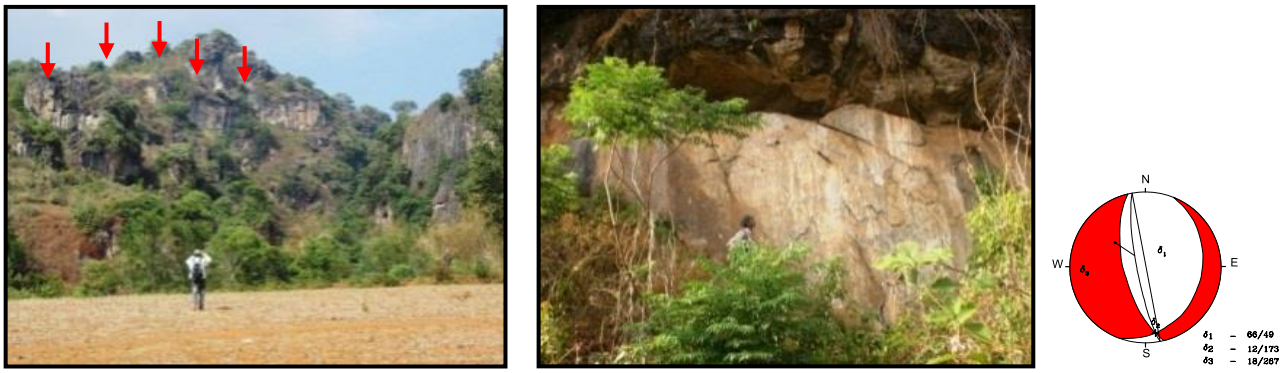


Figure (9). NNW-SSE trending Pinhmigon fault scarp on the Kalaw Red Beds (20° 24' 55.84"N, 96º 43' 50.67"E) Photo Facing - 80º

Figure (10). NW-SE striking normal fault on the sand shale unit of the Loi-an Group (20° 22' 30.9"N, 96º 43' 35.3"E) Photo Facing - 60º

Figure (11). NNW-SSE trending layer parallel shear normal fault observed on the Loi-an Group (20° 23' 50.1"N, 96º 39' 20.8"E) Photo Facing - 345º

Reverse Fault and Thrust Fault

At the Tigyit coal mine (20º 24' 50.3"N, 96º 42' 51.9"E), the notable criteria of reverse evidence are observed. It occurred in the tightly folded of coaly clay unit of the Tigyit Formation. Direct measurement of the thrust fault plane is 59º inclinations and directed toward 125º. Above these evidences show that the coal and coaly clay unit was progressively deformed as, firstly folded and thrusted in the lower part of the strata, caused by E-W compressional deformation. Stereo plot analysis of the fault plane is indicates that the maximum stress σ_1 is 26 º inclinations and directed toward 114º. The intermediate stress σ_2 is 9º inclinations and directed toward 210º and minimum stress σ_3 is 56º inclinations and directed toward 310º (Fig.14).

NNW-SSE trending reverse fault was observed the Loi-an Group located at (20º 24' 58.7" N, 96º 38' 28.1" E). This fault strongly affected on the siltstone and sandstone unit. The directed measurement of the fault plane solution indicates about 65º inclination and directed toward 240º. Stereo plot analysis of the fault plane indicates that the maximum stress σ_1 is 33º inclinations and directed toward 230º. The intermediated stress σ_2 is 10º inclinations and directed toward 325º and minimum stress σ_3 is 55º inclinations and directed toward 68º (Fig.15). This fault indicated that the SSW-NNE compression direction and NNW-SSE extensional direction. A thrust fault criteria is observed on the Loi-an Group at the west of the Naunglin Village (20° 23' 50.1"N, 96º 39' 20.8"E). The fault plane solution indicated as NW-SE trending and the inclination is 54º and downthrown toward SW. Stereo plot analysis of

slicken plane indicates that the maximum stress σ_1 is 21º inclination and directed toward 208º. The intermediate stress σ_2 is 15º inclinations and toward 302º and the minimum stress σ_3 is 62º inclinations and directed toward 62º (Fig.16).

