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GEOLOGY, STRATIGRAPHY, STRUCTURAL ANALYSIS AND PETROGRAPHY OF QALANDARABAD AREA WITH SPECIAL EMPHASIS ON TANOL FORMATION, HAZARA DIVISION, PAKISTAN

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Abstract

This research work displays an inclusive depiction of Geology, Stratigraphy, Structural analysis and Petrography of Qalandarabad area with special emphasize on Tanol Formation, Hazara Division, Pakistan. The analysis was carried out by the collection of different field samples from field areas; around the vicinity of Qalandarabad and their attached boundaries. Tectonically, the investigation area is a part of the northern metamorphic zone in the Lesser Himalayas and the major tectonic controlling feature is Panjal Thrust. Therefore, the structures developed in this area are mainly the result of this major thrust. The structures like joints, foliation surfaces and folds are analyzed by using stereographic plots. Stratigraphically, the area is comprised of Tanol Formation, Hazara Formation and Mansehra Granite. The petrographic studies of the Tanol Formation, Hazara Formation and a number of basic bodies are carried out to understand the mineralogical composition. The manuscript includes structural analysis of the Tanol Formation and geological mapping of 18-20 square Kilometers at a scale of 1:10,000.

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1. Introduction

Geographically the research area is a part of the outer southern ranges of Himalaya (covering 43F/3 & 43F/7) which is located 10 Km from Abbottabad along the Karakoram Highway (KKH) whereas Qalandarabad is the main locality/town of the area. The Himalayas have been divided into three parts, the Outer Himalayas, the Middle Himalayas, and the Central Himalayas. The project area is located in the Middle Himalaya (geographically) in the northwestern section of the chain. Most of the major valleys and gullies are aligned along the faults. At other places anticlines and anti-forms become the site of negative landforms. This trend is particularly well exhibited in certain areas. Many valleys in the studied area are located on anticlines whereas spurs on anticlines giving an inverted topography. Emerging technologies i.e. GPS, Oriana software for stereographic projections was applied for the best and precise results.

