



XXII INQUA INDIA 2027

FIELD GUIDE

INMID - 03

FLUVIAL GEOMORPHOLOGY AND SEDIMENTOLOGY
OF THE SARYU (GHAGHARA) RIVER AYODHYA,
UTTAR PRADESH, INDIA

Kamlesh Kumar, Arvind Kumar Singh
and Anurag Kumar



बीरबल साहनी पुराविज्ञान संस्थान

Birbal Sahni Institute of Palaeosciences

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Field Guide Book

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Fluvial Geomorphology and Sedimentology of the
Saryu (Ghaghara) River Ayodhya, Uttar Pradesh, India

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including Honorary Assistant Professor, AcSIR, PhD Guideship, Kachchh University, Best Presentation, SERB ITS fellowship, Volkswagen-Stiftung Fellowship, Germany, UTA fellowship, Delhi University, Birbal Sahni International Deputation Grant. he has also convened major conferences and serving on key academic and scientific committees, including National Advisory Committee of Vindhyan Conference, and is also a life member of IAS and Himalayan Geology associations.



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Dr. Anurag Kumar is a Scientist at the Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow, specializing in palaeoclimate reconstruction and stable isotope geochemistry. His research focuses on reconstructing past climate and environmental variability using isotopic and geochemical signatures preserved in sediments and other paleoenvironmental archives. He specializes in compound-specific isotope analysis (CSIA) of organic molecules to investigate past hydroclimatic and environmental changes. His work particularly examines variations in precipitation and vegetation during the Quaternary period. By integrating isotope geochemistry, sedimentology, and paleoenvironmental proxies, his research contributes to understanding Quaternary climate variability, hydroclimatic change and landscape evolution.

Abstract

This field excursion examines the fluvial geomorphology, sedimentology, and tectonic setting of the Saryu (Ghaghara) River at Ayodhya, Uttar Pradesh, a reach where active river processes intersect with a site of deep cultural and religious significance. The core research issue is twofold: first, to characterize the Quaternary alluvial sequence exposed in riverbank cut sections (palaeosol, silt, sand, and mud facies) and relate them to depositional and erosional processes such as lateral bank migration, point-bar accretion and channel-bar formation; and second, to place these surface observations within the region's deeper tectonic framework, particularly the buried Faizabad Ridge, a basement high in the Ganga Foreland Basin that underlies Ayodhya and is of interest for both long-term basin evolution and Himalayan seismic-hazard studies. During the excursion, researchers can expect to log and interpret exposed bank sections, observe active erosional features such as tension cracks and cut banks alongside depositional features such as sand bars, record GPS-referenced field data using the provided observation forms, and collect representative sediment samples. The visit also integrates the region's cultural landscape, including the ghats, temples, and pilgrimage sites along the riverfront, offering a combined geological and cultural perspective on why the Ayodhya reach is significant, both as a dynamic natural system and as one of India's most revered sacred cities.

Preamble

Understanding how large alluvial rivers respond to the combined influence of tectonics, climate, and base-level change remains a central problem in Quaternary geology. Foreland-basin rivers, particularly those flowing across actively subsiding basins in front of young mountain belts, such as the Ganga, are shaped by an interplay that is difficult to disentangle in the field. Subtle, often buried basement structures can locally uplift or depress the basin floor and steer channel position over thousands of years, while short-term climatic cycles (monsoon intensification, glacial-interglacial discharge variability) control sediment supply, channel avulsion, and terrace formation. Globally, most studies of this problem rely on either deep subsurface data (seismic, gravity, drilling) to infer basement control or surface sedimentology of exposed terraces and cut-banks to infer depositional history. The Saryu (Ghaghara) River at Ayodhya offers an unusually direct field opportunity to connect these two aspects. The reach sits precisely above the Faizabad Ridge, a well-documented buried basement high within the Ganga Foreland Basin, meaning the alluvial sequences exposed in the riverbank here are deposited directly over a zone of inferred differential subsidence rather than over a tectonically featureless basin floor, as is the case for most stretches of the Ganga plain used for similar studies. This gives the transect a rare quality: surface facies changes and active bank/channel processes observed first-hand can be interpreted against a known subsurface structural control, rather than an assumed or inferred one.

Objectives: This field visit aims to acquaint the researchers with fluvial landforms, sedimentary facies, and the regional tectonic setting of a major Himalayan foreland river at a locality of exceptional cultural and historical significance.