Figure (12). NW-SE striking normal fault on the siltstone unit of the Loi-an Group (20° 24' 58.9"N, 96º 38' 26.9"E) Photo Facing – 15º

Figure (13). Nearly N-S trending normal fault found on the sandstone unit of the Loi-an Group (20º 25' 01.5"N, 96º 38' 57.6"E) Photo Facing–SE

Figure (14). NNE-SSW trending thrust fault observed in the coaly clay and coal interbedded unit of the Tigyit Formation (20º 24' 50.3"N, 96º 42' 51.9"E) Photo Facing –S

Figure (15). NNW-SSE trending reverse fault on the sandstone and siltstone unit of the Loi-an Group (20° 24' 58.7" N, 96º 38' 28.1" E) Photo Facing - SE

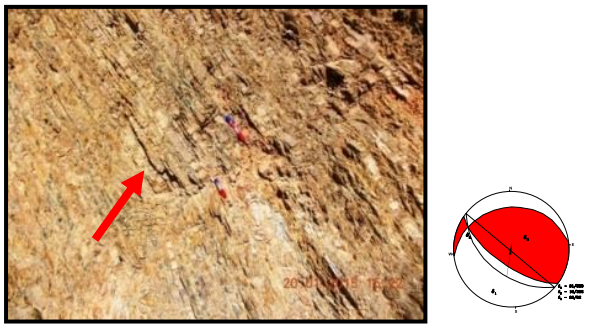


Figure (16). NW-SE trending thrust fault observed in the sand shale interbedded unit of the Loi-an Group (20° 23' 50.1"N, 96º 39' 20.8"E) Photo Facing - 345º

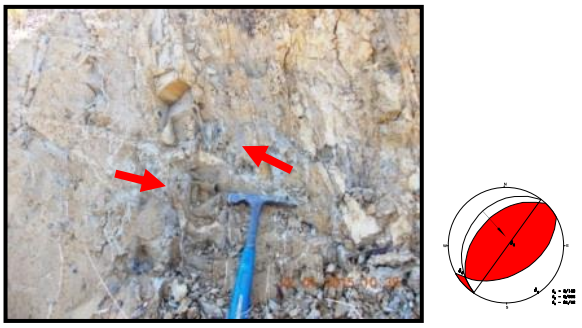


Figure (17). NE-SW trending thrust fault observed in the siltstone unit of the Loi-an Group (20° 20' 47.5"N, 96º 42' 37.0"E) Photo Facing – S

A thrust fault indicator is observed in the siltstone unit of the Loi-an Group at the east of Aunglae Village (20º 20' 47.5"N, 96º 42' 37.0"E). The direct measurement of the fault plane solution indicates about 29º inclination and directed toward 305º. Stereo plot analysis of the fault plane indicates that the maximum stress σ_1 is 2ºinclinations and directed toward

142º. The intermediate stress σ_2 is 8º inclinations and directed toward 232º and minimum stress σ_3 is 81ºsinclination and directed toward 42º (Fig.17). Another NNW-SSE trending thrust fault was observed in the sand shale interbedded unit of the Loi-an Group located at (20° 20' 48.0"N, 96º 42' 43.3"E). The direct measurement of the fault plane solution indicates about 15º inclination and directed toward 210º. Stereo plot analysis of the fault plane indicates that the maximum stress σ_1 is 13º inclinations and directed toward 16º. The intermediate stress σ_2 is 4º inclinations and directed toward 285º and minimum stress σ_3 is 75 º inclinations and directed toward 180º (Fig.18).