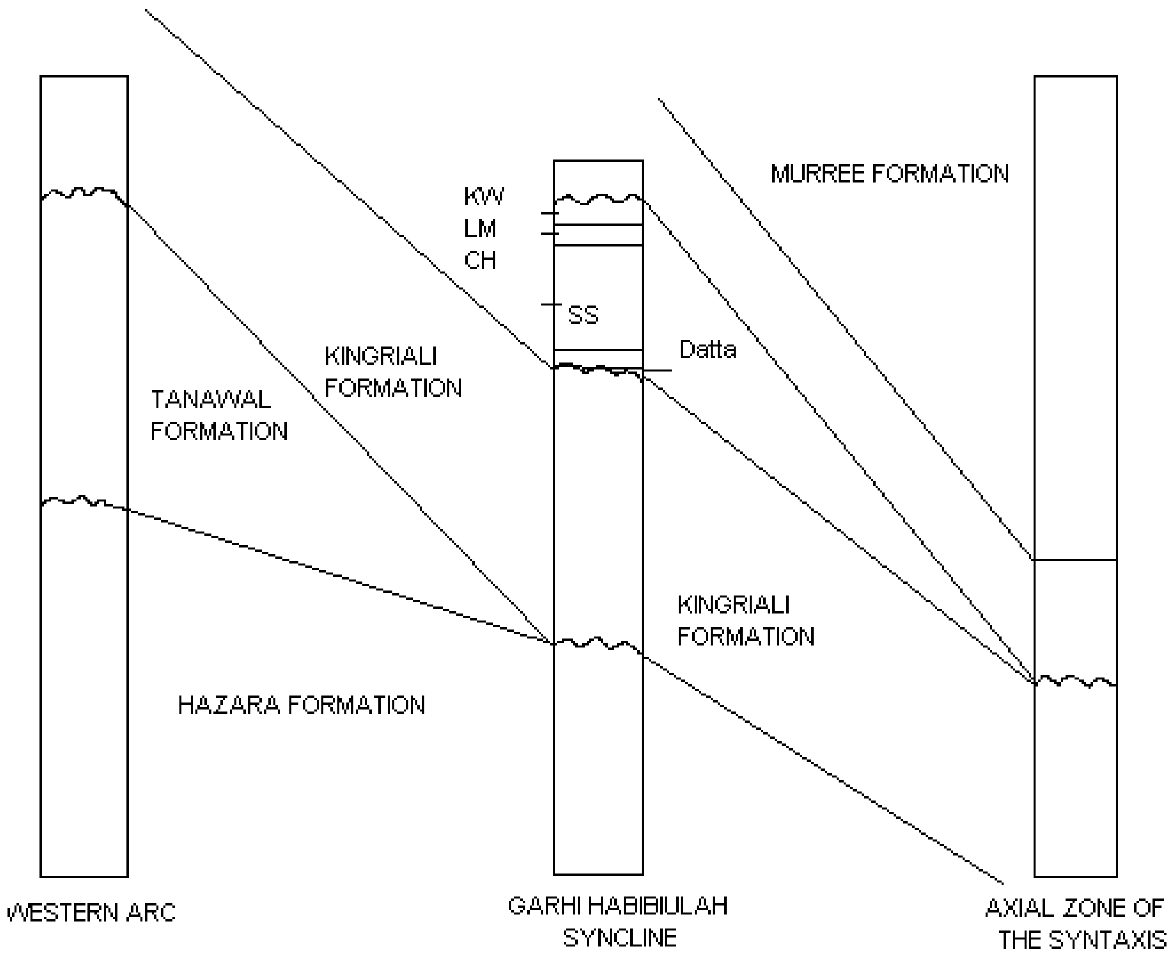
1.1. Tanol Formation/ Field observation

The observed lithology of Tanol Formation was mainly of quartzose schist, quartzite, and at places, layers and lenses of quartzose conglomerate (Plate.1). The unit is well exposed in the south and south eastern margin of the Mansehra Granite. In these areas, granite, biotite muscovite-quartz schist, and andalusite-staurolite schist constitute the greater part of the Tanol Formation. The Tanol formation underlies the Abbottabad formation and overlies the Hazara formation in the area between Abbottabad and the Indus River. The contact between the Abbottabad formation and the Tanol formation, in this area is marked by an unconformity which is represented by a boulder bed known as Tanaki conglomerate. Major lithologies at main localities are as follows, Mohayan area (metagreywacke and impure quartzite,) Manglaur (metagreywacke), Karer (impure quartzite folded, faulted having boundinage structures in the quartz,) Bihali (metagraywacke laminated, folded, faulted, foliated, jointed, and cross-bedding in lamination, quartz veins, and joint filled with quartz veins as well as having alluvium), Burjan (alluvium and Mansehra granite and intrusion of diabase, quartz veins showing cross-cutting behavior. A normal fault with in the Mansehra granite along with diabase intrusion was observed), Matial-Potha Area (metagraywacke, alluvium and schist), Shahila-Burj, (Mansehra granite having phenocrysts of larger size) and Tarnawai Area (metagraywacke showing s-type folding and also alternating layers of metamorphosed sandstone and shale). Intrusive Rocks (Mansehra granite & dolerite intrusions) & alluvium are also present in the research area. The Tanol formation is known only to be younger than the Hazara formation of Precambrian and possibly early Paleozoic age and older than the Abbottabad formation of Carboniferous to Triassic age.

1.2. Stratigraphy

Columnar sections (Fig.1) showing the stratigraphic correlation between the three structural areas. The description of the stratigraphic units is based upon information from all three. Undulating lines represent regional unconformities. The regional unconformities and rapid facies changes show that considerable tectonic activity must have taken place in the region long before the Himalayan orogeny, although any such earlier movements did not involve penetrative deformation and metamorphism (Calkins et al., 1975).

Fig.1: Correlation in the three structural blocks of the Southern Hazara- Pakistan and part of Western Kashmir.



1.3. Structural Analysis

The principal orientation data acquired during the field study consisted of measurement of planar structures i.e. foliation surfaces, joints, fold limbs and fault planes. This information's provided the frame work on which subsequent analysis of structural geometry was built.

