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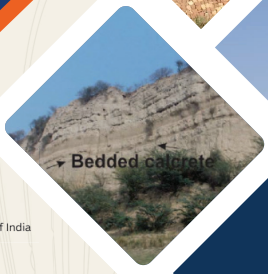
FIELD GUIDE

INPOST - 15

LATE QUATERNARY LANDSCAPE EVOLUTION IN THE SOUTHERN GANGA PLAIN AT KALPI AND ADJOINING AREAS, UTTAR PRADESH: IMPLICATIONS FOR PALEOCLIMATE AND FOREBULGE TECTONICS

U. K Shukla and Anupam Sharma







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INQUA INDIA 2027
Field Guide Book

INPOST-15

Late Quaternary Landscape Evolution in the Southern Ganga Plain at Kalpi and adjoining areas, Uttar Pradesh: Implications for Paleoclimate and Forebulge Tectonics

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Dr. Anupam Sharma is currently the senior-most scientist of the Birbal Sahni Institute of Palaeosciences, Lucknow. He is Scientist-G and Group Head of the Geochemistry, TL/OSL and Coal Laboratory of the institute. With his vast research experience, his main focus is on Quaternary palaeoclimate, earth-surface processes, sediment provenance, and elemental and isotope geochemistry. His research across the Himalaya, mainland Gujarat, Ganga Plains, north and south poles (Antarctica, and the Arctic) has advanced understanding of monsoon variability and climate-tectonic interactions, natural resources and so on. He currently leads BSIP's flagship Quaternary Lake Drilling Program (QLDP) while mentoring numerous doctoral and postdoctoral researchers in India.

Abstract

Ganga Basin is the result of India Asia collision and drained by the River Ganga and its tributaries. Yamuna River is the most dynamic tributary of Ganga and shaped the Marginal Plaines (MP) in the southern part of the basin. Many tributaries of Yamuna drain the Peripheral bulge and contribute to its sediment and water budget from south. Most of marginal plain rivers are incised 10-20 m exposing Quaternary sediments along the channels. The sediments are excellent archives for multiproxy studies. Well established OSL chronology of many of these sections is available. These sediments vary from gravels to sand and silt-mud deposits and contain abundant fauna. The sediments were emplaced by continental processes including propagating fans, channels, lakes and ponds. Such section provide scope to showcase to participants joining the field trip.

Preamble

The Ganga foreland basin is part of the Himalayan foreland basin system occupies a central position within it (may be you can mention the geographical location here). It is a peripheral, under filled basin with an oversupply of sediments. It came into existence during middle Miocene, and is active today. From north to south, it shows an active orogeny (the Himalaya), uplifted and deformed foreland basin deposits (Siwalik range, Neogene), an active depositional basin (Ganga Plain, Late Quaternary), and a Cratonic peripheral bulge (Precambrian Bundelkhand – Vindhyan range; Figure 1).

Adjacent to the Siwalik ranges, a gravelly piedmont zone developed, forming a broad belt of small gravelly fans and ephemeral rivers. These deposits are exposed in small rivulets cutting through them (Figure 1). They are followed southward by megafan deposits formed by channel belts on a rather steep slope in a humid climate. The upper reaches of the Ganga River cuts through these deposits, exposing the succession formed by channel systems. The piedmont fan and megafans formed by changing neotectonic activity and climate conditions during the late Pleistocene, with their upper part representing sedimentation during the wet post Last Glacial Maxima (LGM).

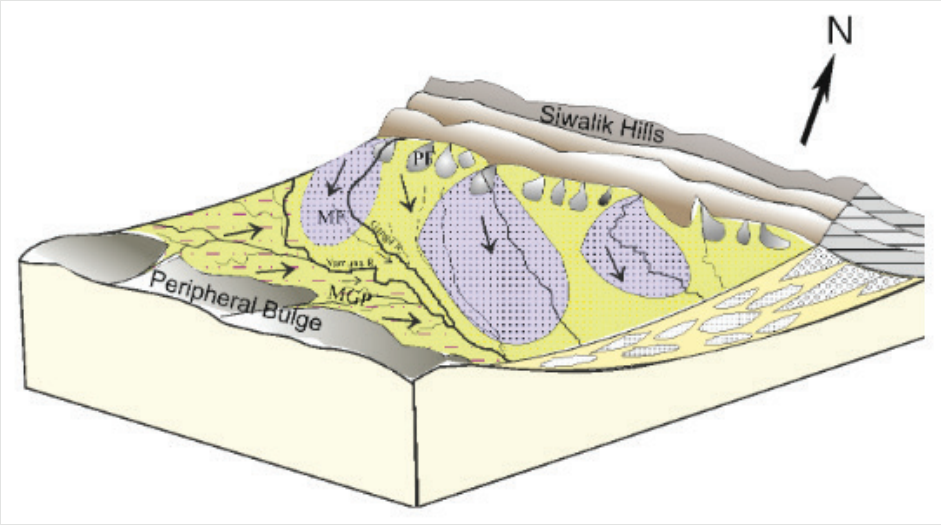

Fig. 1. A Model showing the geomorphic component of the Foreland Basin.

