INDIAN INSTITUTE OF TECHNOLOGY KANPUR

Department of Earth Sciences

Field Report - Chitrakoot

30 Nov - 2 Dec 2023

Mentors

Dr. Thupstan Angchuk
Dr. Govindarao Boddepalli

Group Members

Shourya Khare
Gautam Kumar
Arya Sorate
Yuvraj Singh Kharte

Under the guidance of :

Riddhiman Ghosh (TA)
Abhishek Lakra (TA)
Gourab Dey (TA)

ES 207

15 March 2024

ACKNOWLEDGEMENT

We express our sincere gratitude to our mentors Dr. Govindarao Boddepalli and Dr. Thupstan Angchuk for their invaluable guidance throughout the course that has illuminated our understanding of the various features of different rocks and minerals and geologic features thus, enriching our field trip to Chitrakoot.

Our profound gratitude is also extended to our dedicated Teaching Assistants - Riddhiman Ghosh, Abhishek Lakra and Gourab Dey. Their enthusiastic efforts in aiding us with doubt clarifications and providing essential resources have significantly contributed to the success of our field work.

We express our gratitude to our fellow peers for their collaborative spirit. Special thanks go to our families, whose support has been instrumental in our pursuit of higher learning. Their collective effort has enriched our field experience and has been pivotal to the successful completion of the report.

Table of Contents

List of Figures

Fig 5.3 movement of peak shown due to water flow

Fig 6.1- Quartzite-Metamorphism of quartz rich Sedimentary rock

Fig 6.2 Formation of Sandstone over Igneous rock can be easily seen

Fig 6.3 Lithologic profile of crust at Kamadgiri Hill

Fig 6.4 Presence of both Sedimentary rock and Igneous rocks can be seen

Fig 6.5 Formation of Oolitic Limestone

Fig 7.1 - A view of the Sangrampur Hill in the Chitrakoot area, Uttar Pradesh. The Bundelkhand Granite is seen below, whereas the Semri Group is noted above it. The lower succession of the Kaimur Group is exposed on the top of the hill.

Fig 7.2 (a,b) - Quartzite (non-foliated metamorphic rock which was originally pure quartz sandstone. Sandstone is converted into quartzite)

Fig 7.3 - Granite (porphyritic texture) Pink colour is due to orthoclase , Plagioclase is easily visible