1.4. Foliation Analysis

Foliation is the preferred orientation of planar fabric elements. It includes both primary and secondary planar surfaces. The project area comprises of low to medium grade metasedimentary rocks (meta gray-wacke, impure quartzite, phyllite, chlorite mica schist). In some rocks the original bedding was preserved while in others it was observed by the development of secondary foliation. A total 145 readings were taken of these planar features during the course of field work. Their orientation was analyzed by using stereographic techniques, the poles of these surfaces were plotted using Geo-orient software and a preferred orientation was found at N26ºW. So the direction of principal stress axis is found on the basis of stereographic plotted data in which the poles to the surfaces lie in the south east quadrant. The stress is generally perpendicular to these poles. Therefore, the stress direction from the plot is NW.

Fig. 2: Pole density diagram and contouring diagram Shown below:

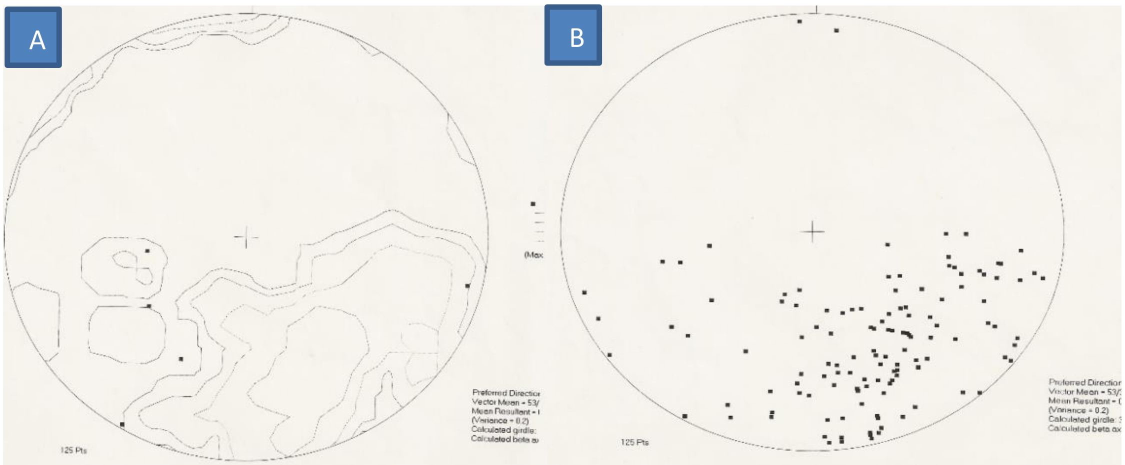
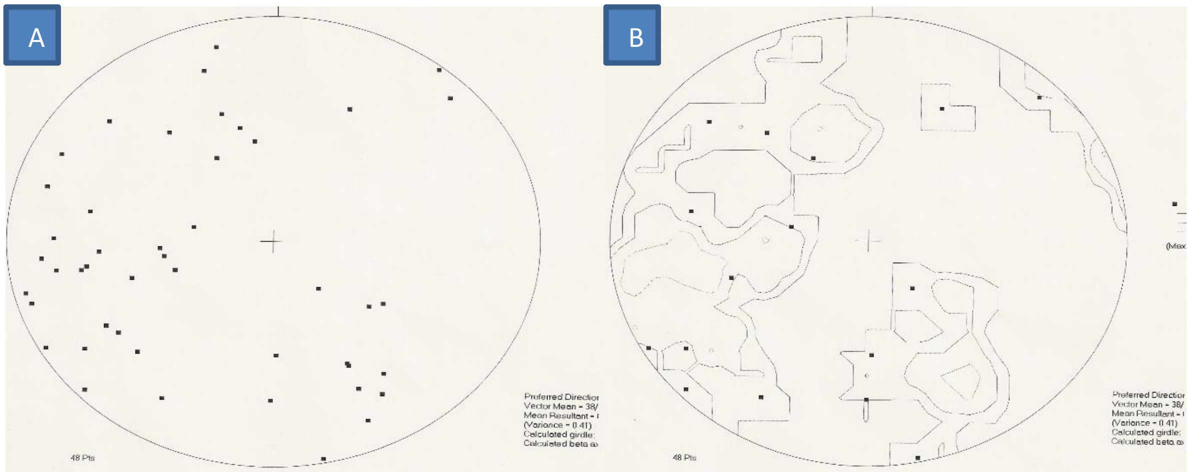


Fig. 2, Pole Density (B) and Contouring Diagram (A) showing direction of principal stress axis found on the basis of stereographic plotted data in which the poles to the surfaces lie in the south east quadrant. The stress is generally perpendicular to these poles. Therefore, the stress direction from the plot is NW.

