



XXII INQUA INDIA 2027

FIELD GUIDE

INMID - 01

QUATERNARY GEOLOGY, FLUVIAL GEOMORPHOLOGY,
GEARCHAEOLOGY, AND LANDSCAPE EVOLUTION OF
THE YAMUNA RIVER VALLEY

Pawan Govil, Srinivas Bikkina and
Sadhan K. Basumatary



बीरबल साहनी पुराविज्ञान संस्थान

Birbal Sahni Institute of Palaeosciences

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Published under the overall supervision of:

Mahesh. G. Thakkar, Director, Birbal Sahni Institute of Palaeosciences, Lucknow
Binita Phartiyal, Organising Secretary, INQUA India 2027
Pradeep Srivastava, President, INQUA India 2027
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Anupam Sharma, BSIP, Lucknow
Akhilesh K Yadava, BSIP, Lucknow
Rakesh Rao, Goa
Creative Team, Expression 360, New Delhi

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Field Guide Book

INMID-01

Quaternary Geology, Fluvial Geomorphology, Geoarchaeology, and Landscape Evolution of the Yamuna River Valley

Principal Investigator

Dr. Pawan Govil

Scientist F

Birbal Sahni Institute of Palaeosciences, Lucknow, India

Co-Principal Investigator

Dr. Srinivas Bikkina

Scientist F

Birbal Sahni Institute of Palaeosciences, Lucknow, India

Dr. Sadhan K. Basumatary

Scientist-F

Birbal Sahni Institute of Palaeosciences, Lucknow, India

Email of Contact Person

pawan_govil@bsip.res.in

Mobile No.

+91 9568007219

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Team Leaders



Dr. Pawan Govil

Scientist F,
Birbal Sahni Institute of Palaeosciences, Lucknow, India
pawan_govil@bsip.res.in

Dr. Pawan Govil serves as a Scientist-F at the Birbal Sahni Institute of Palaeosciences (BSIP) in Lucknow, India. Holding a doctoral degree in Marine Sciences, I specialize in ocean and polar paleoclimate alongside paleoceanography. His primary research focuses on reconstructing past climate variability by applying advanced biogeochemical and micropaleontological proxies to Indian Ocean and Antarctic Lake sediment cores. Participated in 26th, 32nd, and 35th ISEA Antarctic expeditions and Ocean Science Expeditions. Additionally, Dr. Govil uses stable isotopes and elemental ratios from planktonic foraminifera to systematically analyze past glacial-interglacial cycles and evaporation-precipitation budgets



Dr. Srinivas Bikkina

Scientist F,
Birbal Sahni Institute of Palaeosciences, Lucknow, India
sbikkina@bsip.res.in

I, Srinivas Bikkina, am a senior scientist (Scientist-F) at the Birbal Sahni Institute of Palaeosciences (BSIP) in Lucknow, India. I lead the Radiocarbon dating lab and specialize in organic geochemistry, dual-carbon isotope forensics ($^{14}\text{C}/^{13}\text{C}$), and sediment provenance using Sr-Nd isotopic systematics. My research focuses on carbonaceous aerosol pathways, sedimentary soot cycling, and organic biomarker dynamics in marine, terrestrial, and polar ecosystems. I've participated in the 15th Indian Arctic Expedition and the 44th Antarctic Expedition. I use compound-specific stable carbon isotope measurements, radiocarbon constraints, and organic biomarker distributions to understand the contributions of continental outflow, palaeoclimate transitions, and carbon cycling dynamics in marine systems, the Indo-Gangetic Plain, and polar regions.



Dr. Sadhan K. Basumatary

Scientist-F,
Birbal Sahni Institute of Palaeosciences, Lucknow, India
sadhankumar_basumatary@bsip.res.in

Dr. SADHAN K. BASUMATARY has completed his M.Sc. in Botany from the University of Gauhati in 1998 and a Ph.D. in Quaternary Palynology from the University of Lucknow in 2011. He is currently working as a Scientist 'F' at the Birbal Sahni Institute of Palaeosciences in Lucknow. His research primarily focuses on Quaternary Palynology and Palaeoecology, using multiproxy analysis. In addition to conventional soil samples, his current research integrates pollen and non-pollen palynomorphs, particularly coprophilous fungal spores preserved in soil and in wildlife dung samples, to reconstruct vegetation dynamics in relation to palaeoherbivory and palaeodietary analyses. In recognition of his scientific contributions, he was awarded the "Iyenger-Sahni Medal" in 2015 and the "Chandra Dutt Pant Medal" in 2016. Dr. Basumatary has published more than 90 research papers in national and international journals.

