ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 14, Issue, 05, pp.21377-21384, May, 2022

DOI: https://doi.org/10.24941/ijcr.43462.05.2022

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

GEOLOGY AND DRAINAGE CHARACTEISTICS OF KASHMIR BASIN (JAMMU AND KASHMIR) WITH SPEACIAL REFERENCE TO DISTRICT SHOPIAN

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ARTICLE INFO

Article History:
Received 09th February, 2022
Received in revised form
19th March, 2022
Accepted 18th April, 2022
Published online 30th May, 2022

Key words:

Geology, drainage, Kashmir Basin, Shopian, Geo-spatial tools.

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ABSTRACT

The Kashmir basin situated in the north-western Himalaya has a NW-SE extent with a strike length of about ~145–150 km and width of ~45–50 km (Fig. 1). The Kashmir basin located in the collision zone between the Indian and Eurasian plates can serve as an excellent study area for neo-tectonic activity and earthquake risk. It is a classic example of an out-of-sequence thrust faulting and is tectonically active as observed from multiple geological evidences. Its geomorphology, structure and lateral extent indicate significant accommodation of stress since long. It seems this fault is actively accommodating some portion of the total India–Eurasia convergence, apart from two well-recognised active structures the Medlicott–Wadia Thrust and the Main Frontal Thrust, which are referred in Vassallo *et al*. (Earth Planet SciLett 411:241–252, 2015).Advent of satellite remote sensing and GIS has opened new field of vision for geological and hyrological studies. Remote sensing and GIS technology, with its advantages of spatial, spectral and temporal availability of data covering large and inaccessible areas within a short time has become an effective tool in the hands of researchers. The present study gives usdetailed description about the geological and drainage characteristics of the Kashmir basin and district Shopian of Jammu and Kashmir using Geo-spatial tools.

Citation: ***Mr. Shoib Maqbool and Dr. Vineesha Singh.* 2022.** "Geology and drainage characteistics of kashmir basin (jammu and kashmir) with speacial reference to district shopian". *International Journal of Current Research*, 14, (05), 21377-21384.

INTRODUCTION

Several Himalayan intermontane basins were formed throughout the Tertiary Period due to hybrid tectonism, where both compressional and extensional tectonic activities controlled their shape and structure (Burbank & Johnson 1983; Yin, 2006). These intermountain basins are filled with sediments derived from adjacent uplifted regions since the Last Glacial Maximum (Kuhle, 2005). The previous geological literature shows that the formation of the Kashmir basin is broadly attributed to three tectonic models, which are related to a) the rifting of India and Cimmeria, b) the classic piggyback basin development during thrusting, and c) the pull-apart basin formation during the dextral strike-slip faulting. The Kashmir Basin (KB), *790 km N of Delhi (India), is classified as one of the Neogene–Quaternary intermontane basins (Burbank and Johnson 1983) of the Himalayas. These basins occur at many places in the Himalaya and southern Tibet (Hodges 2000) and are divided into three major types. (1) The extensional basins, which are located just north of the Himalayan crest and are associated with *E striking South Tibetan fault system (Burchfiel *et al*. 1992). (2) These are related to the kinematically linked displacement on NW and NE-striking strike-slip faults and north-trending rift systems in southern Tibet (Molnar and Tapponnier 1978). (3) The 'thrust top' or 'piggy-back' basins, for example, the Kashmir Basin . Such basins are located to the north of the Himalayan thrust front and south of the range crest (Burbank and Johnson 1982). The KB contains strata, which are equivalent in age and similar in lithology to the Upper Siwalik Group (Burbank and Johnson 1982). The basal part of the sequence is slightly older, perhaps 5 Ma, but much of that succession is of late Pliocene–Pleistocene age, with deposition continuing locally into the Holocene age (Burbank and Johnson 1983)

MATERIALS AND METHODS

The areas of investigation Kashmir basin and district Shopian is located between latitude 32° and 34°N, and longitude 74° and 75°E and between 33°29' to 33°50' North latitude and 74°32' to 75°5' East on the Survey of India (SOI) to posheets respectively.

Top sheets in the digital format at a scale of 1:50,000 were used and provided by Survey of India.The materials used in the present study areASTER DEM with 30 mresolution, and geological map of area. The methodology includespreparation of base maps using Survey of India toposheets and DEMwith the help of Arc GIS (10.3) .A thoroughliterature review was carried out to analysis thedrainage and geology of the study areas.

STUDY AREA

Kashmir Basin: The Kashmir basin situated in the north-western Himalaya has a NW-SE extent with a strike length of about ~145–150 km and width of ~45–50 km (Fig. 1). The Kashmir basin located in the collision zone between the Indian and Eurasian plates can serve as an excellent study area for neotectonic activity and earthquake risk. Since the KB is one such regions in the NW Himalayas where deformation is distributed away from the front (e.g. Nakata 1989; Kaneda *et al*. 2008; Madden *et al*. 2010, 2011), therefore, in this work, the active geomorphic elements of such distributed deformation are mapped. This is achieved by using a variety of freely available satellite data, which include Shuttle Radar Topography Mission (SRTM), Google maps and Global Multi-Resolution Topography (GMRT).