The fan deposits are followed southward by the central alluvial plain, which shows a gentle east to southeast slopes, and all rivers follow this slope. The major rivers, namely, Ganga, Yamuna, Ramganga etc., carry large amounts of sediment and are mostly braided, with large braid bars. The small rivers originating within the alluvial bring low amount of sediment and are meandering. The active rivers are incised several meters into the general surface.

Generally, three regionally significant surfaces are identified, to (active flood plain) T1 (river valley terrace = Khadar) and T2 (upland interfluve = Bangar). These surfaces were formed in response to the climatic fluctuations over the last 50 Ka. Prominent incision took place post LGM.

The Marginal Ganga Plain (MGP) is located south of the axial river, which in the western part is the Yamuna River. In this region, rivers flow in a north-east direction, perhaps following the basement lineament of the peripheral bulge. These rivers carry sediment derived from the peripheral bulge. The Marginal Ganga Plain exhibits highly dissected landform, with 20-30 m deep ravines near the rivers. Incised gullies and ravines are prominent. This part has been strongly affected by active tectonics of the peripheral bulge and shows features suggesting extensional tectonics in the form of fractures, often filled with calcrete. The beds may show 2o – 3° dip with minor warping. The cliff sections and drilled cores show a regional pedogenic surface with significant pedogenic features which is dated to >100 Ka . The surface is followed by a gravelly sandstone with sediments coming from the craton (Figure 1). This horizon has yielded a fossilized elephant skull and numerous vertebrate fossils. In a younger horizon above it, dated 45 Ka, a horizon rich in vertebrate fossil and animal bone artifacts has been recognized, indicating middle Palaeolithic occupation of the area.

This guidebook aims to show the geomorphic and sedimentological architecture of the Ganga foreland basin near the marginal plain peripheral bulge deposits. Aspects of Pedogenesis in different areas are emphasized. Some important geo-archaeological sites are also exhibited. It is designed to expose the INQUA-2027 community to the contributions of various study groups on different aspects of the Himalayan foreland basin.

Objectives

1. To showcase Geomorphology of the Marginal Plaines.

2. To show neotectonic features

3. To show exposed sediment profiles and lithofacies

4. To display architectural elements of deposits

5. To show pedogenic horizons

6. To show fauna embedded within Quaternary deposits

Location Approach and Basic Information

Item	Details
District / State	Jalaun, Uttar Pradesh
Regional Setting	Interfluve region of Ganga and Yamuna Rivers, Kalpi on the bank of Yamuna river
Section 1	Shergarh Section
Section 2	Daulatpur Section
Section 3	Rasulpur Section
Section 4	Kalpi Section
Typical Access	Road from Lucknow to Kalpi (~170 km, 3hrs 20 min one way); access via Kanpur, Akbarpur/Orai to Jalaun (Ram Mandir, Hanuman Garhi, Guptar Ghat, Svargadvara Ghat)

General Geology and Stratigraphy of the Marginal Ganga Plain

The prominent undulatory topography, mixed architectural framework of loose unconsolidated sediments of aeolian and fluvial origin as well as hardend calcrete bands with low rainfall regime of the Marginal Alluvial Plain has given the present day rugged landscape where sudden gush causes rapid erosion of sediments and had transformed the area into ravinous and dissected terrain. However, few studies suggest slightly different views for the evolution of the southern part of interfluve areas in response of strong monsoon during 15 Ka to 5 Ka. It has been argued that in the southern Gangetic Plain increased discharge had promoted incision of rivers and widespread badland formation especially in southern Gangetic Plain; and decline in rainfall had caused floodplain aggradation and degradation, parts of interfluve resulting in low relief degradation surfaces and development of badland ravines. Some workers have argued that climate was an important factor near the craton margins in the western plain, where tectonic activity is minor and subsidence rates are moderate. Role of tectonic activities in development of surface features have not been considered in these studies. Because, High degree of incisions along the river channel and

varying escarpment heights along the river channel, undulatory surface of Ganga plain could not have been formed alone by the climate fluctuations and subsequent aggradation and degradation, role of tectonics is certainly an important factor; climate played a subordinate role.