Abstract

The Yamuna River Valley constitutes one of the most important Quaternary landscapes of the Indian subcontinent, preserving an exceptional record of geological evolution, vegetation succession, climatic variability, ecological transformation, and human adaptation. The integrated observation of the Archaeological sites of Agra, especially the Taj Mahal, Agra Fort, the Yamuna River, and adjoining areas, provides a multidisciplinary perspective on the long-term interactions between fluvial processes, environmental change, biodiversity, and cultural development within this dynamic alluvial system.

The Archaeological Sites of Agra represent a significant geoarchaeological archive that demonstrates the close association between human settlements, adaptation, and the resource-rich floodplains of the Yamuna valley. Its cultural stratigraphy, archaeological remains, and environmental setting reveal how ancient communities successfully adapted to changing hydrological regimes, exploited fertile alluvial soils, and utilized freshwater resources for sustenance and socio-economic development. The site offers valuable insights into the evolution of human–environment relationships during the Late Holocene and underscores the role of riverine landscapes in fostering cultural growth and the continuity of settlement. The Yamuna River valley, through fluvial processes associated with the other tributaries (the Chambal River, the main tributary), serves as a key palaeoenvironmental archive for reconstructing the region's Late Pleistocene–Holocene environmental history. Its stratified lacustrine sediments preserve high-resolution records of monsoon variability, hydrological fluctuations, vegetation succession, and anthropogenic activities spanning the Holocene period. Palynological and sedimentological evidence from the sedimentary soil record of the wetland and Archaeological sites provides critical information on vegetation succession and climatic fluctuations in relation to human activities in the Yamuna River valley and adjoining region.

The UNESCO World Heritage sites, especially the Taj Mahal (one of the seven wonders of the world), Agra Fort, and other important monuments in and around Agra (e.g., Fatehpur Sikri), illustrate the evolution of archeological sites, landscapes, vegetation, and climate, as well as human civilization. The importance of integrating geology, geomorphology, palaeoecology, archaeology, and conservation science to reconstruct past environmental changes and evaluate present-day challenges. The region serves as a natural laboratory for investigating long-term human–environment interactions and offers valuable lessons for sustainable management of wetlands, archaeological heritage, and natural resources in the face of rapid urbanisation and climate change.

The preservation and scientific study of these interconnected landscapes are therefore essential not only for advancing knowledge of the Yamuna River valley but also for safeguarding its Geoheritage, cultural heritage, and ecological integrity for future generations.

About Agra and the Taj Mahal

Agra is a historic city in Uttar Pradesh, India, famous for the Taj Mahal, Agra Fort, and Fatehpur Sikri. It sits on the Yamuna River and was once the capital of the Mughal Empire. Agra once served as the Mughal capital from 1556 to 1648 and is home to three UNESCO World Heritage Sites. Agra city was founded as a modern capital by Sultan Sikandar Lodi in 1504. The famous landmark includes the Taj Mahal, a white marble wonder built by Shah Jahan. The Agra Fort is a massive red sandstone fort near the river. Additionally, Itimad-ud-Daulah built a delicate marble tomb, which is often called the "Baby Taj". Agra is very famous for its sweets, which are called "PETHA". This city is one of the major manufacturers of leather and shoes. The city is very well known for the UNESCO World Heritage Site "Taj Mahal". The Taj Mahal is considered the greatest architectural achievement in Indo-Islamic architecture. Its recognized architectural beauty features a rhythmic combination of solids and voids, concave and convex, and light and shadow; elements such as arches and domes further enhance the aesthetic. The colour combination of a lush green landscape, a reddish pathway, and a blue sky above it showcases the monument in ever-changing tints and moods. The relief work in marble and inlay with precious and semi-precious stones makes it a monument apart.

The marble used for the Taj Mahal came from the famous Makrana quarries in Rajasthan. Persian writers describe this marble not merely as a building material but as a substance with remarkable visual qualities. They mention three important characteristics. The first is *subu-dari*, the ability to achieve an exceptionally smooth polish that makes the stone appear almost liquid in sunlight. The second is *khamiri-safedi*, a soft translucent whiteness compared to the glow of an eggshell held against the sun. The third is *sang-i-zinda*, or "living stone," referring to marble that absorbs light and slowly releases it instead of simply reflecting it. Because of these qualities, the Taj Mahal constantly changes its appearance with the changing light. At sunrise, the marble takes on a delicate pink shade. By noon, it becomes a brilliant white, so bright that the poet Abu Talib Kalim wrote that it seemed to erase its own shadow. During sunset, it reflects soft violet and amber tones, while under the full moon, it glows with a silvery light that makes the monument appear almost weightless. The French traveller François Bernier, who visited the Mughal court in the seventeenth century, also described these remarkable colour changes, observing that the marble seemed to participate in the sky's changing moods.



