Structural and stratigraphic evaluation of Kashmir Basin at Himalayan core Belt

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Abstract- As Hazara Kashmir Syntaxes is the part of Himalayan Fold and thrust belt situated in sub- Himalayan and the studied area lies in the southern part of the Hazara Kashmir Syntaxis Pakistan. The Hazara Kashmir Syntax is an antiformal structure. The core of syntaxis comprises of Himalayan molasse deposits. These molasse deposits ranging from Early Miocene to Recent are exposed in the area. This study deals with the structure and stratigraphy of Bator, Gawandh, Dhulian Jattan and Rajdhani areas of Azad Kashmir and Pakistan. The Himalayan molasse deposits are exposing in the southern Hazara Kashmir Syntaxis. The study area includes The Middle Miocene to Recent molasse sedimentary deposits are exposed in the project area. The exposed sedimentary sequence includes the Chinji Formation, Nagri Formation, Dhok Pathan Formation, Soan Formation and Recent alluvium. The area is deformed into folds and faults due to Himalayan orogeny. The major folds in study area are Palak Syncline, Gawandh Anticline, Rajdhani Syncline and Nar Saniah anticline. The folds are northwest southeast trending and northeast or southwest vergent. These folds are closed in nature. The study area consists of four major faults primarily Gawandh fault, Kotli Sarsawah fault and Bajwal Banyan fault. Dhongolo fault is the splay of the Kotli Sarsawah fault. Faults and folds are northwest southeast trending and are related to Himalayan compression.

Index Terms- Syntaxis, Kashmir Basin, lithology, folds, faults and plates.

I. Introduction

The study area is the part of Hazara Kashmir Syntaxis. It lies in districts Kotli and Mirpur, Azad Kashmir, Pakistan. This area includes Bator, Gawandh, Dhullian Jattan, and Rajdhani areas. The area lies between longitudes 73° 47' 30" to 73°50' 00" E and latitudes 33°15' 00" to 33° 23'20" N and lies on topographic sheet no 43 G /15 of the Survey of Pakistan (Fig 1.1, Plate 1). The project is located in the southeastern part of the Hazara Kashmir Syntaxes and is imbricated along Jhelum Fault, Riasi Fault, Punjal Thrust and Main Boundary Thrust (Baig and Lawrence, 1987). The western limb of the Hazara Kashmir Syntaxes terminated by regional Jhelum Fault (Figure 1.1). The exposed sedimentary sequence of the project area includes the molasse rocks sediments of Siwalik Group. The stratigraphic sequence includes Chinji Formation, Nagri Formation, Dhok Pathan Formation and the Soan Formation. The age of these formation ranges from Middle Miocene to Pliocene. The Recent alluvium overlies unconformably on the earlier rock formation. The workers like Ashraf *et al.* (1983), Wells and Gingerich (1987), and also Geological Survey of Pakistan carried only regional geological mapping and stratigraphic.

1. To prepare the geological and structural map of the project area.
2. To prepare detail structural cross sections of the area.
3. To prepare β and π diagrams for structural analysis of the area.

II. Methodology

The data acquired in 30 days field work Traverses were made along and across the strike of the different rock units (Plate1). The Brunton compass was used to measure the attitude of different bedding planes of rock units the in study area. The facing of rock units were determined on the basis of sedimentary structures. The structural data is plotted on the stereonet and presented in the tables. Cross-sectional profiles of structural and stratigraphic sequence was constructed. Distinguished feature of folds and faults have been recognized and with the help of this data mapping has been accomplished i.e Traverse route Map (Plate 1) Geological Map (Plate 2), Structural Map (Plate 3) and Structural Cross-sections (4a, 4b, 4c, 4d, 4e, 4f, 4g and 4h).

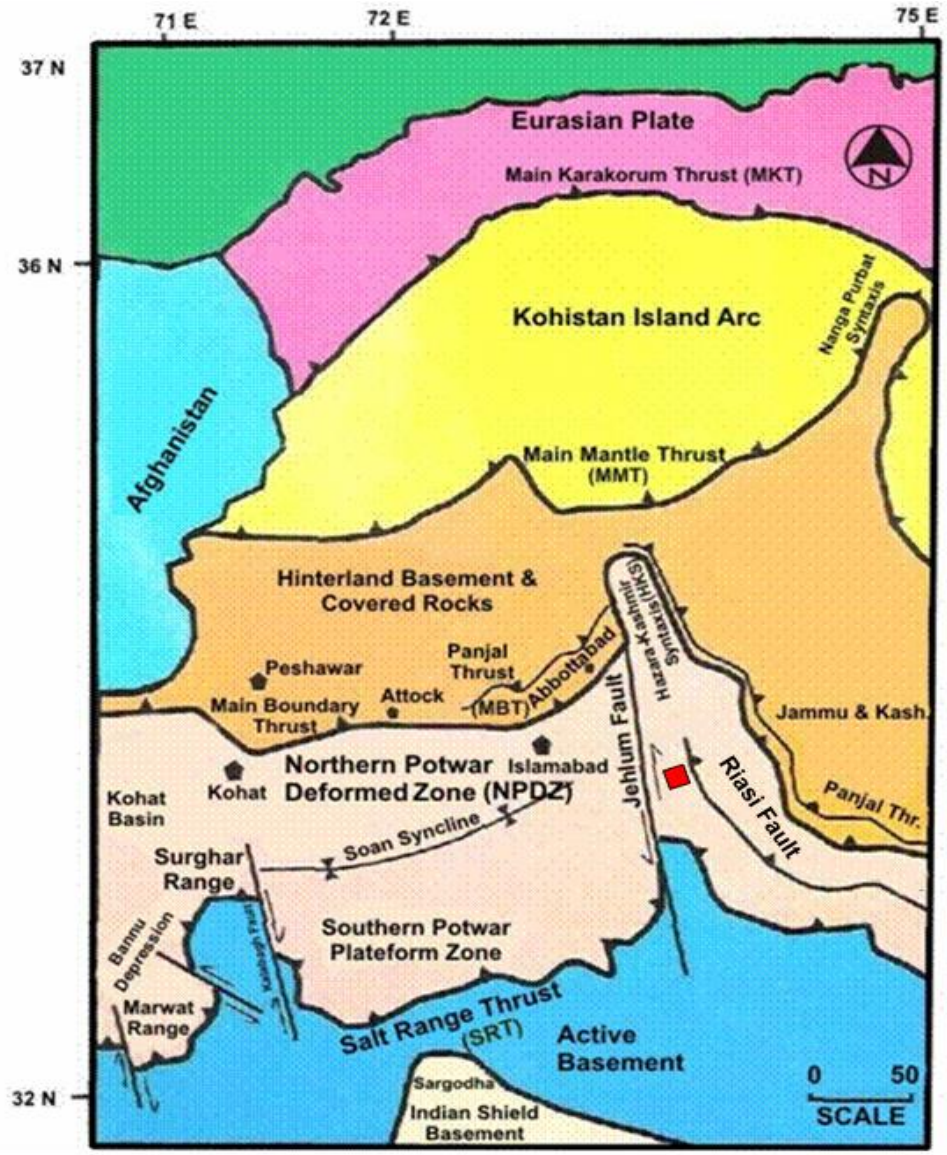

Figure 1.1 Regional tectonic map of the northwest Himalayas of Pakistan. The rectangle shows the location of the area (Modified after Baig and Lawrence 1987; Monaliza and Azam, (2004).