1.5. Joint Analysis

The project area lies in the vicinity of the Panjal thrust and mainly longitudinal joints observed in this area. The data was taken in the form of dip and strike. To plot this data on Geo-orient stereographically, it arranged in the form of Dip direction. 48 readings were taken for the stereographic plotting. Stress direction was determined by the rose diagram in Oriana software. Poles diagrams are three dimensional stereographic displays of strike and dip data. Preferred orientation of fractures emerged from pole diagram are dense clustering of poles to joints. The orientation of the center of distribution represents the average orientation of the set.

Fig. 3: Stereographic projections (A) Rose diagrams and Strike histograms (B) the maximum principal stress direction is (δ1) and found as (N 35º E).



1.6. Fold Analysis

The folds in the project area were mostly small scale having small wavelength and the result of buckling (layer parallel compression) as greatly plays no important role in such folds (Ramsey et. al., 1984). These parasitic folds have their axial trace orientation parallel to the regional strike of the area, so these are in phase (formed by same stresses or result of single generation of fold) with larger folds. In such highly deformed areas these are generally multiphase of folding; however, these folds are result of same forces. These folds are analyzed by using stereographic projection using л-diagram and β-diagram (Ramsey et. al., 1984). Fold-1: By adopting the β and л- diagrams procedure we determined the fold axis and type of folds. L1=252º/89ºN and L2=225º/60ºN Orientation of this fold axis is 253/40 and inter limb angel is 125º which is the type of open fold (F-G-H Blyth and M.H.de Freitas, 1984, Ramsey1984 and Fleuty 1964). It is plunging moderately in W-SW direction shown in Fig (4 upper part). Fold-2: L1=210º/41ºNW and L2=215º/85ºNE Orientation of this fold axis is 214º/04º, it is gently plunging at angel of 04º in SW direction and the inter limb angel is 55º which show that it is a close fold. (F-G-H Blyth and M.H.de Freitas, 1984, Ramsey1984 and Fleuty 1964) shown in Fig (4 lower part). Fold-3: L1=100º/50ºN and L2=195º/85ºW Orientation of the fold axis is 010º/50º, it is moderately plunging towards N-NE direction and the inter limb angel is 86º which is a tight fold (F-G-H Blyth and M.H.de Freitas, 1984, Ramsey1984 and Fleuty 1964). Axial plane direction is N26ºW/64º NE, it is steeply inclined shown in Fig (5 upper part). Fold-4: L1=081º/74ºN and L2=065º/85ºS Orientation of the fold axis is 068º/36º, it is moderately plunging towards E-NE and the inter limb angel is 24º which is a close fold (F-G-H Blyth and M.H.de Freitas, 1984, Ramsey 1984 and Fleuty 1964) and its axial plane is nearly vertical shown in Fig (5 lower part).

Fig. 4: Shows the plunging directions of two folds (Fold-1 &Fold2) from W-SW direction