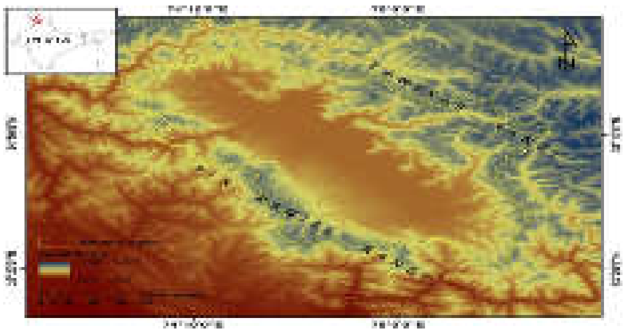


Fig. 1. Location map of Kashmir Basin

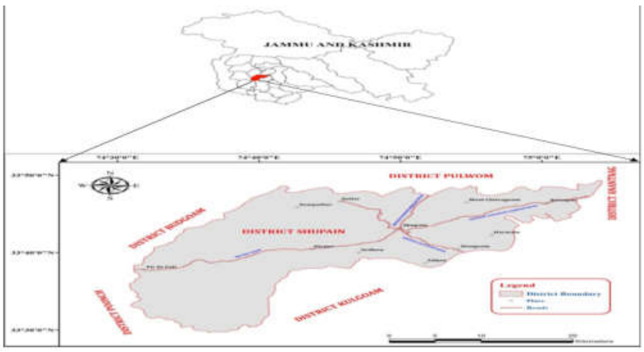


Fig. 2. Location Map Of Shopian District

District Shopian: Shopain is a historical town and has gained importance from the times of Mughal rulers. Shopain was one out of six *Wazarat* Headquarters in Kashmir from 1872-1892 A.D. The total geographical area of the District is about 852 sq. kms including 229 villages and hasa population of 2.66 lac as per census 2011. The district falls in Survey of India Degree sheet no 43 K and is located between 33°29' to 33°50' North latitude and 74°32' to 75°5' East longitude with an average elevation of 3042 meters amsl. It is situated towards southwest of summer capital of J&K state, Srinagar, at a distance of 51 km. The district is flanked by District Budgoam in northeast,

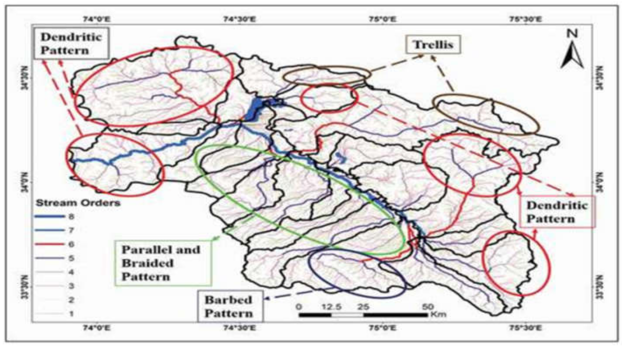


Figure 3. Observed different types of drainage patterns in the Kashmir basin

District Pulwom in north, District Anantnag in east and District Kulgoam in southwest. The mighty Pir Panjal Range separates district Shopain from District Rajouri and Poonch.

The district Shopian derives its name from the town “SHOPIAN” about which “Frederic Drew”, while justifying the basis of its nomenclature, states that it is the distortion of word “ SHAH PAYAN” i.e, Royal Stay. Shopian has been an ancient town of Kashmir, which among other factors in the past has historical importance, since it situates on the ancient imperial route commonly known as “MUGHAL ROAD”. In view of its location, trade and transit activities, Shopian was having one of the Wazarat Head- Quarters out of Six Wazarats of the time in Kashmir from 1872-1892 AD. Consequent upon the reduction in the administrative divisions of Kashmir three Wazarats including Shopian ceased to exit. The district, however, as investigated from its locals, derives its name from the Kashmiri word “SHINNEH –YEN”(Snow Defile) meaning an area which experiences heavy snowfall. Subsequently it lost its name and presently it is famous by the name “SHOPIAN”.

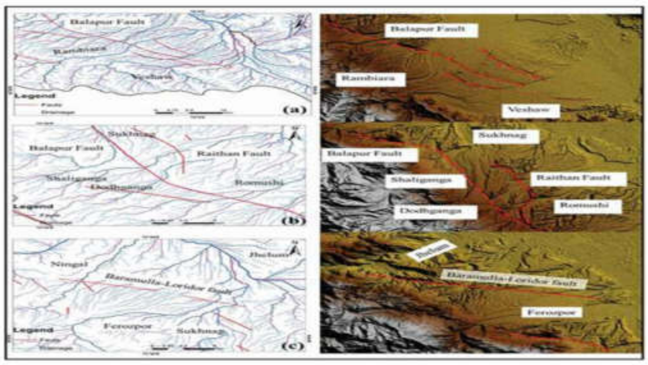


Fig 4 (a,b,c). Tectonic setup and Drainage Patterns of different streams of Kashmir Bain

DRAINAGE CHARACTERISTICS OF KASHMIR BASIN: The drainage pattern of KB is highly elusive. The KB is a geologically young with high of tectonic influence and activity due to continuous Himalayan uplift. This rapid uplift has modified the drainage pattern in the past (Basavaiah *et al*., 2010; Burbank, 1983) and is currently controlling their shape, structure and pattern. Hard rocks mainly dominate the headwater/source region while as after entering the basin they pass over homogenous and soft rock lithologies, i.e., Karewas and recent flood plains. The KB is drained by a by single major river, the Jhelum River. It traverses through the center of the basin and is fed on both sides by several tributaries along its course and drains the basin through narrow gorge at

Baramulla. The river is fed on north by Bringi, Kuthar, Aripat, Lider, Aripal, Dachigam, Sind, Erin, and Madhumati, while as on south it's fed by Sandran, Veshaw, Rambiara, Romushi, Doodhganga, Shaliganga, Sukhnag, Ferozpor, Ningal, Garzan, and Vijay-Dhakil. The Pohru and Mawarjoins the it from east. The Jhelum river is more shifted toward north, closer to Greater Himalayan side due to continuous uplift of PPR side. The river flows mostly on soft rocks and is characterized by considerable meandering along its course. This is due to very gentle slope of river course in the valley and the presence of unconsolidated sediments along the river course. On northern side (Greater Himalayan side), the streams flow towards south and pass mainly through hard rocks for most of their river course before merging with Jhelum River. These rivers are mainly lithologically controlled. Among these Lider and Sind rivers show upto sixth-order streams. These rivers are perennial in nature with high gradient. Smaller rivers (Madhumati, Erin, Dachigam, Aripal, Aripat, Kuthar, Bringi and Sandran) show upto fifth-order streams. Most of these rivers show much entrenched narrower river course with highly incised steep valleys and gorges (Figure 6).