INTRODUCTION

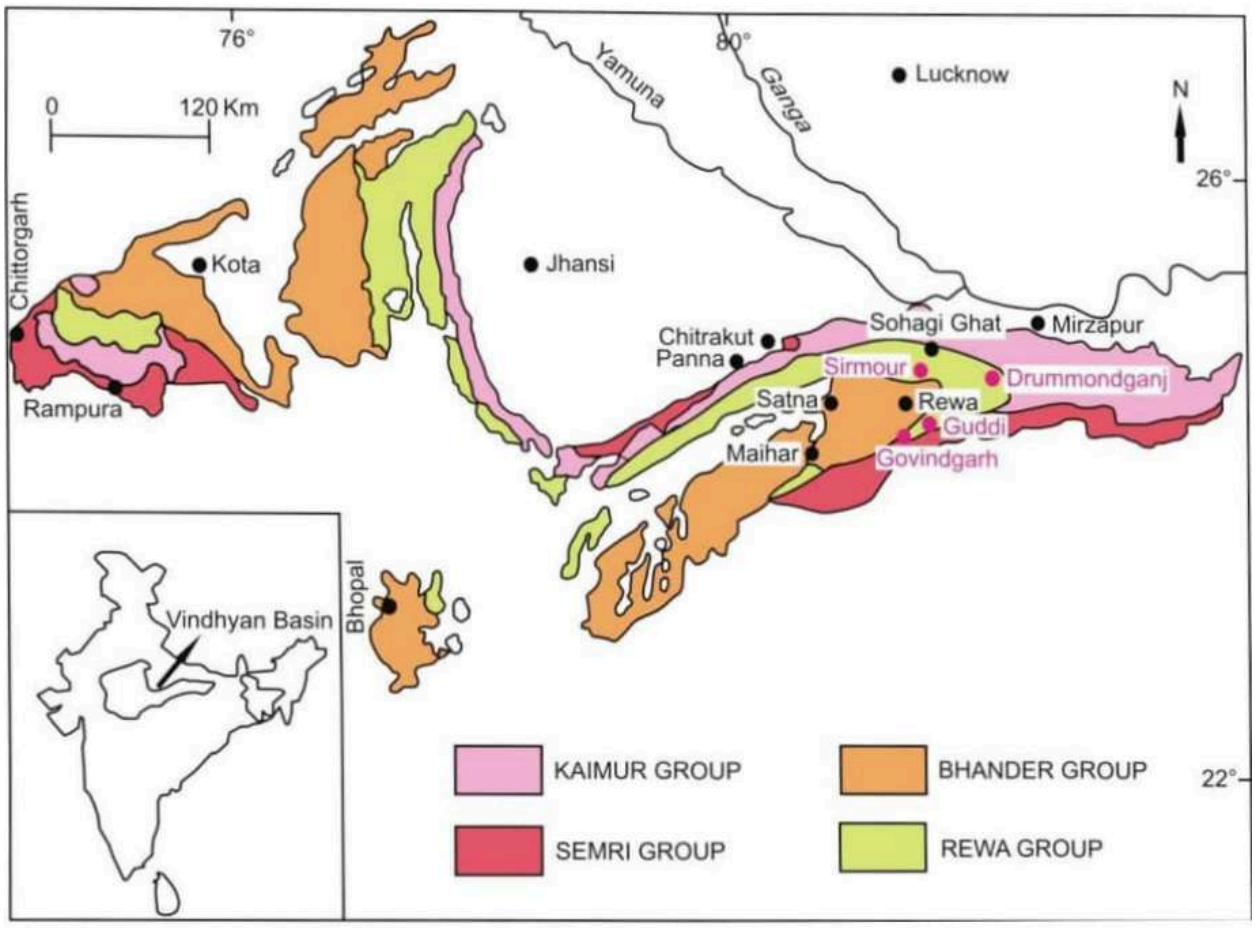

Fig a - Stratigraphy of the Vindhyan Supergroup

General Geology of Vindhyan Basin

Among the Precambrian sedimentary basins, Vindhyan Basin is the largest with currently exposed area of approximately 1,04,000 sq. km and occupies a large part of the Peninsular India. It contains a thick (~ 4000 m in the eastern parts) sequence of largely unmetamorphosed and undeformed succession of shales, sandstones, limestones, dolostones with subordinate conglomerates and volcanics. Tectonically, Vindhyan Supergroup is bounded by Narmada-Son lineament in the South, Great Boundary Fault in the West and Indo-Gangetic Plains in the East.

According to the generalized lithostratigraphy in the Son Valley, the Lower Vindhyan consists of the Semri Group and the Upper Vindhyan includes the Kaimur, Rewa and Bhander Groups. The base of the Vindhyan sediments is believed to be ~ 1600

Ma old. Bhander, the youngest group is around 600 Ma old, indicating the cessation of Vindhyan sedimentation.

Basin Evolution

The Vindhyan Basin was formed as a result of a large crustal downwarp in the northern part of the Indian Platform, after the Delhi orogeny. The initial transgression of the sea from the north is inferred to have taken place in the eastern part of the basin over the Bijawars. The shallow sea appears to have established lagoonal conditions near the coastal part during the subsequent regressive phase. Initially, the Son-Narmada Lineament was dormant, but at the onset of Vindhyan sedimentation later, the fault system along this downwarp became active with the formation of the southern limit of Vindhyan deposition. After the deposition of Kajrahat Limestone, the Son-Narmada Lineament again became active resulting in emission of volcanic material, which was deposited as the Jardepahar Porcellanite. In the subsequent regression, the shore line shifted towards northwest. The Fawn Limestone was deposited over the shelf in a tidal flat environment. This was followed by shallowing of the basin as is evident from the overlying Glauconitic Sandstone. The fresh marine transgression resulted in the deposition of marine shales followed by Rohtas Limestone.

Tectonic Framework:

The basin is bounded by the Son-Narmada Geo Fracture in the south, the Great Boundary Fault in the west, the Monghyr-Saharsa Ridge in the east, and the Bundelkhand Massif and Indo-Gangetic Plains in the north. Bundelkhand Massif divides this basin into two parts – the Son Valley on the southeastern side and the Chambal Valley where exposures occur from Agra (Uttar Pradesh) to Chittorgarh (Rajasthan). The southern margin of the Vindhyan basin is marked by a major ENE–WSW trending Directorate General Of Hydrocarbon The Vindhyan basin 2 2 lineament termed Narmada–Son lineament south of which occurs the Satpura orogen. A NE–SW trending major lineament known as Great Boundary Fault separating the Aravalli– Delhi orogen from the Vindhyan, also marks the western margin of the Vindhyan basin in the Rajasthan sector. The Vindhyan strata define a broad, regional syncline trending ENE–WSW. The axis of the syncline is slightly curved and plunges gently towards west. The average dip of the southern limb is greater than that of the northern limb rendering the axial plane to dip southerly.