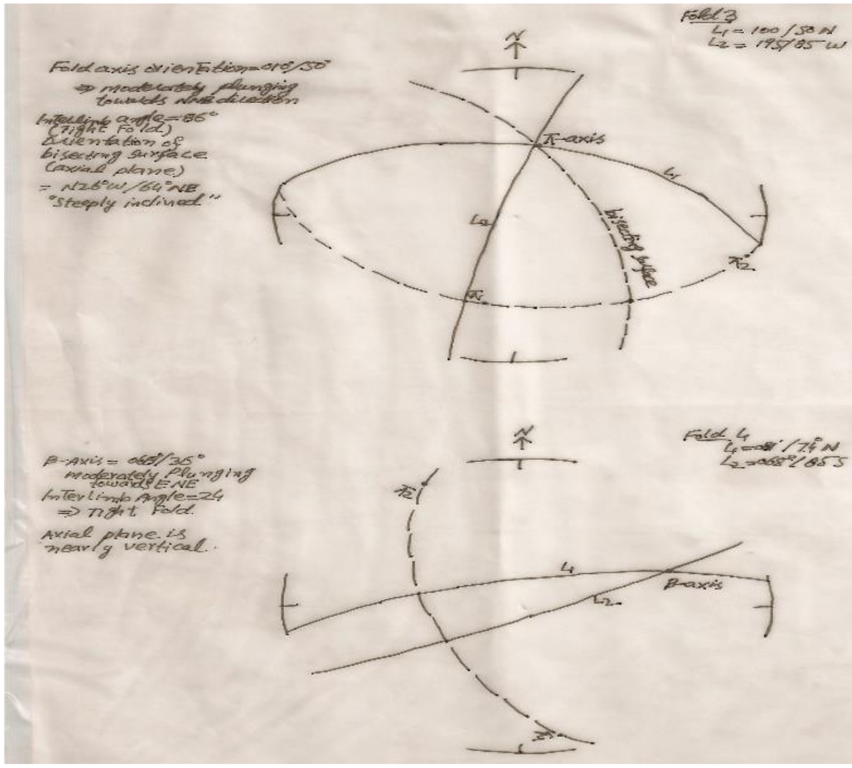
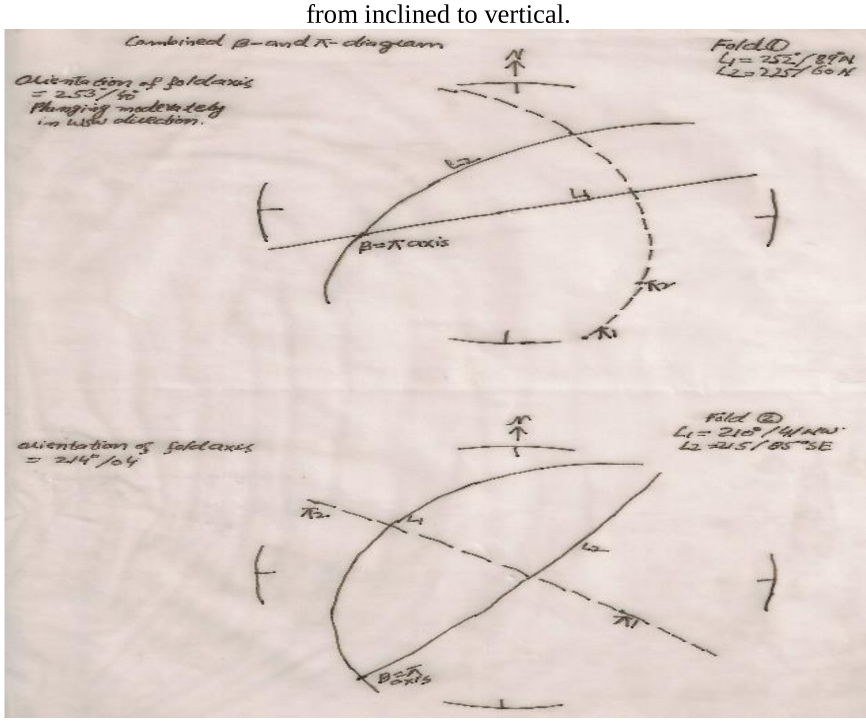
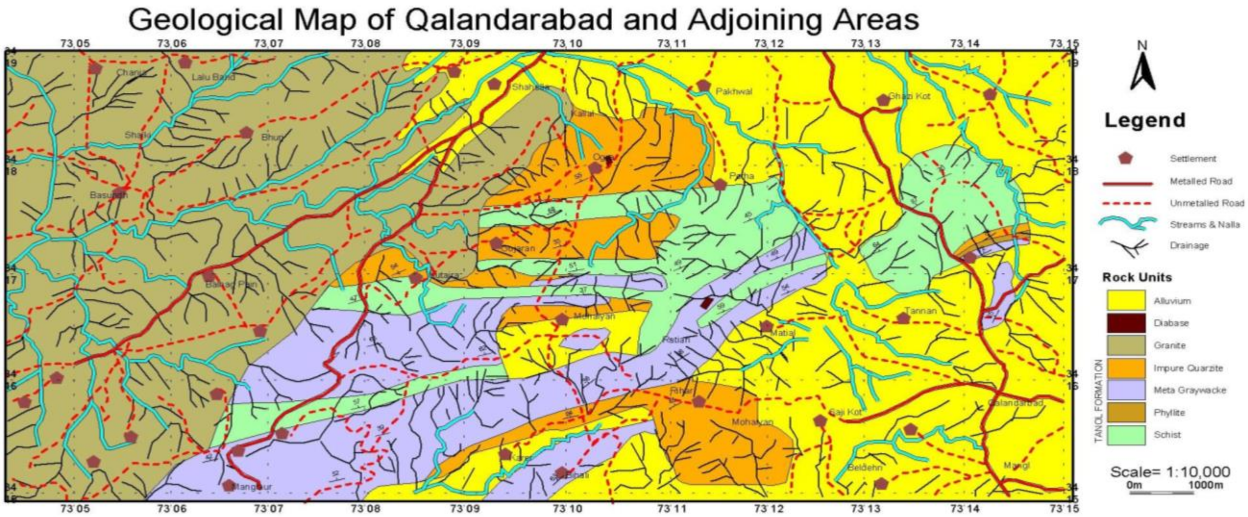


