Deformation Style of the Western Part of Laymyethna Area, Ayeyawady Region

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Abstract

The Western Fold Belt is composed of sedimentary, metasedimentary, intrusive and volcanic igneous rocks, that has been considered as accretionary wedge (Arakan Yoma Wedge, by G.I.A.C. Final Report, 1999), including ophiolite obduction (Curry, et al 1979; Bender; 1983; Hutchison, 1989). In the research area, three deformational behaviors are founded such as (1) semi-brittle, (2) brittle- ductile, and (3) brittle. Semi-brittle deformation includes both brittle mechanism and some ductile aspects, such as en-echelon fractures and veins. Brittle-ductile shear zone contains boudins, rock fragments and microfaults. Fracturing and faulting are dominant in brittle deformation.

Keywords: Deformation, Semi-brittle, Brittle-ductile, Brittle, Laymyethna, Ayeyawady Region

Introduction

The study area is located at the southeastern flank of the Western Ranges. It is bounded by the latitudes 17°33' N to 17°42' N and longitudes 94°54' 30″ E and 95°04' E. The study area lies on one inch topographic maps of 85 O/2 and 85 K/14 (Fig. 1). The rocks are grouped into the Undifferentiated flysch unit (Late Cretaceous to Paleocene), Paunggyi Formation (Paleocene), Undifferentiated molassic unit (Eocene to Early Oligocene), Okhmintaung Formation (Late Oligocene), Pyawbwe Formation (Early Miocene) and Irrawaddy Formation (Late Miocene to Pliocene) in the study area. Undifferentiated flysch and undifferentiated molassic units are highly deformed by the intense shear-folding processes. It is found out that the older rocks are strongly folded by the NE-SW compressional stress. The younger rocks are folding by the NW-SE extensional processes. Many normal faults are trending in various directions in the undifferentiated flysch unit and the trend is prominent normal faults in Paunggyi Formation trend N-S or E-W in directions, but NE-SW trend is prominent in the Undifferentiated molassic unit. Most of the joints are striking NE-SW direction in the study area.

Regional Structure

There are at least three major lineaments recognized. The most prominent major lineament is running NNW-SSE from the 18° N to 21° N. The existence of this major lineament as a fault along the Western Ranges was long recognized by early workers like Chhibber (1934), Clegg (1938, 1941), Brunnschweiler (1966), Win Swe (1972, 1981, 1993) etc. This major lineament occurs as a major strike-slip fault in Western Ranges and it is also known as Kabaw Fault (Hla Maung, 1987). The Kabaw Fault forms a major tectonic break between the Western Ranges and the Central Basin. It continues to the south, and joins the West Andaman Fault.