Stratigraphy - (Fig 1)

The Vindhyan Supergroup has been litho stratigraphically subdivided into four groups; in stratigraphic order these are: the **Semri Group**, the **Kaimur Group**, the **Rewa**

Group and the **Bhander Group** (Table 1). The Vindhyan sediments show much facies variation and both horizontal and vertical gradation in lithology is well recorded. Thus, different areas show different lithostratigraphic successions. This aspect is well demonstrated when a comparison of lithostratigraphic succession is made between the eastern and western parts of the Vindhyan Basin. The stratigraphic succession of the eastern part does not compare well with the stratigraphic succession of the western part of the basin. Thus, in absence of the radiometric dates and definite index fossils, the correlation of the lithostratigraphic units of the eastern part with the litho units of the western part of the basin has become very subjective. Such an attempt has led to very erroneous conclusions about correlations, as very little information is available on the facies variation of the different sequences of the Vindhyan Basin. Absence of any regional unconformity or regionally correlatable litho unit has also compounded the problem.

Day \ Time	**8:00**	**9:00**	**14:00**	**Evening**	
Day 1	Assembly at Old SAC	Departure from Old SAC	Arrival at Ken River, Banda	Stay at Chitrakoot	
	09:30	**11:00**	**13:00**	**15:30**	**Evening**
Day 2	Gupt Godavari Caves	Hill near Paldev Temple	Janaki Kund / Mandakini Stream	Hanuman Dhara	Stay at Chitrakoot
	08:50	**10:20**	**19:00**	**20:00**	
Day 3	Kamadgiri Hill	Sangrampur Hill	Arrival at Old SAC	Dispersal	

