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Acknowledgement

It is a matter of great pleasure for me to present this report on the field work conducted in Uttarakhand, India. I am very thankful to God that he made me a part of this great event and it is my deep expression of gratitude towards my all the faculty members for their worthy guidance and cordial support.

I am very thankful to Prof. R. S. Rana and Mr. Raman Patel (Research Scholar) for their enthusiastic encouragement, support, guide and to enlighten me with their deep knowledge throughout the training to accomplish the field work successfully.

It was a tour, full of knowledge. It expanded our spectrum of understanding the subject matter of Geology. I want to thank my peers who boosted me to perform well. At last but not the least I also want to thank the whole team including Non-Teaching Staffs, the students for playing their role in the part of management and the transporting agencies. The role of each of them was inevitable for making this training successful.

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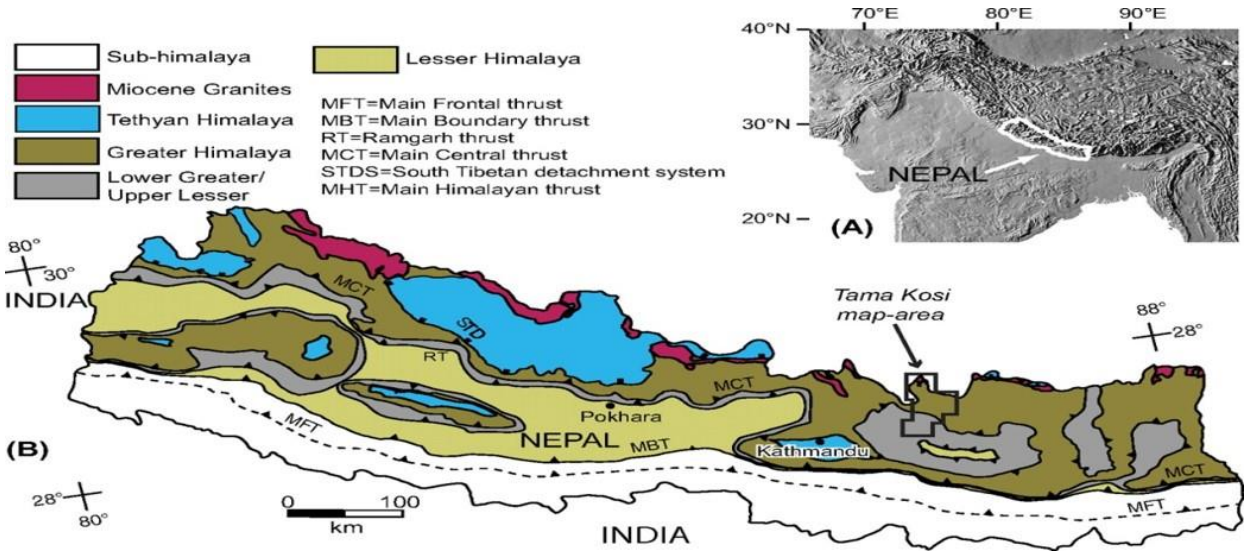
INTRODCTION

HIMALAYAS:

Himalayas have had a very restive history. It is reflected in the occasional earthquakes that shake these mammoths. The configuration of these mighty mountains reflects the balance of power, so to speak between the endogenic and exogenic forces. It occurred when the Austral- Indian plate collided with the Eurasian plate some 60 million years ago, generating a host of geological events that pushed up the Himalayas.

ORIGIN:

The scientists conjecture that the Indian plate started drifting northwards in the pots- Mesozoic times. In this process, it gradually separated from the Gondwana landmass some 100 million years ago. As it moved forward, it rotated anti-clockwise and finally collide with the Eurasian plate like a **door slamming shut.** This led the Tethys Sea lying between to retreat and moved. It is believed that Lato (a village in Jammu and Kashmir) was the pivot around which the Indian plate moved. The Indian plate eventually got thrust under the Eurasian plate creating a double layer of low density rocks. This accounts for the massive height of the Himalayas.



EVOLUTION:

The geologists have discerned a five evolutionary succession that led to the formation of these mighty mountains.

First stage: The first upliftment look place in the late Cretaceous – Early Eocene time along spurs of the mountains to a leading to a palaeo-island arc system.

Second stage: The second upliftment started in the late Eocene, deforming the Tethyan Himalayan region the emplacement of granite and granitic gneisses that comprises the Higher Himalayan zone.

Third stage: The third upheaval occurred around the middle Miocene when the rocks of the Lesser Himalayan zone got deformed into recumbent fold, nappe formation and thrust faults by far it was the most pronounced tectonic event.

Fourth stage: The fourth cataclysm occurred in the Pliocene-Pleistocene epoch raising Himalayan foothills with broad folds.

Fifth stage: Commenced when the Pleistocene glaciers receded into the higher Himalayas, leading to its isostatic upliftment and the process continues till date.