Preamble

The Yamuna River valley represents one of the most significant geomorphic, geological, ecological, and cultural landscapes of the Indian subcontinent. Occupying a vast stretch of the Yamuna River and its tributaries in the Indo-Gangetic Plain, this region has evolved through complex interactions among Himalayan tectonics, Quaternary climatic fluctuations, fluvial dynamics, sedimentation processes, and human activities. The plain serves as a natural archive, preserving evidence of environmental changes over hundreds of thousands of years, while simultaneously supporting some of the earliest agricultural societies and urban settlements in South Asia. The study of the Yamuna River valley, therefore, provides a unique opportunity to understand the interconnected evolution of landscapes, ecosystems, and human civilizations.

The Yamuna River valley and its tributaries have continuously changed the landscape through erosion, transportation, deposition, channel migration, floodplain aggradation, and human activities. The resulting geomorphic features include active and abandoned channels, oxbow lakes, flood basins, plains, escarpments, wetlands, badlands (ravines), and alluvial terraces. These landforms collectively record the history of river dynamics, tectonic influence, and climatic variability that have governed environmental conditions throughout the Quaternary period. Understanding these geomorphic processes is crucial for reconstructing past environments, assessing contemporary environmental challenges, and developing sustainable strategies for land and water resource management.

The Taj Mahal and Agra Fort, situated on the bank of the Yamuna River in Agra, are among the most important geoarchaeological sites in the world. Consequently, the archaeological sites located at Agra provide a valuable window into the interactions between humans and their changing environment over time. From a geoarchaeological perspective, variations in river courses, flood frequencies, sedimentation patterns, and climatic conditions would have affected agricultural productivity, resource availability, transportation routes, and the sustainability of settlements. By integrating geological, geomorphological, and archaeological evidence, researchers can reconstruct the environmental contexts within which ancient societies emerged, adapted, and transformed. Such interdisciplinary investigations contribute significantly to our understanding of human resilience and environmental adaptation in one of the world's most densely populated river basins.

There are a number of wetlands and lakes, especially the Soor Sarovar Bird sanctuary, located 17 km from Agra city in the Agra District of Uttar Pradesh, which can provide insights into long-term interactions among hydrology, sedimentation, climate, and biological processes. Their formation is closely linked to river migration, floodplain aggradation, and the creation of low-lying areas that retain water seasonally or permanently. These environments function as natural reservoirs, groundwater recharge zones, sediment traps, nutrient cycling centers, and biodiversity hotspots. Moreover, wetlands preserve valuable palaeoenvironmental records in their sediment sequences, including pollen, diatoms, phytoliths, geochemical signatures, and organic matter assemblages. Such proxies enable the reconstruction of past climatic conditions, vegetation changes, hydrological fluctuations, and anthropogenic influences, thereby contributing to a deeper understanding

of Quaternary environmental history.

Combining the Archaeological Site and the wetlands of its neighboring areas can illustrate the dual dimensions of landscape evolution within the Yamuna River valley—one reflecting the history of human occupation and cultural adaptation, and the other representing the ecological and geomorphological consequences of fluvial processes. Their combined study offers an integrated perspective on how natural processes have shaped environmental opportunities and constraints for both ecosystems and human societies.

In the context of contemporary environmental challenges, including rapid urbanization, wetland degradation, groundwater depletion, river pollution, and climate change, understanding the Quaternary evolution of the Yamuna River valley is increasingly important. Historical and geological records provide critical insights into the long-term behavior of river systems and landscape responses to environmental stress. Such knowledge is essential for informed conservation planning, heritage management, disaster mitigation, and sustainable development initiatives.

This one-day field visit to the Archaeological sites in the Yamuna River valley (27°10'35.91"N and 78°02'30.40"E), therefore, seeks to integrate perspectives from Quaternary geology, fluvial geomorphology, geoarchaeology, palaeoenvironmental reconstruction, and wetland ecology. Through the examination of these sites, participants gain a comprehensive understanding of the processes that have shaped the landscape over geological timescales and continue to influence ecological and cultural systems today.



