CHAPTER I

GEOGRAPHY AND GEOLOGY

The state of Jammu and Kashmir situated in the extreme north of the sub-continent derives its name from an erstwhile princely state with its headquarter at Srinagar. At present the state has three clear divisions: (a) the plains and the Outer / Middle Himalayan region of Jammu (b) the Valley of Kashmir (c) the Inner Himalayan region of Ladakh, Baltistan and Gilgit.

For the present study only the Jammu division was chosen because of its interesting geographical situation and cultural individuality. (pl.1)

Physiography

Jammu is the southern half of the state of Jammu and Kashmir which extends between 32°11' N and 73°26' E with an area of 83023.65 square miles. The state is encircled on the three sides by the international boundaries of Pakistan in the west, Afghanistan in the north, and China in the north and east. In the south it is bounded by the state boundaries of Punjab and Himachal Pradesh.
Jammu largely a sub-mountainous region forms a heterogeneous orographic landmass with altitudes ranging from 1000-1500 feet. Fringed in the south by a strip of plains and Kandi hills, it is bounded in the north of a great rock-barrier—the Pir Panjal rising steeply over the Shiwalik-Murree belt. The snow-clad heights of the Pir Panjal form the most dominant feature in the geography of Jammu, the abruptness of whose relief among the lesser ranges of the Kashmir Himalayas singles it out. South of the Pir Panjal lies the mountainous region of small temperate valleys with rivers hurrying through fir-clad heights. The region forms the catchment and drainage area of Chenab. Further south lies the sparsely wooded sub-montane region which dips gently into the Punjab plains. The right hand tributaries of the Ravi run through this tract.

While, the Banihal pass, the only access to the Vale of Kashmir from the south marks the northern limit of Jammu, its eastern and western limits, formed by the Ravi and the Jhelum respectively. In

1. Wadia, D.N., 1928 "The Geology of the Poona ch state (Kashmir) and adjacent portion of the Punjab" Mem. G.S.I. 51 (2).
2. Imperial Gazetteer of India vol. xx, 1908.
3. With the opening of Jawahar tunnel at 7200' in the Pir Panjal the road over the Banihal Pass has been discarded.
4. The area between the ceasefire line and the Jhelum are under the occupation of Pakistan.
the south a small town Ramnagar in the Kathua district marks the southern limit. The region is well populated and includes the districts of Jammu, Kathua, Udhampur, Doda and Punch. Its total area is 12972 square miles.

Briefly described below are the various physiographic divisions of Jammu as an introduction to its complex geological structure and ecology. (Pl. 2)

(1) The Outer Plain

Lying at the foot of the Shiwalik terrain a narrow strip of plains 5-25 miles wide stretches E-W from the Ravi to the Jhelum. This is an extension of the Punjab plains which marks the southern boundary of the mountainous region of Jammu and Kashmir. Being situated at an average height of 1000-1200 feet it occupies an area of 2609 square miles, cut and traversed by torrents and streams which are the tributaries of the Ravi and the Chenab. The surface of this tract is largely covered by pebble spreads and a thin veneer of sandy loam. Emerging from the mountains the Chenab debouches upon this plain near Akhnur while the Ravi does the same near Lakhnpur. The entire district of Jammu and the tehsils of Kathua and Jasmergarh of the Kathua district come under this division.
The Sub-Himalayan Zone

North to the plains, the Kashmir Shiwaliks is represented in the 'Jammu hills' which extend from the Ravi to the Jhelum. Rising with a gentle slope these ranges extend to an average elevation of 3000-4000 feet. Inward the ranges end in deep escarpments and are followed by narrow parallel ridges separated by longitudinal valleys called 'duns'. In the Jammu hills the extensive and picturesque duns of Udhampur and Kotli are typical. The hills are largely anticlinal and are dissected by numerous transverse streams. Shiwaliks are succeeded in turn by the Murree which are here represented in the Punch hills. They show older topography and mature relief and rise up to 8000 feet.

Most of the Shiwalik region is called 'Kandi' in the local dialect. This region is highly susceptible to erosion. Except the duns which are well populated and intensively cultivated, the region is agriculturally poor. While the outer ranges are sparsely covered with low scrub bushes, the Chil (Pinus longifolia) gradually predominates as the inner hills are reached. Beyond the sub-Himalayan Zone, the Pir Panjal rises steeply.