PHYSIOGRAPHIC DETAILS:

- **The Indus- Tsangpo Suture Zone-** It represents a belt of tectonic compression caused by under- thrusting of the Indian shield against the Eurasian. It marks boundary between Indian and Eurasian plate.
- **The Tethyan Himalayas-** about 40km wide, lying north of the Inner Himalayas, has an altitude between 3000 to 4000 meters. It is composed of fossil ferrous sedimentary rocks ranging in age from the earliest Paleozoic to the Tertiary (from Cambrian to Eocene)
- **The Inner Himalayas-** The Himalayas gradually gives way to the Inner Himalayas towards the south. They form the northern most lines of ranges. With average altitude of over 6000 meters, they are perpetually covered with snow. It formed by granites, gneisses and schist. Sometimes sedimentary deposits of the Purana deposits are also found.
- **The Main Central Thrust (MCT) -** It separates the Inner and middle Himalayas. This is a reverse fault of high angle and gives orthoclinal structures. Schist, Gneisses, Phyllites, Quartzite and Limestone compose narrow thrust zone.
- **The Middle Himalayas-** form a complicated and often strongly folded and faulted belt. The average elevation in this section ranges from 3600 to 4200 meters, and it is 60-80 km wide. This zone, characterized by allochthonous rock mass, is mainly composed of unfossiliferrous Pre-Cambrian, Paleozoic and Mesozoic formations.
- **The Main Boundary Fault (MFT)-** It is also reverse fault of great dimensions, it separates the Sub Himalayas from the middle Himalayas.
- **The Sub Himalayas-** It made up of almost exclusively tertiary formations, with Proterozoic inliers, which are folded into a series

of anticlines and synclines, whose axis parallel to the arrangement of the mountains. The southern limits of the Siwaliks are mostly erosion and extensions are marked by fans of alluvial deposits.

- **The Himalayan Front Fault (HFF) -** As the Indian plate continues to move northward the belt of crustal deformation has shifted southward. Now the Himalayan Front Faulted demarcates the Siwaliks from the Indo-Gangetic plains.

The Himalayas mountain complex, in their west to east extent, have been dissected by the deep gorges, creating distinct regional block, namely the Punjab Himalayas (lying between Indus and Sutlej), the Kumaon Himalayas (lying between Sutlej and Kali)**,** the Nepal Himalayas (lying between Kali and Teesta) and Assam Himalayas (Tessta and Dihang).

General Geology of The Investigated Area

1. Physiography, climate drainage and vegetation of siwalik hills (H.P.):

Area = 55,763 square km

Highest Point= Shilla (7026m)

The state H.P. is spread cover an area 55,673 square km and is bordered by Jammu and Kashmir on the north, Punjab and Chandigarh on the east, Haryana on the South- West. Tibet Autonomous region on the east.

1.1 physiography- the siwalik hills is a mountain range of the outer Himalayas. This range is about 2,400 km long enclosing an area that starts almost from the Indus a Indus and close to the Brahmaputra, with a gap of about 90 km between the Teesta and raidak rivers in Assam. The width of siwalik hills varies from 10 to 50 km; the average elevation is 1,500 to 2,000m. The siwalik hills belong to the tertiary

deposits of the outer Himalayas. They are chiefly composed of sandstone and conglomerate rock formations.

1.2 climate- there is a huge variation in the climatic condition of h.p. due to variation in altitude (450-6500 meters). The climate varies from hot and sub- humid tropical (450-900 meters) in the southern low tracts, warm and temperate (900-1800 meters), cool and temperate (1900-2400 meters) and cod glacial and alpine (2400-4800 meters) in the northern and eastern high elevated mountain ranges. By October, night and mornings are very cold. Snowfalls at elevations of nearly 3000m is about 3km and lasts from start December to march end.

1.3 drainage- siwalik range, also called siwalik hills or outer Himalayas. It extends west-north westward for more than 1,000 miles from tista river in Sikkim state, north-eastern India, and into northern Pakistan. It arises abruptly from the plain of the Indus and Ganges rivers (south) and parallels the main range of the Himalayas (north), from separated by valley. The siwalik are sometimes considered to include the southern foothills of the Assam Himalayas, which extend eastward for 400 miles.

1.4 vegetation- siwalik hills has shallow erodible soils, which marks it unsuitable for agricultural production. The forests consist mainly of chir pine and tropical mixed hardwoods of which sal is often a major component. Middle –upper siwalik have grassland type of vegetation. Maize, wheat, millet and mustard are the main crops produced in the siwalik hills. The availability of irrigation water markes it suitable for the production of the rice.

Stratigraphy of siwalik super group: the succession named after the siwalik hills near Haridwar is best exposed in the tawi valley in the Jammu and hartayanagar area in himanchal Pradesh. The basement of the succession is generally not exposed. The nahan formation of the south eastern himanchal pradesh which the underlying kasauli formation has been correlated with the lowermost unit of the siwalik group. The sediments of the siwalik group were derived from the rising mountains in the north. The lower parts of the siwalik group succession

contain fine to medium grained greywackes indicating a marine influence have also been reported from lower part of the succession. The siwalik formation has yielded a rich assemblage of vertebrate fauna. The succession also contains molluscs, ostrocodes, chalophytes, spores, pollens and pant remain. On the evidence of the vertebrate fauna, pilgrim the siwalik succession into three units assigning them middle Miocene, late Miocene to early Pliocene and late Pliocene to early Pleistocene ages. The lower unit subdivided into the kamlial and chinji zones, middle unit into the dhokpathan and nagri zones and upper unit into tartot, pinjore and boulder conglomerate. Staurolite dominates the heavy mineral component of the lower siwalik, kyanite dominates the heavy mineral in the sediments of the middle siwalik and hornblende dominates the heavy mineral in the sediments of the upper siwalik.