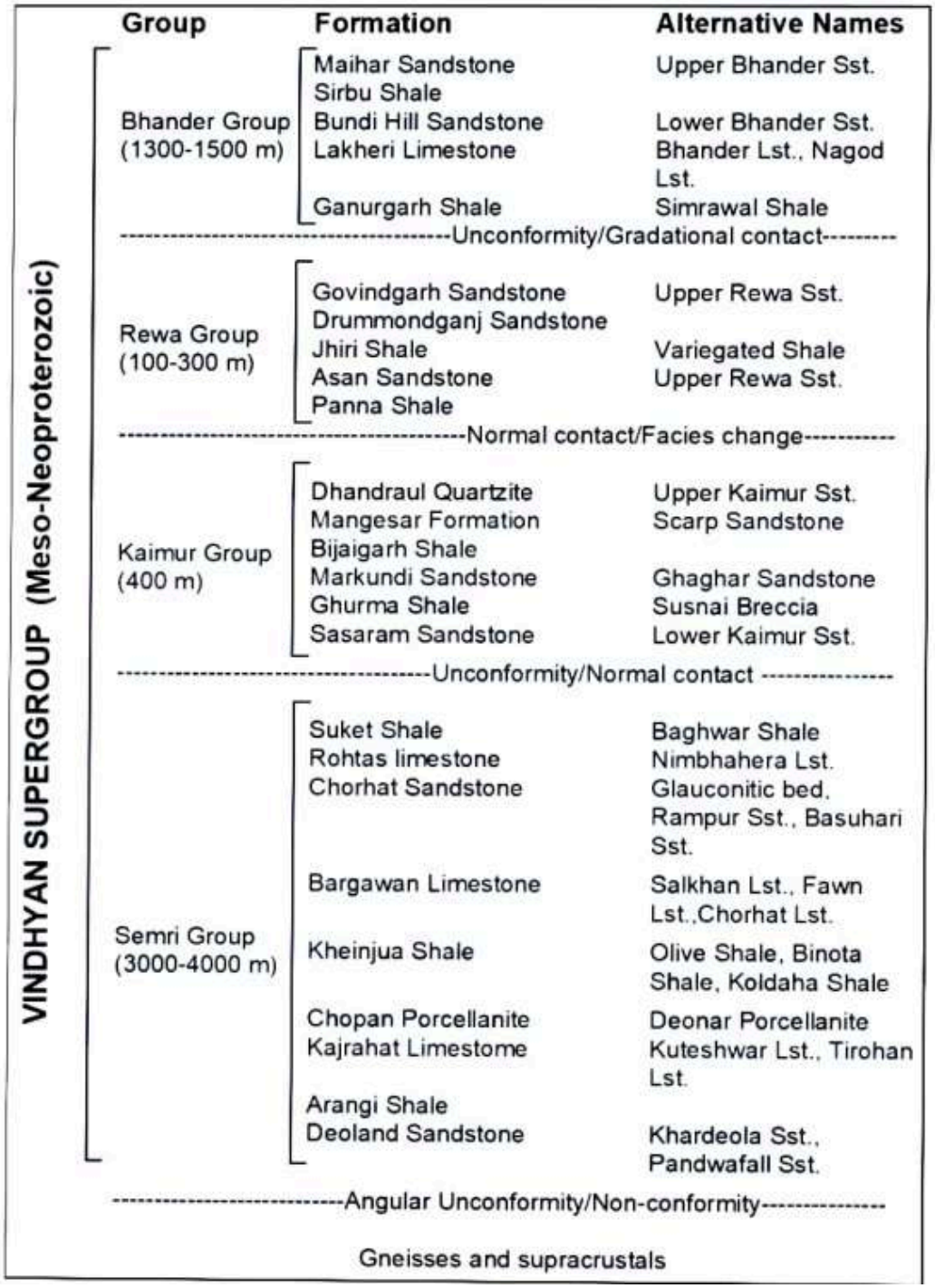

Table 1 - Stratigraphic classification for the Vindhyan Supergroup

Source: Ramakrishnan and Vaidyanadhan, 2008

Day 1 (30 Nov 2023)

Site 1:

Ken River Section, Banda

Location: Lat - 25° 28’ 49" N ; **Long -** 80°18’ 53" E ; **Elevation:** 100m

Time - 2PM

Approach: Next to Ken river bridge, Banda, Uttar Pradesh.

The **Ken River** is one of the major rivers in the Bundelkhand region of central India and flows through the states of Madhya Pradesh and Uttar Pradesh. It is a tributary of the Yamuna.

Key Observations: Geological Units observed at this location include Granite (Gneissic Complex) and Alluvial Sediment Accumulation. Here, the basement of the Vindhyan Supergroup is exposed. The river is meandering and point bars are present in the river. Secondary deposition of quartz as veins are seen. Alluvial deposition is observed on the banks. Inclined vertical and horizontal joints were observed in this granitic terrain. The upper exposure was weathered and blocky in nature indicating solution activity and thermal expansion and contraction in joints.

Fig 1.1- Ken river adjoining area. Alluvial deposition and granite (basement of the Vindhyan Supergroup) are visible. The river is meandering.

Fig 1.2- Secondary deposition of quartz veins between granitic rock

Fig 1.3- Brunton Compass (Several dip measurements of basement rocks were taken)

Fig 1.4 - Minerals visible:

alkali feldspar *(pink, bottom left image)*,
Biotite *(dark green),*
Quartz *(white, right side image)*

Day 2 (1 Dec 2023)

Site 2:

Gupt Godavari Caves :

Location: **Lat -** N 25° 5’ 50" ;
Long - E 80°46’ 14.7"
Elevation : 208m

Time - 11:34 AM

Approach: 15 kms south west of Chitrakoot, along Satna road.

Fig 2.1- GuptGodavari stream forming well developed cavernous cave within the Limestone ;Ripples are visible.

Key observations: A pair of very fine- mud caves seen in the Limestone (Dolomite) which are identified by observing bubbles by reaction with HCl or HNO3. Calcareous sandstones are also present. One of the caves has a high and wide entrance while another has a long and narrow entrance with a stream of water flowing from the cavernous limestone. The cavernous Tirohan Limestone is well exposed in both the caves. Small-scale ripples, cross beddings, parallel beddings can be noticed in the caves. Stylolites are very common.

Fig 2.2 Formation of Stalactites

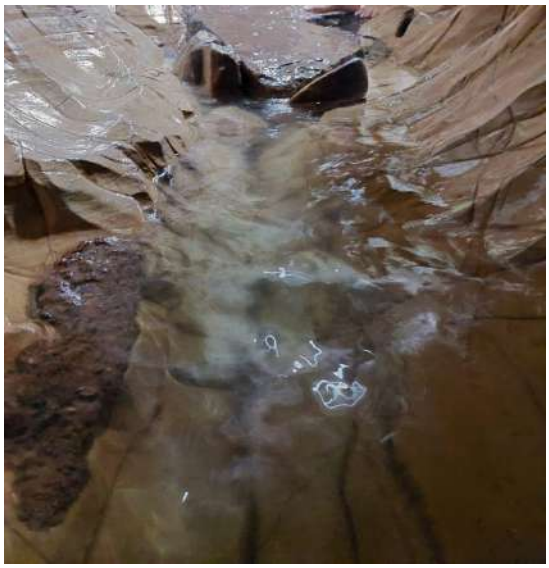

Fig 2.3 Elephant skin weathering due to flowing water in caves

Speleothems are observed (both stalactites and stalagmites). Dolomite is confirmed by the presence of elephant skin weathering. Stalactites formation can be easily seen. But stalagmites are not visible White colour weathering in rocks due to flowing water.