Fig. 5: Shows the plunging directions of Fold 3 &Fold 4 from N-NE and E-NE as well as their axial plane directions from inclined to vertical.





2. Method and Material

All available data in form of reports, maps or other research workers including private entities were collected. Field work were initiated after desk studies. Following steps were carried out to execute the field. Field investigation and reconnaissance of the desired areas. Samples collections from all the areas for laboratory analysis. Large scale geological mapping of the study area. Different rock samples exposed at different localities were collected for further laboratory works. Thin sections of the oriented field samples from exposed rock units prepared and studied under microscope (Plate.2).

2.1. Petrography

A total number of 35 slides were prepared for detailed petrographic studies of the area.

2.2. Sampling

The Tanol Formation lithology varies such as metagreywacke, impure quartzite, chlorite mica schist and phyllite. The area has also some exposures of Mansehra Granite and at some places intrusions of Diabase and Acidic veins (quartz) as well as exposures of Hazara Formation. So a diverse variety of samples including different lithologies of Tanol Formation, Mansehra Granite, Diabase and Quartz veins were collected.

2.3. Preparation of slides

In order to prepare the thin section of standard thickness 0.03 mm, first cut the chip of rock about 8-10 mm by using the rock cutter. Smoothen the one side of the chip by using carborundum powder on the window glass. Then these chips were mounted on the glass slide having thickness 1-2 mm with the help of epoxy, making sure that there would remain no air bubble between the rock chip and the glass slide. After 15-30 minutes the chips were grinded on a diamond wheel to reduce their thickness up to 0.03 mm and finally the slides were polished by using fine carborundum powder so that each grain should have clear visibility under microscope.