GEOLOGY OF THE SIWALIK SUPER GROUP

AGE	FORMATION	LITHOLOGY
Up. Siwalik (**Up. Pliocene to Low Pleistocene)**	Boulder -conglomerate	Coarse boulder, Clays Sand, Grits, Fossils-*Eleplas nomadicus Equus, Camelus*
	Pinjor Formation	Conglomerate, Sandstones, Fossils-*Elephas planiferous Hemibos*
	Tatrot Formation	Sandstones, Clays, Fossils –*Hyppophys Leptobos*

^^^^^^^^^^^^^^^^^^^^^^^^^^^^**unconformity**^^^^^^^^^^^^^^^^^^^^^^^^^^^^

Middle **(Up. Miocene to Lo .Pliocene)**	Dhokpathan	Sandstones, Shale Fossils- *Stegodom, Mastodon*
	Nagri Formation	Massive red sandstones, Fossils- *Masodom, Hipparion*

^^^^^^^^^^^^^^^^^^^^^^^^**unconformity**^^^^^^^^^^^^^^^^^^^^^^^^

Lower **(Middle Miocene)**	Chinji	Nodular shales, Clays, Fossils- *Mastodon, Hipparion*
	Kamlial	Dark hard sandstones, Red and purple Shale, Fossils- *Anthropoids, Hypoboos*

Tatrot formation- the tatrot formation well exposed in the north chandigarh and narayangarh tehsil of the Ambala district comprises soft grey, brown to red massive sandstones, silts, variegated clays and conglomerate. The faunal assemblage of the formation contains a number of genera common to the underlying dhokpathan formation. The fauna is suggestive of a late Pliocene age for the formation.

Middle Siwalik- it is subdivided into two formations.

- **Dhok pathan formation-** this stage named after the dhok pathan on the soan river and includes brown sandstone, drab shale, orange clay and some bed of gravel. In some areas the sandstone is variegated and brown but there is a variation when they are followed along the strike. The sandstone gradually gives place to shale in an easterly direction and the shaly facies extend downwards into the nagris also. The middle siwalik thin down also in a southerly direction. The source of the

sediments from the northwest i.e. from the present Indus basin.

The dhok pathan stage is the richest fossiliferous stage of the siwalik and has yielded a large number of fossils. At the end of this formation time uplift occurred and strata were folded and eroded, before the deposition of tatrot beds.

some fossils are (primates) macacus, sivapithecus: (Rodentia) rhizomes and hystris: (Equidae) hipparion, (upside) agriotherim: (tragulidae) dorcabune, dorcatherium, tragulus: (cervadae) cervus.

- **Nagri formation-** this is named after the nagri in the attock district and consists of hard grey or buff colored sandstone with small proportion of shale and clay. This formation is the starting point of evolution of the major part of the siwalik fauna. It is poorly fossiliferous, many of the mammals of the previous stage having apparently disappeared. Several primates– brahmapithecus, sivapithecs and surgivapithecs are present. The first primates are found here.

lower siwalik- it is subdivided into two formations.

- **Chinji formation-** taking it's named from chinji, this stage shows alternating ash-grey sandstone and bright red shale. The sandstones are in the potwar area, but dominant in the Jammu area. The thickness varies between 400 to 1800 meters. This stage is apparently of longer duration than the kamlial and contains large number of vertebrate fossils and also wood. In the Haridwar area the lower siwalik have been called nahan beds and they correspond mainly to the chinji stage.

- **Kamlial formation-** this stage is named after kamlial near khaur oilfield and consists of hard red sandstone with clay nodules (pseudo-conglomerate) and purple shale. The sandstone generally forms conspicuous strike rides and are somewhat finer grained than those of the murres. In the Jammu area the kamlials are not easily separable from the Murree sandstones as they look alike and contain few fossils. In northern potwar, the kamlial contain much tourmaline and only a little epidote, while the Murree and chinji beds contain abundant epidote, but only a little tourmaline. They are about 550ft. Thick and the shale is deeper red in than chinjis.

Microflora in Siwalik-

- The present report ideals with the micro flora analysis of middle and upper siwalik formation from the bhakla-nangal area of Punjab, India.
- The micro flora an assemblage which these contain consist of monolete, trolobate grains, triletes, Pinus, pollen grains of palmeae (arecaceae) and compositae (asteraceae), tetracolpites.
- During lower siwalik times, it is inferred that the vegetation was coastal, subtropical to temperature, while during middle siwalik times it changed to a predominantly temperature and inland vegetation.

- During middle siwalik times, the gymnosperms were dominant over the angiosperms, and pteripdohytes were rather poorly represented
- This is suggestive of a gradual cooling of the surrounding and an uplift of the sediments, supporting temperature conifers.

krol group-the Mesozoic rock of the krol bed is classified into carbonate predominant krol formation overlain by the flyschoidal tal formation. The contact between two formations is characterized by the presence of phosphorite bearing bed which is exposed in the east of masuri. The phosphatic horizon represents the evaporatesfacies indicating a partial withdrawal of marine condition. The phosphate bearing bed has been generally regarded as the basal part of the tal formation. Views, however, differ whether there was any break in deposition between krol and tal formation. Evidence of erosion unconformity as well as perfect krol tal transition has been reported from different section of the krol belt. these observations presumably suggest variable condition of the deposition in different segment of the krol basin.

Blaini formation-the areaofbaliana river near solon consists of a succession of boulder beds, dark shale, siltstone and pink dolomitic and

siliceous limestone. The thickness of the formation is highly variable ranging from few ten of meter to 200meters. The boulder beds are composed of clast of quartzite, slate, sandstone, siltstone, volcanic and granites. The clasts seem to have derived from the underlying formation of simla and jausar groups which must have been partially eroded during the deposition of the blaini formation. The base of the blaini formation demarcates an important datum line in the geological history of the lesser Himalaya. It marks the beginning of a prolonged phase of sedimentation extending over a period from late Palaeozoic unite the closing of the Himalaya geo syncline during the tertiary period.