S. Wadia, D.N., 1957 Geology of India, p.12.
(iii) The Lesser Himalayan Zone

A series of echeloned ranges known collectively as the lesser Himalayas are represented by the Pir Panjal range. The region consists of higher mountains (10000-15000 feet) and consists of highly compressed rocks. The Pir Panjal range takes off from the Great Himalayan range about 30 miles south-west of Mauj Purarbat and runs for 250 miles eastwards first going round the western run of the Valley of Kashmir and then forming the watershed between the Chenab and Ravi. Within our region this tract is 20 miles long with peaks rising to 14000-15000 feet. It is the best defined region of the Pir Panjal. The Pir Panjal crest is merely a residual ridge on the broad plateau like surface whose accentuated relief is mainly due to glaciation. In contrast to the outer hills the zone shows ridges of irregular direction which branch out again and again. The ridges present generally a steep-escarpment towards the plains and a gentle slope towards the Kashmir. Due to this ortho-clinal character the north-eastern slopes are clothed with dense forests and are capped with snows, while the southern slopes being too

steep, are devoid of forests and snows. The Pir Panjal is traversed by many passes; well known among them are the Pir Panjal pass (11400 feet) and the Banihal pass (3200 feet). It is breached by the Kishanganga, Jhelum and Chenab. The highest altitude is attained by the Tata-Kuti peak (15524 feet). The Pir Panjal continues towards the S/W as far as Sutlej and fuses with the north flank of the Dhauladhara.

**Drainage Pattern**

Three of the well known five rivers of the Punjab (Panchnad) flow through Jammu, while the Jhelum and Ravi girdle its western and eastern boundaries, the Chenab and its tributaries swift through the deep gorges, cutting it from east to west. These rivers are snowfed and thus perennial. The catchment areas of the Ravi and the Chenab, the two principal rivers of Jammu are 8100 and 10500 square miles respectively. The Jhelum which just touches the western boundary of Jammu division has a catchment area of 12000 square miles whereas the remaining two of the five rivers of the Punjab, the Sutlej

and the Beas drain 18500 and 5600 square miles respectively which do not come under our area.

In the outer hills (Shiwalik zone) the minor river valleys follow the direction of the strikes but most of the larger rivers especially the Ravi and the Chenab have cut directly through the opposing barriers without any adventitious aid. Similarly the Punch and the Tawi have cut directly across the synclinal azea.

As observed by DeTerra (1939), the large rivers still show steep gradient and are in a state of erosion. In the outer region where ever these rivers are graded they drop their load-gravels, sand and silt. One of these regions, according to him, is the Upper boarder of the plains in Jammu and Punch. In the primary supply of debris from the foothills of the Pir Panjal gets added the sand and silt supply from the Shiwalik formation. These alongwith a vast store of loose gravel in the Boulder Conglomerate ridge of the outer foot - hills furnish the rivers with great quantities of coarse debris.

A number of streams and torrents join one or the other major river. Most of these tributaries rise in the lower slopes and are largely fed by the local rain fall. A curious fact about these tributaries is their
large sandy beds—quite disproportionate to the streaks of channels flowing through them. Now degenerated into mere torrents—indocile in rainy season and desolating wastes of sands rest of the year, their past history was different. That some of them find reference in classical literature and moreover, as the present studies reveal, their banks were the successive habitats of prehistoric man, it can be considered that these streams were of considerable magnitude in the past.

**Ravi: (Sanskrit: Parushni or Iravati)**

It is the smallest and most rapid of the Punjab rivers. It rises in the mountains of the Banghal basin in Himachal Pradesh, situated near the Rohtang Pass (32° 26’ 7”). It drains the northern slopes of the Dhauladhar range and the southern slopes of the Pir Panjal. In Bara Banghal the river is called Rawa, while in its early stages it is also called Raina. It leaves the basin through an inaccessible gorge and flows through Chamba in a north-westerly direction parallel to the Dhauladhar range. Forty miles below its source Ravi is joined by holy Budil and Nai or Duna. The Seul joins Ravi below Chamba.

The Siawa falls into it above Bisohli. The Ravi cuts through the Dhauladhar Range a few miles to the north-west of Dalhousi. Then it turns to south west and leaves the mountains at Basohli. Here it enters the region of Jammu and Kashmir after a course of 130 miles during which it drops by 1500 (115 feet/ mile) in altitude. It forms the boundary of the state for 25 miles and leaves the hills opposite the town of Shahpur and sways to the west like the Chenab. The rest of the journey of the Ravi is the thing of the past. Formerly it used to join the combined Jhelum and Chenab near Ahmedpur (32 31 71 51). The remaining 320 miles of its journey below the Madhopur barrage are recorded by the sandy courses only.

The drainage lines to the west of the Ravi are briefly described below:

\[ \text{Uddhya} \]

It is the Uddhya of the Panini. It rises in the Middle Himalayas at the height of 12000-14000 feet. Covering a distance of some 80 miles in the mountains it emerges from the Shawalik hills.