Table 2.1 Stratigraphic sequence of the Kashmir Basin

Formation	**Age**	**Description**
Quaternary alluvium	Recent	Consist of silt, gravel and unconsolidated deposits of clay
…….Unconformity…….		
Mirpur Formation	Pleistocene	Consist of conglomerates having cobbles and pebbles of igneous, metamorphic and sedimentary rocks
…….Unconformity…….		
Soan Formation	Pliocene	Consists of clays, claystone and grey sandstone. Clays are brown, yellowish grey in colour
Dhok Pathan Formation	Late Miocene	Dominantly consists of sandstone, siltstone and clays. Sandstone is grey, fine to medium grained and medium to thick bedded
Nagri Formation	Late Miocene	Dominantly it consists of greenish grey sandstone, siltstone and clays. Sandstone has massive beds and has medium to coarse grained texture. Sandstone alternates with clay and are 70% and 30% respectively.
Chinji Formation	Middle to Late Miocene	Red to purple, greenish grey, ash grey sandstone and siltstone and purple and reddish brown mudstone. 40% clays and 60% sandstone.
Kamlial Formation	Early to middle Miocene	Mainly sandstone, clays and intraformational conglomerates
Murree Formation	Early Miocene	Mostly clays, shales and sandstone. Sandstone is red to purple red in colour and is fine to medium grained.
Kuldana Formation	Middle to Late Eocene	Variegated shales with subordinate sandstone. Shales are arenaceous.
Chorgali Formation	Early Eocene	Mostly Calcareous shale, limestone and dolomitic limestone
Margalla Hill Limestone	Early Eocene	Dominantly nodular fossiliferous limestone with subordinate shales
Patala Formation	Late Paleocene	Mainly shales interbedded with marl and limestone
Lockhart Limestone	Early Paleocene	Grey to dark grey limestone with subordinate shales
Hangu Formation	Early Paleocene	Mainly Laterite, bauxite and fireclay
…….Unconformity…….		
Muzaffarabad Formation	Cambrian	Mainly Dolomitic limestone with cherty dolomite and chert bands.
……...Unconformity…….		
Dogra Formation	Precambrian	Slates, phyllite and shales with minor amount of limestone and graphite.
……Unconformity……		
Precambrian Basement rocks		

III. REGIONAL STRATIGRAPHY OF THE KASHMIR BASIN

In Kashmir basin the stratigraphic units constitute the cover sequence of Indian Plate. The early workers like (Wadia (1928), Lydekker (1883), Wells and Gingerich (1987)) have established regional stratigraphy of the area. The regional stratigraphy of Kashmir Basin is presented in table 2.1.

IV. STRATIGRAPHY OF THE STUDY AREA

The study area is comprises stratigraphic units of Siwalik Group of rocks. The exposed Siwalik group's stratigraphic sequence includes the Chinji Formation, Nagri Formation, Dhok Pathan Formation and the Soan Formation of Late Miocene to Pliocene and recent Alluvial cover (Table 2.2). These formations are described as under:

Table 2.2 The Stratigraphic sequence of the project area

Formation	Age	Description
Recent Alluvium	Recent	Unconsolidated deposit of clay, gravel, pebbles *etc.*
…… . . . ……Unconformity……...		
Upper Soan Formation	Pliocene	The Upper Soan Formation is composed of thick hard and massive conglomerates with minor clays.
Lower Soan Formation	Pliocene	The Lower Soan Formation is composed of sandstone and clay with subordinate conglomerate levels. The bentonite clay is also found in the lower part.
Dhok Pathan Formation	Late Miocene	Cyclic deposition of clay and sandstone, Ribbed topography, flaser or lenticular bedding, hard and compact conglomerate and pink garnet.
Nagri Formation	Late Miocene	Sandstone and clays. Sandstone massive and thickly bedded.
Chinji Formation	Middle to Late Miocene	Red to purple, grey, ash grey sandstone and mudstone. It consists of 60% clays while 40% sandstone.

Chinji Formation

The Chinji Formation is exposed near Gawandh and Hatta colony area (Plate 1 and 2). The Formation is dominantly composed of variegated clays (Photo 2.1) and sandstone. The clays are brown grey and purple. The sand stone is grey to ash grey coloured and is fine grained to medium grained. The clays are 60% to 70%. Intraformational conglomerates are also found in the Chinji Formation. The sand stone of Chinji Formation contains of quartz, muscovite, biotite, tourmaline, epidot and garnet. The Formation is underlain by the Kamlial Formation with a gradational contact while upper contact with the Nagri Formation is faulted in the study area. The age is Middle to Late Miocene.

Photo 2.1 Photograph showing different clay and grit level in Chinji Formation. Photograph facing Northeast (Station no. PR-1; Plate 1).

2.3.2 Nagri Formation

The Nagri Formation is exposed in our project area in Gawandh and Billi Puhrian areas (Plate 1 and 2). The Nagri Formation is mainly composed of sandstone and clays. The fresh colour of sandstone is greenish grey and weathered colour is dark grey to brownish grey. The sand stone is medium to coarse grain, and at places bluish grey and dull red. The sandstone in Nagri Fornation is 60% to 70%, while some parts of the Nagri Formation have 80% sandstone with subordinate clays. The characteristic feature of Nagri sandstone is salt and pepper texture. The shale is yellowish, reddish and blackish. The conglomerate layers are also present in the Formation having pebbles and gravels of older rocks like punjal volcanic and quartzite. The volcanic clasts are present in upper part of the Nagri Formation. The cross bedding (Photo 2.2) and load casts are the sedimentary structure observed in the Nagri Formation. The lower contact with the Chinji Formation is faulted while the upper contact with the Dhok Pathan Formation is gradational in the study area. The age of Nagri Formation is Late Miocene.

Photo 2.2 Photograph showing cross bedding in sand stone of Nagri Formation. Photograph facing northeast (Station no. BP - 3; Plate 1)

2.3.3 Dhok Pathan Formation

The Dhok Pathan Formation is exposed in Mera Kandi, Batar, Ganol, Palak, Dulian Jatta, Tarnat and Rajdhani area (Plate 1 and 2). The Dhok Pathan Formation is composed of sandstone with alternating clays and hard compact conglomeratic beds. The sandstone to clay ratio is 50:50 in the Dhok Pathan Formation. The sandstone is commonly grey, light grey, brownish red and greenish grey. The clay is orange, brown, dull red or reddish brown and greenish yellow. The sandstone of Dhok Pathan Formation is friable. Mineralogically, the Dhok Pathan Formation composed of garnet, epidote, quartz, mica, feldspar, hornblend and tourmaline.