Geomorphology of Agra District

The geomorphology of Agra District, as depicted in the map, reflects the combined influence of fluvial processes, tectonic controls, and long-term landscape evolution within the Yamuna River basin of the Indo-Gangetic Plain. The district is characterized predominantly by alluvial landforms, with localized structural features and a dense network of active and abandoned drainage systems that together shape its present-day terrain.

Agra lies within the central part of the Ganga-Yamuna alluvial plain and is primarily occupied by extensive older alluvial plains (T2), which constitute the dominant geomorphic unit. These older alluvial surfaces cover most of the district and represent elevated terraces formed by ancient depositional activities of the Yamuna River and its tributaries. The T2 surface is relatively stable and has undergone prolonged weathering and pedogenic development. Due to its higher elevation compared to the active floodplain, it experiences limited seasonal flooding and supports extensive agricultural activities and urban settlements, including the city of Agra.

Scattered within the older alluvial surface are patches of younger alluvial plains (T1). These deposits are comparatively recent and are associated with active fluvial sedimentation. The younger alluvium generally occurs near present drainage channels and flood-prone zones, where rivers continue to deposit fresh sediments during seasonal floods. These areas possess relatively fertile soils due to continual replenishment of fine-grained sediments and organic matter.

One of the most prominent geomorphic features of the district is the extensive floodplain of the Yamuna River. The floodplain stretches along the southern and southeastern parts of Agra and forms a broad belt characterized by active sediment deposition. During periods of high discharge, floodwaters spread across these low-lying areas, depositing layers of silt, clay, and fine sand. The floodplain is therefore highly dynamic and continuously modified by fluvial processes such as erosion, transportation, and deposition. Its presence indicates the ongoing geomorphic activity of the Yamuna River, which remains the principal agent shaping the landscape.

The district exhibits a remarkable abundance of palaeochannels, represented by numerous abandoned river courses distributed throughout the region. These palaeochannels are relics of former river pathways and indicate repeated shifts in river alignment over geological time. Their widespread occurrence suggests that the Yamuna River and its associated drainage systems have undergone significant lateral migration, avulsion, and channel abandonment during the Late Quaternary period. Palaeochannels serve as valuable indicators of past hydrological conditions and reveal the dynamic nature of fluvial evolution in the region. Many of these abandoned channels may also serve as important groundwater reservoirs due to their coarse-sediment fills and enhanced permeability.

A dense network of streams and drainage channels traverses the district. These drainage systems play a vital role in surface runoff and sediment transport. The drainage pattern appears largely dendritic to sub-dendritic, reflecting the relatively homogeneous nature of the alluvial substrate. In several areas, the drainage network follows subtle topographic

gradients and may also be influenced by structural controls. The streams ultimately contribute water and sediments to the Yamuna River system, reinforcing its role as the dominant geomorphic agent.

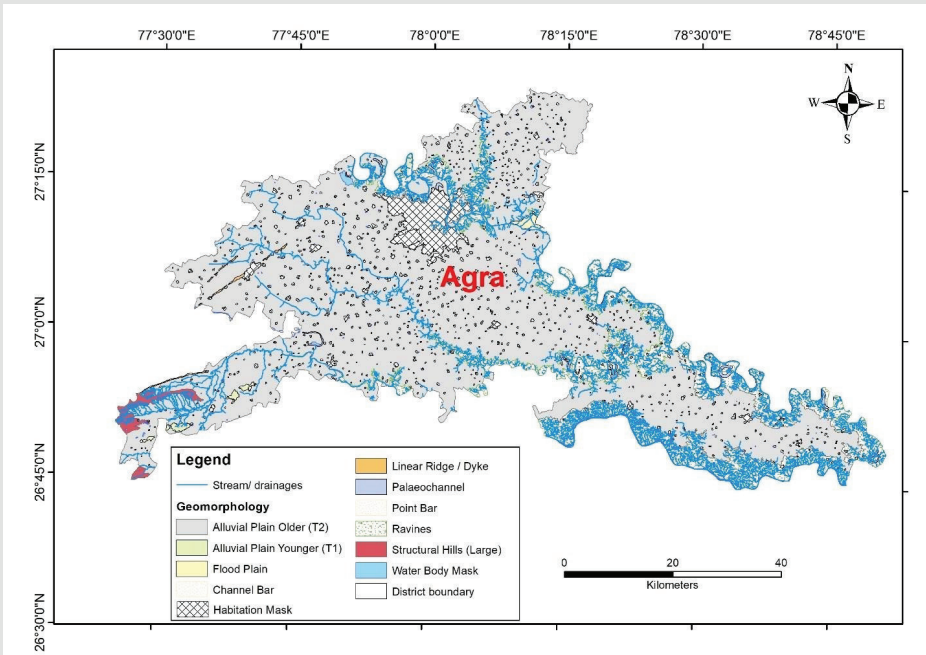
Associated with the active river system are depositional landforms such as channel bars and point bars. Channel bars occur within river channels where sediment accumulates due to reduced flow velocity. These bars are composed primarily of sand and silt deposited during fluctuating discharge conditions. Point bars, on the other hand, develop along the inner bends of meandering river channels as a result of lateral accretion. Their presence indicates active meandering processes and continual channel migration. Together, these fluvial depositional features highlight the dynamic sedimentary environment of the Yamuna floodplain.