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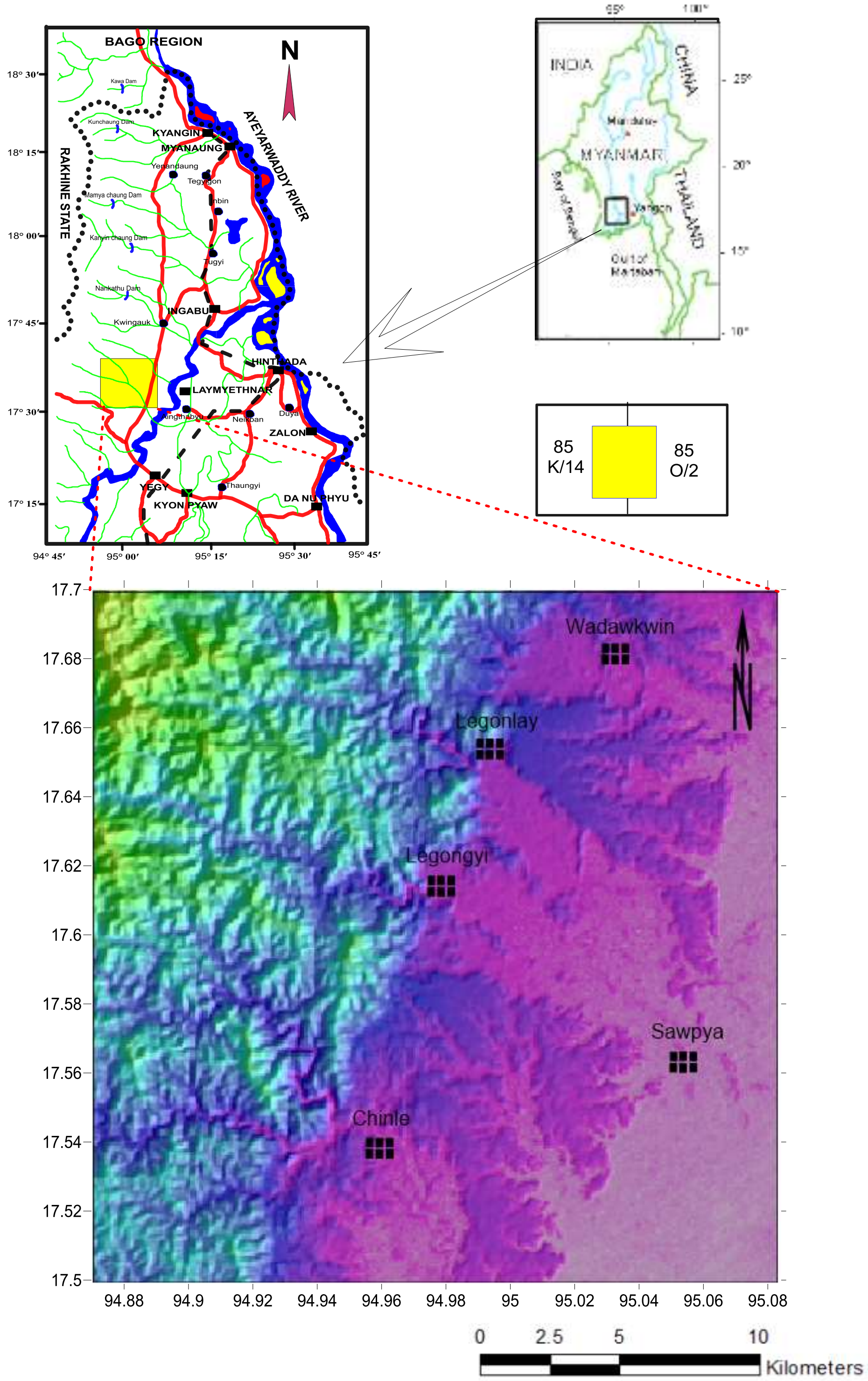


Fig. (1) Location map of the study area

Another major lineament is showing NNE-SSW to NE-SW direction. These are more dominant in the southern part of the Western Ranges. It appears to be Seindaung Fault extending from Hainggyi Island. It is supposed to be southward extension of the Kabaw Fault. And another major lineaments is trending ESE-WNW in direction. These are cross-cut with the second major lineaments in the Western Ranges.

The flysch is tightly folded all along the ranges but more intensely in the Naga Hills than farther south (Hutchison, 1996). Folding can be observed in many places within the

Neogene sediments of the central lowlands. As in the Western Ranges, the folds curve from northwest in the south to north-northeast in the north, but folding is much gentler in the lowlands. In the Rakhine Roma, south of the Chin Hills, the older rocks of the Western Ranges are recumbently folded olistostrome mélanges and feldspathic turbitides of Eocene and Oligocene age. They are interpreted as trench floor deposits tectonically accreted during Eocene-Oligocene subduction (Hutchison, 1996). The olistoliths were derived from westwards overthrusting sheets of the eastern belt of the ranges, implying syn-subduction thrusting within the outer arc.

General Geology

Six lithostratigraphic units are mainly exposed in the study area. Thin alteration sequence of thinly bedded slate with minor fine grained sandstone and pebbly greywacke along the western part of the area represents the Undifferentiated Flysch Unit of Late Cretaceous age. Paunggyi Formation is composed of thick accumulation of grain-supported, sub-angular to sub-rounded rock materials with a wide range of variation in size, ranging from small pebbles to large boulder. Undifferentiated Molassic Unit is mainly composed of slate, calc-slate, calc-phyllite, thick alteration of sandstone or quartzite and shale or slate, thin alteration of sandstone or quartzite and shale or slate with local present of grain supported to matrix-supported, polylithic conglomerate lenses.

Okhmintaung Formation is mainly made up of poorly sorted, coarse-grained massive sandstone, argillaceous grits with minor intercalation of sandy shale layers. Mainly grey and bluish grey sandy clay layers, sandstone and intra-formational conglomerate can be designated as Pyawbwe Formation.

Irrawaddy Formation is most widely distributed in the eastern part of the study area. The formation is well recognized by loosely cemented sandy grits, with milky quartz pebbles and gravel beds and subordinate sandy shale with thick to very thick bedded nature.