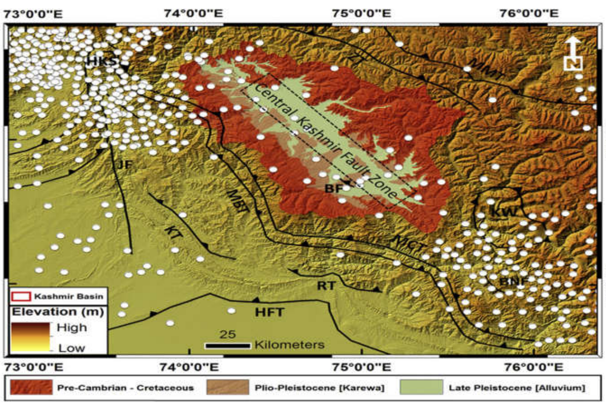


Fig. 5 Geological setting of the Kashmir basin. MMT: Main Mantle Thrust; ZT: Zanskar Thrust; KW: Kishtwar Window; BNF: Bhaderwah Nornal Fault; MCT: Main Central Thrust; MBT: Main Boundary Thrust; HFT: Himalayan Frontal Thrust; KT: Kotli Thrust; RT: Reasi Thrust; BF: Balapur Fault, from Agarwal and Agrawal (2005), Hussain et al. (2009), Thakur et al. (2010) and Ahmad et al. (2013); broad lithology of the Kashmir basin (after Raza et al., 1978; Burbankand Johnson, 1983) superimposed on SRTM DEM, white dots represent seismic events (1950e2016) in and around Kashmir basin (USGS database).

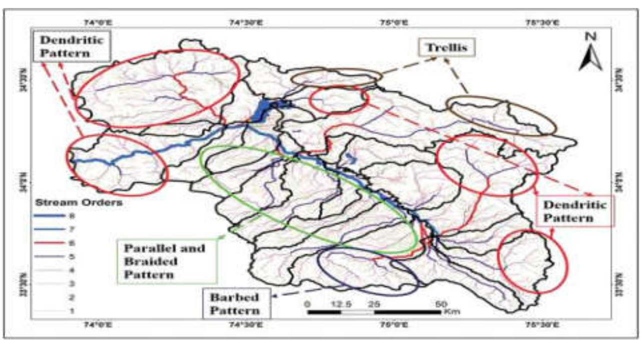


Figure 6. Observed different types of drainage patterns in the Kashmir basin.(Source.online Research gate)

Much of the difference and evolution is found on the north flowing river systems. The river basins on this side are elongated and with distinctive drainage divides in higher reaches and anomalous in lower portions due to inter-basin crossover of rivers. These rivers mostly pass over soft rock terrains (Karewa and river Alluvium) for most of their river course. These originate in the higher elevations of PPR and flow toward north. Their river course is very different than the south flowing rivers. They have steep to gentle slopes and presence of various Knick points along their river course (Ahmad *et al*., 2015). Except Veshaw (seventh-order streams) most of these rivers show upto fifth-order streams.

Drainage patterns: In KB, various styles of drainage patterns are present like dendritic, trellis, radial, parallel, rectangular, and barbed patterns (Figure 6). Dendritic drainage pattern is widely present with most low-order tributaries meeting the higher at less than 90°. This type of drainage is observed where lithology is homogenous and where lithology controls the drainage pattern with less structural control. Both antecedent as well as superimposed dendritic patterns are found in less resistant rocks as well as flat lying horizontal sedimentary, massive igneous, and metamorphic rocks at different locations of the basin. This type of drainage is also found in folded and tilted rocks that can be attributed for superimposition of the drainage post folding and tilting of beds. The Pohru, Erin, Lider basins as well as higher elevated regions shows this type of drainage pattern indicating less structurally controlled drainage patterns. Sub-trellis to trellis pattern is observed in Madhumati and Sind basins. In these basins, a system of parallel-sub-parallel streams flow along the elevated linear ridges. In these areas the major streams are found abruptly bending at 90° while crossing the structural obstructions and low-order streams (first order) flow perpendicular with respect to main stream, however middle-order (second and third order) streams are mostly parallel to sub-parallel with respect to each other. These drainage patterns suggest noticeable structural control of most stream courses. The trellis pattern is mostly fault-controlled where by segmented and layered fault splays produce alternating bands of resistant and weak rocks. In KB, the trellis drainage patterns are found closely associated along Himalayan thrust sheets. The thrust sheets are folded and refolded producing alternate layers or bands of rocks suitable for the formation of trellis drainage. In the upper reaches of Sindh and Madhumati sub-basins, the presence of offset and linear drainage lines also suggest structural control. Most of the southern basins on PirPanjal side show parallel drainage pattern. The basins are highly elongated with deeply incised valleys both in hard rocks as well as in Karewa sediments. The rivers flow irregularly with broad and braided pattern with tributaries mostly showing cross-over trend in lower portions of the basin. In the Veshaw basin, the KandaiKol tributary show barbed pattern flowing in opposite direction and take a hair pin bend before joining the main Veshawriver. The presence of paleo-channel, strath terraces and unpaired river terraces in Veshawriver near the Tangmarg village suggest that the basin has been uplifted and structurally controlled. The same features are observed in Rambiara, Doodhganga, Romushi sub-basins indicating regional/local uplift and structural controls.