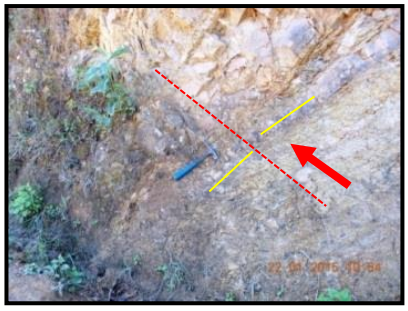
Another reverse fault indicator is located at (20° 24' 01.9"N, 96º 44' 12.5"E). These faults mainly cut cross the Nwabangyi Dolomite. The direct measurement of the slickenside indicates about 40º inclinations and directed toward 250º. Stereo plot analysis of the fault plane indicates that the maximum compressive stress σ_1 is 6º inclinations and directed toward 225º, intermediate stress σ_2 is 16º inclinations and directed toward 316º and minimum stress σ_3 is 71º inclinations and directed toward 110º (Fig.19). Nearly N-E trending thrust fault is observed in the dolomitic limestone unit of the Nwabangyi Formation located at (20° 24' 07.7"N, 96º 44' 22.9"E). The direct measurement of the slickenside indicates about 35º inclinations and directed toward 70º. Stereo plot analysis of the fault plane indicates that the maximum compressive stress σ_1 is 5º inclinations and directed toward 49º, intermediate stress σ_2 is 12º inclinations and directed toward 141º and minimum stress σ_3 is 76º inclinations and directed toward 301º (Fig.20).

Right lateral strike-slip Fault

A slicken plane is observed in the Nwabangyi Dolomite beside the Tigyit- Pinkin car road northeast of Pinkin Village (20° 25' 01.1"N, 96º 37' 45.8"E). The direct measurement of the fault plane shows left-lateral shear sense and 72º inclinations and directed toward 130º. Stereo plot analysis of slicken plane indicates that the maximum stress σ_1 is 19º inclination and directed toward 15º. The intermediate stress σ_2 is 70º inclinations and directed toward 161º and minimum stress σ_3 is 10º inclinations and directed toward 279º (Fig.21). Another slicken planes are observed in the dolomitic limestone unit of the Nwabangyi Dolomite at the north east of Latpanpin Village (20° 21' 22.6"N, 96º 43' 26.7"E). The direct measurement of fault plane shows right-lateral shear sense and 59º inclinations and directed toward 320º. Stereo plot analysis of slicken plane indicates that the maximum stress σ_1 is 40º inclinations and directed toward 64º. The intermediated stress σ_2 is 48º inclinations and directed toward 272º and minimum stress σ_3 is 12º inclinations and directed toward 166º (Fig.22).

Left lateral strike-slip Fault

At the east of Tatkon Village (20° 24' 01.9"N, 96º 44' 12.5"E), slicken plane is observed in the dolomitic limestone unit of the Nwabangyi Dolomite. The direct measurement of fault plane shows left-lateral shear sense and 60º inclinations and directed toward 290º. Stereo plot analysis of slicken plane indicates that the maximum stress σ_1 is 18º inclinations and directed toward 177º. The intermediated stress σ_2 is 60º inclinations and directed toward 301º and minimum stress σ_3 is 23º inclinations and directed toward 78º (Fig.23). Another fault indicator located at (20° 24' 07.7"N, 96º 44' 22.9"E). The direct measurement of slickenside shows left-lateral shear sense and 71º inclinations and directed toward 12º. The fault affected on the dolomitic limestone unit of the Nwabangyi Dolomite. Stereo plot analysis of the slicken plane indicates that the maximum stress σ_1 is17º inclination and directed toward 254º. The intermediated stress σ_2 is 68º inclinations and directed toward 42º and minimum stress σ_3 is 10º inclinations and directed toward 165º (Fig.24).



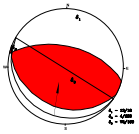


Figure (18). Loi-an Group with NW-SE trending thrust fault (20° 20' 48.0"N, 96º 42' 43.3"E) Photo Facing - 140º

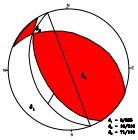
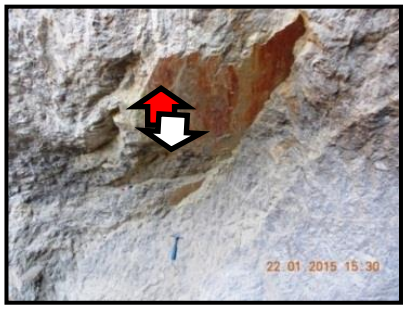