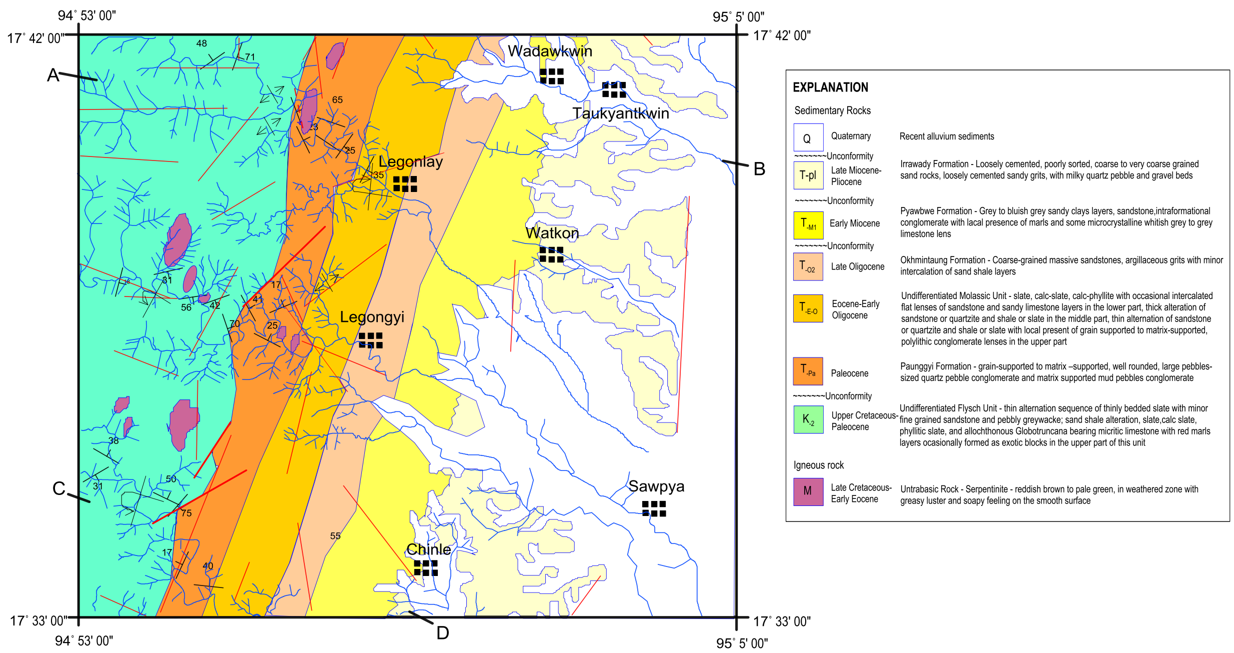


Fig. (2) Geological Map of the Study area

Behaviors of Rock Deformation

Macroscopic and microscopic studies of structural deformation in the study area indicates that, the rocks are deformed into three different behaviors, such as (1) semi-brittle, (2) brittle ductile and (3) brittle behaviors.

Semi-Brittle Deformation

Semi-brittle deformation characters of the study area include both brittle mechanism and some ductile aspects. A common example of a semi-brittle shear deformation in the study area is well preserved by en-echelon fractures and veins (Fig. 3). Brittle deformation mechanism within the semi-brittle deformation is composed of fracturing and brecciating. Ductile aspects within the semi-brittle shear deformation are mainly composed of ductile necking, boudins, and pinch-and-swell structures and shear fractures. Folding may be accommodated by brittle or semi brittle mechanisms (Davis & Reynolds, 1996) (Fig. 4).

Ductile necking and boudins are common in the interbedded sequence of the mechanically stiff layers (sandstone) and mechanically soft layers (shale or mudstone) (Fig. 5). According to the ductility contrast the stiff layer is stretched by the layered-parallel extension (Davis & Reynolds, 1996).

Pinch-and-swell structures are common in the thin alteration sequence of thinly bedded slate and thin intercalated sandy limestone, which are exposed along the Gyat Chaung area (N17° 41′ 24.7″, E94° 57′ 46.2″) (Fig. 6). Lenticular bodies of mechanically stiff layer (sandy limestone), which are enveloped by the mechanically soft layer (calc-slate), also stretches in the layered-parallel extension (Ghosh, 1993).