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11. Aggarwal, V.S. India As Known to Panini p.44.
under the fortress of Jasrota. Below Rajbag the Ujh 
degenerates into number of torrents called Shap Nadi, 
Phag Nadi and Bachhera Nadi which join one of the 
branches of the Tarnah Nadi which in turn again joins 
the main branch of the Ujh. From the left side, the 
Ujh is joined by Baju and Jalalia nadi before joining 
the Ravi at Timmo. From the large breadth of its bed 
it can be imagined that it was an important tributary 
of the Ravi in the past.

Tarnah

It rises in the low outer hills of the Shiwalik. 
Below Dyala Chak the course of Tarnah degenerates into 
many channels. Of these channels, one joins the Ujh towards 
the east while the other joins the Ben a little west. 
In both the cases it loses its name. However one of 
its branches joins the Ravi a little west of the Ujh. 
Though today there is little water in its channel but 
its past history was not the same. As evidenced 
by a large number of lithic artifacts found on its 
bank and the magnitude of its valley outlet it may be said that 
it carried much larger volume of water in the past so as to
sustain a large population of early man on its banks.

Ran

It is also called the Rei and is the Bhidya of Panini.\(^2\) It is joined by several little torrents which enclose the town of Sukhnu-chak. It joins the Ravi almost opposite Bera-Manak. It is almost dry through the major part of the year. The curious fact is the large sandy course through which trickles the insignificant channel of the Ran.

Basantar

It also rises in the low Chimalik hills. It is joined by Kiran (Kurir) nadi before it joins the Ravi a few miles to the west of the Bhas. Its bed too is incredibly large compared to its small channel.

Devak

It is the Devika of the Panini.\(^3\) It unites with the Basantar before joining Ravi in the Montgomery district at \(\text{\ell } 81^\circ 20' 94'\). The united Devak-Basantar stream is called Degh.

\(^{12}\) Ibid, p. 44.
\(^{13}\) Ibid, p. 48.
Chenab

(Sanskrit: Asikni or Chandrabhaga) The two tributaries of the river, the Chandra and Bhaga rise from the two opposite sides of Baralacha pass (16221) in Lahoul. The Chandra is a stream of good size and passes through snow clad barren uninhabited country. The Bhaga is a precipitous stream. Its total length is 40 miles with an average fall of 125 feet / mile. After a course of 115 miles and average fall of 65 feet / mile, the Chandra is joined by Bhaga at Tandi (32 33; 771). The united Chandrabhaga flows through Chamba in a north-westerly direction for 100 miles in a trough between the Great Himalayas and the Pir Panjal on the same alignment as the Jhelum in the Kashmir Valley. DeTerra states that Jhelum flowed in a south-east direction reverse to the present direction into the Chenab Valley. Before piercing the Pir Panjal the Chenab is joined by the Wardwan. The Chenab makes a sharp knee bend at Kishtwar, similar to that of Ravi at Chamba, and flows across the Pir Panjal through a fine gorge. Further on it is joined by the Golan Lar, Lidar Kol, Bichlari and Ans. And still further on it is joined by the

15. Ibid.
Tawi and Hanawar Tawi. Chenab leaves the Himalayas at Akhnocor, 180 miles below Kishtwar and 400 miles from the source, the average gradient being 86 feet per mile. It joins the Jhelum at Trimmu at 31° 15' 72° 15'.

Tawi

The Tawi rises in the mid-Himalayas from a lake called Baskund. Near Chenani it takes a southerly turn and flows past Udhampur (2600). It leaves the hills near Nagrota after covering a distance of 80 miles in the mountains. Jammu is situated on a precipitous cliff, 150 feet high above the Tawi. It is a river of considerable magnitude and depth. It is joined by the numerous torrents. About 10 miles to the south of Jammu the Tawi joins Chenab.

Soils

Jammu area is distinct from moist temperate region of Kashmir valley and dry temperate region of the N/W part of the State (Gilgit). While the western part of Jammu is sub-tropical, its eastern part, comprising Bhaderwah and Kishtwar is sub-temperate.

16. Ibid.
The sub-montane and foot-hill region below Jammu is of alluvial nature. Above Jammu city the whole region is mountainous with small valleys here and there. Texturally the soils grade from loam to sandy loam. Nitrogen varies from 0.08 to 0.04 percent; P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O are moderate. pH is above 7.0. In paddy areas alkalinity develops rapidly and white patches are located in most of the fields. From the study of soil profiles under the deodar soils of the Batoti range, it has been concluded that the soil belongs to the brown earth. The data of the study of a type locality Kishtwar (5400 feet) is given below:

<table>
<thead>
<tr>
<th>Locality</th>
<th>Type</th>
<th>N%</th>
<th>P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</th>
<th>K&lt;sub&gt;2&lt;/sub&gt;O</th>
<th>CO&lt;sub&gt;2&lt;/sub&gt;</th>
<th>Loss ignition</th>
<th>pH</th>
<th>CaO%</th>
<th>T.S.S.%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kishtwar</td>
<td>Saffr</td>
<td>0.049</td>
<td>0.17</td>
<td>-</td>
<td>5.07</td>
<td>7.3</td>
<td>6.37</td>
<td>0.26</td>
<td></td>
</tr>
</tbody>
</table>

The whole of the southern Jammu is affected by erosion due to overgrazing and removal of vegetation. Sheet erosion, gully erosion and river bank erosion are the chief types of erosion.