Figure (19). NNW-SSE trending thrust fault found on the Nwabangyi Dolomite (20° 24' 01.9"N, 96º 44' 12.5"E) Photo Facing - 20º



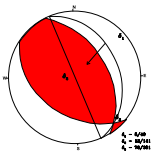


Figure (20). Massive dolomitic limestone unit of the Nwabangyi Dolomite with SSE-NNW trending thrust fault (20° 24' 07.7"N, 96º 44' 22.9"E) Photo Facing -100º

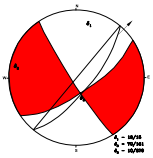


Figure (21). NE-SW trending right lateral strike slip fault found on the Nwabangyi Dolomite (20° 25' 01.1"N, 96º 37' 45.8"E) Photo Facing –NE

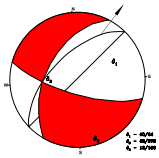


Figure (22). NE-SW striking right lateral strike slip fault on the dolomitic limestone unit of the Nwabangyi Dolomite (20° 21' 22.6"N, 96º 43' 26.7"E) Photo Facing -170º

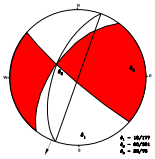


Figure (23). Dolomitic limestone unit of the Nwabangyi Dolomite with left lateral strike slip fault (20° 24' 01.9"N, 96º 44' 12.5"E) Photo Facing -100º

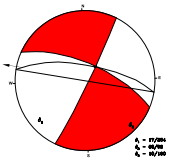


Figure (24). Nearly E-W striking left lateral strike slip fault observed on the Nwabangyi Dolomite (20° 24' 07.7"N, 96º 44' 22.9"E) Photo Facing -5º

Fault distribution pattern

The distribution pattern of the principal stress field for thrust faults in the study area is shown in (Fig.25). Normal faults in the study area show in (Fig.26) and the principal stress field for the strike-slip faults show in the (Fig.27).

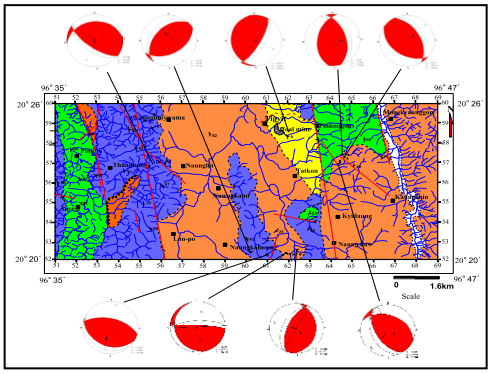


Figure (25). Stereo plot analysis of structural data from the Reverse Fault and Thrust Faults show in the study area

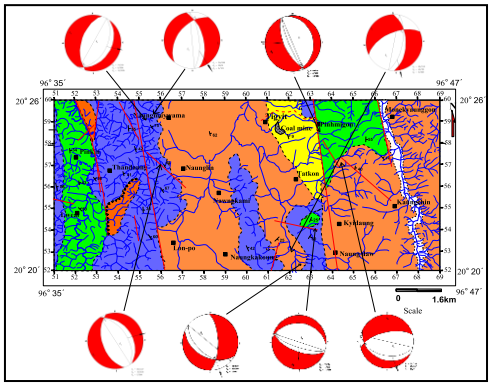


Figure (26). Stereo plot analysis of structural data from Normal Faults show in the study area

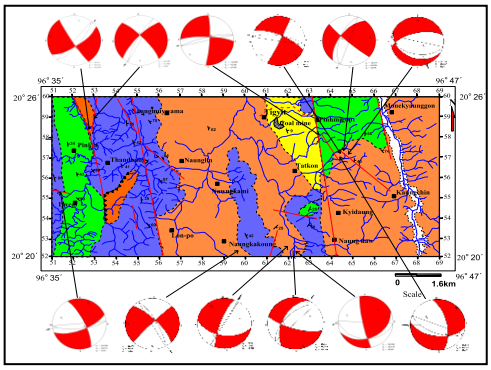


Figure (27). Stereo plot analysis of structural data from Strike-slip Faults show in the study area