Fig. (3) Nearly E-W trending quartz vein is cross cut by N-S veins (Loc. N17° 34′ 55.1″, E94° 55′ 55.8″, Facing; 120°)

Fig. (4) Semibrittle critea of en-echelon folds occurred in the Undifferentiated Flysch Unit (Loc. N17° 34′ 18.8″, E94° 56′ 07.0″, Facing; 80°)

Fig. (5) Ductile necking and boudin showing layer parallel extension in the slate unit of the Undifferentiated Flysch Unit (Loc. N17° 41′ 06.8″, E94° 58′ 25.0″, Facing; 40°)

Fig. (6) Pinch and swell structure showin layered parallel extension in slate and intercalated sandy limestone of Undifferentiated Flysch Unit (Loc. N17° 41′ 24.7″, E94° 57′ 46.2″, Facing; E)

Brittle Deformation

Brittle deformation forms in the shallow parts of the earth crust, generally 5-10 Km below the Earth's surface, where it is dominated by the brittle mechanism, which produced such features as fracturing and faulting (Davis & Reynolds, 1996). Brittle deformation is favored by the relatively rapid increase of strain rate as that occurs during seismic events. The characteristic features of the brittle deformation in the study area are composed of faults, numerous joints and tension fractures and brecciation. The dominance of faulting and fracturing in brittle shear zones result in abrupt, discontinuous margins that truncate and offset markers.

At the Gyat Chaung area, the brittle deformation criterion of fault is observed in the greenish serpentinite (Fig. 7). Notable brittle characters of joints are occurred at the thick bedded sandstone unit of the Okhmintaung Formation. It indicates that the rocks of this area are deformed by different stress regimes (Fig. 8).

Brittle Ductile Deformation

Rock deformation is dominated by brittle mechanism in the upper level of the earth curst and by ductile mechanism at the deeper levels. The depth at which deformation switches from dominantly brittle to dominantly ductile mechanisms is called brittle ductile transition. Within the most continental crust, the brittle ductile transition generally occurs at 10-15 km below the earth surface. Brittle ductile shear zone contains boudins and rock fragments. At the microscopic study, the evidences of this deformation are microfaults, grain scale fractures, zone of microbreccia (Fig. 9) and cataclastic. The physical conditions permit brittle and ductile deformation to occur simultaneously (Davis & Reynolds, 1996).

At Mezali Chaung, the oriented thin section of the Undifferentiated Flysch Unit shows the brittle ductile deformation criteria of NE-SW trending vein cross cut by NW-SE vein. It shows that a left lateral strike slip fault was activated in this area (Fig. 10).

Fig. (7) NW-SE trending normal fault observed in the serpentinite rock body (Loc. N 17° 37′ 50.7″, E94° 58′ 05.3″, Facing; N)

Fig. (8) Brittle criteria of joints occurredin the Okhmintaung Formation (Loc. N17° 41′ 24.9″, E94° 59′ 15.3″, Facing; 230°)

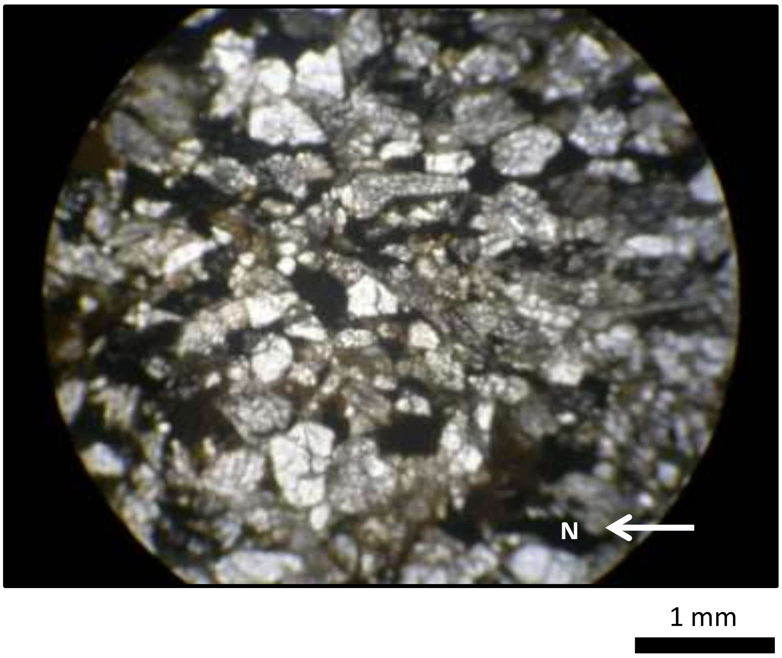


Fig. (9) Micro breccias in sand shale alteration unit of the Flysch Unit (Loc. N 17° 41′ 08.8″, E94° 58′ 28.0″)