The various cliff sections exposed in the area, have been extensively studied for its alluvial stratigraphy and depositional history. Each section has its own characteristics and history.

In general, the Quaternary alluvial deposits of the Ganga Plain vary greatly from the Himalayan foothills, to the rugged Upper Ganga Plain, to the almost flat central plains and the delta region. In the upper parts of the Ganga, Yamuna interfluve and river valleys, the rivers have deeply incised channels. If we look at near the Himalayan foothills, the older deposits consist mainly of gravel and sand left behind by braided rivers. The upper Ganga plains have rivers that have cut deep into the land, creating steep riverbanks that are about 15 to 30 meters high. Over time, the rivers have repeatedly eroded the land and then deposited new layers of sand, silt, and soil. These layers are separated by clear breaks, showing that the landscape changed several times in the past. The alluvial deposits also suggest that sediment built up slowly over a long period.

In the interfluve region between Ganga and Yamuna rivers, the sediment layers are characterized with several breaks or discontinuities. Although most of the deposits are made up of mud, river deposition did not happen continuously. There were periods when little or no sediment was deposited, and at other times, sediments from sources other than rivers (aeolian) accumulated or sediments might have eroded as well owing to the interplay of climate and tectonics. At many places, these breaks are marked by the formation of soils and hard layers of calcium carbonate called calcrete, showing that the land remained stable for some time.

The individual litho-architecture, stratigraphic sequence and sedimentary facies relationship vis a vis fossil finds is provided with the details of each section. The Kapli section is particularly most famous and interesting as it provides the archaeological and geological evidence of human occupation and climate conditions around 30,000 years ago (30 Ka) This site represents the oldest record of human occupation found in the Ganga Plain alluvium. The rich vertebrate fossil remains, including a 3.54-meter-long elephant tusk, a 1-meter shoulder blade of an elephant, and molars of Equus, Bos, bovids, and hippopotamuses are of great interest and can be seen in the Museum of Department of Geology, University of Lucknow, adjacent to BSIP.

History of Kalpi Town and surrounding Area

Located on the interfluve region of Ganga and Yamuna rivers, Kalpi is a small town in the BundelKahnad region far from hustle and bustle of densely populated adjoining cities of Kanpur and Jhansi. It falls under the district Jaulan, Uttar Pradesh. At first, it appears to be an ordinary town, but it is had treaded with rich and fascinating history.

The history of Kalpi goes back as old as about 45,000 years to the Middle Palaeolithic age (Stone Age) based on the evidences of its fossil finds and human settlement. It is one of the few places in the Ganga-Yamuna region where evidence of very early human settlement has been discovered. The town is also believed to be the birthplace of Sage Ved Vyasa, who wrote the epic 'Mahabharata' (the battle between Kauravs and Pandavas). The ancient historical records suggest that the area was under the reign of Chandela Dynasty during 10th and 11th centuries and many forts were built during that time. Later,in 12th century, it was captured by Qutb-ud-din Aibak, an aide of Muhammad Ghori, and rule of Delhi Sultanate was established. For the following 4-5 centuries, the Kapli town remained one of the hot seat for subsequent dynasties including the Mughals for its strategic location in the Yamuna Valley, as a result a number of monuments (tombs, towers, small forts) were also built. Many old tombs can still be seen in Kalpi. During Mughal Emperor Akbar's reign, Kalpi became an important administrative centre and was the site for minting the copper coins. It is also believed that Birbal, one of Akbar's most trusted ministers and one among his 'Nine Jewels;was born in Kalpi.

Later during 18th century, the town came under the control of Hindu, ruler and later ruled by Marathas. The British took control of Kalpi in 1803 and annexed it in the Bundelkhand Agency/Region. During the Revolt of 1857, the town became an important centre of fighting when Indian soldiers rebelled against British officers. When the seat of Jhansi was annexed by British under the Policy of Doctrine of Lapse, the Queen of Jhansi, Rani Laxmi Bai escaped the Jhansi Fort and bravely fought with British Army at Kalpi, which is nearly 150 km away from Jhansi, though she was defeated. After the revolt ended, Kalpi came back under British rule. A British cemetery in the town still reminds visitors of its colonial past. Some notable monuments of the Kalpi are 'Chaurasi Tomb' (means 80 tombs), of a Lodi Sultanate, LanKa Tower and British Cemetery.