Climate

Due to difference in the altitude in various parts, Jammu shows diversity in climate. The western

19. Ibid, p.107
part of Jammu is sub-tropical whereas the north-eastern part comprising Bhadarwah, Kishtwar and Arthal is sub-temperate and salubrious. The precipitation is received during two periods with a highly capricious rainfall varying between 25" - 120" which divide the year into four somewhat irregular seasons. The first precipitation is received from late June to September due to south-west monsoons. The N.W.-S.E. trend of the Pir Panjal stretching directly across the path of the south-west monsoon, provide conditions necessary for an abundant precipitation. The months of July and August record the maximum rainfall of the year. In October rainfall is small, while the November is the driest month of the year.

The cold season precipitation due to N.E. or returning monsoons begins in December and lasts till the end of March. Due to these violent winds the higher regions of Pir Panjal experience heavy snowfall, the maximum being in the months of January and February. Sometimes the precipitation extends beyond that period and ingresses the short spring season.

The southern part of the region is more exposed to warm air-currents from the plains. In the hottest months, from mid April to June, gusty afternoon winds and convective phenomenon like dust
Precipitation in Jammu is related to its major physiographic features i.e. the main Himalayan range. To the south of the Pir Panjal average annual rainfall ranges from about 40" - 120". Sometimes the upper limit of the average annual rainfall rises unexpectedly. One of the recording stations, Gulabgarh recorded 225.86" in 1914, an unusually high figure for this region.

North of the Pir Panjal, in the Kashmir Valley the summer rainfall is meager, for the monsoon winds lose most of their moisture before reaching the region. Here winter and spring precipitation derived from storms advancing from west make up the greater part of a yearly total of 20" - 40". Across the inner Himalayas the rainfall decreases further till it is 3" at Leh. (Pl.3)

Temperature

The mean daily temperature is the lowest in January and highest in June or July. There is rapid increase in temperature in April and May after winter and equally rapid decrease in October after the south-west monsoons.

Flera

The types of vegetation occurring at various heights are as follows:

(1) **The Sub-montane zone below 5000 feet**: In this zone xerophytic plants occur. The Kandi hills are sparsely covered with scrub bushes and stunted growth of garna santan and bahaiker bushes, broad-leaved species of trees, aecis and in parts bamboos (in Jasrota Tehsil) . The Tor (Euphorbia) is used to hedge the fields and paths. Inside, the hills are interspersed with sal (Shorea robusta), dhak (Bhutea frondosa), semul (Bombax Malabaricum); riverain forests of khair (Acacia catechu) and shisham (Dalbergie Sissoo); swamp forests of jaman (Eugenia jambolana), siris (Albizzia procera) and gular (Ficus glomerata); dry thorn forests of ber (Zizyphus Jujuba) and allied species; the mixed deciduous forests with several species of terminalia, semul (Bombax malabaricum), amla (Phyllanthus Emblica), jhingan (Odina wodier) and kuthan (Hymenodictyon excelsum) . Towards the upper limit chir (Pinus longifolia) appears and forms a belt.

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The Temperate Zone (5000-11,12000 ft): In this zone mixed coniferous forests and broad leaved trees occur. While the lower elevations are overgrown by Chir, higher up, above 5000 ft, Deodar (Cedrus deodaro) and Blue pine (pinus excelsa) occur. Deodar extends between 5000-9000 ft and is at best between 6000-9000 feet. The blue pine appears at 6000 ft and extends nearly to 1000 ft. Between 8-11000' the Silver fir (Abies Pindrow) and spruce (picea morinda) form large belts. Locally cypress (Cupressus torulosa) also occurs.

The broad-leaved trees include species of oaks of which Quercus incana and Quercus Dilbata are important. Other types are poplar (Populus ciliata), alder (Alnus nepalensis), elm (Ulmus Wallichiana) and birch (Botula alnoides). Trees and shrubs disappear above 11000' except few dwarf species of juniper and rhododendron.

