Stratigraphy and Structural analysis of areas within Hazara Kashmir Syntaxis, North Western Himalayas, Pakistan

By

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Abstract

The Paleocene-Eocene sedimentary rocks with unconformable contact with underlying Late Cambrian Abbottabad Formation and disconformable contact with overlying Miocene Murree Formation are exposed within a regional geological structure recognized as the Hazara Kashmir Syntaxis (HKS) in North Western, sub Himalayas, Azad Jammu and Kashmir, Pakistan. The area is highly deformed by the folds and faults owing to tectonic activities. The Chalpani anticline, Patikka syncline, Patikka anticline, Panjgran syncline, Panjgran anticline, Devlian anticline, Balgran syncline and Nauseri anticline are the intraformational folds within Murree Formation.

TheYadgar-Back Thrust, Ghori-Back Thrust, Chalpani fault, Devlian fault and Main Boundary Thrust (MBT) are the emergent faults of the area. The Yadgar-Back Thrust is reverse in nature and marked in Margala Hill Limestone. The Ghori-Back Thrust is a northeast-southwest trending fault within Murree Formation. This fault is a back Thrust which is reverse in nature. The Chalpani fault is a northwest-southeast trending fault within Murree Formation. The Devlian fault within Murree Formation is marked on the basis of shearing, crushing, breccia, tilted or uplifted terrace and offset of river. The Main Boundary Thrust (MBT) is a northwest-southeast trending regional structure between Miocene Murree Formation and Panjal Formation in which Panjal Formation is thrusted over the Murree Formation. The MBT and Panjal thrust are folded around the syntaxis.

Introduction

The study area forms the core and the eastern limb of a regional geological structure known as Hazara Kashmir Syntaxis (HKS) in Muzaffarabad city along Neelum valley road, Azad Jammu and Kashmir, Pakistan.

The rock formations of various kind and ages with major unconformities among them form the subdued outcrops of mountains along road side.

The Himalayan orogeny is the main cause of deformation in these rock sequences. Folds and faults are the main deformations in study area as shown on the Geological map. The rock Formations of various age with a few unconformities among them are exposed in this area. Among rock Formations, the Paleocene-Eocene rocks unconformably overlying Late Cambrian Abbottabad Formation and disconformably underlying the Miocene Murree Formation are exposed throughout the area