Field Transect

The Ganga Plain is the largest alluvial tract that evolved as a foreland basin in front of rising Himalaya. It witnesses the signature of the Himalayan tectonics and the records of the South West (SW) Indian Summer Monsoon. The sedimentary architecture and landscape of this basin have attracted the attention of several working groups, who have studied it in details and therefore have a chronologically well constrained evolutionary model. This includes the Sedimentary architecture and landscape of marginal Ganga Plain vis-à-vis peripheral bulge tectonics. Several lakes and archaeological sites that are well studied offer the evolution of past climate and human societies.

The proposed transects thus offer all geological aspects of Ganga foreland basin in terms of

(a) River Science
(b) Interfluve Region
(c) Active Tectonics
(d) Impact of climate change on rivers
(e) Sedimentology
(f) Fluvial Geomorphology
(g) Paleopedology
(h) Geoarchaeology

1. Shergarh Section (26° 25′ 50.60″N; 79° 28′ 41.40″E)

This section, located about 26 km downstream of the Pachnada along the northern bank of the Yamuna River, exposes a 15–20 m thick interfluve deposit. The sequence begins with 6–8 m of massive mottled brown clayey silt interlayered with well-sorted laminated sand and calcrete-bearing silty clay. This is overlain by a 2–3 m thick crudely laminated silt horizon with bedded calcrete. Above lies a 4 m thick ripple- to cross-bedded fine sand unit. The uppermost 1–2 m consists of an anthropogenic layer containing archaeological remains such as broken pottery and bricks, indicating human occupation and construction activity.



Fig..1. Field photo from Shergarh section showing Bedded Calcrete of interfluve Succession (note- the height of person is ~1.6 m).

2. Daulatpur Section (26° 8′ 24.40″N; 79° 44′ 58.96″E)

This 20 m thick section is located about 1.5 km downstream of Kalpi on the right bank of the Yamuna River. The basal unit consists of 1.5 m thick bioturbated clayey silt, overlain by a 2.5 m thick cross-bedded gravel dated to 71 ± 7 Ka. The gravel forms a laterally persistent fining-upward gravel bar rich in vertebrate fossils.

Above this lies a 9–10 m thick interfluve deposit composed of finely laminated clayey silt and fine sand with ferruginous and calcrete nodules, mottling, and an upper age of 14 ± 2 Ka.

The gravel bars at the Daulatpur section are lens-shaped, extending hundreds of meters, aligned NE–SW with bar axes trending E–W. They average about 2 m thick and show three fining-upward depositional cycles separated by reactivation surfaces and silty fine sand lenses. Gravel clasts, up to 9 cm in size, include quartzite, quartz, feldspar, chert, calcrete, and limestone. The gravel bodies contain abundant vertebrate fossils and rest on the surfaces erosional channel.

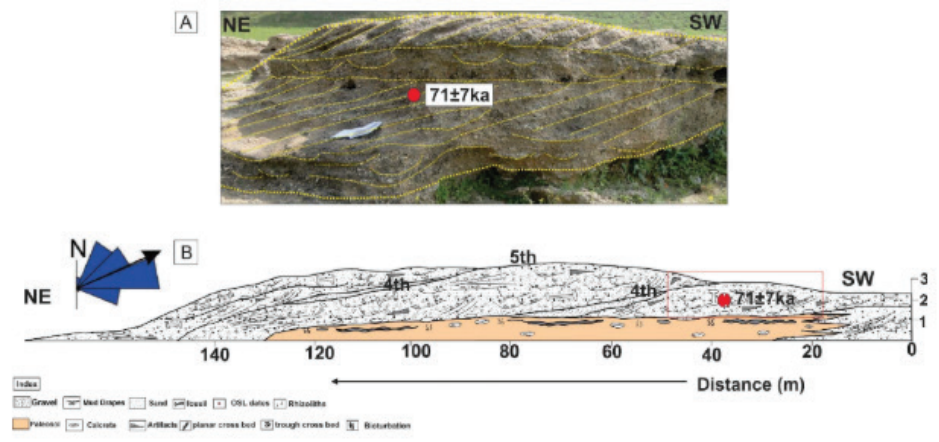

Fig. 2. Lateral litholog of channel lithofacies association in Daulatpur section. The lensoidal channelbody are separated by 4th order surfaces.

3. Rasulpur Section (26° 6′ 56.65″N; 79° 46′ 42.14″E)

This 14–15 m - thick section lies on the right bank of the Yamuna River, opposite the Kalpi section, extending about 350 m along the river. It is divided into three units.

Unit 1 consists of 1.6–2.5 m thick reddish-brown bioturbated clayey silt with calcrete nodules, mottling, rootlets, and occasional gravelly sand lenses. The upper contact is erosional and marked by laminated yellow silty clay.