1. To study the geomorphology of the Saryu (Ghaghara) River valley at Ayodhya: channel form, bank profile, riverine terraces (ghats), and point-bar/floodplain features.
2. To log and describe exposed sedimentary sections (cliff/bank cuts) in terms of lithology, grain size, sedimentary structures, and facies.
3. To relate surface fluvial processes (channel migration, bank erosion, flooding) to the underlying tectonic framework of the Ganga Basin, including the buried Faizabad Ridge.
4. To collect representative sediment samples and photographic records for laboratory analysis (grain-size, mineralogy, provenance).
5. To assess flood hazard, lateral bank erosion, and riverfront engineering (ghats, embankments) visible in the study reach.



Location, Approach & Base Information

Item	Details
District / State	Ayodhya (formerly Faizabad), Uttar Pradesh, India
River studied	Saryu: local name for the Ghaghara River
Regional drainage	Ghaghara is a left-bank tributary of the Ganga; catchment ~1,27,950 km ² spanning Nepal and India
Typical access	Road from Lucknow (~120–135 km); local access via Ayodhya ghats (Ram Mandir, Hanuman Garhi, Guptar Ghat, Svargadvara Ghat)



Regional Geological & Tectonic Setting (Pre-field Reading)

Ganga Foreland Basin

Ayodhya lies within the central Ganga Basin, a foreland basin formed by flexural down warping of the Indian Plate under the load of the Himalaya since the Miocene. The basin floor ('basement') is masked almost everywhere by a thick cover of Quaternary-Recent alluvium deposited by the Ganga, Ghaghara and their tributaries, so no bedrock is exposed anywhere in the study area. The outcrops seen in the field are unconsolidated to semi-consolidated alluvial sediment.



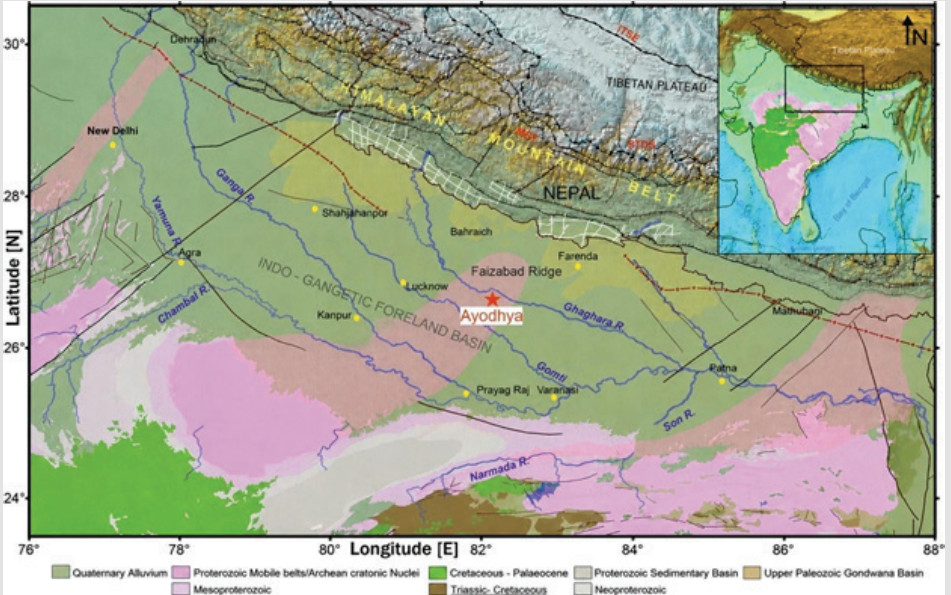


Fig. 1 Regional tectonic map showing the Indo-Gangetic Foreland Basin, the Himalayan thrust belt, and the trace of the Faizabad Ridge passing beneath Ayodhya on the Ghaghara River. (Modified after: Babu et al., 2024)

The Faizabad Ridge

Subsurface geophysical surveys (aeromagnetic, gravity, seismic) and deep hydrocarbon-exploration drilling have revealed that the basement beneath this part of the Ganga Basin is not flat. It is broken into basement highs ('ridges') and lows ('depressions/deeps'). The Faizabad Ridge is one such buried basement high, interpreted as a NE–NNE-trending extension of the Bundelkhand Craton beneath the alluvial cover, flanked by the Sharda and Gandak depressions. Near Faizabad, magneto telluric surveys place the top of this buried ridge at roughly 3–4 km depth.