The sedimentary structures like cross bedding, rip up, and load casts are observed in the study area. Lenticular bedding and the ribbed topography (Photo 2.3) are the characteristic features of the Dhok Pathan Formation. The Dhok Pathan Formation can be marked on the basis of ribbed topography and presence of pink garnet. The lower contact with the Nagri Formation is gradational while its upper contact with the Soan Formation is faulted in the study area. The age of the Dhok Pathan Formation is Late Miocene.

Photo 2.3 Photograph showing lenticular bedding in Dokh Pathan Formation. Photograph facing southwest (Station no. DB-4; Plate 1).

2.3.4. Soan Formation

The Soan Formation is exposed in study area near Dhonglo, near Chaksawari, Liaqatabad areas (Plate 1 and 2). The Soan Formation consists of compact, massive conglomerate levels, clays (Photo 2.4) with subordinate interbeds of varicoloured sandstone and siltstone.

2.3.4.1 Lower Soan Formation

The Lower Soan Formation is mainly exposed in Dhongolo and Mera Kandi. The Soan Formation is composed of sandstone and clay with subordinate conglomerate levels. The bentonite clay is also found in the lower part (Plate 1 and 2). The sandstone is friable, coarse grained and less compacted. The sandstone is composed of quartz, biotite, hornblend and garnet. Clays are khaki.

Upper Soan Formation

The Upper Soan Formation is mainly exposed in Dhonglo area. The Upper Soan Formation is composed of thick hard and massive conglomerates (Plate 1 and 2) with minor clays. The conglomerates contain pebbles and boulders of quartzite, limestone, cherty dolomite and granite gneisses. The clays are brown, yellowish and gray.) The age of the Soan Formation is Pliocene.

Photo 2.4 Photograph showing compact, massive conglomerate levels and clays in Soan Formation. Photograph facing northeast (Station no. DG- 4; Plate 1).

Recent Alluvium

The Recent deposits include terrace deposits and alluvium. These terraces are horizontally bedded clays and gravels which are yellowish in color. It unconformably blankets the bed rocks of different ages. The age of the alluvium is Recent.

STRUCTURE

The project area is a part of Sub Himalayas of Pakistan. The area is tectonically very active containing mostly regional folds and faults. This area lies in the southern Hazra Kashmir Syntaxis. The Hazara Kashmir Syntaxis is an antiformal structure which is formed by the folding of Himalayan thrust sheets. The project area is bounded by Jhelum Fault to the west, Riasi Fault to the east and the Salt Range thrust to the south. The folds of the project area are northwest southeast trending. Structurally the project area is highly deformed. The different structures like folds and faults are present in the area. The detailed description of the structures of the area is described as under:

a. Folds

Study area composed four regional folds. These folds are the Palak syncline, Rajdhani syncline, Gawandh anticline and Nar Saniah anticline. These folds are northeast vergent closed folds.

1. Palak Syncline

The Palak syncline is formed by the folding of Nagri Formation and Dhok Pathan Formation (Plates 3, and 4a; Cross section EE´, FF´ and GG´). The Dhok Pathan Formation lies in the core whereas Nagri Formation is on the limbs of the Palak syncline.

The strike of the northeastern limb varies from N30°W to N52°W, whereas the strike of the northeastern limb varies from N45°W to N55°W. The dip of northeastern limb varies from 60°SW to 61°SW whereas, southwestern limb ranges from 51°NE to 60°NE (Table 3.1).

The northeastern limb is relatively steeper than the southwestern limb. The attitude of axial plane varies from N45°W/89°SW to N47°W/85°SW. The trend and plunge of fold axis varies from 4°/315° to 10°/313° (Table 3.1; Plate 3; Fig. 1.2; Figs β1 and β2). The Palak syncline is a northwest plunging and northeast vergent fold. The interlimb angle varies from 60° to 69°. On the basis of interlimb angle the fold is classified as a closed fold.

Table 3.1 Structural data for the Palak Syncline

Attitude of bedding		**Axial plane**	**Fold axis**	**Interlimb angle**	**Type of fold**
Northeastern limb	**Southwestern limb**				
Northwestern					
Part (β_1) N52°W/60°SW	N55°W/60°NE	N45°W/89°SW	4°/315°	60°	Closed

Southeastern					
Part (β_2) N30°W/61°SW	N45°W/51°NE	N47°W/85ºSW	10°/313°	69°	Closed

2. Gawandh Anticline

The Gawandh Anticline is formed by the folding of Nagri Formation and Dhok Pathan Formation (Plates 2, 3, and 4a; Cross section CC´, DD´, EE´ and FF´). The Nagri Formation is in the core while the Dhok Pathan formation is on the limbs of the anticline (Plates 3, and 4a, Photo 2.5, 2.6, Plate 1). The strike of the northeastern limb ranges from N25°W to N45°W, whereas the strike of the southwestern limb varies from N42°W to N58°W. The dip of the northeastern limb ranges from 60°NE to 60°NE, whereas the dip of the southwestern limb varies from 30°SW to 40°SW. The Gawandh anticline is faulted anticline. The core of the Gawandh anticline is faulted due to the Gawandh fault.

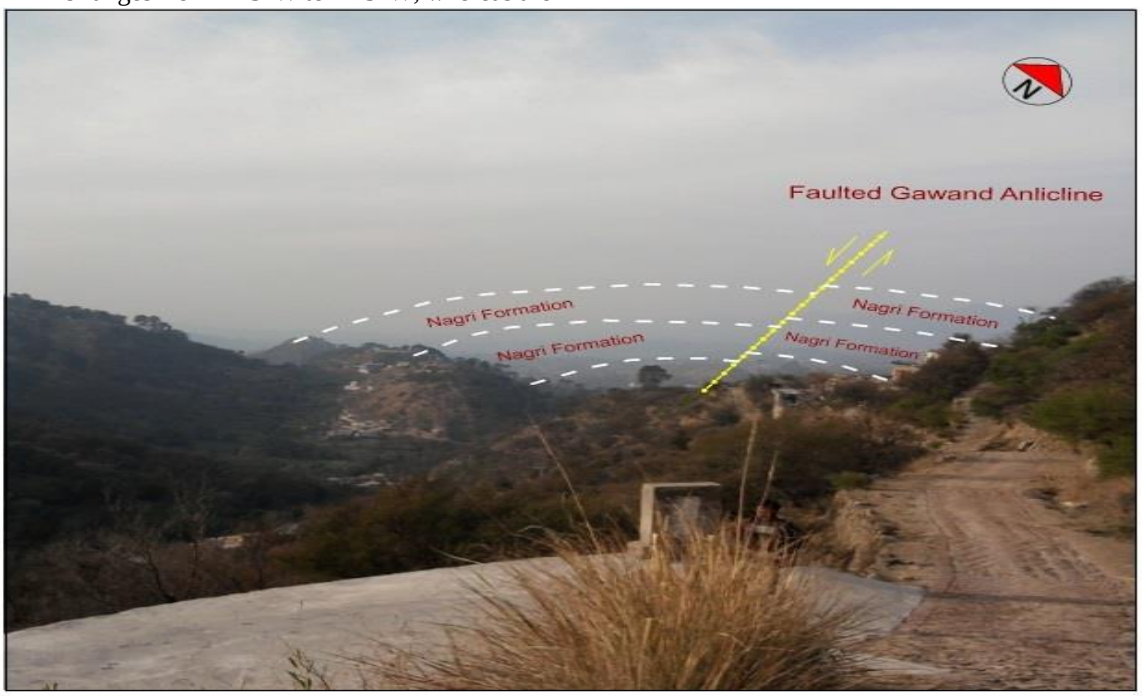

Photo 2.5 Photograph showing core faulted Gawandh Anticline. Photograph facing southwest (Station no. JD-7; Plate 1).