Unit 2 begins with 2–2.5 m thick cross-bedded gravel dated to 80 ± 7 Ka. The gravel shows foreset laminae dipping 15°–30° toward the NE and contains calcrete clasts, arkosic sand matrix, vertebrate fossil fragments, and channel-fill structures. Paleocurrent data indicate ENE-directed flow. Upward fining gravel and cross-bedded facies are prominent.

Unit 3 consists of 1.3–5.5 m thick calcrete nodule-bearing silty clay, laminated sandy silt, and bedded calcrete representing five alternating depositional events. The top of the unit is dated to 27 ± 2 Ka. An overlying 1–1.5 m anthropogenic layer contains bricks and pottery fragments.

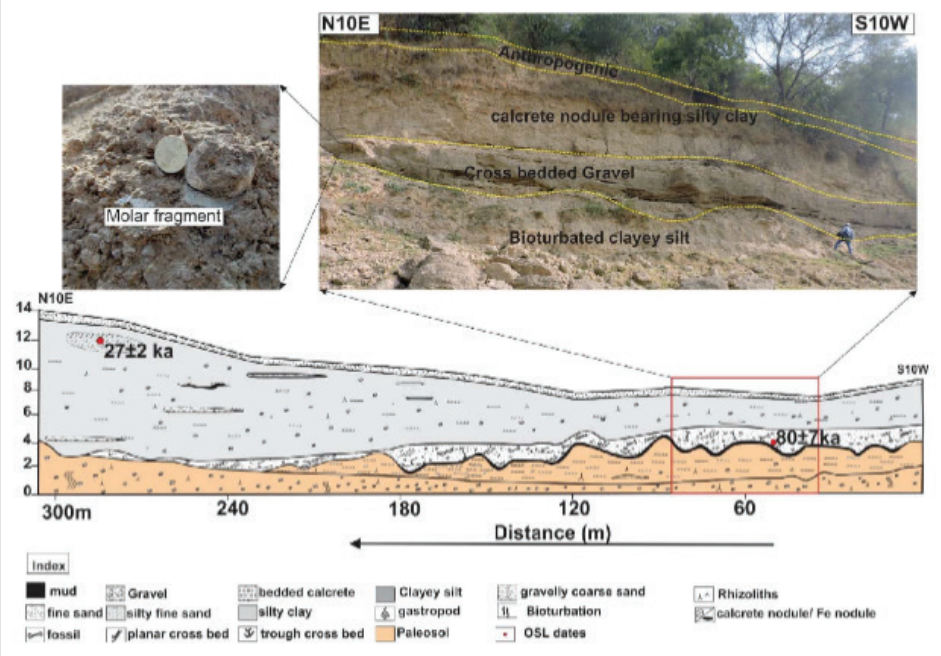

Fig. 3. Lateral litholog of lithofacies association in Rasulpur section.

4. Kalpi Section along Yamuna

Five stratigraphic units were identified along the 1.4 km cliff line.

Unit 1 (up to 6.6 m thick) consists mainly of red-brown silty clay with carbonate nodules, rhizoconcretions, and poorly defined muddy channel fills. The top surface is irregular and marked by carbonate-cemented sand and gravel.

Unit 2 (up to 4.2 m thick) contains two sandy channel bodies with gravel lags, convoluted stratification, ripple lamination, and abundant nodules. Carbonate-cemented sand caps the unit, and vertical calcite and mud-filled fractures cut Units 1 and 2.

Unit 3 (up to 3 m thick) is a dark brown silty clay with sparse fossils, carbonate nodules, mottles, slickensides, and shrinKage-related calcareous features.

Unit 4 (up to 23.3 m thick) is dominated by brown silty clay with local channel fills, ripple-laminated silts and sands, dark clay layers, and carbonate gravel horizons. Rhizoconcretions, KanKar nodules, and dark nodules are common.

Unit 5 represents three episodes of gully cutting and filling. The gullies contain silty sand, brown mud, and carbonate gravel channel bodies with erosional surfaces and cross-bedding.

Dating results indicate Unit 1 is the oldest (about 119 ± 12 Ka), while Units 2–5 range mainly between about 82 Ka and 30 Ka, and with some younger gully-fill ages around 36 Ka.