The Rambiara basin shows considerable amount of rejuvenated streams with braided bar deposits. Three fault splays representing surficial expressions of Balapur fault has produced beheaded streams (Figure 7 a, b). The Rambiara river near Balapur village has laid down ~500 m wide braided bar in the middle of the channel due to dissection of this river by Balapur fault uplifting the northern segment causing damping and deposition of river sediments. The Balapur fault extends through most of the southern sub basins showing significant geomorphic expressions (Ahmad *et al*., 2015).

In Doodhganga and Shaliganga sub-basins, the Balapur fault branches into two sections one moving towards the east while (Balapur fault) as the other one (Raithan fault) traverses towards northeast. The presence of uplifted strath terraces, dissected scarps and emergence of new streams suggests that these splays are tectonically young and active.Figure 7. (a, b), Showing drainage modifications by Balapur fault and Raithan Fault along the southern portion of Kashmir basin. Beheaded streams, offset drainage and emergence of new streams are observed along the strike of the faults. (c) Showing traces of Baramulla-Loridor fault (Ahmad *et al*., 2014) or Hayatpor-vatnu fault (Ahmad *et al*., 2015) and deflection in drainage produced by the fault. The Ferozpor, Ningal, and Sukhnag sub-basins are dissected by Baramulla-Loridor fault (Ahmad *et al*., 2014) or Hayatpor-vatnufault (Ahmad *et al*., 2015). This fault has been considered as source fault of 1885 earthquake (6.8 Mw; Ahmad *et al*., 2014; Shah, 2015) and has produced a nearly 3 m scarp (Bilham, 2019) during 1885 earthquake. The drainage pattern in this region clearly exhibits structural control with most parallel tributaries (Figure 7c). The streams follow the observed fault creating an offset drainage patterns.

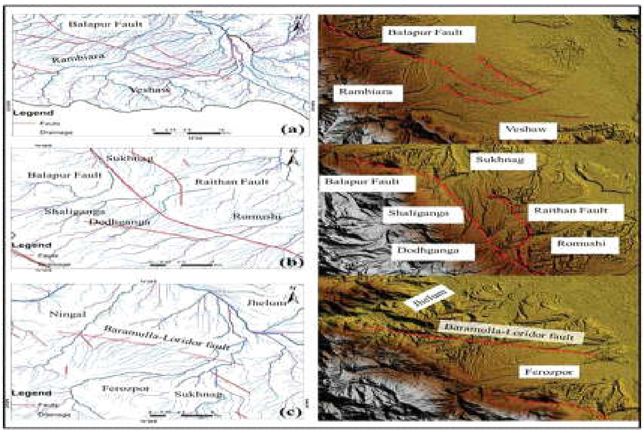
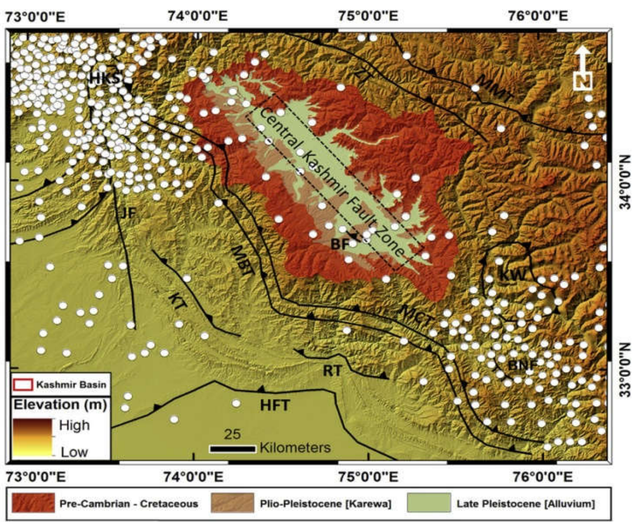


Fig 4 (a,b,c)Tectonic setup and Drainage Patterns of different streams of Kashmir Bain



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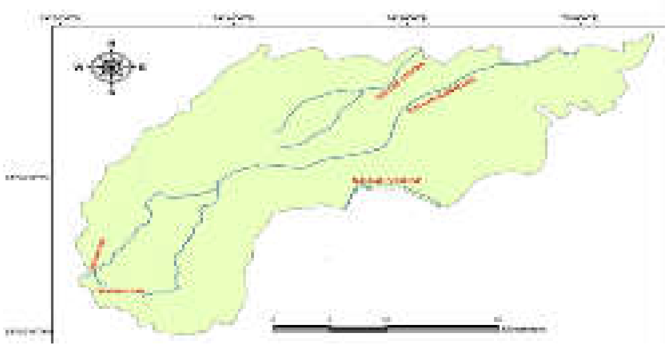

Fig.-9: Map showing mainstreams of district Shopain.