3. Rajdhani Syncline

The Rajdhani Syncline is formed by the folding of Nagri Formation and Dhok Pathan Formation (Plates 3, and 4a; Cross section BB´, CC´ and DD´). The Dhok Pathan Formation is in the core whereas the Nagri Formation lies on the limbs of the Rajdhani syncline (Photo 2.6 and 2.7, Plate 1)

The strike of the northeastern limb ranges from N19°W to N52°W, whereas the strike of the southeastern limb varies N28°W to N60°W. The dip of the northeastern limb ranges from the 32°SW to 39°SW, whereas the dip of southwestern limb varies from 60°NE to 63°NE (Table 3.2).

The southwestern limb is relatively steeper than the northeastern limb. The attitude of the axial plane varies from N23°W/79°SW to N66°W/80°SW. The trend and plunge of the fold axis varies from 4°/294° to 6°/156° (Table 3.2; Plate 3; Fig. 1.2; Figs β3 and β4). The Rajdhani syncline is doubly plunging and northeast vergent fold. The interlimb angle varies from 71° to 85° (Table 3.2). On the basis of the interlimb angle the fold is classified as a closed fold.

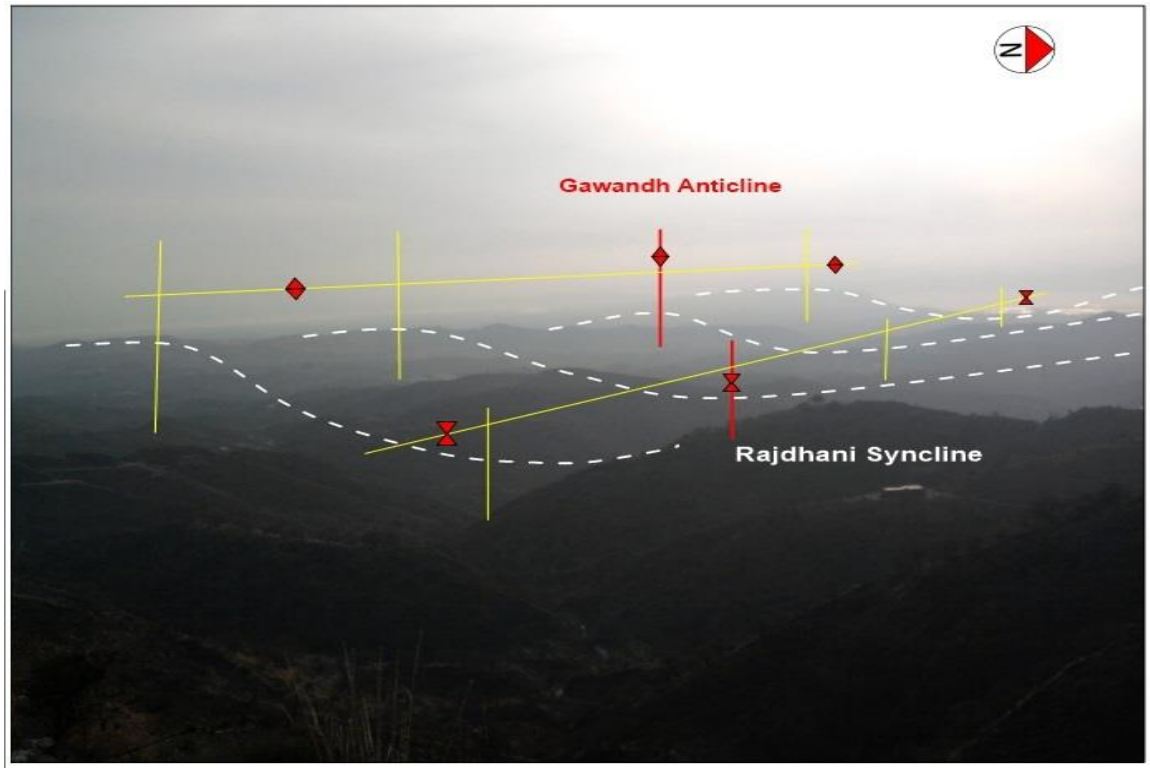

Photo 2.6 Photograph showing reginal view of Gawandh Anticline and Rajdhani Syncline. (Station no.PR-2; Plate1).

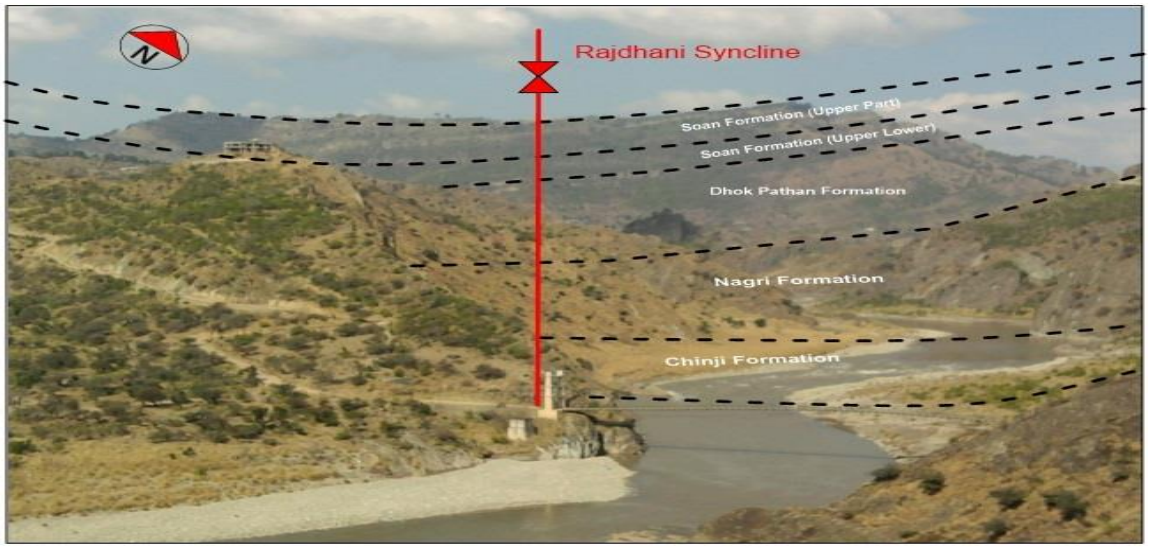

Photo 2.7 Photograph showing Rajdhani Syncline. Photograph facing southwest (Station no. RJ-4; Plate 1).