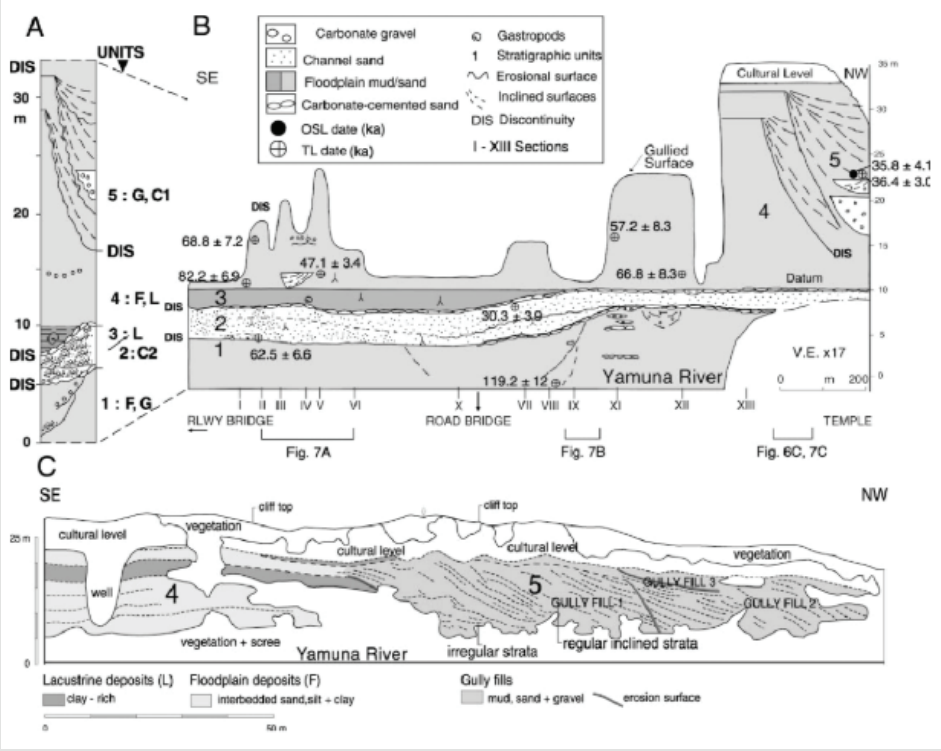

Fig. 4.—Kalpi section (Fig. 3), based on cliffs on southern bank of Yamuna River. A) Representative stratigraphic column based on B) 13 measured sections and correlation of units. C) Gully fills within Unit 5 in northwestern area, cut into bedded floodplain and lacustrine strata of Unit 4. F 5 floodplain deposits; L 5 lacustrine deposits, G 5 gully fills; C1 5 gravelly channel fills, C2 5 sandy channel fills.