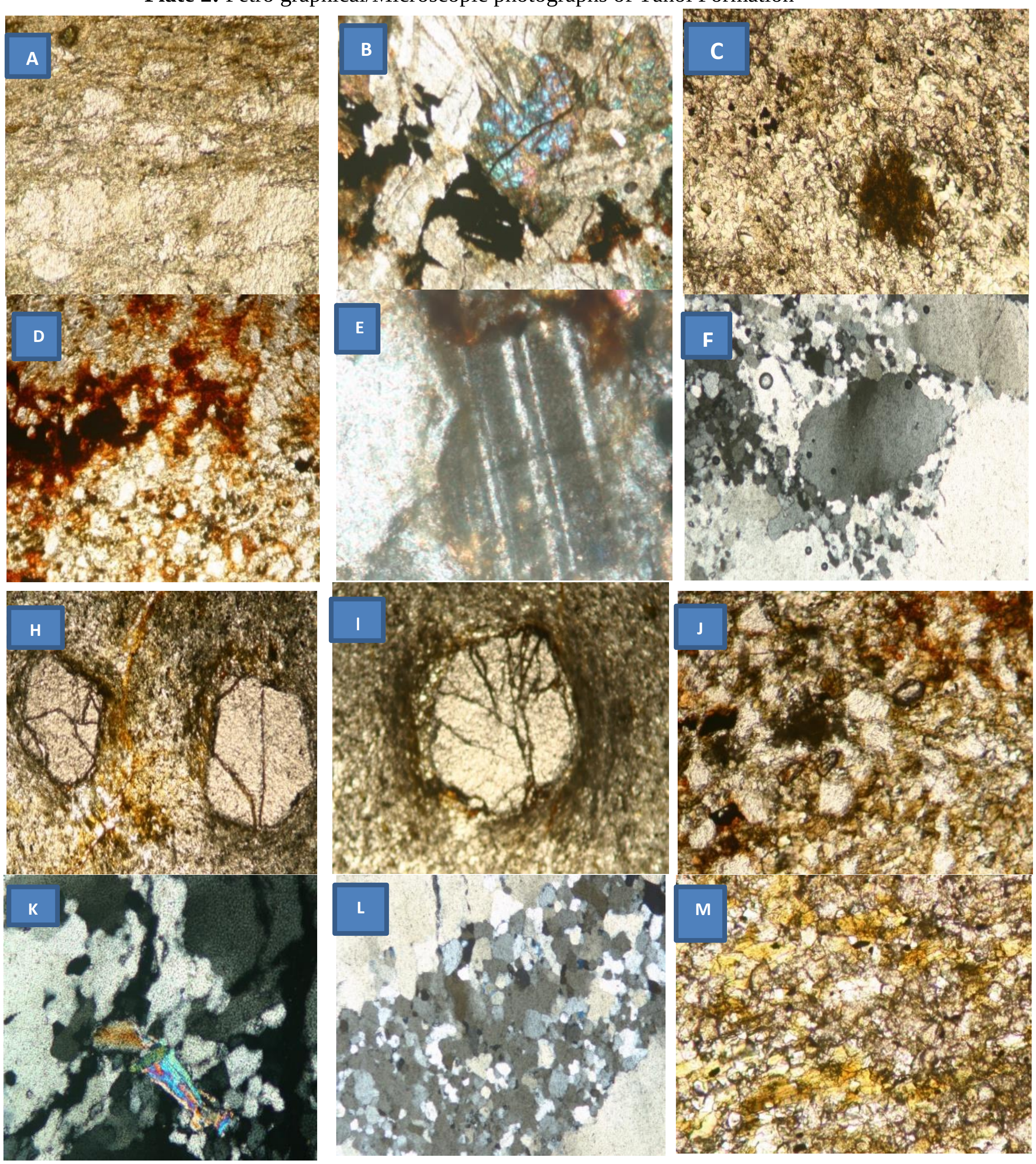
3. Conclusion and Recommendation

The conclusion and recommendations based on the research work is: The area was located near the Panjal thrust so all the structures developed in the studied area are the result of this major thrust or the off shoots of this major thrust. Different lithologies of Tanol Formation were mapped for first time though these lithologies were reported in the literature in the past but were not marked on the map. A detailed petrographic as well as mineralogy studies and petrographic interpretations of Tanol Formation were carried out. The direction of forces of the studied area are determined by using stereographic plots with the help of software Geo-orient. The direction of the forces was N26ºW in the case of foliation surfaces and N35ºE in case of joints. Further detailed study in the area with respect to minerals prospects exploitations as well as detailed geological mapping also needed to be done by using latest techniques and software.

Plate 1: Outcrop exposure snapshots of Tanol Formation

Whereas, A: Fine laminated metagreywacke located on Data road, B: Impure quartzite located near Data village, C: Kink band present in schist located in Mansehra area, D: diabase and acidic vein located in metagreywacke near Mohiyan village, E: Plumose structure developed in impure quartzite near Bihali, F: Thrust fault present in Mansehra granite and diabase Intrusion, G: Development of fold due to creep movement in schist located near Potha village, H: Aligned phenocryst present in Mansehra granite and I: Alternating layers of metamorphosed sandstone and shale located on Tarnwai road.