Joints

In the study area, the study about joints is important to subdivide the rock units into structural domains. These structural domains are designated in the basis of major lithologic groups or associations. The carbonate rocks such as micritic limestone, calcitic limestone, dolomitic limestone and dolostone of Plateau limestone group are in generally moderate to well jointed in nature. The Jurassic rock unit such as sandstone, siltstone, mudstone and shale of Loi-an Group are well jointed in nature. In the Cretaceous clastic rock unit of Kalaw Red Beds, conglomerate is low jointed nature and lower parts of grossly red siltstone and sandstone is well jointed in nature. Their dimension and spacing of joints may vary from place to place.

Nwabangyi Dolomite

Rock units of the study area shows systematic jointing related to the structural deformation. Nwabangyi Dolomite consists of carbonate rocks that have been dolomitized, leading to intense shattering and brecciation which give it a characteristic fragmented

appearance on fresh and weathered surfaces. Numerous joint sets (criss-cross joint), developed on the weathered surface of Plateau Limestone Group were also observed. It is highly jointed and intensely brecciated (Fig.28). At least two sets are observed in fine grained dolomitic limestone. Joint strike rose diagrams are drawn by using the Rockwork software version 15.0. Stereo plot analysis of measured joint data is shown that the vector means direction is 7.7º (Fig.29). It indicates that the compressional direction ENE-WSW in the Permian to Early Triassic age of the Nwabangyi Dolomite in study area.

Figure (28). Highly brecciate and highly jointed nature of the blue grey color dolomitic limestone unit of the Nwabangyi Dolomite (20° 21' 53.5"N, 96º 41' 36.8"E) Photo Facing- 110º

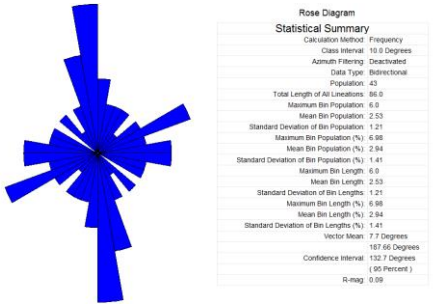


Figure (29). Strike rose diagram of the Nwabangyi Formation, using Rock Work software

Loi –an Group

Joints are also distinctive deformation feature in the Loi-Group (Fig.30). Most of the joints in the western part of the study area were measured in the rock units of Loi-an Group. Numerous joint set are developed on the siltstone and sand stone were also observed. This unit including grey color indurated mudstone, buff color sandstone, siltstone and shale are well jointed. At least three joint sets are observed in indurated siltstone and sandstone (Fig.31). Stereo plot analysis of the joint data is shown that the vector means direction is 83.6º (Fig.32). It shows that the compressional directions NNW-SSE in Jurassic age of the Loi-an Group in the study area.

Figure (30). Well jointed nature of the sandstone and shale unit of the Loi-an Group (20° 25' 04.8"N, 96º 38' 01.5"E) Photo Facing -30º

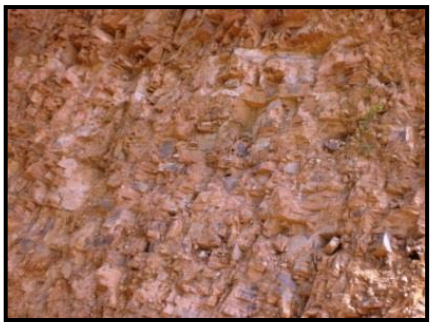


Figure (31). Highly jointed indurated siltstone unit of the Loi-an Group (20° 24' 50.4"N, 96º 39' 10"E) Photo Facing- NW

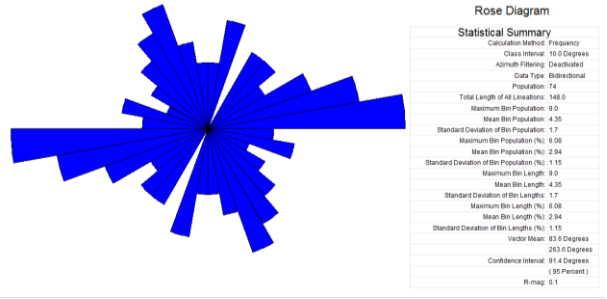


Figure (32). Strike rose diagram of the Loi-an Group, using Rock Work software

Kalaw Red Beds

Siltstone and sandstone have moderately jointed in nature while Kalaw Red Beds thick to massive bedded Conglomerates have relatively poorly jointed (Fig.33). Stereo plot analysis of the joint data is shown that the vector means direction is 36.6º (Fig.34).