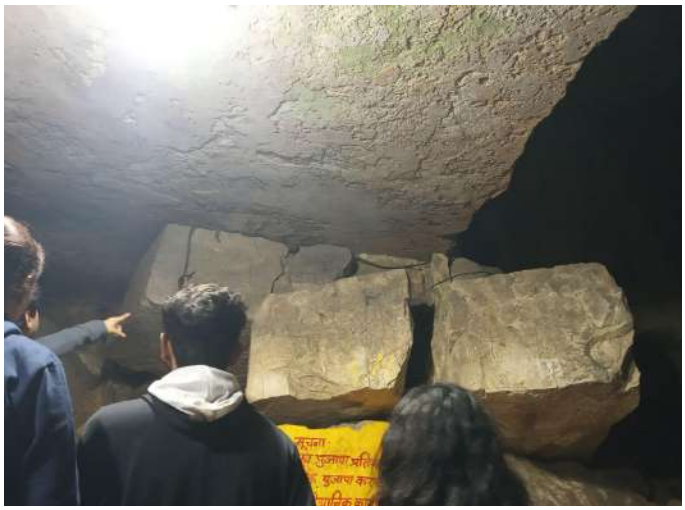

Fig 2.4- Massive Calcites broken into Rhombohedral

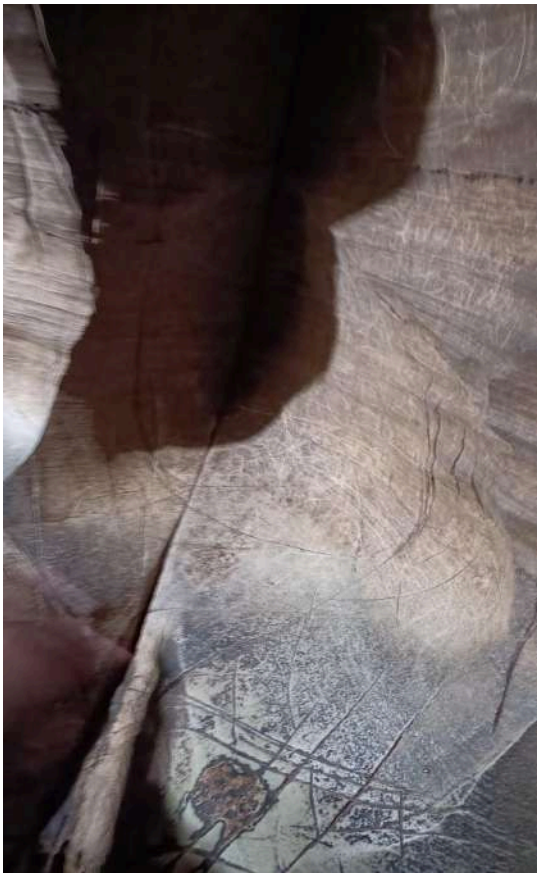

Fig 2.5- Conchoidal fracture

Fig 2.6- Stylolites are visible

Site 3 : A small mountain (1 Dec 2023)

Location : Lat - N 25° 06’ 46.6" ; **Long -** E 80°48’ 35.6"

Elevation : 176 m

Approach : A hill around 5 km away from Gupt Godavari , on the side of Gupta Godavari road . Near Paldev Mandir , Chitrakoot , Madhya Pradesh.

Fig 3.1 - Measuring strike and dip of the rock

Fig 3.2 -Alkali Feldspar rich rocks (pink color)

Strike = 085° - 265°
Dip direction - 175°
Dip angle - 50 °

Fig 3.3 Reacting the rock with acid to test presence of carbonates

At the mountain we explored different types of igneous rocks and measured their strike, dip and dip angle. We performed an acid test experiment on a rock using a very dilute Hydrochloric. If the rock has carbonates then it will produce carbon dioxide with reaction.

$$CaCO_3 + 2\ HCl \rightarrow CaCl_2 + CO_2(g) + H_2O(l)$$

Site 4 : Janki kund river section :

Location : Lat- N 25° 6’ 48.6" ; **Long-** E 80°48’ 30.5" ;
Elevation:175m (below the escarpment Fig 4.1)

Approach: Around 18 Km Ramghat, Chitrakoot, Madhya Pradesh.