This structure is not visible at the surface and will not be seen directly in the field. It is included here as an essential regional context. This basement geometry is significant for three reasons:

1. It controls the long-term thickness and subsidence pattern of the alluvial cover beneath the Ghaghara valley at Ayodhya. The ridge crest is a relative basement high compared with the flanking Gandak and Sharda depressions.
2. Transverse basement ridges of this kind are studied as possible controls on the lateral extent of Himalayan earthquake rupture, making the region relevant to seismic-hazard assessment even though no surface fault is exposed.

3. Because the ridge is entirely buried under Quaternary alluvium, none of it is visible in outcrop, and everything observed at river level is unconsolidated recent-sub-recent sediments.

Quaternary Alluvial Stratigraphy

Published sedimentological work on cliff/bank sections of the Ghaghara at Ayodhya recognizes four broad facies units:

- Facies I: Paleosol unit: reworked, mottled, oxidized horizon marking a period of surface stability/soil formation between depositional episodes.
- Facies II: Silty unit: massive bedding, deposited under relatively low-energy, suspension-dominated conditions (overbank/floodplain).
- Facies III: Sandy unit: planar and trough cross-bedding, indicating high-energy, traction-dominated channel or point-bar deposition.
- Facies IV: Mud unit: parallel lamination, deposited under low-energy conditions, typically waning-flood or abandoned-channel settings.

Field Observation: The natural cliff section formed by lateral (bank) erosion of the river provides the best available 'outcrop' in an area with no exposed bedrock. From top to bottom, the following can be distinguished:

- A dark brown, rooted surface horizon with scattered cavities, consistent with a soil/paleosol zone formed during a period of surface stability, now colonized by vegetation and burrowing fauna (the small dark holes are typical of riverbank-nesting birds such as bee-eaters, which favor soft silty cliffs like this one).
- A pale tan, thinly banded silt unit below the soil zone, showing faint sub-horizontal lamination, interpreted as overbank/floodplain silt deposited from suspension during past flood events.
- A lighter, greyish-white unit at the base of the section with a more massive, blocky appearance typical of older Gangetic alluvium.
- A prominent near-vertical tension crack running through the full height of the exposed face indicates active bank instability and indicates that a slab of this cliff is in the process of detaching and will likely collapse into the channel in a future high-flow event.



Fig. 2 Vertical cliff section exposure of the Saryu River, showing color-banded alluvial sequence.

This section is a miniature stratigraphic log recording of at least two to three depositional/pedogenic episodes, and it simultaneously demonstrates the process (lateral bank erosion) by which the Ghaghara continually reworks its own floodplain, the same process that has redistributed sediment above the buried Faizabad Ridge over geological time.



Fig. 3 Broad view of the Saryu channel from a bridge showing mid-channel sand bars.

Geological significance: This photograph documents the depositional counterpart to the erosional cut bank in Fig. 2. Together, the two images capture the classic erosion (concave/cut bank) and deposition (bar/point bar) pairing that drives continuous channel migration in the Ayodhya region.



Fig. 4 View of the Ayodhya riverfront, engineered ghats and temple on the stable right bank, contrasted with the open floodplain of the opposite bank, Saryu River.

The above image shows built-up on the right bank (temples, ghats), which sits on an elevated, stable terrace surface, while the flat, open far bank shows the typical floodplain/lower terrace of a Gangetic River. This asymmetric bank development is a diagnostic feature of a laterally migrating meander belt, consistent with the erosional/depositional pairing already recorded at the cut-bank and bar localities.

Geological Significance of the Study Area

Ayodhya city sits on the right (northern/eastern) bank of the Sarayu. The river here shows a typical anastomosing, aggrading, fluvial channel pattern with the following features to identify and record in the field:

- Active channel and fluvial sedimentary processes.
- Fluvial sedimentary architecture of channel deposition and flood plain.
- Sequential sedimentary building (Vertical accretion) of T0, T1 and T2 surfaces.

Nearby culturally significant places to visit: The field area lies within the sacred town of Ayodhya, the geological traverse can be combined with visits to sites of major cultural and religious significance, all within easy reach of the riverbank localities studied above:

- Guptar Ghat: a bathing ghat directly on the bank of the Saryu, traditionally regarded as the place where Lord Rama is believed to have taken 'Jal Samadhi' (departed from the mortal world into the river). Being riverside, it is a natural stop to compare bank morphology at a second locality along the same traverse.