Table 3.2 Structural data for the Rajdhani Syncline

Attitude of bedding		Axial plane	Fold axis	Interlimb angle	Type of Fold
Northeastern limb	Southwestern limb				
Northwestern					

Part (β_3) N52°W/32°SW	N60°W/63°NE	N66°W/80°SW	4°/294°	85°	Closed
Southeastern Part (β_4) N28°W/39°SW	N19°W/60°NE	N23°W/79°SW	6°/156°	71°	Closed

4. Nar Saniah Anticline

The Nar Saniah anticline is formed by the folding of Nagri Formation and Chinji Formation (Plates 3, and 4a; Cross section BB´). The Chinji Formation is in the core while the Nagri Formation is on the limbs of the anticline (Photo 2.8). The strike of the southwestern limb ranges from N32°W to N38°W while the dip of southwestern limb varies from 41°SW to 42° SW. The northeastern limb is not exposed in our project area. The southwestern limb is exposed in Rajdhani and Hatta Colony area in the project area.

Photo 2.8 Photograph showing Nar Saniah Anticline and Bajwal Banyan fault. Photograph facing southwest (Station no. PR-3; Plates 1).

b. Faults

There are four major faults present in the project area are Gawandh Fault, Kotli Sarsawah fault, Bajwal Banyan fault and Dhonglo fault. These faults are reverse in nature.

1. Kotli Sarsawah Fault

The Kotli Sarsawah Fault is a reverse fault running northwest southeast in project area. The Kotli Sarsawah fault is in between Dhok Pathan Formation and Soan Formation (Plates 3, and 4a; Cross section EE´, FF´, GG´ and HH´). The Kotli Sarsawah fault is running northeast southwest. The Dhok Pathan Formation is thrusted over the Soan Formation. Gouge, breccias and drag folds are present along the fault plane. The Dhok Pathan Formation is exposed in the hanging wall block while Soan Formation is exposed in footwall block. The attitude of the hanging wall block is N45°W/39°SW to N50°W/48°NE. The attitude of fault plane is N48°W/85°NE.

Photo 2.9 Photograph showing Kotli Sarsawah fault. Photograph facing southwest (Station no. MK-8; Plate 1)

2. Gawandh Fault

It is the major fault passing through the project area which is reverse in nature. The Gawandh fault is a regional is intraformational fault passing through the Nagri Formation. The Gawandh fault cuts the core of Gawandh anticline. The northeastern limb of Gawandh anticline is thrusted over the southwestern limb (Plates 2, 3, and 4a; Cross section CC´, DD´, EE´ and FF´). The gouge and breccias are visible along the fault in the project area (Photo 2.10). It is passing through Gawandh area. The Gawandh fault is running northeast southwest. The attitude of hanging wall is N23°W/60°NE to N48°W/40°NE while the attitude of the foot wall is N39°W/40°SW to N50°W/60°SW. The attitude of fault plane is N43°W/80°NE.

Photo 2.10 Photograph showing intraformational Gawandh fault. Photograph facing northeast (Station no. GL-2; Plate 1)

3. Bajwal Banyan Fault

The Bajal Banyan fault is regional fault passing through the field area. The Chinji Formation is thrusted over the Nagri Formation along the Bajwal Banyan fault (Plates 2, 3, and 4a; cross section BB´). The fault is passing through the southwestern limb of the Nar Saniah anticline (Photo 2.8). The Bajwal fault is running northeast southwest. The Chinji Formation is exposed in the hanging wall while Nagri Formation exposed in the footwall.

The attitude of the footwall is N32°W/40°SW while the attitude of hanging wall block is N38°W/42°SW. The attitude of fault plane is N40°W/70°NE. The fault is reverse in nature.

4. Dhonglo Fault

The Dhonglo fault is a splay fault of Kotli Sarsawa fault. It is a reverse fault which has thrusted the lower part of the Soan Formation over the upper part of the Soan Formation (Plates 2, 3, and 4a; Cross section FF´, GG´ and HH´). The lower part of the Soan Formation acts as hanging wall while the upper part is the foot wall (Photo 2.11). The attitude of hanging wall block is N45°W/5°SW to N48°W/10°SW while the attitude of footwall block is N40°W/12°SW to N50°W/24°SW. The attitude of the fault plane is N45°W/80°NE.

Photo 2.11 Photograph showing Dhonglo Fault between Soan Formation upper and lower part. Photograph facing southwest (Station no. MK -1; Plate 1).

V. CONCLUSION

The project area lies in the southern part of Hazara Kashmir Syntaxis. The project area is comprised thick cover of sedimentary rocks of Himalayan molasse deposits. The molasses sequence exposed in the area includes the Chinji Formation, Nagri Formation, Dhok Pathan Formation and the Soan Formation.

The project area is highly deformed and regional folds and faults are present in the area. The faults are mainly thrust faults and northwest-southeast trending. The folds are tight to closed and southwest or northeast vergent.

The major folds in the area are Palak Syncline, Gawandh Anticline, Rajdhani Syncline and Nar Saniah Anticline.

The major faults in the area are mainly Gawandh Fault, Kotli Sarsawa Fault, Bajwal Banyan Fault and Dhonglo Fault.

VI. DISCUSSION

The project area lies along the so thern part of the Hazara-Kashmir Syntaxis in the sub-Himalaya of Pakistan which is developed after the Tertiary collision of the Indian and Eurasian Plates (Bossart*et al*., 1988). The south and southwestern part of the Hazara Kashmir Syntaxis is imbricted along Panjal thrust, MBT and Salt Range thrust (Baig and Lawrenece, 1987). The western limb of the Hazara Kashmir Syntaxis is displaced by left laterial strike slip Jhelum Fault. The core of the the syntaxis is highly deformed.

The sedimentary rocks are exposed in the area range in age from Middle to Late Miocene to Recent. These include the Chinji Formation, Nagri Formation, Dhok Pathan Formation, Soan Formation and Recent Alluvium.

The area is highly deformed into large scale folds and faults due to stresses produced by the tectonic activities. The major folds of the area are the Rajdhni syncline, Gawandh anticline, Palak syncline, and Nar saniah anticline.

The Rajdhani syncline is formed by the folding of Dhok Pathan Formation and Nagri Formation. The Dhok Pathan Formation is in the core where as Nagri Formation lies on limbs. The southwestern limb is relatively steeper than the northeastern limb. It is northeast vergent and doubly plunging fold.

The Gawandh anticline is formed by the folding of the Nagri Formation and Dhok Pathan Formation. The Nagri Formation is in the core while the Dhok Pathan Formation is on the limbs. The core of the Gawandh anticline is faulted and cut by the Gawandh Fault. The Gawandh anticline is northwest southeast trending and northeast vergent Fold.

The Palak Syncline is formed by the folding of Dhok Pathan Formation and Nagri Formation. Dhok Pathan Formation is in the core while the Nagri Formation lies on the northeastern limb. The southwestren limb is cut by the Kotli Sarsawah Fault due to which Soan Formation is thrusted over the Dhok Pathan. The Palak

Syncline is northwest southeast trending and northeast vergent Fold.