The map also identifies extensive ravine landscapes, particularly along portions of the river valleys. Ravines are deeply dissected erosional landforms produced by intense gully erosion on unconsolidated alluvial sediments. Their development is facilitated by seasonal rainfall, sparse vegetation cover, and steep local gradients. Ravines represent areas of active land degradation and are characteristic features along the margins of the Yamuna River and its tributaries. They significantly influence land use patterns because the dissected terrain is less suitable for agriculture and infrastructure development.

An important geomorphic element of the Agra District is the occurrence of linear ridges. These elongated features likely represent resistant geological structures or tectonically controlled landforms that stand above the surrounding alluvial plain. Their linear nature suggests structural influences on landscape development and drainage organization. Such features may act as local topographic barriers, influencing runoff pathways and sediment distribution.

Although Agra is predominantly an alluvial region, the southwestern part of the district contains isolated structural hills, represented as large rocky uplands. These hills constitute remnants of older bedrock formations that protrude through the alluvial cover. Their resistance to erosion has enabled them to persist as elevated geomorphic features while the surrounding areas were subjected to extensive sedimentation. These structural hills provide evidence of the geological framework underlying the Quaternary alluvium and contribute to local topographic diversity.





Geomorphology of Agra District

Numerous water bodies are distributed across the district, including ponds, lakes, wetlands, and abandoned channel segments. These water bodies are often associated with palaeochannels and floodplain depressions. They play a significant role in groundwater recharge, biodiversity conservation, and local hydrological regulation. Their distribution further reflects the fluvial origin of the landscape and the influence of changing river courses through time.

Urbanization is represented by the habitation mask, concentrated around the city of Agra and its surrounding settlements. The city occupies a relatively stable alluvial surface that provides favorable conditions for habitation and infrastructure development. However, continued urban expansion into floodplain areas may increase vulnerability to flooding and alter natural drainage patterns.

From a broader geomorphological perspective, the Agra district represents a classic example of a Quaternary fluvial landscape shaped primarily by the Yamuna River system. The coexistence of older and younger alluvial plains, active floodplains, palaeochannels, bars, ravines, and isolated structural uplands demonstrates the interplay between depositional and erosional processes operating over different temporal scales. The geomorphic framework records repeated phases of river migration, sediment accumulation, channel abandonment, and landscape dissection that have collectively produced the present terrain.

The geomorphology of Agra is dominated by extensive alluvial plains and fluvial landforms associated with the Yamuna River. Older alluvial terraces form the principal geomorphic surface, while younger floodplain deposits, palaeochannels, bars, ravines, and drainage networks reflect ongoing river activity. Localized structural hills and linear ridges reveal the influence of underlying geological structures. These landforms provide important insights into the Quaternary evolution, hydrology, groundwater potential, environmental management, and landscape dynamics of the Agra region.

Stratigraphy of Agra District

The stratigraphy of the Agra district reflects a long and complex geological history spanning from the Proterozoic Era to the Recent period. The district is situated within the Indo-Gangetic foreland basin and is predominantly covered by Quaternary alluvial deposits, while isolated exposures of older geological formations occur in the southwestern and localized central-eastern parts of the district. The stratigraphic framework records episodes of tectonic activity, sedimentation, erosion, and river migration that have collectively shaped the present landscape.