Fig. 5 View of the Guptar ghat situated on the Saryu River.

- Shri Ram Janmabhoomi Temple (Ram Mandir): The newly built temple marking the traditionally believed birthplace of Lord Rama, a short distance inland from the riverbank; one of the most visited pilgrimage sites in India now-a-days.





Fig. 6 View of the Ayodhya temple and its decoration during the Pran Pratishtha ceremony. (taken from <https://akhilbharat.in/blog/ayodhya-ram-mandir-tour-november-travel-guide/>)

- Hanuman Garhi: A prominent hilltop temple dedicated to Lord Hanuman Ji, located in the heart of Ayodhya on a raised mound; its elevated setting also offers a useful vantage point over the town's alluvial terrain.



Fig. 7 Image showing the entry of Hanuman Garhi. (Taken from Google images)



Combining the geological traverse with these stops allows the field party to appreciate both the natural (fluvial/tectonic) and cultural landscape that together define the significance of Ayodhya.

Cultural Significance: Ayodhya, set on the banks of the sacred Saryu River in Uttar Pradesh, is revered as one of India's holiest cities and the birthplace of Lord Ram. The city's name comes from the Sanskrit word "Ayodhya," meaning "the unconquerable city". Ayodhya is not merely a city; it is a living embodiment of faith, righteousness, and timeless spirituality. It is venerated as the divine birthplace of Lord Ram, the seventh incarnation of Lord Vishnu, whose life and virtues continue to illuminate the path of dharma for millions across the globe. Celebrated in the ancient scriptures of India, including the Ramayana, Ramcharitmanas, Atharva Veda, Skanda Purana, as well as Jain and Buddhist traditions. Every lane, temple, and riverbank echoes with the sacred memories of Ram's divine presence, filling the city with an atmosphere of peace and transcendence. Counted among the revered Sapta Puri, the seven sacred cities believed to bestow moksha or spiritual liberation, Ayodhya invites every pilgrim and traveler into a profound journey of inner reflection, devotion, and divine connection.

Although primarily associated with Hinduism, Ayodhya is also significant in Jainism, as it is believed to be the birthplace of several Jain Tirthankaras. Buddhism, as historical accounts suggest, and Sikhism, as Sikh Gurus, including Guru Nanak Dev, are believed to have visited Ayodhya. This shared heritage makes Ayodhya an important symbol of India's pluralistic and layered cultural history.



Climate

January is Ayodhya's coldest and driest month, part of the region's cool, dry winter season (roughly November–February) that follows the monsoon. Because it falls in the dry season, the Ghaghara/Saryu is at its seasonal low discharge and low water level in January. Sandbars, point bars, and cut-bank sections are best exposed, making it a favorable month for riverbank fieldwork. Expect cool, sometimes foggy mornings requiring a light jacket or woolens, clear and comfortable midday conditions well suited for full-day outdoor work.



Flora and Fauna

January falls in the peak winter/dry season, which is when both riverine vegetation and birdlife are at their most visible and active along the Saryu. Winter is the best season for birdlife on the Saryu system. Notably, the Parvati Arga Bird Sanctuary, an oxbow-lake remnant of the Saryu's former course in nearby Gonda district, hosts migratory species arriving from Siberia, Tibet, China, and Europe from October through roughly February/March, including graylag goose, northern pintail, cotton teal, red-crested pochard, gadwall, northern shoveler, Eurasian coot and mallard, alongside resident species such as sarus crane, painted stork, Indian peafowl, white ibis, and pheasant-tailed jacana. The Saryu (Ghaghara) supports two significant groups of aquatic megafauna: Gangetic river dolphins and crocodilians (gharial/gavial).

Local conveniences

Service	Service
Ambulance (UP state service)	108
National Ambulance Service	102
Fire Service	101
Police / Crime Stopper	112
Women's Helpline	1090
Child Helpline	1098
CM Helpline (UP)	1076

Police Station: Ram Janm Bhoomi, Abhimanyu Shukla- 9454403310,
Email: sho-rjb.ay@up.gov.in

Fire Station: Ram Janam Bhumi, Girish Kumar Dubey- 9454418712,
Email: fsorjb.fz-up@gov.in

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

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.

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.







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