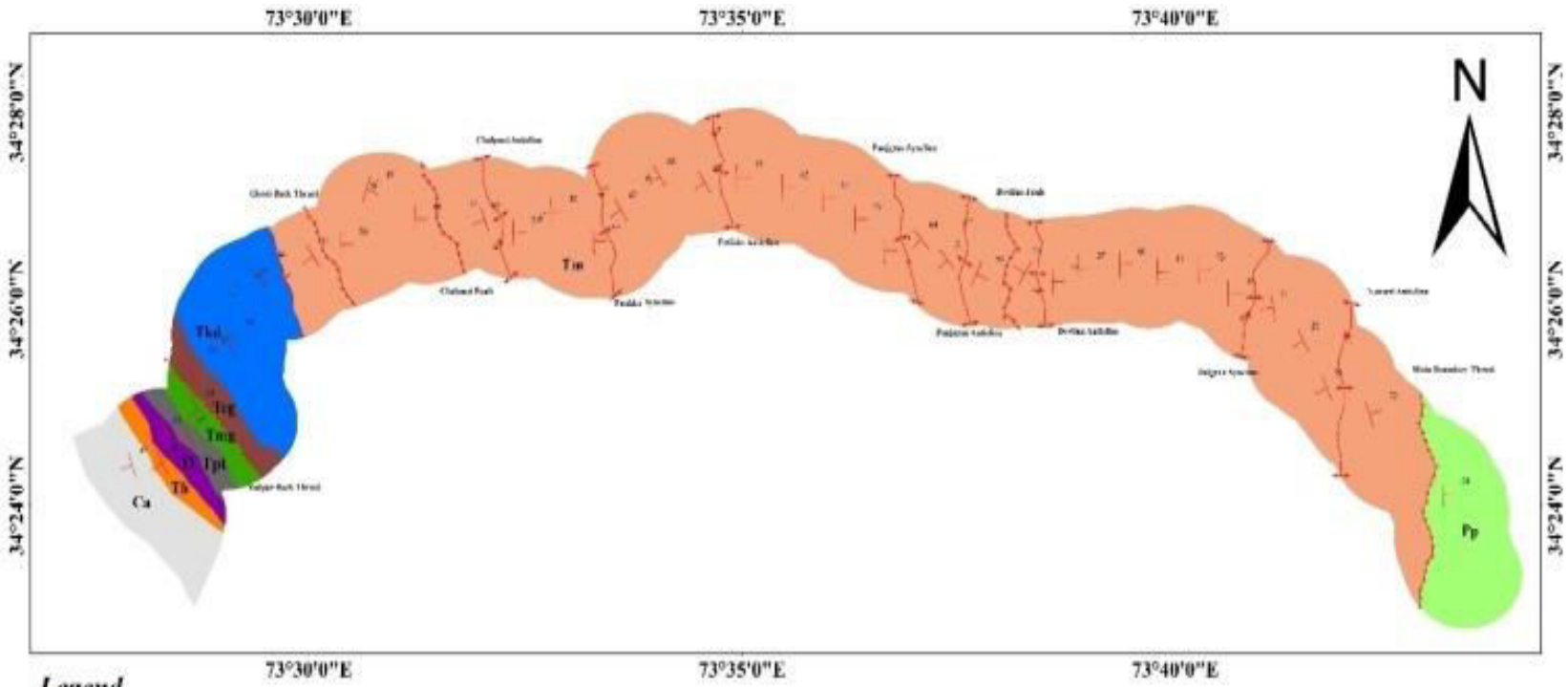
Objectives

1. To create a field based Geological map at 1:25,000 scale having composite Stratigraphy and Structural details of the area.
2. To clearly establish the nature of contacts among various rock Formations.
3. To carry out structural analysis of folds based on π - β diagrams.

Materials and Methods

The duration of twenty days was spent on outcrops while examining rocks for geological research work in the area forming the core and eastern limb of Hazara-Kashmir Syntaxis. The Structural deformation (Faults and Folds) were marked all along the traverse from Yadgar to Nauseri area, Muzaffarabad, Azad Jammu and Kashmir, Pakistan. The attitude of bedding was taken into account while collecting the structural data. The Dip and Strike of various rock units were measured with ease using the Brunton compass and their GPS locations were plotted on the map. The nature of contacts among various rock Formations were clearly established in field. A composite Geological and Structural map at 1:25,000 scale was created with the aid of Arc GIS 10.7. Moreover, the β-π diagrams were produced on stereonet and the folds were classified on the basis of interlimb angle. The Formations, their contact relations, major faults, folds with their trend and plunges were plotted on the composite Geological and Structural map.

The Geological map of the area having composite Stratigraphic and Structural details.



Legend

- Tm — *Murree Formation*
- Tkd — *Kuldana Formation*
- Tcg — *Chorgalli Formation*
- Tmg — *Margalla Hill Limestone*
- Tpt — *Patala Formation*
- Tl — *Lockhart Limestone*
- Th — *Hangu Formation*
- Pp — *Panjal Formation*
- Ca — *Abbottabad Formation*

Geological Symbols

- *anticline*
- *fault*
- *syncline*
- *Dip & Strike*
- *Trend and Plunge*
- *Samples Location*