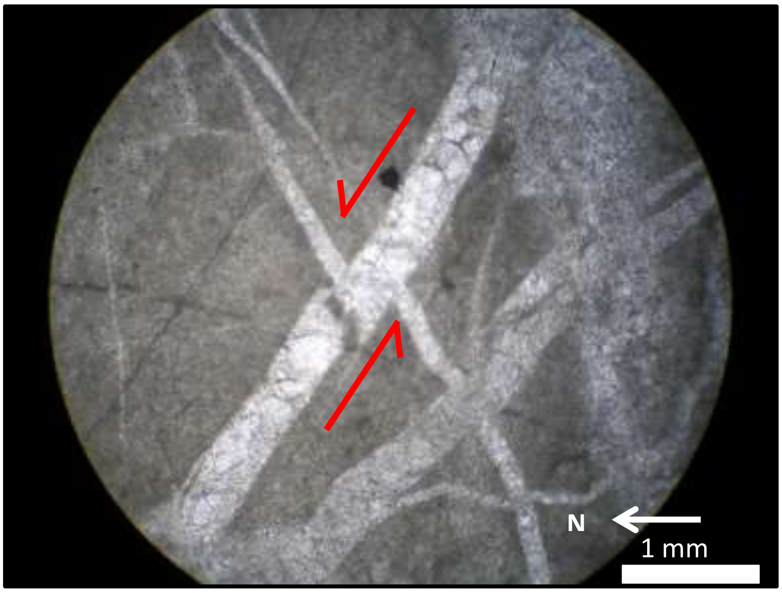
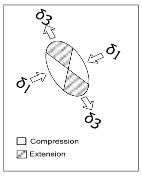
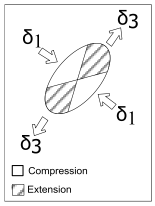
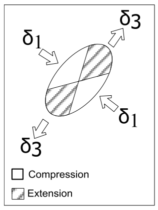


Fig. (10) Photomicrograph showing left-lateral shear deformation and two progressive deformation, (1) NW-SE left-lateral and (2) nearly E-W right-lateral observed at Undifferentiated Flysch Unit (Loc. N 17° 37′ 27.5″, E94° 57′ 53.8″)

Table (1) Possible deformation style of structural features in the research area

<table>
<tr><th>Rock Units</th><th>Sequence of Structural feature</th><th>Structural Trend</th><th>Character of Deformation</th><th></th></tr>
<tr><td rowspan="3">Okhmintaung Formation</td><td>Joint</td><td>NNW-SSE</td><td>Brittle</td><td rowspan="3">
</td></tr>
<tr><td>Faulting</td><td>None</td><td></td></tr>
<tr><td>Folding</td><td>None</td><td></td></tr>
<tr><td rowspan="3">Undifferentiated Molassic Unit</td><td>Joint</td><td>NE-SW</td><td>Brittle</td><td rowspan="3">
</td></tr>
<tr><td>Faulting</td><td>NE-SW</td><td>Brittle</td></tr>
<tr><td>Folding</td><td>NE-SW</td><td>Semibrittle</td></tr>
<tr><td rowspan="3">Paungyi Formation</td><td>Joint</td><td>NE-SW</td><td>Brittle</td><td rowspan="3">
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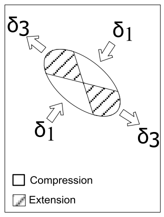
<tr><td>Faulting</td><td>Nearly N-S</td><td>Brittle</td></tr>
<tr><td>Folding</td><td>NE-SW</td><td>Semibrittle</td></tr>
<tr><td rowspan="4">Undifferentiated Flysch Unit</td><td>Lineation</td><td>N-S</td><td>Brittle ductile</td><td rowspan="4">
</td></tr>
<tr><td>Joint</td><td>NE-SW</td><td>Brittle</td></tr>
<tr><td>Faulting</td><td>Various direction</td><td>Brittle</td></tr>
<tr><td>Folding</td><td>NW-SE</td><td>Semibrittle</td></tr>
</table>

Conclusion

Some rock units are deformed into three different behaviors, such as (1) semi-brittle, (2) brittle and (3) brittle ductile behaviors. Semi-brittle deformation includes both brittle mechanism and some ductile aspects, such as en-echelon fractures and veins, ductile necking, boudins, and pinch-and-swell structures and shear fractures. Folding may be accommodated by brittle or semi brittle mechanisms. Brittle deformation forms in the shallow parts of the crust, generally 5-10 Km below the Earth's surface. Fracturing and faulting are dominant in this deformation. Brittle ductile shear zone contains boudins, rock fragments, microfaults, grain scale fractures, zone of microbreccia and cataclastic. Brittle deformation is more dominated and other two are moderately affected in the area and the stress field is various directions.

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