Infra- krol formation- theblaini formation is conformably overlain by a sequence of about 200meters thick black carbonaceous shales and slates with intercalation of brown quartzite named as infra krol formation in view of its underlying position below the krol formation. The shales are often pyritiferous indicating a euxinic facies of deposition. The carbonate rich sequence of krol formation conformably the infra krol formation has been assigned a permotaiassic age.

Krol formation-the marine transgression which engulfed parts of the lesser Himalaya during the late Palaeozoic persisted for a measure part of the Mesozoic era. A thick sequence of dolomite and limestone and shale were laid down in quiet, shallow water and shelf sea during the Triassic and part of Jurassic period. This succession named as (krol series by-medlicott-1864 after a prominent hill near solon in h.p.). The krol formation is separated from the underlying infra-krol formation of Permian age by about 7 meters thick yellow coloured soft sand-stone known as krol sandstone member.

the krol formation has been divided into a lower and upper limestone member intervened by a red shale member (medlicott-1864). Auden (1934) classified into krol-a, krol-b, krol-c, krol-d, krol-e member. The

upper three members of auden corresponds to the upper limestone member whereas krol-a and krol-b represents the lower limestone and red shale member respectively. The lower krol limestone member consists of interbedded limestone and calcareous shales showing current and graded bedding structures. The red shale member comprises red and green shale with interbed of grey limestones and layer of gypsum. The upper limestone member comprising massive dolomites, limestone and chirty bed contain pockets of baryts and gypsums in its upper part. Oolitic and algal structures are common in the upper limestone members the entire krol succession represents the tidal flat facies with the development of evaporates facies condition the top of the succession. According to Bhattacharya and niyogi (1971) - the lower part of krol sequence was deposited in near shore, high energy environment while the upper part accumulated in a shallow and stable marine basin. The age of krol formation has been highly disputed in view of lack of definite fossil evidence. The underlying infra-krol formation of Permian age fixed the upper age limit of the krol formation. The upper part of the overlying tal succession has yielded upper cretaceous fossils. Thus, a Triassic Jurassic age has been generally accepted for the krol formation. Certain groups of palynomorphs occurring from permo-carboniferous to early-Jurassic algal remains belonging to the group solenoporaceae of Permian to early cretaceous age have been reported from the red shale member exposed in the south of the type area. Valdia (1980) however has suggested a late Palaeozoic and possibly late carboniferous age for the upper krol limestone on the basis of reported occurrence of a single spind brachiopod.

Tal formation-the tal formation first described from south western Garhwal is exposed in the central and northern part of the krol group in sirmur distt of h.p. and masuri disst of u.k. the succession consists of

black pyritiferous cherty, calcareous, arenaceous and argillaceous, flyshoidal rocks in the lower part and sandy oolitic and shaly limestone upper part of the succession. Poorly preserved remains of coral lamellae branches and gastropod suggesting a probably Jurassic age were reported from the basal part of the upper tal formation. The upper most-shaly limestone has yielded lower cretaceous bryozoans and foraminifera. Bhatia (1980) suggested that the presence of certain echinoids spines in the upper tal grainstone may indicate a late cretaceous palaeocene age for those beds.

fossils assemblage of the bioclastic grain stone forming the uppermost part of the tal succession indicates a maasttichian to danian age. The fossil assemblage consists of calcareous aglaea hydro zones bryozoans foraminifera, spines and tubercles of echinoids and some unidentlyfiable gastropods and bivalves.

Day 1

12 April 2018

Srinagar to Trilokpur

We travelled from Srinagar to Trilokpur, and along the roadside we saw a thrust in Kirti Nagar. We reached to our camp at 8pm.

Day 2

13 april 2018

Trilokpur to saketi fossil park

Spot no. 1

location- siwalik fossil park, suketi (h. P.)

Siwalik fossil park, also known as the suketi fossil park, is a fossil park in the sirmaur district in the indian state of himachal pradesh. It has a collection of prehistoric vertebrate fossils and skeletons recovered from the upper and middle siwalik geological formations of sandstones and clay at suketi.

the park is named after the suketi village where it is located, at the site where the fossils were found, in the markanda river valley, at the foot of the himalayas.

History- the idea to establish a museum was mooted to preserve the fossil site and the fossils from being indiscriminately extracted and vandalized. The geological survey of India, in association with the government of himachal pradesh, established the park on 23 march 1974.

the fossils are identified by the geological survey of India as vertebrates that lived in the area about 2.5 million years ago. Scientists believe that the shivalik hills, which formed about twenty-five million years ago, show the evolution of mankind. The mammalian fossils found in the shiwaliks of this park are one of the world's richest antiquities.

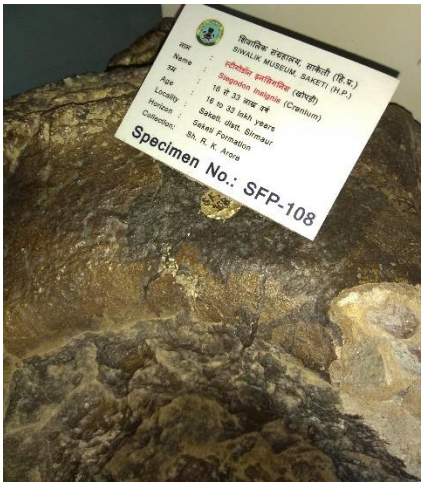
the suketi park has a unique feature, in a miniature form, of the prehistoric biological record of the upper siwalik rocks, similar to

those found in the patwar plateau and adjacent hills, also in mangla dam areas in the region.

museum-the exhibits in the museum contain skeletal remains of different groups of skulls and limbs of mammals, skulls of hippopotamuses, tortoises, gharials and crocodiles, tusks of 22 species of elephants, rocks and charts and paintings related to the several aspects of plant and animal life of the past and present. The stone items on display belong to the early paleolithic man. Also preserved in the museum are fossils of two genera of extinct primates, sivapithecus and ramapithecus. The museum also houses antiquities unearthed by captain cautley in the area, from which he dug out the remains of asia's oldest human ancestor. Exhibits also include an indian postage stamp with images of two elephants and tusks, issued in 1951 on the occasion of the centenary of the geological survey of India.