Plate 2: Petro graphical/Microscopic photographs of Tanol Formation



Whereas Plate A. Showing Quartz rich layer contact with mica layer in PPL present in metagreywacke, Plate. B. Pyroxene cut by margin feldspar lath in XPL present in Diabase, C. Saphene zircon opaque grains in chloride bearing phyllite in PPL. D. Iron oxide patches in metagreywacke in PPL, Plate E. Feldspar grain showing albite twinning in XPL, F. Irregular embayed quartz grains in XPL due to acidic intrusion, G. Two garnet grain one is small and other is in PPL present in metagreywacke, H. Texture of metagreywacke quartz grains are surrounded by clay in PPL, I. Garnet mineral showing pressure shadow on one side in PPL (x10) garnet bearing cholite, J. Prismatic zircon in metagreywacke in PPL K. Fine grained aggregate of quartz in XPL Due to acidic intrusion, L. Muscovite flakes in quartz in XPL due to acidic intrusion & M. Fine grain biotite in schist in PPL. Note: PPL (Plain polarized view) (x 10), XPL (Cross Polarized view) (x4).

Reference

Ali, C.M (1962). The Stratigraphy of the southwestern Tanol area, Hazara, West Pakistan: Punjab Univ. Geol.Bull.2., p. 31-38

Calkins, A., Offield, T.W., Abdullah, S.K.M., & Tayyab Ali, S. (1975). Geology of the southern Himalaya in Hazara, Pakistan and adjacent area. Geological Survey Professional Paper 716-C.

Davis, G.H., & Reynolds,.J, (1984). Structral Geology of Rocks and Regions. New York: John Wiley & Sons, INC

Ibrahim Shah, S.M. (91977). Stratigraphy of Pakistan. Memoirs of the Geological Survey of Pakistan, vol.1

Javaid.S. & Pervaiz. R. 2000 Magnetic Survey of Lahore, Kasur, Okara, Bahawalnagar, Faisalabad and Sheikhupura District. Punjab, Pakistan. G.S.P... I.R.No.723

Javaid.S 2002 Computer applications in the evaluation of 2nd derivatives and residual of potential field data I.R.No 769.G.S.P…Quetta

Marks, P., & Ali, C.M. (1961). The geology of the Abbottabad area with special reference to Infra-Trias: Punjab Univ. Geol. Bull. 1, p. 47-55.

Middlemiss, C.S., 1896, The Geology of Hazara and the Black Mountains. India Geol. Survey Mem., v.26, 302 p.

Ramsey, G, & Huber, M.I. (1981). The Techniques of Modern Structural Geology. Vol. 2. p. 653-660 New York: Academic Press Harcourt Brace Jovanovich Publishers.

Rehman, A. (1961). A gravity study of the granites in the Mansehra Area, West Pakistan: Punjab Uni. Geol. Bull. 1, p 15-20.

Shams, F.A. (1961). A preliminary account of the Mansehra area, Hazra district, West Pakistan: Punjab Univ. Geol. Bull. 1, p. 57-62.

Shahid Baig,M., Snee, L.W., La Fortune, R.J., & Lawrence, R.D. (1989). Timing of Pre-Himalayan orogenic events in the northwest Himalaya: 40Ar/Ar30 Constraints: Kashmir Journal of Geology. Vol. 6 & 7 p. 29-39.

Sherif, R.E., 1980, encyclopedic Dictionary of Exploration Geophysics, S.E.G., Tulsa Oklahoma.

Telford, Geldart, Sheriff & kery 1984 Applied Geophysics. Cambridge university press. Cambridge.

Telford, W.D., Geldart, L.P, and Sheriff, R.E., 1990. Applied Geophysics 2nd Ed, Cambridge University press, Cambridge.

Waagen, Wilhelm, and Wynne, A.B., 1872, The Geology of Mount Sirban in the Upper Punjab. India Geol. Survey Mem., v. 9, pt. 2, p.331-350.

Wadia, D.N., 1928, The Geology of Poonch State of Kashmir and adjacent portions of the northern Punjab. India Geol. Survey Mem., v. 51, pt. 2, p.185-370