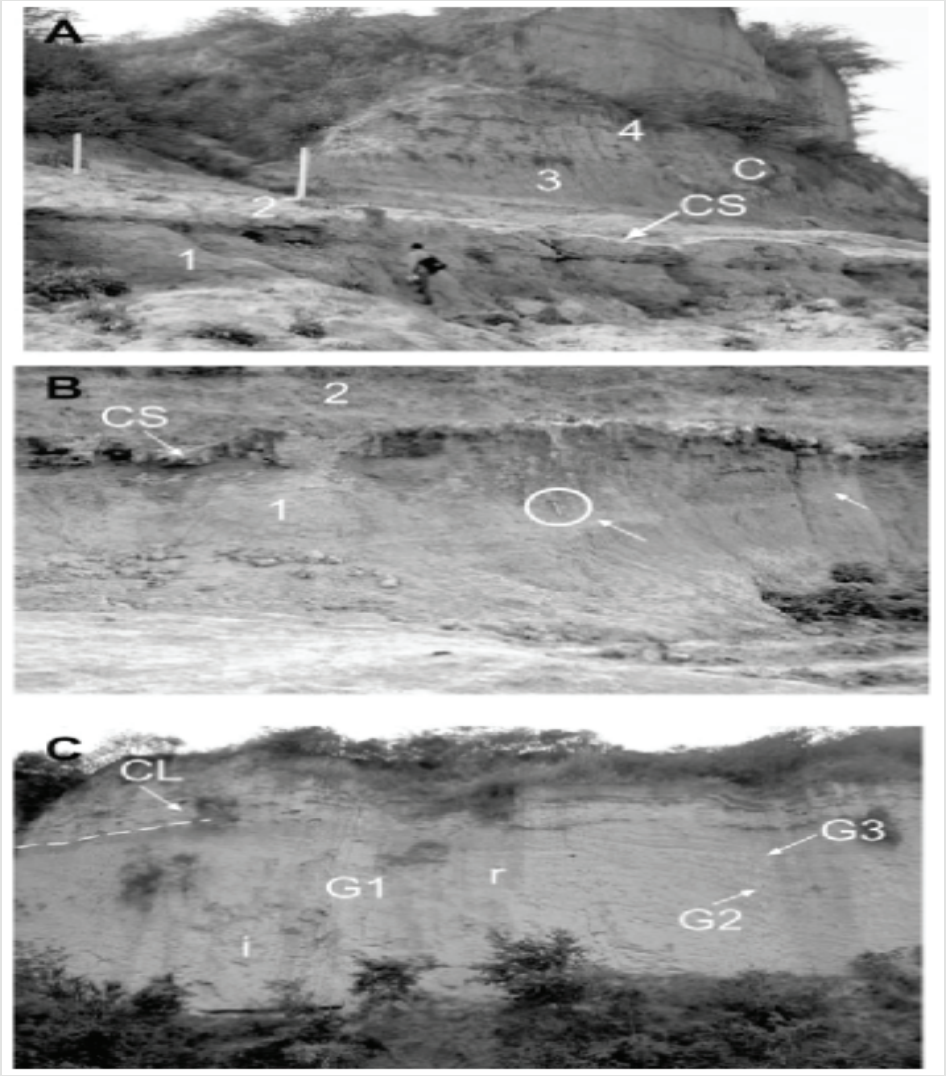

Fig. 5. Kalpi section (photos located in Fig. 6). A) Floodplain deposits of Unit1 are overlain by a channel fill of Unit 2, capped by carbonate-cemented sand (CS) that marks a major discontinuity. Lacustrine deposit of Unit 3 forms the darker cliff base, and floodplain deposits of Unit 4 include two closely spaced dark clay layers (lacustrine beds) that extend for at least 200 m in the upper part of the cliff. Unit 4 contains a small channel fill with inclined strata B) Contact between Units 1and 2 northwest of road bridge. Unit 1 contains a partially exposed channel fill of mud and lenses of reworked pedogenic carbonate with inclined layers (arrowed).The unit top is marked by a carbonate-cemented sand (CS) that follows an irregular paleotopographic surface. Hammer (circled) is 30 cm long. C) Three gully fills (G1 to G3, in order of formation) in Unit 5. Bases of G2 and G3 are arrowed. Fills include regularly bedded, inclined strata (r) and irregularly bedded, mounded strata (i) CL 5 cultural level, with base dashed at left. Cliff is 20 m high.

Climate

The climate around Kalpi, Uttar Pradesh, is warm and temperate, experiencing very hot summers, a pronounced monsoon rainy season, and mild winters. Temperatures typically range from an average low of 9 °C (48 °F) in January to an average high of 40 °C (105 °F) in May, with an annual rainfall of about 892 mm. The temperature in May and June often exceeds 46 °C.

Flora

The modern vegetation of Kalpi and nearby areas, in the semi-arid Bundelkhand region of Uttar Pradesh, mainly consists of tropical dry deciduous forests, thorn forests, and scrublands. The area is home to many drought-resistant trees, shrubs, and medicinal plants. Common Trees include Neem (Azadirachta indica) Kardhai (Anogeissus pendula) Dhak or Palas (Butea monosperma), Babul (Acacia leucophloea, Acacia nilotica), Bel (Aegle marmelos). Common Shrubs include Seetafal (Custard Apple, Annona squamosa), Aak (Calotropis procera), Karonda (Carissa carandas) and Herbs such as Tridax (Tridax procumbens), Tulsi or Holy Basil (Ocimum sanctum), Gokhru (Tribulus terrestris) and other plants.

Fauna

The area is home to a variety of wildlife. Its dry forests, scrublands, rivers, and reservoirs support many mammals, birds, reptiles, fish, butterflies, and other insects. The common Mammals are Nilgai (Blue Bull), Chinkara and Blackbuck, Wild Boar, Golden Jackal and Jungle Cat. Avian fauna is vivid and is an important habitat for endangered vultures, including the Long-billed Vulture and the Egyptian Vulture. Waterbirds such as Painted Storks, Asian Openbills, Black-headed Gulls and Brown-headed Gulls are commonly seen. Other familiar birds include the Indian Peafowl (Peacock), Rose-ringed Parakeet, Black Drongo, and several species of Kingfishers. Reptiles are also very common, include Indian Monitor Lizards, several species of snakes, and Mugger Crocodiles, which are found in some permanent stretches of the Yamuna and Betwa rivers.

Conclusion

Field work in the cliff sections exposed along the incised river shall provide the opportunity to evaluate Quaternary sediments in a time framework. Based on pedogenic horizons the sections may be correlated to have a regional prospective of the southern Ganga Basin. Identification of architectural elements in the exposed section will help to identify their depositional setting in a palaeogeographic context. Faunal collection can be done for the further identification and isotope geochemistry to unravel paleo climate and vegetation during the Quaternary.