Museum 1

- Name-stegodon insignis (right maxilla m1-m2 and socket of tusk)
  Age- 25 to 33 lakhs
  Locality- 1km north of gharatwalay near kodewala
  Horizon-lower part of saketi formation



- Name- lissems (carapace)
  Age- 20 to 33 lakhs
  Locality- section on left bank of dhakwall stream, 1.5 km , west of moginand disst. Sirmaur
  Horizon- lower part of saketi formation

- Name- indotestudo sp. (carapace)
  Age- 16 to 33 lakhs
  Locality- 1km east of jahron village, sirmour
  Horizon- saketi formation

- Name- hardella (carapace)
  Age- 16 to 20 lakhs
  Locality-sfp, saketi , dist. Sirmour
  Horizon- upeer part of saketi formation

- Name- stegodon insignis
  Age- 20 to 25 lakhs
  Locality-100km from khari village, sirmour
  Horizon- middle part of saketi formation
- Name- fossil tortoise
  Age- 7 crore years ago

Locality- worli hills bombay
Horizon- intertrappean bed

- Name- fossil fish (scales)
  Age- 16 to 33 lakhs
  Locality- sfp saketi dist. Sirmour
  Horizon- saketi formation

- Name- fossil wood
  Age- 16 to 33 lakhs
  Locality- kodewala stream bed
  Horizon- saketi formation

- Name- gondwanidium valdium
  Age – 29 crore years ago
  Horizon- karaharabri formation

- Name- glossopteris communis
  Age- 2 crore years ago

Horizon- raniganj formation

- Name- fossil (plancleat)
  Age- 2 crore years ago
  Horizon- kasauli formation

- Name- plillophyum acutifolium
  Age- 15 crore years ago
  Locality- near madras

- Name- equas sivalensis (upper molar)
  Age- 10 to 15 lakhs
  Locality- 1km east of uttarbami dist. Jammu
  Horizon- marikhui member
- Name- hipparion (left upper molar)
  Age- 20 to 25 lakhs
  Locality- north of toka, khairi stream right bank of exposure near bridge
  Horizon- middle part of saketi formation

Museum 2

- Indo gangetic alluvial plain sediment
  Lithology- medium to fine grain sand with gravels
  Age- recent to sub –recent

^^^^^^^^^^^^^^^^^^Himalaya frontal thrust^^^^^^^^

- Dok-pathan formation (siwalik group)
  Age- late miocene

- Tartot formation (saketi) siwalik group
  Age- lower pliocene

- Pinjore formation (siwalik formation)
  Age- middle pliocene

- Boulder conglomerate (mudstone)
  Age- upper pleistocene

^^^^^^^^^^^^^^^^^^^^nahan thrust^^^^^^^^^^^^^^^^

- Nahan formation
  Age- upper miocene

^^^^^^^^^^^^^^^^^^main boundary fault^^^^^^^^^^^

lesser Himalaya

- Subathu formation
  Age- palaeocene to eocene

- Dasghai formation (sirmaur group)
  Lithology- red purple siltstone
  Age- eocene to oligocene

- Kasauli formation
  Lithology- greenish grey sandstone drifted wood fossil
  Age- early miocene

^^^^^^^^^^^^^^^^main boundary fault^^^^^^^^^^^^^^

- Blaini formation (balaina group)
  Lithology- pink dolostone

Age- neo-proterozoic

- Infra-krol formation
  Lithology- black to grey shale
  Age- neo-proterozoic to ediacaran

- Chambaghat formation (krol formation)
  Lithology- well sorted unimodal sandastone
  age- neo-proterozoic to edicaran

- Mahi formation (krol formation)
  Lithology- calcareous argillite with chert nodules
  Age- neo-proterozoic to edicaran

- Jarasi formation
  Lithology- red purple shale with gypsum bands
  Age- neo-proterozoic to edicaran

- Kuriyala formation (krol formation)
  Lithology- limestone with fenestral fabric
  Age- neo-proterozoic to edicaran

- Basantpur formation
  Lithology- dolomitic limestone with siltstone
  Age- neo-proterozoic

- Chausa formation (shimla formation)
  Lithology- shale and sandstone with load cast
  Age- neo-proterozoic

- Sanjaui formation (shimla formation)

Lithology- purple sandstone with occasional conglomerate
Age- neo-proterozoic

- Stromatolitic limestone (shali formation)
  Age- meso-proterozoic

- Rohtang gneises
  Lithology- granitic gneises with augen structure
  Age- palaeo-proterozoic

^^^^^^^^^^^^south-tibet detachment fault^^^^^^^^^^^^^^^^

- Batal formation
  Lithology- siltstone
  Age- early cambrian

- Kunzum la formation
  Lithology- thiny laminated medium grained sandstone
  Age- middle cambrian