Figure (33). Moderately jointed nature of the red sandstone unit of the Kalaw Red Beds (20° 22' 22.7"N, 96º 43' 18.5"E) Photo Facing – SE

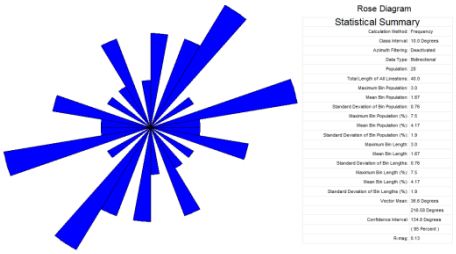


Figure (34) Strike rose diagram of the Kalaw Red Beds, using Rock Work software.

Tigyit Formation

Tigyit unit sediments including loosely unconsolidated clay, silty to sandy clay, loosely unconsolidated sand and coal seam are well jointed and at least two sets of joints are frequently common in coal seam (Fig.35). Among them, the most common joint are perpendicular to the bedding. Bedding joints are also recognized in silty clay unit. Stereo plot analysis of measured joint data in the Tigyit Formation is shown that the vector means direction is 38.8º (Fig.36).

Figure (35). Well jointed nature of the coal unit of the Tigyit Formation (20° 24' 56.94"N, 96º 42' 45.18"E) Photo Facing – S

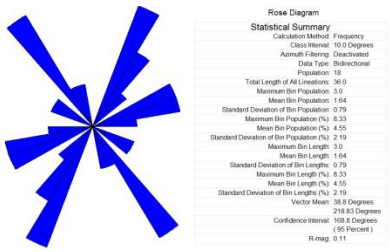


Figure (36). Strike rose diagram of the Tigyit Formation, using Rock Work software

Relative correlation of joints

Possible force direction of the study area and relative age of numerous joint sets are interpreted from the joint strike rose diagrams. The frequency distributions of numerous joint sets are grouped and the rose diagrams are draw, according to their different stratigraphic units; such as Nwabangyi Dolomite (Permian to Early Triassic), Loi-an Group (Jurassic), Kalaw Red Beds (Cretaceous) and Tigyit Formation (Tertiary). Then, these total joints sets were combined and determined the possible compression direction and extensional direction of the study area. The stereo plot analysis of the joints data is shown that the vector means direction is 53.9º (Fig.37) . It shows that the maximum compressional directions NNW-SSE in the study area. Stereoplot analysis of joints data in the study area (Fig.38) and its environs indicated that, the mean joints can be divided into three four units; (1) Nwabangyi dolomite (2) Loi-an Group (3) Kalaw Red Beds and (4) His-hkip Formation.

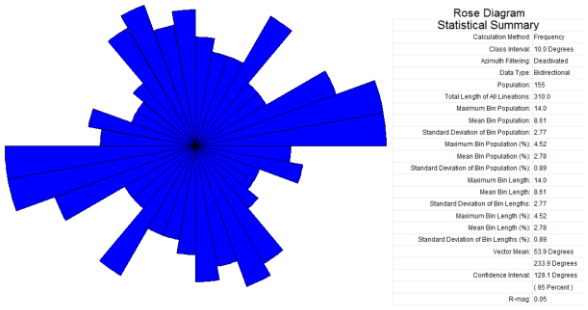


Figure (37). Strike rose diagram of the Study area, using Rockwork software.