Cultivated vegetation: Due to climatic variation the cultivated vegetation changes accordingly. While the lower tracks cultivate Punjab crops viz., wheat, maize etc higher up, saffron, poppy, buck wheat, rice, maize

23. Imperial Gazetteer of India, op.cit.
25. Wadia, D.N. op.cit. 1928.
and barley are cultivated. Wheat, barley and harashef (rape) are sown in the spring, millet and maize are sown in the autumn. The valley of Bhadarwah known as miniature Kashmir is known for its apples, pears and pulses; Kishtwar is known for its saffron fields. Some parts of Jammu district especially the tehsil of Ranbir Singh Pura, and the inner valleys like Udhampur (2500') and Ramnagar (2700') are agriculturally rich. Large area of the sub-montane zone has been damaged by erosion. The rain sweeps the soft earth and what remains on the surface is a mass of stones.

26.

Fauna

The Pir Panjal and the higher regions of Sub-Himalayas are infested with wild life. Barasinga, gurel or Himalayan chamois is found on the Panjal range and in Kishtwar. The Khakar or barking deer is found on the southern and western slopes of the Pir Panjal. The serpent eater or markhor a species of giganet goat is also found on these flanks. In parts in birch woods, the musk deer is also found. The sarran or mountain goat and the thar, another variety of mountain goat are found in the interior of the Pir Panjal range. Wolves, Monkeys, two species of marmot

called drium or pua are infrequently found. The porcupine is found in Kishtwar.

Several varieties of eagles, vultures, and also of falcons and hawks are found. Among the game birds, black chikor, and grey species of patridge figure prominently. Of pheasants the varieties found are the argus, munol, kallich, koklas and the snow.

The common kind of quail, the jack-spine, and wood-cock are met during winter. Water fowl, bald-costs, moor-hens, dev-chicks, torno, grebes, herons are common. Sarus or gignatic crave is seen in marshes and also small size pelican. Bulbul or nightingale, the cuckoo, the maione and the hoopoe, parrots are common.

People

Nearly 44% of the total population of the State of Jammu and Kashmir (3560976) lives in Jammu which forms only 1/6th of its area. The district of Jammu is the most thickly populated while Kathua is the thinnest. The population is predominantly rural (only 1.14% is urban). The population of the scheduled castes forms only 5.6%. 
The following table based on the census of 1961 gives the population figures.

<table>
<thead>
<tr>
<th></th>
<th>Total Population</th>
<th>F/1000</th>
<th>Scheduled Castes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Jammu area.</td>
<td>157287</td>
<td>828623</td>
<td>744264</td>
</tr>
<tr>
<td>Rural</td>
<td>138131</td>
<td>722125</td>
<td>6591188</td>
</tr>
<tr>
<td>Urban</td>
<td>191574</td>
<td>106498</td>
<td>85076</td>
</tr>
</tbody>
</table>

The sub-montane region from the right bank of the Ravi to the Manawar Tawi is inhabited by the Dogras. They are mostly Rajputs and Brahmins settled beyond the towns of Basohli, Batoti and Malikani. From the Manawar Tawi to the Jhelum the land is inhabited by the Chibs. All the Chibs, now Muslims, are converts from Rajputs. The people of Mirpur, Punch, Rajouri, Ramban, Bhaderwah and Kishwar are Paharis.

Dogri, the language of the Dogras, is the main language of Jammu. Chabi (a form of W. Panjabi) is the language of the Chibs, while the Paharis speak Pahari dialects-Kistwari, Bhaderwahi, Rambani etc. Two
semi-pastoral communities the Gaddis and Gujars live in these hills. While the Gaddis speak Gaddi and are Hindus, Gujars who are mostly Muslims speak Primu. Both of these dialects are Pahari. The people of Jammu are sturdy; agriculture and soldiering is their chief occupation.
The dominant geological features of Jammu are intimately related to the geological pattern of the Himalayas. The mountainous part of Jammu being the extension of the Punjab Himalayas contains those dominant geological features as are common with the whole length of the Himalayas. So also the alluvial plains, an extension of the Panjab plains. (Pl. 2)

The Pir Panjal and its neighbourhood is the principal area in which rocks of Archean, primary and secondary Era are found to be well developed. The sub-Himalayas are formed mainly of Tertiary and later formations. The following table gives in chronological order the various geological formations within the area of our study:

<table>
<thead>
<tr>
<th>Rock Formation</th>
<th>Area</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sub-Recent</td>
<td>River terraces, pebble beds low level alluvium.</td>
<td></td>
</tr>
<tr>
<td>2. Shiwaliks</td>
<td>Upper 6000', Middle 6000', Lower 5000'</td>
<td>Sub-Himalaya to L. Miocene Pleistocene.</td>
</tr>
<tr>
<td>3. Murrees</td>
<td>Upper 3000', Lower 5000' Basal-Fatehjang zone of ossiferrous conglomerates.</td>
<td>Sub-Himalaya L. Miocene</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Rock Formation</th>
<th>Area</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Subathu 300-600'</td>
<td></td>
<td>Sub-Himalaya M.Eocene</td>
</tr>
<tr>
<td>Grey and redgypseous shales with subordinate lenticular limestone; coal seams; pisclitic limonite (laterite) at base; dykes of ultra-basic, intrusive; chert breccia.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unconformity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permo-Carboniferous Sirbar Limestone or 'Great limestone'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Chharat 1000; Nummulitic limestone and shales with coal seams at the base.</td>
<td>Pir Panjal</td>
<td>L.Eocene</td>
</tr>
<tr>
<td>Hill limestone</td>
<td>200-400; Massive nummulitic limestone, some shale and thin coal (Ranikot Stage)</td>
<td></td>
</tr>
<tr>
<td>Panjal Trap &amp; Permian or Trias Limestone.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Jurassic of Pir Panjal (Banihal) Limestone, shales,SS.</td>
<td>Pir Panjal</td>
<td>Jurassic</td>
</tr>
<tr>
<td>7. Upper Trias Limestone etc.</td>
<td></td>
<td>U.Trias</td>
</tr>
<tr>
<td>of Pir Panjal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Zewan Series Limestone</td>
<td></td>
<td>M.Permian</td>
</tr>
<tr>
<td>Rock Formation</td>
<td>Area</td>
<td>Age</td>
</tr>
<tr>
<td>------------------------------</td>
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<td>----------------</td>
</tr>
<tr>
<td>9. Gangaramopteris beds</td>
<td>Pir</td>
<td>U. Carboniferous to L Permian</td>
</tr>
<tr>
<td>10. Panjal Trans Agglomerate Slates</td>
<td>Panjal</td>
<td>U. Carboniferous</td>
</tr>
<tr>
<td>11. Fenestella shales</td>
<td></td>
<td>M. Carboniferous</td>
</tr>
<tr>
<td>12. Syrinothyris Limestone</td>
<td>Near Banhal</td>
<td>L. Carboniferous</td>
</tr>
<tr>
<td>13. Tanawal Series</td>
<td></td>
<td>Cambrian to U. Carboniferous</td>
</tr>
<tr>
<td>14. Cambrian beds</td>
<td></td>
<td>Cambrian</td>
</tr>
<tr>
<td>15. Dogra Slates</td>
<td></td>
<td>Algontien</td>
</tr>
<tr>
<td>16. Salkhala Series</td>
<td></td>
<td>Archean</td>
</tr>
</tbody>
</table>
Large parts of Jammu are covered by the Tertiary rocks. While the older Tertiary rocks abut on the southern face of the Pir Panjal, the newer rocks form the Murree-Shiwalik which forms the outer zone of the Himalayas.

The Shiwaliks are well known for the rich collection of fossils of Vertebrate fauna of which the class Mammalian predominates. About 11 genera of fossil primates are known which furnish a valuable study of the possible link of human ancestry. The Shiwalik region was the habitat of the Early Man in N.W. India, whose cultural remains are found in the form of lithic artifacts in various river valleys in this area. The constituent gravel of river terraces in these valleys, derived from the older Himalayan rocks was the source of the raw material for these artifacts.

The intimate association of the Shiwaliks with the evolution of Early Man and his later cultural
development calls for an optimum reconnaissance into the geological and geomorphological peculiarities of these formations.

Shiwalik System: (Mid Miocene to L.Pleistocene)

The Shiwaliks are the water-borne debris of the granitic core of the central Himalayas deposited in the furrow formed after the 3rd upheaval of the Himalayas. The deposits give the evidence of a warm humid climate through the greater part of the period of sedimentation. Palaeontologically, the Shiwalik group is classified into Lower, Middle and Upper. In each there is preponderance of Sandstone in the lower portion and abundance of clays and shales in the upper except in the upper Shiwaliks in which there are intercalation of conglomerates and the upper beds are coarser than the lower.

Wadia (1928) working in the Punch area observed that the L. Shiwaliks of that area shows local variation which relate them more closely to the underlying Murrees than to the Kamalial and Chinji of the Potwar or Nahan of the Himachal. He introduced 2 local stages—
the Palantri and the Manz. Later work showed that this

27. Krishnan, M.S. and N.K.N.Aiyengar. 1940
Did the Indobrahma or Shiwalik River Exist.
two fold division of the L. Shiwalik is discernible upto Jammu.

Then comes a stretch of unrecorded region till we reach the Ravi valley. Here the two fold division noticed from Punch to Jammu is not discernible. Lithologically the sequence of entire Shiwalik of this region is similar to that of Himachal Pradesh.

Overlying the L. Shiwalik, the M. Shiwalik beds are composed of coarse micaceous sandstones of pepper and salt grey parted by thin clays or silts of reddish brown or orange colour. This zone consists of two stages Nagri and Dhok Pathan.

According to geologists the M. Shiwalik beds indicate a gradual change from sub-tropical to arid conditions. The fauna of Nagri is smaller than the Chinji below and Dhok Pathan above and is the richest of all Shiwalik forms.