The Nar-Saniah anticline is formed by the folding of Nagri Formation. The vergence of the fold is north or southwest limb. The Nar- Saniah anticline is a faulted anticline. The southwestern limb of the anticline is cut by Bajwal –Banyan fault.

The major faults are the Kotli Sarsawa fault, Gawandh fault, Bajwal Banyan fault and Dhonglo fault. The kotli Sarsawa fault is a reverse fault which separates upper part of the Soan Formation from the lower part of the Dhok Pathan formation. The Dhok Pathan Formation lies in hanging wall and Soan Formation in foot wall of the Kotli Sarsawa Fault. The Gawandh fault is reverse fault marked between the upper between upper and lower part of the Nagri Formation. The lower part of the Nagri Formation lies in the hanging wall and upper part of Nagri Formation in foot wall of the Gawandh Fault.

The Bajwal Banyan fault is a reverse fault between Chinji Formation and the Nagri Formation in which Chinji Formation is thrusted over the Nagri Formation. The Chinji Formation lies in the hanging wall and Nagri Formation in foot wall of the Bajwal Banyan Fault. The Dhonglo fault is also reverse fault in which lower part of the Soan Formation is thrusted over the upper Soan formation in the project area. The primary sedimentary structures like load casts, ripple marks and cross bedding are present in the study area.

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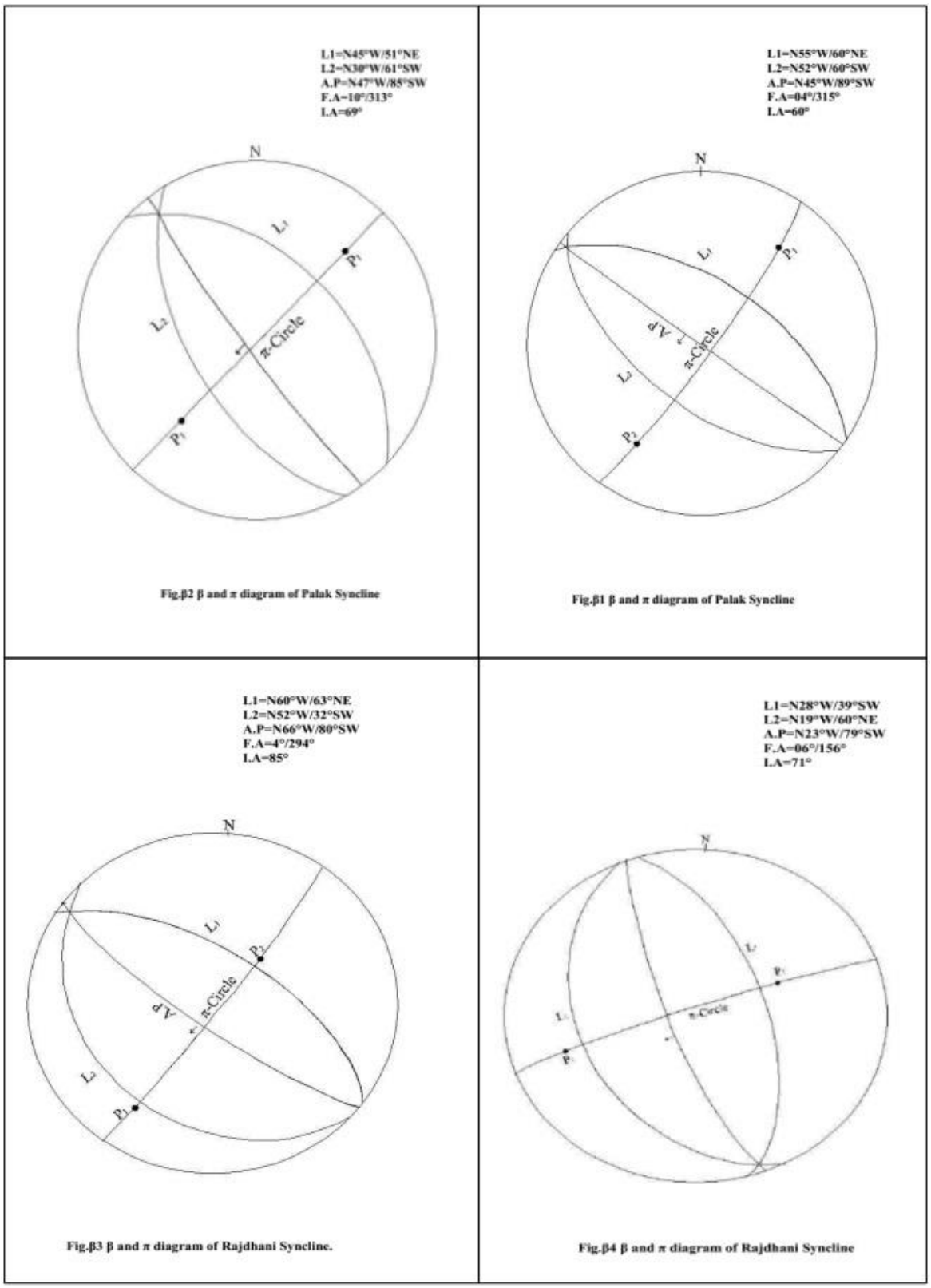

Figure: 1.2. Beta Diagrams.