- Thango formation
  Lithology- middle grained ferrugineous sandstone with ripple mark
  Age- early oradovician

- Takche formation
  Lithology- fossiliferous limestone with fossilized stem of shale
  Age- early ordovician

- Muth formation

Lithology- white coloured sandstone with ripple mark
Age- early devonian

- Lipok formation
  Lithology- coralline limestone
  Age- early carboniferous

- Po formation
  Lithology- coarse to medium grain sandstone
  Age- early carboniferous

- Ganmachidam formation
  Lithology- pebbly coarse grained sandstone
  Age- late carboniferous

- Gechang formation
  Lithology- coarse to medium grained sandstone
  Age- early permian

- Gungri formation
  Lithology- siltstone with zoophycos traces fossile
  Age- late permian

- Mikin formation
  Lithology- limestone
  Age- lower triassic
- Kaga formation
  Lithology- limestone
  Age- m. Triassic

- Chomure formation
  Lithology- limestone

Age- m. Triassic

- Rongtong formation
  Lithology- limestone
  Age- u. Triassic

- Rangrik formation
  Lithology- sandstone, siltstone, shale with phosphatic nodules
  Age- middle norik

- Hangrang formation
  Lithilogy- massive to bedded limestone
  Age- late norik

- Kioto formation
  Lithology- lmestone
  Age- late triassic to early triassic

- Spiti formation
  Lithology- fossiliferous shale containing ammonites, brachiopods
  Age- lower jurassic to early createceous

- Giumal formation
  Lithology- fossileferous calcareous sandstone with shales
  Age- lower createceous

- Chikkim formation
  Lithology- limestone
  Age- upper createceous
- Nindam formation

Lithology- chromite (ophiolite suite)
Age- jurassic to createceous

- Nindam formation
  Lithology- serpentinized harzburgite and lhezolite
  Age- l. Jurassic to createceous

- Nindam formation
  Lithology- peridotic with magnesite veins (ophiolitic suite)
  Age- l. Jurassic to createceous

- Nindam formation
  Lithology- lyered gabbro with pillow structure (ophiolitic suite)
  Age- l. Jurassic to createceous

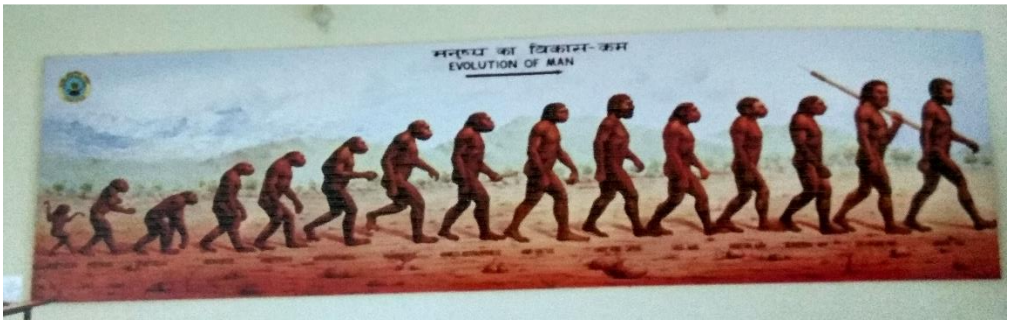
- Radiolarian chert (Indus group)
  Age- l. Jurassic to createceous

- Numulitic limestone
  Lithology- siltstone, sandstone with limestone
  Age- early pliocene to eocene

^^^^^^^^^^^^^^^^indus-tsango suture zone (itsz) ^^^^^^^^^^^^^^

- Laddakh granitoid (laddakh plutonic complex)
  Age- early createceous to eocene

Evolution of Man



Day3

14 april

Trilokpur to markanda river section

location- left side of markanda river, 2 km downstream

formation – tatrot formation

trend of river- n35^{0}s (from opposite kalamb)

Shale
Sandstone
Siltstone
sandstone

suketi road, kala amb and presence of medium grained sandstone with

dip amount - 25^0, strike -300^0, dip direction- 209$^{0.}$

dip amount- 47^0, strike- 270 , dip direction- 181^0,

dip amount- 10^0, strike- 162^0, dip direction- 72^0.

Spot no. 3

location- 200 m upstream from spot 1

- A nala having an extinction of 5m joints the river from the left side.
- The trend of nala is n270^0.
- Siliceous sandstone present.

Upstream – medium grained sandstone having chert nodule with a dimensions of 32*30cm, with dark grey colour, some of the nodules are elongated in the shape (25*13).

Laminations- thin bedding, less than one cm in thickness and are usually found in fine grained rocks.

Spheroidal weathering- it is a form of chemical weathering that affects joints bedrock and result in the formation of concentric & spherical layers.

Spot no. 4

location- 3km from suketi fossil park in markanda river

- At the side of river, we searching fossil for vertebrates.
- First, we found a set of teeth of elephant fossil.
- about 300 m away from first fossil site, we found tusk and skull of elephant fossil in tatrot formation.

Day 4

15 april

Trilokpur to nahan

Spot no. 1

location- along the road between moginand & nahan.

Latitude-$26^0 53' 13'' n$, longitude-$80^0 57' 34'' e$

Upper part of siwalik

Nahan sandstone, strike-$n60^0 w$, $n30^0 e$

Sandstone id micaceous and coarse grained.

Sandstone is usually light colour because without mica.

spot no. 2

location- 10m backward toward south from spot 1

greety sandstone beds, grayish shale and sandstone contact.