Fig 4.1 Rock carved by flowing river through inclusions

We went to the bank of the mandakini river. Where the river is very shallow we can easily see the ground below it.

Fig 4.2 Rock cut due to flowing river, formation of stromatolites seen

Fig 4.3 Concentric formations (Fossiliferous limestone)

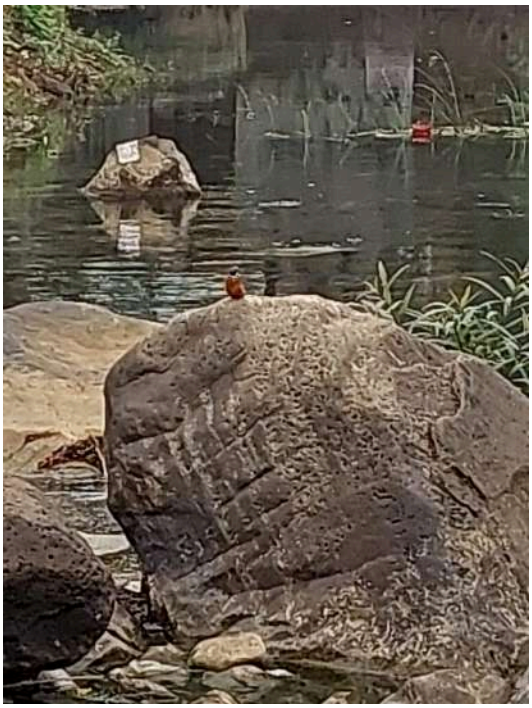

Fig 4.4 Guessed strike and dip of rock when it is far away

Key Observations : River has a Laminar flow. Sediments vary in size in the river. It has suspended, Dissolved load and sediments also move through Saltation. There are big boulders also present of different compositions brought by the stream. Elephant weathering of white colour can be easily seen on rocks. **Stromatolite** formation can be seen - these are layered sedimentary formations formed by

fossils of **Cyanobacteria.** Dead animals' carcasses buried immediately are fed upon by cyanobacteria releasing calcareous membranes which fossilize the carcass. These formations are Millions of years old. Fossil types can be ➖

1. Imprint :- Like layers on a leaf
2. Trace :- Eg. Dinosaur fossils

Site 5:

Hanuman Dhara : [Upper Vindhyan Sandstone]

Date - 01 December 2023, **Time - 15:30**

Location **[fig 5.1,5.2] : Lat-** N 25° 41’ 8.1" ; **Long-** E 80°52’ 57.7"

Elevation: 233 m

Approach : Near Hanuman Dhara Rd, Naya Gaon , Chitrakoot.

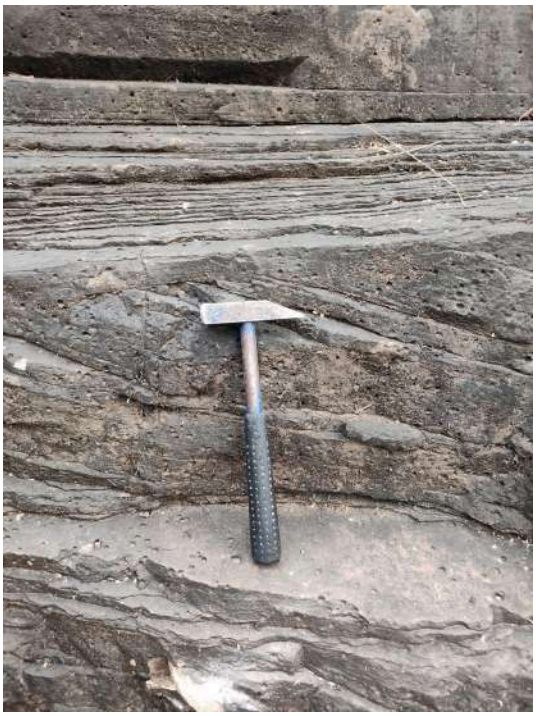

Fig 5.1- : Cross bedding of sandstone

Key Observations : A most prominent spring is also present. This is the exposure site for the Kaimur sub-group of the Vindhyan. **Parting lineation marks** common in Kaimur sandstone was one of the first observations. These lineation marks are evidence of primary sedimentary structure. These are **paleocurrent indicators**. Kaimur Sandstone formation over Semri Limestone shows Cross Bedding. Sandstone is formed under Tidal deposition and Limestone is formed under Deep Marine Environment(Calm deposition). The Hanuman Dhara is dominatingly made of Vindhyan sandstone which exhibits very good sedimentary structures like ripple marks. This shows unconformity in the rock layer. These porosity in sandstones are the reason for the perennial source of water in these hills.