1:25,000

0 1 2 4 6 8 Kilometers

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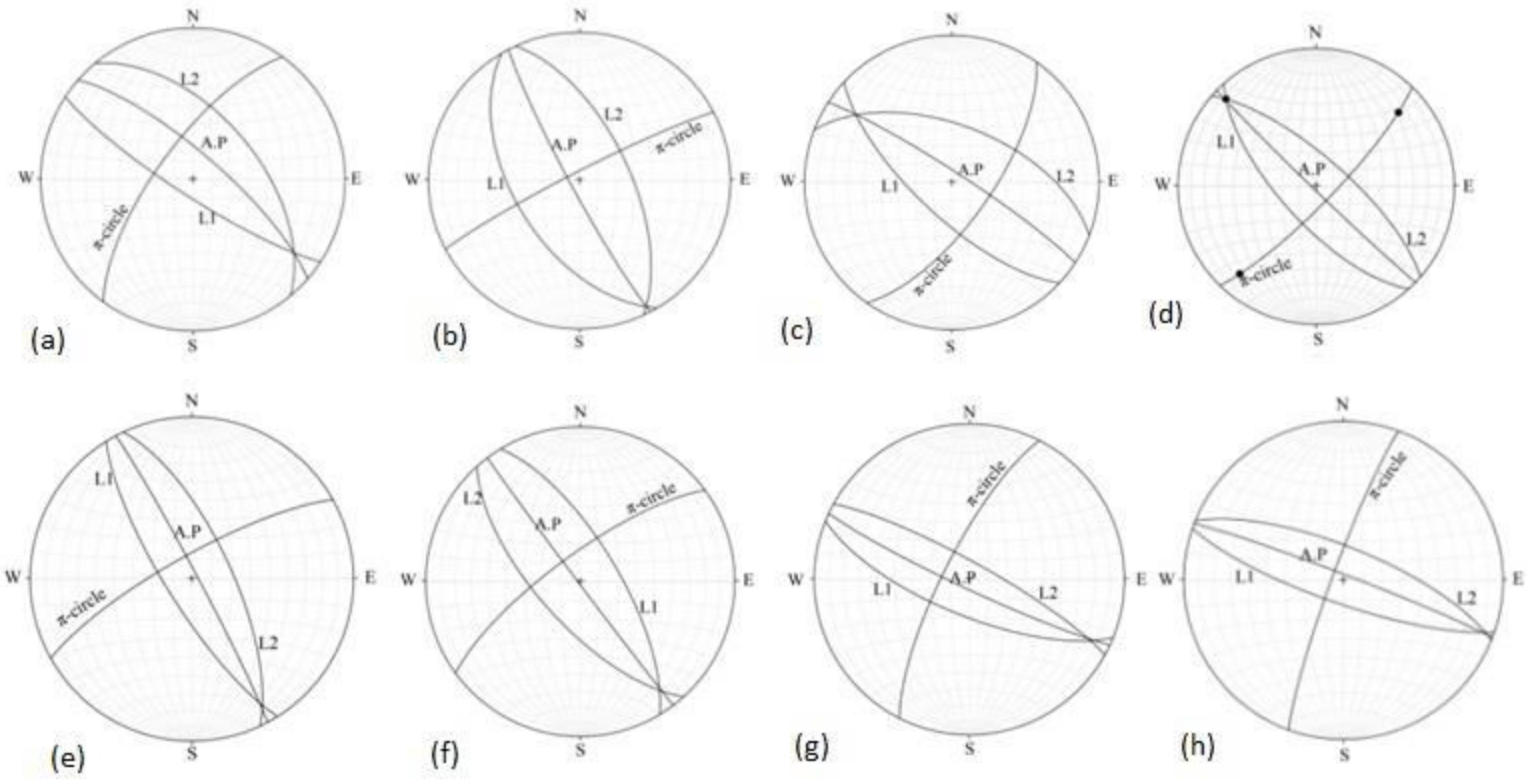
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Structural interpretation of folds in the study area.

Folds	Limb-1 Attitude	Limb-2 Attitude	Axial Plane (A.P)	Fold Axis	Interlimb Angle	Fold Type
Chalpani Anticline	N57°W/81°SW	N40°W/55°NE	N49°W/76°SW	126/20°	55°	Close
Patikka Syncline	N45°W/63°NE	N31°W/54°SW	N16°W/58°SW	153/6°	63°	Gentle
Patikka Anticline	N47°W/71°SW	N69°W/58°NE	N57°W/84°SW	306/21°	55.2°	Close
Panjgran Syncline	N49°W/73°NE	N42°W/69°SW	N26°W/88°SW	314/10°	38.6°	Close
Panjgran Anticline	N32°W/77°SW	N25°W/70°NE	N28°W/87°NE	151/12°	33.7°	Close
Devlian Anticline	N42°W/68°SW	N31°W/70°NE	N27°W/89°SE	114/14°	43.4°	Close
Balgran Syncline	N61°W/81°NE	N68°W/72°SW	N45°W/85°SW	116/15°	27.9°	Tight
Nauseri Anticline	N71°W/78°SW	N68°W/73°NE	N64°W/88°NE	296/13°	29.8°	Tight