Primates are most abundant in Chinji and Nagri. It seems that Dhok Pathan period was less favourable for their existence as is attested by their less number. In the Tatrots they are entirely absent.
Nagri
Sivapithecus giganteus, Sivapithecus indicus, Dryopithecus punjabi cus, Dryopithecus cautleyi, Sigrivapithecus calmontanus.

Dhok Pathan

In the late Dhok pathan times there was sudden coarseness of deposits which indicate rejuvenation of the Himalayan drainage. 29 This distinct sedimentary change accompanied by faunal change from Middle to Upper Shiwalik has been taken by DeTerra and DeChardin as the boundary between piocone and pleistocene. 30

The U. Shiwalik have been divided into 2 faunistic and lithological sequence separated by unconformity. The lower division (Tatrot-pinjor) of the L. Pleistocene age is characterized by the primitive Elephant, Stegodon, Equus & Sivatherium while the upper zone the Boulder conglomerate belonging to M. Pleistocene is represented by Elephas, antiquus (namadicus). The appearance of Elephas, Equus, Bos in the Tatrot-Pinjor and total absence of Hipparion indicate a faunal break from pontian to


30. Ibid. (For different views on the boundary see Morris 1938; Wadia 1948; 1951; Pilgrim 1944; Nair 1960; Vishnu-Mitrè et al. 1962; Vishnu-Mitre 1963 and Ganser 1964. See Tables at the end of Ch. I (pp. 38-39) for general idea).
Villafranchian of the Pleistocene.

Lithologically U.Shiwalik beds are very coarse conglomerates, boulder conglomerates, massive beds of sands, grits and brown to red earthy clays. According to DeTerra Tatrot zone is synchronous with the 1st Himalayan glaciation.

After the end of Tatrot there was another uplift in the Himalayas. The overlying Pinjors though faunistically inseparable are lithologically different from the Tatrots.

An unconformity separates the Boulder conglomerates from the Pinjors. This unconformity was caused by folding and erosion on account of fresh Himalayan diastrophism. In the mountains the uplift was accompanied by glaciation which caused severe erosion and gave rise to wide spread deposits of thick fans of boulders. The fans form ridges bordering the plains. The B.C. is composed of white quartzite, traps, nummulitic limestones and other Tertiary rocks. The Pir Panjal supplied much of the material. DeTerra takes B.C. homotaxial with the 2nd Himalayan glaciation.


* B.C.—BOULDER CONGLOMERATE
The presence of Early Man is attested in the Sohan Basin while B.C. was being deposited. In the next great Interglacial the B.C. was cut and 1st Terrace was formed in the Himalayan foot hills.

At the end of the B.C. deposition there was another diastrophism. The Kalachita and Khair-i-Mur hills (W. Pakistan) were uplifted and the U. Shiwaliks were gently folded.

Pleistocene deposits in Jammu: (Glacial and/or fluvial)

Nature of Deposit:

1. Old glacial moraines and fluvioglacial deposits.
2. High level river terraces.
3. Terraces and fan deposits in the river valleys.
4. Lacustrine alluvium.
5. Newer alluvium, spring deposits.

In the Pir Panjal above 6500 feet, Wadia (1928) observed old glacial moraines and fluvioglacial deposits indicated by large morainic heaps, hummocky crests of the ranges above 6500 feet and covered with vegetation and a number of bare cirque like amphitheatres.
in the sides of the hills with a fan shaped drainage at their basin. Such glacial indications were noticed by him at the Girjan valley west of the Tata Kuta group of peaks and at Basur below the Doda peak. On the other side of the Pir Panjal towards the Kashmir valley nearly 8-10 thousand feet below the present snow line there are miles upon miles of fine morainic debris— the merga of the Kashmir language. They testify the intensity of the ice action. On the either side of the Rajpur pass a cluster of glacial lakes at the head of Girjan valley at an altitude of 12000-13000' are found to be moraine-bound, has an important bearing on the past glaciation of the Pir Panjal mountains (Wadia 1928). The remnants of the glacio-fluvial debris in the middle region of the Chenab and the upper region of the Tawi was noticed by DeTerra.

2. On the high reaches of the Mandhar and Mahal tributary system of the Punch, the channels have cut high level terraces up to the elevation of 1000 feet from the valley bottom. This valley fill is composed largely of reassorted fluvial moraines which have undergone little river transport. In other parts of the valley they are mingled with a certain amount of
fluvio-glacial drift within which the numerous sub-angular blocs (some of them 15-20' across) as well as the smaller masses show some reworking by water (Wadia 1928).

3. Terraces and fan deposits in the river valleys.

Outlet of the Chenab valley near Akhnoor. Chenab in its middle region generally lacks geological record of this period due to precipitous valley. However, remnants of very coarse boulder conglomerate in a silty matrix are seen where Chenab emerges from the Pir Panjal in a gorge like valley.