This (fig 5.2) type of platy arrangement takes place as a result of long time weathering and long time river flow. Symmetrical ripples are also seen in the rock.

Fig 5.2 - Unconformity between limestone and sandstone strata

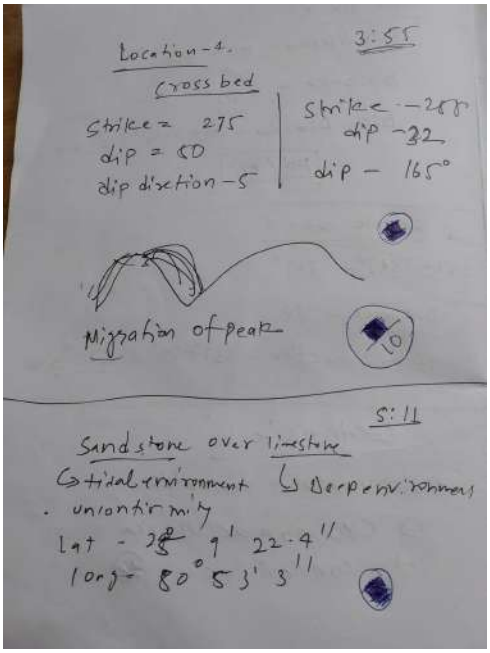

Fig 5.3 movement of peak shown due to water flow

We measured the attitude of rock(fig 5.1):

1. Strike direction - 120 , dip amount - 6 , dip direction - 210
2. Strike direction - 135 , dip amount -6.5 , dip direction - 225
3. Strike direction - 125 , dip amount - 6.2 , dip direction - 215

Day 3 (2 Dec 2023)

Site 6:

Kamadgiri Hill, Parikrama Marg

Location : **Lat -** N 25° 10’ 10" ; **Long -** E 80°51’ 14.5"

Elevation : 144m

Approach **:** Best access point to this hill is on the Kamtanath-Sangrampur road. Near Ramghat (1 Km), Chitrakoot, Madhya Pradesh.

Fig 6.1- Quartzite-Metamorphism of quartz rich Sedimentary rock

Fig 6.2 Formation of sandstone over Igneous rock can be easily seen

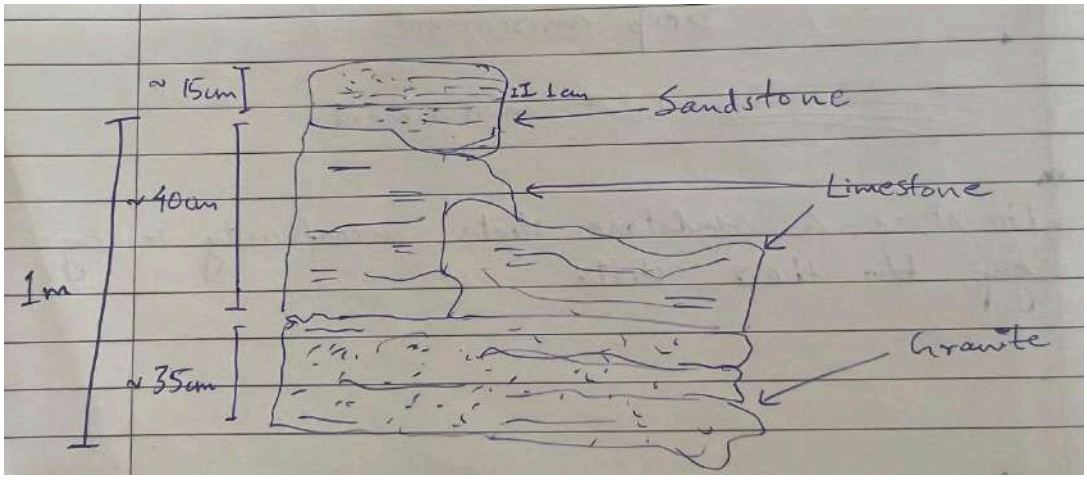

Fig 6.3 Lithologic profile of crust at Kamadgiri Hill

Key Observations : Good exposures of the Bundelkhand Granite-basement can be seen on the Kamtanath. On each hillock, at the base, the Bundelkhand granite is exposed and at the top of it the rocks of the Semri Group with variable thickness are seen. On the Kamtanath hillock, the top part of the basement granite shows weathered profile in the form of fissures and cracks filled with dolomite followed by the Upper Sandstone and Limestone of the Semri Group. The Upper Sandstone shows some cross beddings , horizontal bedding along with small current and wave ripples as the prominent sedimentary structures. The Limestone is extensively exposed in the hillock followed by sandstone of the Kaimur Group.