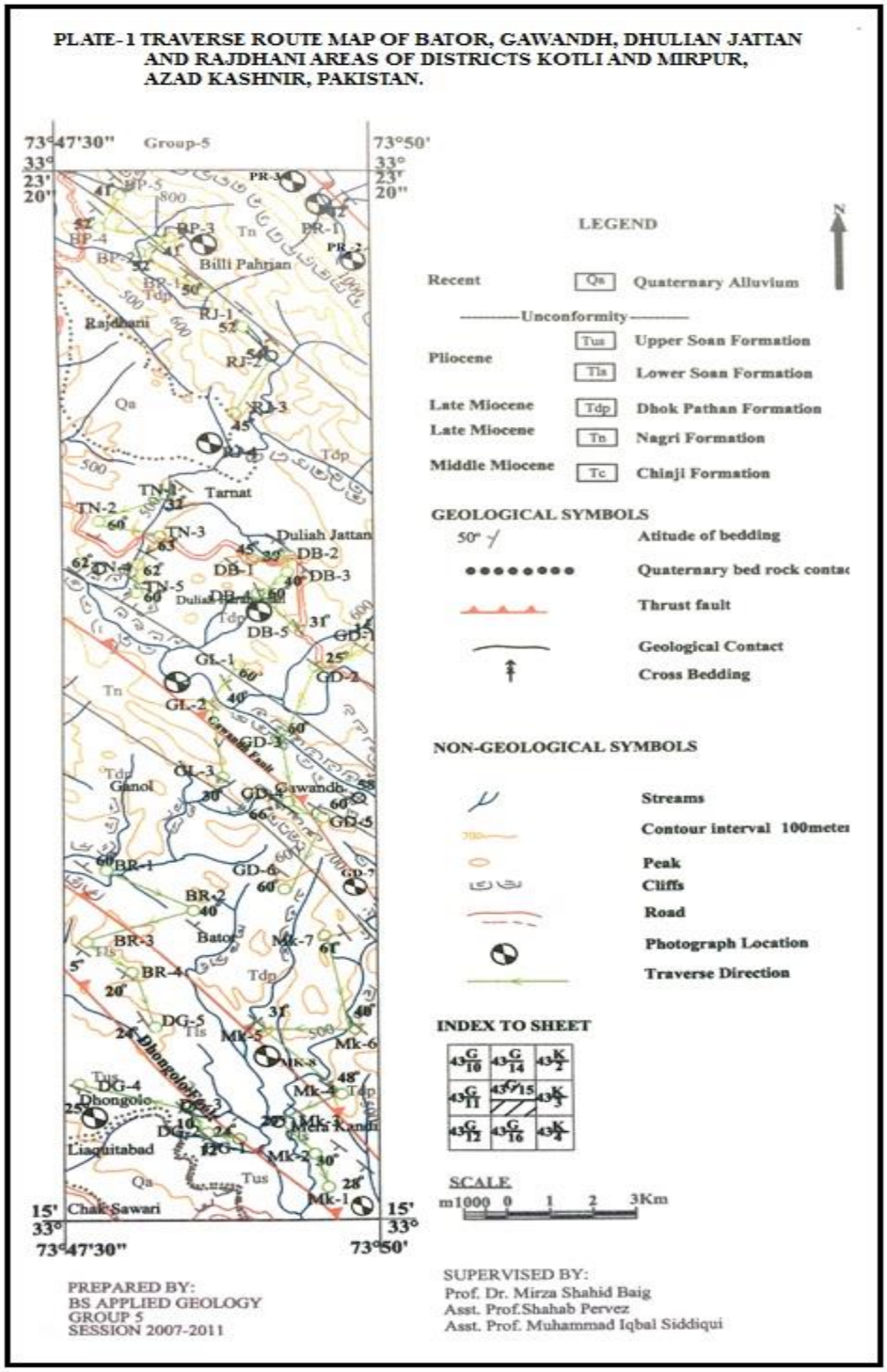
PLATE-1 TRAVERSE ROUTE MAP OF BATOR, GAWANDH, DHULIAN JATTAN AND RAJDHANI AREAS OF DISTRICTS KOTLI AND MIRPUR, AZAD KASHNIR, PAKISTAN.
73°47'30"
Group-5
73°50'
33° 23' 20"
Billi Pahrian
Rajdhani
Tarnat
Duliah Jattan
Gawandh
Ganol
Bator
Dhongolo
Liaquitabad
Chak Sawari
Gawandh Fault
Dhongolo Fault
Mela Kandi
LEGEND
Recent
Qa
Quaternary Alluvium
Unconformity
Pliocene
Tus
Upper Soan Formation
Tls
Lower Soan Formation
Late Miocene
Tdp
Dhok Pathan Formation
Late Miocene
Tn
Nagri Formation
Middle Miocene
Tc
Chinji Formation
GEOLOGICAL SYMBOLS
Atitude of bedding
Quaternary bed rock contac
Thrust fault
Geological Contact
Cross Bedding
NON-GEOLOGICAL SYMBOLS
Streams
Contour interval 100meter
Peak
Cliffs
Road
Photograph Location
Traverse Direction
INDEX TO SHEET
SCALE
m1000 0 1 2 3Km
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SESSION 2007-2011
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PLATE-2 GEOLOGICAL MAP OF BATOR, GAWANDH, DULLIAN JATAN AND RAJDHANI AREAS OF DISTRICTS KOTLI AND MIRPUR, AZAD KASHMIR, PAKISTAN.

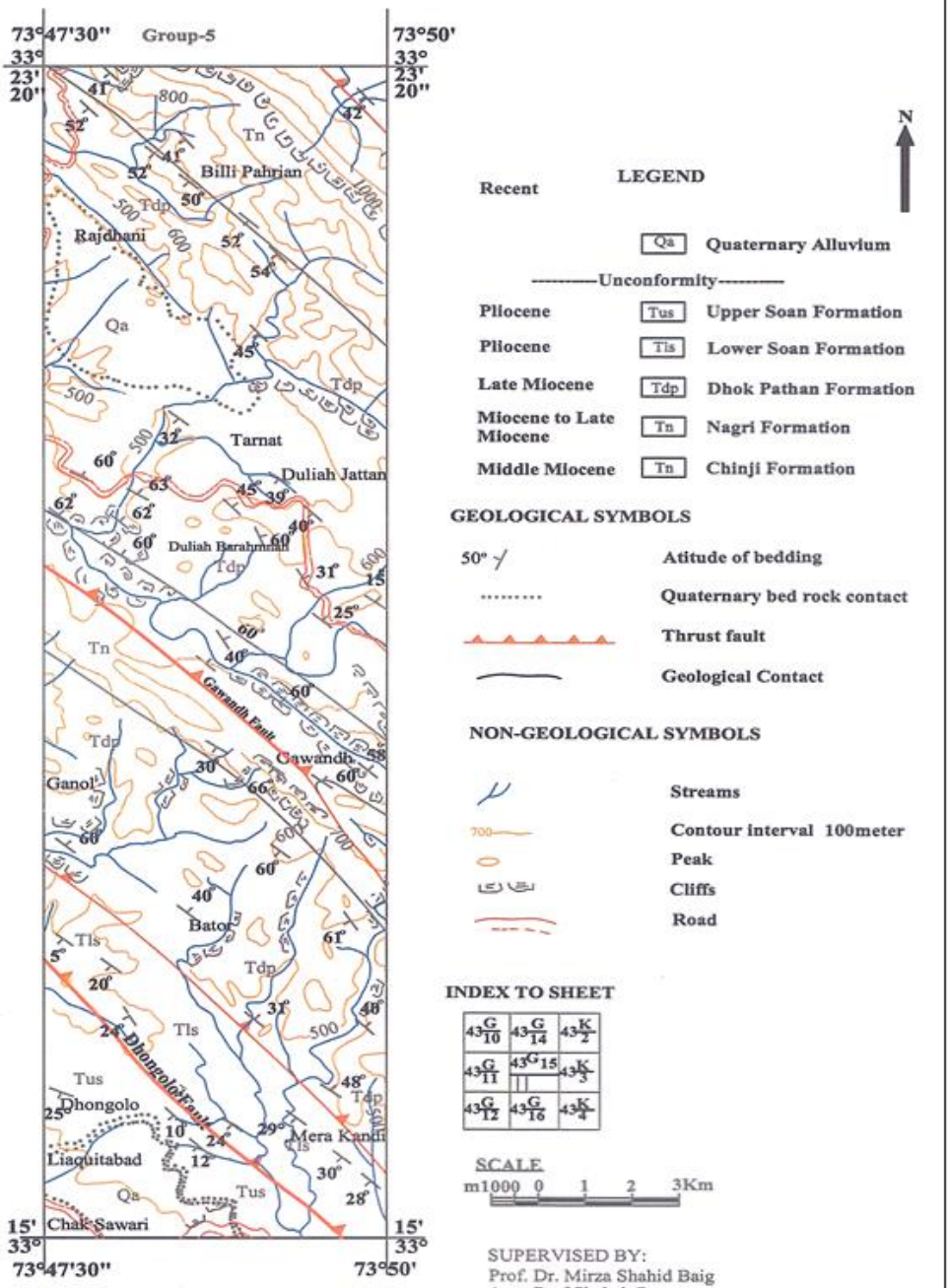

PLATE-3 STRUCTURAL MAP OF BATOR, GAWANDH, DULLIAN JATAN AND RAJDHANI AREAS OF DISTRICTS KOTLI AND MIRPUR,AZAD KASHMIR, PAKISTAN.