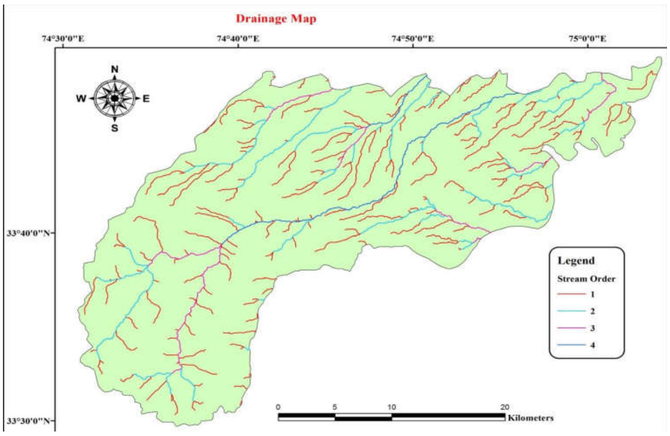

Fig. 10. Map showing drainage pattern of district Shopain

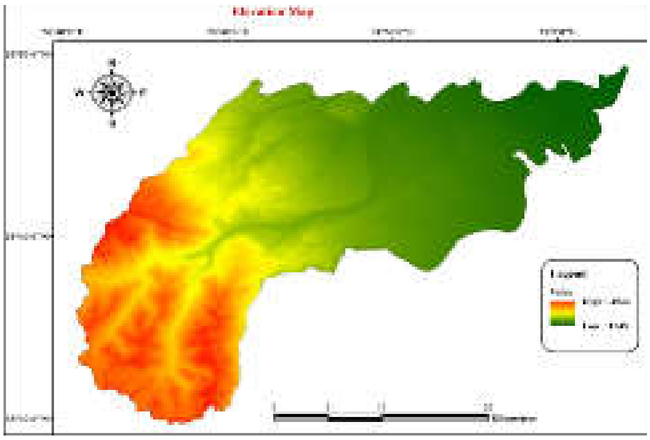

Fig. 11. Digital Elevation map of district Shopian

GEOLOGICAL AND TECTONIC SETUP OF KASHMIR BASIN: The 2,000-km-long Himalayan orogenic system was formed due to continent–continent collision between the Indian and Eurasian plates, which started in the Eocene (Yin and Harrison 2000) and continues till today. The Kashmir Valley is included on the western side of this long orogenic belt . The regional geological and tectonic setting of the Himalaya has been discussed in a number of previous works (e.g. Yin 2006 as one of them). Kashmir Basin (KB), an intermontane piggy back basin evolved in Neogene-Quaternary time, displays major tectonostratigraphic features striking almost parallel to the regional orientation of arcuate fold and thrust belt of NW Himalaya. Regionally known as Kashmir-Hazara Syntaxis, where the Himalayan fold-thrust belt takes a hairpin bend in NS direction.

Table 1. Drainage system with description of main rivers/stream

S.no.	Name of the Stream	Area drained (sq. km)	% area drained in the district
1.	NallaRambiara	360	42.25%
2.	NallaVeshav	60	7.05%
3.	NallaSasara	90	10.56%

Table 2. Regional Stratigraphy of the District Shopain

S.No.	Name of formation	Age	Lithology
1.	Alluvium	Holocene	Unconsolidated clay, silt, sand
2.	Upper Karewa Formation	Pleistocene	Gravel, sand, clay, marl, and loess, paleosols
3.	Lower Karewa Formation	Pliocene	Gravel, sandy clay, clay, carbonaceous clay and lignite
4.	Triassic Limestone	Triassic	Limestone interbedded with shales
5.	PanjalVolcanics	Carboniferous to late Triassic	Andesitic and basaltic lava flows
6.	Salkhala Series	Pre-Cambrian	Phyllite, schist, quartzite, carbonaceous slates, and graphitic phyllites, limestone, marble, calcareous slate and calcareous schist.

Towards east of the Kashmir-Hazara Syntaxial bend the Himalayan mountain range bifurcates into two mountain ranges running parallel to each other for nearly >100 kms sculpting the oval shape of KB. The KB is a classic example of orogen-parallel compressional zone with synclinal architecture composed of crustal scale fold and thrust zones with recurrent seismicity. The basin is spread over an area of 13,605 km^2, characterized by typical nappe type structure bounded on the south and north by steeply dipping Panjal Thrust and gently dipping Zanskar Thrust, respectively (Bhat, 1982; Jaiswal et al., 2009). This region is marked by vast relief variation, complex geological setting with rock formation of Precambrian to Cenozoic in age (Thakur & Rawat, 1992). The basin comprises well-developed stratigraphic successions of Palaeozoic, Mesozoic and Cenozoic rock formations scattered throughout the basin and its peripheries. The KB is filled by ~1300-m-thick unconsolidated sediments comprising clays, sands, silts, gravels, and conglomerates with occasional lignite beds known as Karewas. These sediments provide substantial evidences of the formation and evolution KB (Bhatt, 1975; Burbank & Johnson, 1983), where differential and sporadic tectonic events directed the sedimentation pattern (Agarwal & Agrawal, 2005; Burbank & Reynolds, 1984). The oval-shaped Kashmir valley is a large ~NW–SE trending intermontane basin in NW Himalayas. It is bounded by the Pir Panjal volcanic in southwest and Tethys Oceanic rocks in the northeast .The Pir Panjal rocks, known as Panjal Traps, are of Early Permian (290 Ma) and are the largest outcropping of volcanic (basaltic, andesitic, and silicic) in the Himalaya. These rocks have formed much earlier than the Himalayan orogeny, and are usually associated with the Late Palaeozoic break-up of Gondwana land (Shellnutt, 2018). The Higher Himalayan rock sequence, that is, exposed in much of the Kashmir region is mainly composed of Mesozoic limestone units. The basement rock is subsequently folded and faulted during the collision of India with Eurasia (Yin and Harrison, 2000). These rocks are mostly composed of Triassic limestone units, which have also been intruded by younger episodes of Panjal volcanic. At Guryal Ravine and Chandanwadi, Kashmir, the Triassic carbonates ride over the Panjal Traps and the contact is marked by a thrust fault (Shellnutt, 2018). The presence of pillow basalt (near Awantipora) clearly suggests that some portions of Panjal Trap volcanics erupted underwater. The basement rocks are now overlain by a thick blanket of Plio-Pleistocene to Holocene sediments that have formed in fluvial, glacial, and lacustrine environments (Burbank and Johnson, 1982). The geochemistry of these sediments provides evidence that the source lies in the nearby mountains, which are mainly composed of Panjal Traps, and Mesozoic basement (carbonates). The Kashmir basin is ~0–4 Ma old (Burbank and Johnson, 1983), which means it has formed very recently during the later stages of tectonic collision (Yin and Harrison, 2000). The formation of fault systems greatly contributed to the development of the basin (Shah, 2013; Shah, 2016b; Shah, 2016c), and presently the main Himalayan thrust (MHT) fault is tectonically the most active fault and absorbs ~half of the ongoing convergence between India and Tibet (Schiffman et al., 2013). The latest instrumental earthquake records show that a major earthquake occurred in 2005 at the western Kashmir (Azad Kashmir, Pakistan) and resulted in liquefaction at Jammu, in the Indian portion of the Kashmir basin.