Associate Members



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Dr. Mukesh Yadav is a sediment geochemist specialising in fluvial sedimentology and geochemistry. He completed his PhD from the Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow, and Banaras Hindu University, Varanasi. His research focuses on sediment provenance, weathering, transport processes, depositional environments, and fluvial architecture, integrating field observations with major, trace, and rare-earth element (REE) geochemistry. His doctoral research focused on the Quaternary sediments of the Ganga Plain, where he investigated sedimentological and geochemical characteristics to reconstruct depositional environments and understand the evolution of the Ganga Plain sedimentary system. His broader research interests include sediment–landscape interactions, climate–tectonic influences, and Quaternary fluvial dynamics.



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Rupa Ghosh is UGC Kothari Postdoctoral fellow at Jadavpur University, Kolkata. She did her PhD from Wadia Institute of Himalayan Geology, Dehradun and Banaras Hindu University. She worked on Himalayan fore-bulge dynamics, sediment yield of ravine erosion and past 100 ka sedimentation history in Marginal Ganga Foreland. She also developed the depositional architecture of the Ganga-Yamuna Megafan of the western Himalayan foreland basin. Her research focuses on Late Quaternary fluvial deposits and related landform evolution with a combination of sedimentological and geomorphological modeling, optical stimulated luminescence geochronology.

Annexure

Field Excursion Guidelines: Do's and Don'ts

To ensure the safety of all participants and to promote responsible scientific field practices, all participants are requested to adhere to the following guidelines throughout the field excursions.

Keep a valid passport (for international participants) or a government-issued photo ID (for Indian participants) with you at all times during the field excursion.

Do's	Don'ts
1. Follow the instructions of the excursion leaders, coordinators, and local authorities at all times.	1. Do not collect rocks, fossils, archaeological artefacts, biological specimens, or any other materials without prior authorization.
2. Remain with the group and inform the excursion leader before leaving the designated route.	2. Do not damage, deface, or remove material from geological outcrops, caves, monuments, heritage structures, or other natural features.
3. Wear appropriate field attire, including sturdy closed-toe footwear, full-length trousers, a hat or cap, and weather-appropriate clothing.	3. Do not wander alone or separate from the excursion group without informing the field leaders.
4. Carry sufficient drinking water, personal medications, sunscreen, insect repellent, and other essential field supplies.	4. Do not climb unstable slopes, cliffs, rock formations, or enter hazardous areas unless specifically instructed or supervised.
5. Keep a valid photo identification and your excursion registration details with you during travel.	5. Do not swim or enter rivers, lakes, lagoons, or coastal waters unless expressly authorized by the excursion leaders.
6. Respect local customs, religious sites, cultural heritage, and private property.	6. Do not consume alcohol, recreational drugs, or engage in unsafe or irresponsible behaviour during the excursion.
7. Follow the Leave No Trace principles by carrying back all waste and helping to keep field sites clean.	7. Do not operate drones or other restricted equipment without obtaining the necessary permissions.
8. Use designated trails and approved observation areas to minimise environmental disturbance.	

9. Observe geological, ecological, archaeological, and cultural features carefully without causing any damage.

10. Record field observations systematically and collect samples only with prior permission from the excursion leaders and the relevant authorities.

11. Exercise caution near cliffs, riverbanks, caves, unstable slopes, road cuts, and other potentially hazardous terrain.

12. Respect wildlife by maintaining a safe distance from animals, birds, reptiles, insects, and their habitats.

13. Immediately report any illness, injury, emergency, or hazardous situation to the excursion organizers.

14. Be prepared for changing weather conditions and comply with all safety advisories issued by the excursion leaders.

8. Do not photograph restricted installations, sensitive locations, or local residents without prior permission.

9. Do not create excessive noise or disturb local communities, religious activities, wildlife, or natural habitats.

10. Do not leave valuables unattended or rely solely on mobile phone connectivity in remote areas.

11. Do not undertake any activity that may compromise your safety, the safety of fellow participants, or the conservation of the area's geological, ecological, archaeological, or cultural heritage.

Disclaimer

Participation in the field excursions is entirely at the participant's own risk. While the Organising Committee and excursion leaders will make every reasonable effort to ensure participant safety and provide appropriate guidance, they shall not be held responsible for any personal injury, illness, loss of personal belongings, property damage, delays, or unforeseen incidents arising during travel or field activities. Participants are expected to act responsibly, follow all instructions issued by the excursion leaders, and comply with applicable local laws and regulations throughout the excursion.













Scan for
Field Guide Book

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