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PLATE - 4a STRUCTURAL CROSS SECTIONS OF RAJGHANI, DULIAH JATTAN, CHAUK SAHIBAN AND NAMETAR AREAS OF THE DISTRICTS KOTLI AND MIRPUR, AZAD KASHMIR, PAKISTAN.

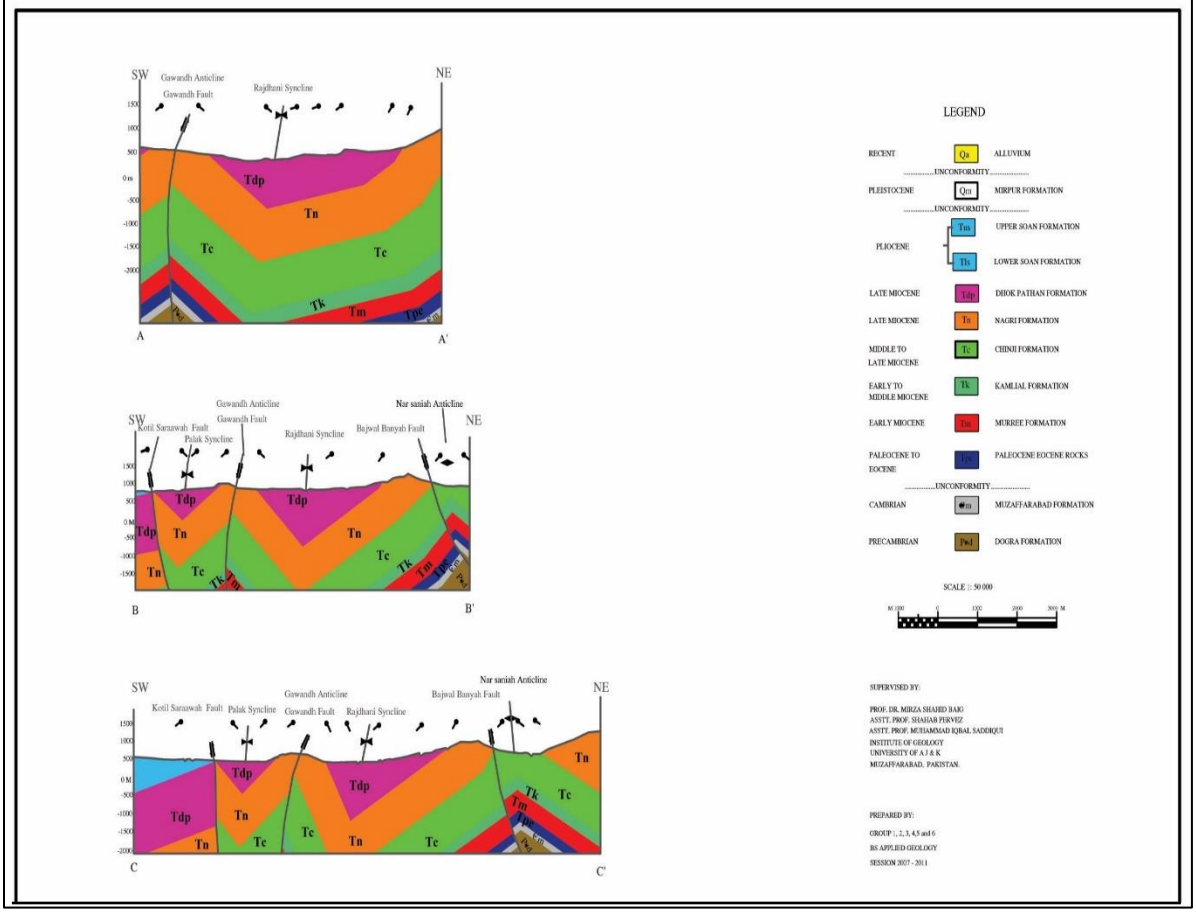
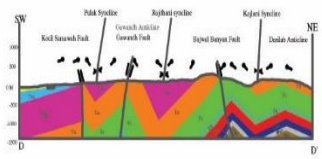
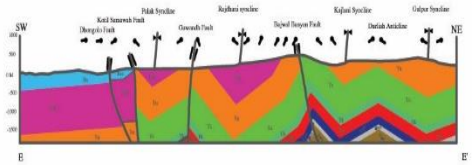
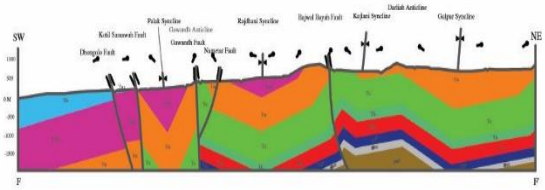


PLATE - 4a STRUCTURAL CROSS SECTIONS OF RAJGHANI, DULIAH JATTAN, CHAUK SAHIBAN AND NAMETAR AREAS OF THE DISTRICTS KOTLI AND MIRPUR, AZAD KASHMIR, PAKISTAN.







LEGEND

RECENT	Qa	ALLUVIUM
……UNCONFORMITY……		
PLEISTOCENE	Qm	MIRPUR FORMATION
……UNCONFORMITY……		
PLIOCENE	Tus	UPPER SOAN FORMATION
	Tls	LOWER SOAN FORMATION
LATE MIOCENE	Tdp	DHOK PATHAN FORMATION
LATE MIOCENE	Tn	NAGRI FORMATION
MIDDLE TO LATE MIOCENE	Tc	CHINJI FORMATION
EARLY TO MIDDLE MIOCENE	Tk	KAMLIAL FORMATION
EARLY MIOCENE	Tm	MURREE FORMATION
PALEOCENE TO EOCENE	Pe	PALEOCENE EOCENE ROCKS
……UNCONFORMITY……		
CAMBRIAN	Єm	MUZAFFARABAD FORMATION
PRECAMBRIAN	Pwd	DOGRA FORMATION

SCALE 1: 50 000

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PLATE - 4a STRUCTURAL CROSS SECTIONS OF RAJGHANI, DULIAH JATTAN, CHAUK SAHIBAN AND NAMETAR AREAS OF THE DISTRICTS KOTLI AND MIRPUR, AZAD KASHMIR, PAKISTAN.