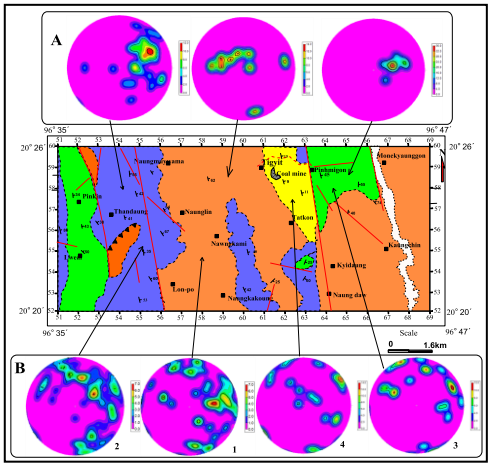


Figure (38). Stereographic projection of contour diagram (Schmidt net) of the study area

(A) Bedding natures and
(B) Joint natures

Lineaments and fractures

Structurally, western part of the study area is highly deformed zone. Major strike of the all rock units are displayed as NNW-SSE direction in the study area. Image interpretation of the area based on the satellite image is shown four major lineaments (Fig.39). They are NW-SE direction, NE-SW direction, N-S direction and E-W direction. Mainly, NE-SW direction lineaments are most dominant fractures occurred in the area (55.4%). Next dominant lineaments are NW-SE direction (36.5%). N-E direction lineaments also occurred in the study area (5.4%). The last one is about 2.7% of all lineaments with E-W direction. NE-SW trending lineament directions are more than NW-SE trending, but NW-SE trending lineaments direction is longer.

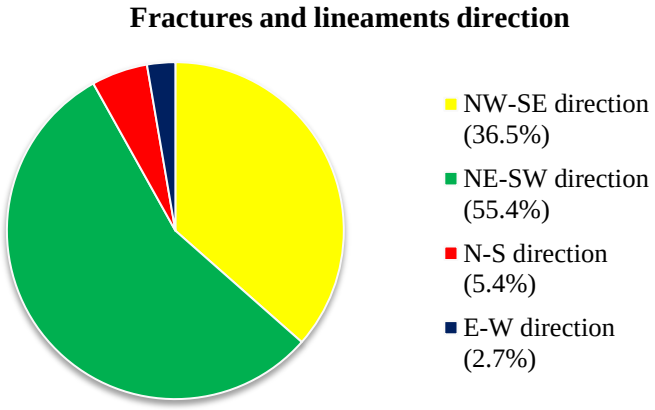


Figure (39). Fracture and lineament direction of the study area based on satellite image interpretation of the structural features

CONCLUSION

The present work is located at the western portion of the southern Shan State (Fig.1). Most of the Cenozoic, Mesozoic and Paleozoic units are well exposed in the Tigyit area, about 22.4 km north of Pinlaung Township and about 27.2km south of Aungpan Township. The structural data analysis is described as; (1) Attitude of beds, (2) Folds, (3) Faults, (4) Joints and other fractures and (5) Lineation and other linear structures. . Field investigation indicates that Loi-an Group and Tigyit Formation of the study area are highly deformed by the intense shear-folding processes. The study area is situated in the southern part of the Kalaw-Pinlaung Basin which is a part of the Shan Plateau. The study area of regional structural trend is nearly NW-SE direction, being parallel to the general topographic trend. The upper Paleozoic and Mesozoic strata are affected by faulting. These faults can be traced not only on the satellite TM-image, but also in the field investigation. The western part of the study area is highly deformed than the eastern part of the study area.The orientation of principal stresses axes are determined on lower hemisphere, Schmidt projection to get the extensional quadrants the σ_3 axis and compressional quadrants that contain the σ_1 axis. Major fault observed at the eastern part of the study area near the Pinhmigon Village. This fault is NNW-SSE trending normal fault, named here Pinhmigon fault.Two distinct stress positions are recognized on the basis of the stress distribution pattern of the study area. The first position indicates nearly E-W to NE-SW maximum compressive stress axis with nearly N-S to NW-SE maximum tensile stress axis. The second stress position displays NW-SE maximum compressive stress axis with NE-SW maximum tensile stress axis. Comparison of relative age among the structural elements can be reflected that, the second stress position is relatively younger than the former one.

Acknowledgements

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