The π and β diagram of (a) Chalpani Anticline, (b) Patikka Syncline, (c) Patikka Anticline, (d) Panjgran Syncline, (e) Panjgran Anticline, (f) Devlian Anticline, (g) Balgran Syncline, (h) Nauseri Anticline.



Stratigraphy of the Project area.

Age	Formations	Lithology
Quaternary	Alluvium	Unconsolidated sediments, Silt, sand, clays and gravel.
	Unconformity	
Miocene	Murree Formation	Molasse Sediments. Cyclic deposition of reddish Brown sandstone, silt stone, shales and clays.
	Unconformity	
Eocene	Kuldana Formation	Includes parti-colored shales with sporadic Sandstone beds, Limestone, Siltstone, Mudstone and Conglomerates, reworked foraminifers.
Eocene	Chorgali Formation	Limestone and shale distinguished by marly nature and large size microfossils.
Eocene	Margalla Hill limestone	Limestone massive, light grey and nodular, richly fossiliferous and intracalated with shale.
Paleocene	Patala Formation	Shale with interbeds of sandstone and nodular limestone.
Paleocene	Lockhart limestone	Limestone with rare intercalations of shale, Limestone hard, massive and light grey, fine grained, micritic, massively bedded and fossiliferous .
Paleocene	Hangu Formation	laterite, sandstone, carbonaceous shales and coal
	Unconformity	
Permian	Panjal Formation	Greenstone, (Basalts, Cherty limestone, graphitic schist and impure marble.
	Unconformity	
Cambrian	Abbottabad Formation	Cherty and banded dolomite, dolomitic limestone, black shales and stromatolites.

Structural details of faults in study area.

Faults	Structural details
Yadgar-Back Thrust	Emplaces the Margalla Hill Limestone on the Chorgali Formation. represents northeast directed thrusting as opposed to the main southwest thrust propagation.
Ghori-Back Thrust	Northeast directed Ghori-Back Thrust emplaces the Murree Formation on the Neelum River terrace. The fault is seismically active and is marked on the basis of shearing, crushing and Breccia along the contact.
Chalpani Fault	It emplaces the Murree Formation on the Neelum River terrace. The anticlinal core is breached along Chalpani fault. It is a reactivated basement normal fault that dips steeply northeast as a reverse fault. It is also a southeast directed splay of Devlian fault.
Devlian Fault	Devlian Fault is mapped in the core of regional anticline. The Neelum River terraces are uplifted along fault.
Main Boundary Thrust (MBT)	The regional geological structure is mapped in Nauseri area. The thrust fault trends northwest-southeast and dips towards northeast. The shearing, crushing and gouge in the project area are a few evidences of deformation.

Conclusion

The Hazara Kashmir Syntaxis (HKS) is an oroclinal or antiformal structure. The core of HKS is deformed with multiple faults and folds. The dipping direction of faults changes which shows that it has undergone multiple phase of deformation. The project area contains clues of active tectonics. The folds of project area are plunging and open to close and tight in nature. The collision of Indian plate with Eurasian plate has formed northwest Himalayan fold-and-Thrust belt. The continuous movement and collision of plates have shaped the structural geometry of the Himalayan orogenic belt. The Hazara Kashmir Syntaxis (HKS) is the main syntaxial bend in area.

The study area is exposed in North western Himalayas in the core of HKS. The Cambrian to Recent sedimentary rock Formations are exposed in project area. Mostly folds in the study area are northeast-southwest trending. The rocks are fractured and crushed along these faults.

Recent Publications

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[3] Basharat M, Rohn J, Baig MS, Khan MR (2014) Spatial distribution analysis of mass movements triggered by the 2005 Kashmir earthquake in the Northeast Himalayas of Pakistan. Geomorphology 206:203-214.

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