- Presence of sandstone, reddish clay patch, reddish brown shales.
- there is alteration of brownish shales and sandstone, the shale are highly weathered, beds are also visible within the brownish shales.
- Shales are highly sheared hence a lot of erosion is present in the exposure.
- Nahan thrust is present between upper siwalik and lower siwalik because of absence of middle siwalik.
- Microfossils are also found in shale rock along the road.
- Some other fossils also greyish sandstone.
- There is a contact between shale and quartzite, micaceous brownish sandstone.
- Trend of nala $n265^0$ and $n323^0$.

spot no. 3

location- 1 km downstream from sainwala towards moginand

- Presence of pebbly quartzite and pebbly shale.
- Black shale, carbonaceous shale is also present.
- Quaternary boulder conglomerate.

- Presence of open folds (anticline).

spot no. 4

location- along the nala near trilokpur.

- Searching for fossils
- Presence of sedimentary rock structure eroded by water.
- Along the river side presence of clay, shale, pitted and grooved, sub angular to rounded and elongated boulders, pebbles, and cobbles, are found along the partially swampy and drying river.
- We found black crocodile teeth and jaw as well as bone.

Day 5

16 april

In and around Jheel area

Spot 1

Location – jheel village near the bridge

- Rock type of this location is clay, mud and sandstone of tartrot formation
- On this place we went to find some fossils along nala, we got bones of horse, teeth of elephant.
- Rock beds of conglomerate and sandstone are attached with pebble, cobbles and boulder.
- On this place we found vertebral coulomb of snake.

Day 6

17 april

Dhaula Kuan to Rishikesh

We travelled towards rishikesh from dhaula kuan, where we saw different lithology of rocks along the roadside. We visited gurudwara in day time.

Spot 2

Working on fossils (sampling and packing)

Day 7

18 april

Rishikesh

Spot no. 1

location- near lakshman jhula (below sachha dham)
right bank of the river.

The rocks which are present here are drive from lesser himalayan region transported by river.
Conglomerate of blaini formation is also present here.
The rocks of tal and krol formation are also present.
Limestone found inside a boulder bed which is used as secondary cemented material.
We found carbonaceous shale from tal formation.
Infra-krol is called t_1, krol is t_2, and tal is t_3.
The fold in rocks is also present.

Day 8

19 april

Rishikesh to neelkanth

We saw different lithology of rocks along the roadside. We studied about limestone gypsum.

Day 9

20 april

Rishikesh to srinagar

Spot no. 1

location- bachelikhal

Youth stage of river. U shaped turning river (alaknanda).

At the bottem saknidhar fm is exposed. Nayar river is a braiding which is tributary of alaknanda river. All the rivers of the himalayan rigion are originated from glaciers. Here brown quartz and maroon having some sedimentary structure. The stream valley is structurally controlled.

Spot no. 2

location- 13 km before kodiyala (blaini boulder bed).

the age of blaini boulder bed is Permian to carboniferous.

In blaini boulder bed, the rocks are mainly siltstone and slates. The origin of this bed is glacio-marine. Here the glacial marks are present.

These are ungraded and patches of quartzite found fixed with phyllite pieces. There are 50m to 80m extension of blaini boulder bed along the road. Corals are found in this.

The fluid cast and ripple marks are also seen in this area.

Krol succession is mainly sedimentary rocks (shale and limestone).

Krol- a, b, c, d, e.

A- Sandstone, limestone and shale.
B- Absent
C- Fine grained limestone and shale.
D- Cherty limestone.
E- Elephant skin weathering dolomite limestone rock.

Spot no. 3

location- 7km - kodiyala (tal shale)

- Rock is quartzite. The age of upper tal formation is cretaceous.

Lower tal formation- tomation fauna and shaly fauna are present.
Trilobites are also present in lower tal formation.
Black shale is formed in reducing environment.
The rocks are highly weathered.
The age of lower tal formation is near jurassic.

Spot no.4

location- singhtali (near jhula pul)

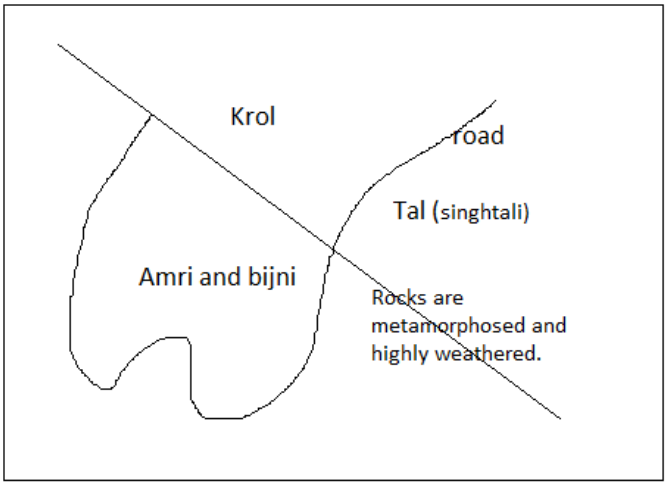
singhtali formation is equivalent to kakra formation in himachal pradesh. The krol thrust is also present here.

- Base of subathu formation- the rock is limestone. Pelecypods and gastropods are found in this area. The age is paleocene to eocene.

The rocks are low grade metamorphic rock. Fault scarp seen on the other side of the river.

Fault scarp- very often result in the development of distinct types of steep slopes which are aptly called fault scarps. In fault scarp, the relief is developed due to downward slip along the fault surface.