Fig 6.4 Presence of both Sedimentary rock and Igneous rocks can be seen

Fig 6.5 Formation of Oolitic Limestone

Limestone: Limestone (calcium carbonate $CaCO_3$) is a type of carbonate sedimentary rock which is the main source of the material lime. It is composed mostly of the minerals calcite and aragonite, which are different crystal forms of $CaCO_3$.

Strike: 015-195
dip angle: 50
dip direction: 105(south-east)

Unconformity: An unconformity represents time during which no sediments were preserved in a region or were subsequently eroded before the next deposition.

Ex: unconformity between limestone and granite.

- Fine grained granite is formed due to upliftment.
- Coarse grained granite is formed in depth.

Inverted stratigraphy:

- Due to excess minerals some **limestones are green** in color.

Elephant skin weathering:

Oolitic Limestone: a type of limestone composed of ooids, which are spherical grains with concentric coatings.

Strike: 200-020
dip angle: 55
dip direction: 290(west-north)

Site 7:

Sangrampur Hill Section (Chitrakoot)

Location : **Lat-** N 25°10’ 41.0"; **Long-** E 80°49’ 46.5" ; **Elevation :** 147m

Approach **:** Easily accessible from the Kamtanath-Sangrampur road, Uttar Pradesh.

Fig 7.1 - A view of the Sangrampur Hill in the Chitrakoot area, Uttar Pradesh. The Bundelkhand Granite is seen below, whereas the Semri Group is noted above it. The lower succession of the Kaimur Group is exposed on the top of the hill.

Key observations : Bundelkhand Granite basement is exposed on the 2/3 part of the hill (Fig. 7.1).On the foot of the Sangrampur Hill, a weathered product of granite. Feldspar and quartz grains were distinctly present in the sample. The degree of weathering could be understood by observing feldspar crystals which on weathering get altered to kaolinite. Grus was overlaid by a little compact and less weathered granite.

An angular unconformable contact of the Semri Group and the Bundelkhand granite is well exposed. The acid test performed on the rock revealed absence of carbonate in the rock as there was no observed effervescence. This layer marked the nonconformity which separated the Basement from the Semri Group of the Vindhyan Supergroup. Uppermost part of the granite shows fissures and cracks filled with limestone.

Fig 7.2 (a,b) - Quartzite (non-foliated metamorphic rock which was originally pure quartz sandstone. Sandstone is converted into quartzite)

Fig 7.3 - Granite (porphyritic texture) Pink colour is due to orthoclase , Plagioclase is easily visible

We witnessed a variety of rocks at the hill. Most of them were normal granitic rocks, although we found some interesting samples and took note. We saw a granite rock containing orthoclase veins depicted in Fig 7.3, a plagioclase rich granite rock, limestone on upper reaches of the hill and granite at the foot of the hill. We saw plenty of quartz crystals scattered around the hill, some as big as 2 feet. Quartz veins were also present in a few granite rocks. We also observed an oolitic limestone sample. An interesting observation we made was that most of the big granite

boulders had perfect flat fractures on one side. We assessed that this was most likely to be a result of falling down of these rocks causing instantaneous fracture in the ensuing impact.

Strike: 150-330
dip angle: 40
dip direction: 240(south-west)

Conclusion

During our trip to Chitrakoot, we got hands-on with the stuff we'd only studied in books. Using tools like the Brunton compass and GPS receivers, we measured dips, strikes, and locations.

Out in the field, identifying rocks and minerals turned out to be trickier than in the lab. Each rock had its own personality. During the field trip we received plenty of valuable practice. We identified several granite, limestone and sandstone rocks as well as veins and fragments of quartz

We also learned about and witnessed completely new features like stalactites and stalagmites in the cave ; fossiliferous limestone at the Mandakini Kund ; elephant skin weathering and oolitic limestone. We got to see geology in action and learned way more than we ever could've from a textbook.

All the members in this group contributed equally in the making of this report.