DRAINAGE CHARACTERISTICS OF DISTRICT SHOPIAN: District Shupain is characterized with moderate type of climate largely defined by its geographic location and is generally described as cool in the spring and autumn, mild in the summer and cold in the winter. July is the hottest month with an average temperature of 30°C while January is the coldest month with an average temperature of -2° C. The mean temperature of district is about 14° C and the average humidity is 69%. Nalla Rambiara, nalla Veshav and nalla Sasara represents the main surface drainage of district Shupain characterized with significant sources of minor minerals in the form of boulder, bajri and sand. A brief description of the drainage of the district is described below:

Nalla Rambiara: It is the most important stream of the District formed by the union of small streamlets originating in Pir Panjal mountains. It is fed by snow melt waters of glaciers and various lakes like Nandan Sar, Chandan Sar, Bhag Sar and Dhaklar Sar housed in the Pir Panjal Range. The drainage pattern of this catchment is not uniform. The upper portion of thecatchment shows dendritic drainage pattern while as lower portion shows more or less parallel drainage pattern. It flows in north-easterly direction for about 58 km in the district upto village Heff-Shirmal and enters into Pulwom district and then joins nalla Veshav. From its origin to Hirpur village, the course of the nalla is very narrow and becomes wide beyond Hirpur. The total catchment area of Rambiara in the district is about 360 Sq. kms. Lar canal irrigating some parts of northern side of the district has been channelized from nalla Rambiara.Nalla Rambiara due to its huge basin area and discharge weathers the host rocks, transports and deposits the sediments as river bed material and represents the main source of minor minerals of the district in the form of boulders, bajri and sand.

Nalla Veshav: The nalla characterizes another important repository of boulder, bajri and sand in the district. The nalla originates from the Kaunsarnag Lake which is a high altitude glacier lake located in the southwestern Pir Panjal mountains in District Kulgoam. It forms the famous 'Aharbal waterfall' at Aharbal. The upper portion of the catchment shows dendritic drainage pattern while as lower portion shows more or less parallel drainage pattern. It flows in south-easterly for about 11 km in district Shupain from Reshinagri to village Adijan and then enters into district Kulgoam. The total catchment area of Veshav in district Shupain is about 60 Sq. kms. Tongri canal fetches its water from Veshav and is utilized to irrigate south-eastern parts of district.

Nalla Sasara: It is a perennial stream, formed by the union of small streams that originates in Kathauhalan Forest division. It flows for about 17 kms in the district from its source upto Village Dumpur and then it enters into district Pulwom at Rajpur. With a catchment area of 90 sq. kms, the general trend of this stream is northerly and the average width of its channelis about 60 m.

GEOLOGICAL SETUP OF DISTRICT SHOPIAN: District Shupain forms the southern part of Kashmir basin wherein Proterozoic to Quaternary rocks of diverse origin are exposed. The main Geological Formations constituting the bed rock and the surrounding mountains include the Salkhala, Panjal Volcanics and the Triassic Limestone covered by Quaternary Karewas and Alluvium deposits. The stratigraphic sequence of the geological Formations with general lithology of District Shupain is given in table-2. The geological map of the region is shown at fig.12. The lithological description and areal extent of the different Formations are summarized below:

Salkhala: Salkhala Formation is the oldest metasedimentary unit of northern Himalaya of Pre-Cambrian Age, representing the basement of Kashmir Nappe in the Pir Panjal Range. The Salkhala Series constitutes phyllite, schist, quartzite, carbonaceous slates, and graphitic phyllites associated with carbonaceous grey or white limestone, marble, calcareous slate and calcareous schist. These oldest rocks are exposed around the southwestern part of the District.

Panjal Volcanics: Salkhala Series is unconformably overlain by Panjal Volcanics which constitute the major volcanic activity that took place in the Kashmir Valley during the latter part of the Carboniferous to late Triassic. It is recognized by a basal Agglomeratic Slate zone and the succeeding- Panjal Trap–the lava flows of mainly basic and partly acidic in nature. The estimated thickness of these lava flows is about 1800-2500m. Panjal Volcanics are well exposed on steep slopes and high peaks of Pir Panjal Range in the south western part of the District.

Triassic Limestone: The Formation is a thick succession of limestone and shale of Triassic Age. The Triassic Limestone is found in the upper reaches of Hirpur and Sedhow Forest divisions of the District. This formation has been exposed by the upliftment of the Pir Panjal Range due to Himalayan orogeny.

Karewa: Karewa represents the glacio-fluvial-lacustrine sediments of Plio-Pleistocene Age with a thickness of 2300m. Karewa is divided into Lower Karewa (Lower Formation) and Upper Karewa (Nagum Formation) deposited in different environmental set up and lithological variation.