Fossiliferous limestone is also found in this area. The age of these rocks are eocene.



conclusion

- Srinagar, rishikesh, himanchal pradesh and its adjoining areas have good importance to the geologists due to its varied geomorphology and structure features.
- Srinagar and some parts of the himanchal pradesh lie within lesser himalayas which are one of the oldest mountain chains of India with a strike of nw-se.

- rocks of this region are sedimentary in nature however at some places.
- We collect the fossils from the upper siwalik super group.
- In beds we study to identify the dip- direction of bed and strike.
- We saw the sequence of krol formation, tal formation, infra-krol formation, blaini formation and also saw the lower and upper siwalik.
- We saw the suketi fossil park museum; there was wonderful collection of fossils and rocks accordingly.
- With the help of teacher they guide us how to mapping along a nala and river section and they identify the middle siwalik.
- This tour took me through the various phases of skill development in a field work and gave me real inside to become geologists.
- The joy of working in a field and tired involves after working, various problem and challenges gave me full of developers a good student of geology.
- bonding of teacher and student very well both teacher are very supportive and helping nature. Both guidance is life time memorable.

Field equipments

Geologist need to carry a number of field equipment with them. A hammer is used essentially to break rock and for collecting minerals sample. Compass, hand lens, toposheet of the area, g.p. s. (global position system), acid bottle, field notebook, camera, scale is useful at times.

Brunton compass-a compass is an instrument used for navigation and mapping because it is used to measure geographic direction between two points. It is fairly a simple instrument that uses a magnet mounted point that in response to earth magnetic field to determine direction. Magnetic needle point to magnetic north, which is different from geographic north.

Parts of brunton compass- basic parts of plate of compass are describe-

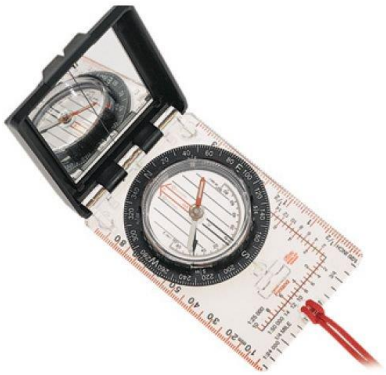
Magnetic needle-it is used for the measuring angle on a circular scale. In the magnetic needle the south direction marks by wire and type of colour point.

Housing with cardinal point & degree- housing include a revolving dial shows point (n-e) and degree (0-360). The housing is rotated to line up compass needle with orienting arrow when taking a bearing or back bearing.

Orienting arrow-the n-s orienting used to align magnetic when taking a bearing.

Index line- it is marked at front side of compass base plate, index line where we read the indicating readings.

Clinometer- some compass have that can be used to estimate slope.



Mirror-some compass has a flip up mirror that can be improve accuracy when reading bearing.

Orienting compass-there is two different ways to orient a compass to magnetic or to geographic north. The purpose of orienting a compass is that we know our location in relation to north.

Hammer and chisels-hammer used to break rock. Generally a hammer weighting less than about 3-4k.g. of little use expect for very soft rock. Hammering alone is not always used to collect rocks or fossils specimen. Sometimes a chisel is needle to break out a specially piece of rock and fossils. Its size depends upon work to be done on thing which you must never do, is to use one hammer as chisel.

Hand lens-every geologist have a hand lens and should develop a habit of carrying it always so that when it needs, it has with them. A magnification of between 7-10 times probably most useful.

Acid bottle-use of acid to find out carbonate and non-carbonate rock. When acid fall on the carbonate rock it give the bubble.

G.p.s. (global position system)- the global positioning system is a satellite based navigation and surveying system for determine the precise position and time utilizing the radio signal from the satellite. The gps technology overcomes the various limitation of a convectional survey. If we consider the advantage of the gps over the convectional techniques such as the high accuracy it achieves in three- dimensional positioning and the economy of its operation, we discover that it is the most promising surveying

Some important definition related to the field

Outcrop - that part of a large or veils, which can be seen on the surface

of the earth.

Feature- is a part of landscape that stands out.

Mineral- a naturally occurring homogeneous solid with a definite chemical composition and highly ordered atomic arrangement, usually formed by inorganic process.

Rock- a hard solid aggregate of mineral derived from the earth there are three type of rock.

(1).igneous rock– rock that has solidom hot molten material called magma. These are of three types.

(1)volcanic – rock formed by eruption of magma at the earth surface as lava or as ash. Example- basalt

(2)plutonic – rock resulting from the solidification of magma well below the earth's surface. Example- granite.

(3)hypabyssal- these igneous rocks are formed at intermediate depths generally up to 2 km below the earth surface.

(2)sedimentary rocks- rock formed when the sediments are deposited in layers and get accumulation slowly. It is soft in nature and stratified. Example- sandstone.

(3)metamorphic rocks- rocks formed due to compression or tension and deformation.example- quartzite, slate etc.

Attitude- refers to the three dimensional orientation of some geological features, such as bed, a joint, a fold etc. It induces the dip and strike of the feature.

Dip- dip of strata is the angle between the bedding and a horizontal plane.

Strike- strike is the direction of the line formed by intersection of bedding and a horizontal plane along which the dip is measured.

Fault- fault is ruptures along which the opposite walls have moved past each other.

Cleavage- it is the property of rocks whereby they break along pearled surface of secondary origin e.g. shown by slate.

Folds- folds may be defined as a curved or zig-zag structure shown by rock beds. Or wavy undulations in the rock beds.

Joint- joint is smooth features along which a rock breaks.

Fracture- it is the closely spaced jointing in minerals but it is not pearled to cleavage.

Lithology- it is the study of the general physical characteristics of rocks.

Group Photo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