Downstream, some 16 km. above Akhnur Chenab crosses finally the monoclinal B.C. ridge, which runs in N/E-S/W direction, in a deep valley. The ridge composed of largely hard rocks-quartzite, quartz, and metamorphics forms an old boulder fan which issues at an old valley outlet. This fan was uplifted along the Shiwaliks and Chenab superimposed its coarse in the centre of it.

It was observed by DeTerra that this fan merges with the coarse boulder conglomerate noticed

32. DeTerra, H. and T.T.Paterson 1939
*Studies in Ice Age in India etc.* (See Plate 5)
in the middle region and that both belonged to the same aggradational stage younger than Tatrot-Pinjore. The nature of these deposits has been explained by glacial accumulation and outwash during the greatest ice-advance in the Pir Panjal (2nd glacial period) the deposition of which was quickened by the uplift in the Pir Panjal. The thickness of this fan is 1600 feet.

Chenab terraces above Akhnur

Chenab makes a final meander and undercuts for the last time the B.C. ridge, 3 miles upstream from Akhnur. As a result a series of terraces have been formed. Just below the dip slope of this fan T1 has been cut into the tilted surface of this fan. In a subsequent geological process the valley was trenched and refilled with a fresh gravel, homotaxial with the outwash of 3rd glacial. It is overlain by yellow loessic silt (Potwar Silt). This forms T2 which is 260' near Dagah. T3 (260') was cut into this gravel during a second phase of trenching the valley in the 3rd interglacial. T4 (65') is underlain
by another coarse gravel in which boulders are scarce. This gravel is homotaxial with the outwash of 4th glacial. In this gravel the Chenab has cut its present bed. (Pl. 5)

Thus two major fan formations represented by the D.O. fan (2nd glacial) and younger fan homotaxial with the outwash gravel of the 3rd glacial are observed in this region. About half a dozen flakes were collected from the lower part of loessic silt by DeTerra.

Terraces and fan deposits in the Tawi Valley

Upper Tawi Tract

Tawi valley contains a remarkable record of pleistocene history. Near Udhasaur U. Shiwaliks occur in an isolated basin and are found faulted against steeply folded lower and middle Shiwaliks and unconformably overlain by a few hundred feet of conglomerates in a reddish sand matrix. North of a major thrust plan the thickness of this deposit

Ibid. (SEE PLATE 5)
As at Chenab and Kashmir valley the boulders rest unconformably on Lower Pleistocene beds and undergo terracing similar to that at Chenab outlet (Pl. 5).

East of Udhampur the Tawi flows round the eastern rim of boulder fan. $T_1$ (435') which is cut into this fan is found submerged under the pink silt which was deposited after the formation of the second terrace $T_2$ (248'). $T_2$ and $T_3$ are underlain by fresh gravel which fills the entrenched valley and is different from the older fan material by the perfect bear of its components. It has been derived from the Eocene and Mesozoic debris of older rocks. As at Chenab its depositional level marks the 2nd terrace while the lower terrace $T_3$ (162') was cut into this in a renewed degradation. $T_4$ is underlain by shingly gravel and lies at 65'. The components of this gravel are quartz, micaschist, quartzite, granite, slate, black chert, Murree S.S. and Shiwalik rocks. As at Chenab a thin loam covers this terrace.

**Lower Tawi tract above Jammu**

Four miles above Jammu the Tawi cuts across the B.C. ridge, which descends towards the plains with a prominent dip slope. Here an old terrace level (T)
presumed to be $T_2$ at 300 and another ($T_2$) at 120' was noticed by DeTerra.

From the graded course of the river it has been inferred that the terrace growth was intermittent and that the major uplift took place between 2nd and 3rd glacial, a period of great erosion. Renewed dissection after quiscene ($T_2$) was followed after 3rd glacial had excavated the fans to next terrace. Due to the incomplete preservation of the later terraces this analysis could not be carried further but an impression was formed that the subsequent uplifts were feeble. Due to recent movements these levels were tilted. A new fan formation mainly derived from the B.C. ridge is in progress at the valley outlet.

4. A staggering basin filled with lacustrine alluvium encompassing 6.8 sq. miles is seen in the upper Murree rocks near Rawl Kot. Old lake alluvium near Palandri pass laid bare by road section was also noticed by Wadia.

5. In Punch, thick deposits of travertine occur at the exit of calcareous springs in Murree and Shiwalik sandstones. Near Shahpur there are few caverns in the Eocene limestone.

34. Wadia, D.N. *op.cit*; 1928.
35. Wadia, D.N. *op.cit*; 1928.
Correlation Tables of the Plio-Pleistocene of N.W. India

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