Lower Karewas (Hirpur Formation): Hirpur Formation accounts for the major thickness of the Karewa Group and shows good exposure in the nallas and rivers flowing down the Pir Panjal range. The Lower Karewas are mostly argillaceous, light grey, sandy, dark grey clays; coarse to fine grained greenish sands but have the gravel beds at the base containing most of the lignite of the Karewas. The original thickness of lower Karewas is estimated to be about 1675m. The Hirpur Formation is further subdivided into three Members i.e. Dubjan Member, Rambiara Member and Methowian Member. These Members are named after prominent type sections/places of District Shupain. The outcrops of Hirpur Formation are well exposed along Rambiara stream in Dubjan-Hirpur belt, Kathuhalan and Zampather areas of the District.

Upper Karewas (Nagum Formation): The Formation consists of gravel, sand, clay, marl and loess, unconformably overlying the Hirpur Formation. The thickness of Upper Karewasis 610m. The Nagum Formation is further subdivided into three Members i.e. ShupainMember, Pampur Member and top Dilpur Member. The Shupain Member is essentially a succession of conglomerates, resting on the top of Hirpur Formation. This Member named after the Shupain town shows variable thickness, with maximum thickness of 135 meters in Shupain area. The Member shows characteristic features of braided stream deposits. The Shupain Member consists of gravel bed, composed exclusively of Panjal Trap fragments of sub-angular to sub-rounded shape. The sediments of Dilpur Member occur as cap sediments and are found over a vast area of the district from Chowgam to Zainpur.

Alluvium: Alluvium is the unconsolidated soil HYPERLINK "https://en.wikipedia.org/wiki/Soil" or sediments, which has been eroded, reshaped by water in some form, and re-deposited in a non-marine HYPERLINK "https://en.wikipedia. org/wiki/Marine_(ocean)" setting. Alluvium is typically made up of a variety of materials, including fine particles of silt HYPERLINK "https://en.wikipedia.org/wiki/Silt" and clay HYPERLINK "https://en.wikipedia.org/wiki/Clay" and larger particles of sand HYPERLINK "https://en. wikipedia. org/wiki/Sand" and gravel. These deposits include alluvial tracts, flood plains, river terraces, and talus and scree fans. In District Shupain, alluvium is mainly found along the terraces, flood plains and courses of nalla Rambiara, Veshav, Sasara and Tongri and Lar Canal.

CONCLUSION

The main conclusions of the present study are summarized as under:

- The drainage pattern of KB is highly elusive. Most of the river courses have been modified by ongoing tectonism resulting in formation of deflected and beheaded streams showing higher structural control by subsurface tectonic structures.
- The basin has developed rejuvenated terrain morphology, fault scarps, offset of Holocene sedimentary successions,

active mountain fronts, offsetted drainage patterns reflecting Quaternary tectonic deformation in this region.

- Physiographically, the Shopain district broadly comprises hills, flat topped plateaus (Karewas) and undulating plains. The mountainous terrain is mainly characterized with Panjal Volcanics and Salkhala while the Plateau landforms belong to Karewa Formation of Kashmir Basin. The land has a general north- easterly slope as indicated by the direction of flow of the streams draining the area.
- The drainage pattern of Nalla Rambiara catchment is not uniform. The upper portion of the catchment shows dendritic drainage pattern while as lower portion shows more or less parallel drainage pattern. It flows in north-easterly direction for about 58 km in the district upto village Heff-Shirmal and enters into Pulwom district and then joins nalla Veshav.
- Nalla Veshu forms the famous 'Aharbal waterfall' at Aharbal. The upper portion of the catchment shows dendritic drainage pattern while as lower portion shows more or less parallel drainage pattern. It flows in south-easterly for about 11 km in district Shupain from Reshinagri to village Adijan and then enters into district Kulgam.
- The main Geological Formations of the district Shopian constituting the bed rock and the surrounding mountains include the Salkhala, Panjal Volcanics and the Triassic Limestone covered by Quaternary Karewas and Alluvium deposits

REFERENCES

1. Agarwal, K. K., & Agrawal, G. K. (2005). A genetic model of thrust-bounded intermontane basin using scaled sandbox analogue models: An example from the Karewa Basin, Kashmir Himalayas,India. *International Journal of Earth Sciences*, 94(1), 47–52. https://doi.org/10.1007/s00531-004-0438-z [Crossref], [Web of Science ®], [Google Scholar]
2. Ahmad, S., Alam, A., Ahmad, B., Bhat, M. I., & Bhat, M. S. (2015). Geomorphic evidence of unrecognized Balapur fault segment in the southwest Kashmir basin of northwest Himalayas. [Google Scholar]
3. Ahmad, S., Bhat, M. I., Madden, C., & Bali, B. S. (2014). Geomorphic analysis reveals active tectonic deformation on the eastern flank of the Pir Panjal Range, Kashmir Valley, India. *Arabian Journal of Geosciences*, 7(6), 2225–2235. https://doi.org/10.1007/s12517-013-0900-y [Crossref], [Web of Science ®], [Google Scholar]
4. Basavaiah, N., Appel, E., Lakshmi, B. V., Deenadayalan, K., Satyanarayana, K. V. V., Misra, S., Juyal, N., & Malik, M. A. (2010). Revised magnetostratigraphy and characteristics of the fluviolacustrine sedimentation of the Kashmir basin, India, during Pliocene-Pleistocene. *Journal of Geophysical Research: Solid Earth*, 115(B8), 1–17.https://doi.org/10.1029/2009JB006858 [Google Scholar]
5. Bhat, M. I. (1982). Thermal and tectonic evolution of the Kashmir basin vis-a-vis petroleum prospects. *Tectonophysics*, 88(1–2), 117–132. https://doi.org/10.1016/0040-1951(82)90205-0 [Crossref], [Web of Science ®], [Google Scholar]
6. Bhatt, D. K. (1975). On the quaternary geology of the Kashmir valley with special reference to stratigraphy and sedimentation. *Geological Survey of India Miscellaneous Publication*, 24(1), 188–203. [Google Scholar]
7. Bilham, R. (2019). Himalayan earthquakes: A review of historical seismicity and early 21st century slip potential. *Geological Society, London, Special Publications*, 483(1), 423–482. https://doi.org/10.1144/SP483.16 [Crossref], [Google Scholar]
8. Burbank, D. W. (1983). The chronology of intermontane-basin development in the northwestern Himalaya and the evolution of the Northwest Syntaxis. *Earth and Planetary Science Letters*, 64(1), 77–92. https://doi.org/10.1016/0012-821X(83)90054-7 [Crossref], [Web of Science ®], [Google Scholar]
9. Burbank, D. W., & Johnson, G. D. (1983). The late Cenozoic chronologic and stratigraphic development of the Kashmir intermontane basin, northwestern Himalaya. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 43(3–4), 205–235. https://doi.org/10.1016/0031-0182(83)90012-3 [Crossref], [Web of Science ®], [Google Scholar]
10. Burbank, D. W., & Reynolds, R. G. (1984). Sequential late Cenozoic structural disruption of the northern Himalayan Foredeep. *Nature*, 311(5982), 114–118. https://doi.org/10.1038/311114a0 [Crossref], [Web of Science ®], [Google Scholar]
11. Burchfiel, B.C., C. Zhiliang, K.V. Hodges, L. Yuping, L.H. Royden, D. Changtong, X. Jiene,(1992) The South Tibetan Detachment System, Himalayan Orogen: Extension contemporaneous with and parallel to shortening in a Collisional Mountain Belt, *Spec. Pap. Geol. Soc. Am*., 269, pp 41.
12. Hodges, Kip. (2000).Tectonic of the Himalayas and Southern Tibet from two Perspectives. *Geological Society of American Bulletin,* vl(112).
13. Jaiswal, M. K., Bhat, M. I., Bali, B. S., Ahmad, S., & Chen, Y. G. (2009). Luminescence characteristics of quartz and feldspar from tectonically uplifted terraces in Kashmir Basin, Jammu and Kashmir, India. *Radiation Measurements*, 44(5–6), 523–528. https://doi.org/10.1016/j.radmeas.2009.04.008 [Crossref], [Web of Science ®], [Google Scholar]
14. Kaneda M, Rensing KH, Wong JC, Banno B, Mansfield SD, Samuels AL. (2008) Tracking monolignols during wood development in lodgepole pine. Plant Physiol **147**: 1750–1760 [PMC free article] [PubMed] [Google Scholar]
15. Kuhle, M. (2005). Glacial geomorphology and ice ages in Tibet and the surrounding mountains. *Island Arc*, 14(4), 346–367. https://doi.org/10.1111/j.1440-1738.2005.00501.x [Crossref], [Web of Science ®], [Google Scholar]
16. Madden, C., Ahmad, S., & Meigs, A. (2011, December) Geomorphic and paleoseismic evidence for late Quaternary deformation in the southwest Kashmir Valley, India: Out-of-sequence thrusting, or deformation above a structural ramp? *In AGU Fall Meeting abstracts* (American Geophysical Union). [Google Scholar]
17. Madden, C., Trench, D., Meigs, A., Ahmad, S., Bhat, M. I., & Yule, J. D. (2010). Late quaternary shortening and earthquake chronology of an active fault in the Kashmir Basin, Northwest Himalaya. *Seismological Research Letters*, 81(2), 346. https://doi.org/10.1785/gssrl.81.2.284 [Google Scholar]
18. Molnar, P. & Tapponnier, P.(1978). Collapse of a Hercynian Tibetan Plateau into a late Palaeozoic

European Basin and Range province, *J. geophys. Res.* 83, pp.5361–5375.

19. Nakata, T. (1989). Active faults of the Himalaya of India and Nepal. *In Tectonics of the Western Himalayas*. 232, 243 264 [Google Scholar]
20. Nakata, T. (1972). Geomorphic history and crustal movement of the foot-hills of the Himalayas. *Science Report Tohoku Univ 7th series (Geography)*, Tohoku University,22, 39–177. [Google Scholar]
21. Shah, A. A. (2015). Kashmir basin fault and its tectonic significance in NW Himalaya, Jammu and Kashmir, India. *International Journal of Earth Sciences*, 104(7), 1901–1906. https://doi.org/10.1007/s00531-015-1183-1 [Crossref], [Web of Science ®], [Google Scholar]
22. Shellnutt, J.(2018) The Panjal Traps, Geological Society Special Publication vl(463)
23. Thakur, V. C., & Rawat, B. S. (1992). *Geologic map of Western Himalaya*: Dehra Dun India. *Wadia Institute of Himalayan Geology, Scale*, 1(1,000,000). [Google Scholar].
24. Yin A. & Harrison T. M. (2000) Geologic evolution of the Himalayan—Tibetan orogen. Annual Reviews of Earth and Planetary Science 28:211–280.
25. Yin, A. (2006). Cenozoic tectonic evolution of the Himalayan orogen as constrained by along-strike variation of structural geometry, exhumation history, and foreland sedimentation. *Earth-Science Reviews*, 76(1–2), 1–131. https://doi.org/10.1016/j.earscirev.2005.05.004 [Crossref], [Web of Science ®], [Google Scholar]
26. Yin, A. (2006). Cenozoic tectonic evolution of the Himalayan orogen as constrained by along-strike variation of structural geometry, exhumation history, and foreland sedimentation. *Earth-ScienceReviews*,76(1–2), 1–131. [Crossref], [Web of Science ®].

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