The most extensive stratigraphic unit in Agra is the Quaternary–Recent succession, which occupies almost the entire district. These deposits consist of unconsolidated sediments comprising sand, silt, clay, gravel, and calcareous materials, deposited by the Yamuna River and its tributaries during the Pleistocene and Holocene epochs. The widespread distribution of these sediments indicates prolonged fluvial activity and repeated cycles of deposition associated with changing climatic conditions and river dynamics. The Quaternary deposits form the fertile alluvial plains that support intensive agriculture and urban development throughout the district. They generally attain considerable thickness and overlie older formations unconformably, masking much of the underlying geology.

Within the Quaternary sequence, younger Holocene deposits are concentrated along active river channels, floodplains, and low-lying areas. These sediments are characterized by fine-grained sand, silt, and clay deposited during seasonal flooding and channel migration. Such deposits are continually reworked and redistributed by modern fluvial processes. The presence of these recent sediments highlights the active geomorphic evolution of the Yamuna floodplain and demonstrates the ongoing accumulation of sediment in the district.

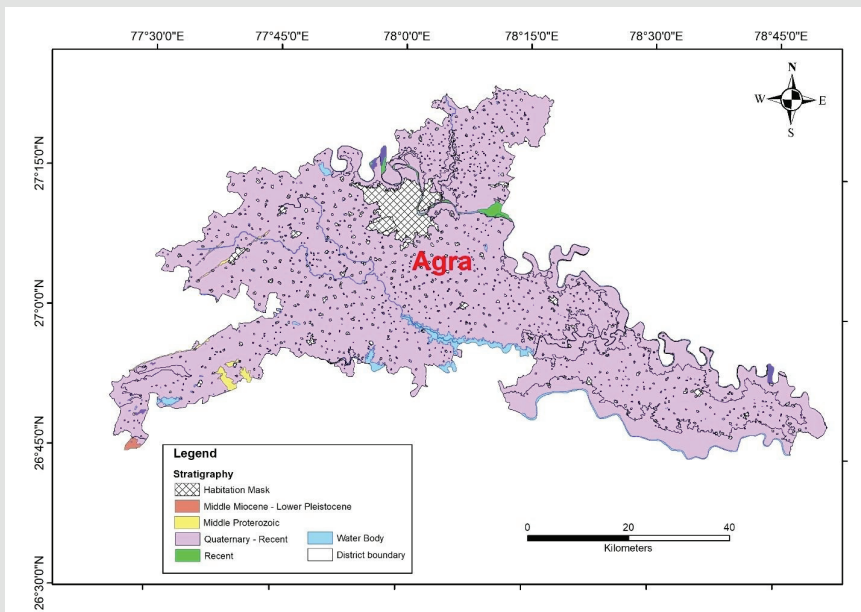
A small but significant stratigraphic component is represented by Recent deposits, occurring in localized patches, particularly in the northeastern and central-eastern sectors. These deposits correspond to very young fluvial sediments associated with active river channels, wetlands, and flood-prone environments. They indicate present-day depositional processes and provide evidence of continued sedimentation under contemporary hydrological conditions.

The southwestern margin of Agra district contains isolated exposures of Middle Proterozoic rocks, which represent some of the oldest geological formations in the area. These rocks are part of the Precambrian basement complex and consist primarily of quartzites, sandstones, shales, and associated metamorphic units. Their limited exposure suggests that most of the ancient basement is concealed beneath younger alluvial sediments. The occurrence of

these Proterozoic rocks provides important evidence regarding the pre-Cenozoic geological evolution of the region and reflects the stable cratonic framework underlying the Indo-Gangetic Plain.

The stratigraphic succession of Agra thus reveals a clear dominance of Quaternary fluvial deposits over older geological formations. The thick alluvial blanket reflects the long-term influence of the Yamuna River system and the continuous supply of sediments from the Himalayan hinterland. Beneath this alluvial cover lie remnants of Neogene sediments and ancient Proterozoic basement rocks that record much older phases of geological evolution.

The stratigraphy of Agra district is characterized by extensive Quaternary-Recent alluvium, localized Recent floodplain deposits, isolated exposures of Middle Miocene-Lower Pleistocene sediments, and small outcrops of Middle Proterozoic basement rocks. This stratigraphic arrangement highlights the transition from ancient crystalline and sedimentary terrains to the modern alluvial plains of the Indo-Gangetic basin. The dominance of Quaternary sediments reflects the enduring role of fluvial processes in shaping Agra's geological and geomorphological character, while older formations provide valuable insights into the region's deeper geological history.



Stratigraphic setup of Agra district



Lithology

The lithology of the Agra district reflects its position within the vast Indo-Gangetic alluvial plain, where Quaternary sediments dominate the surface geology. The district is characterized by thick accumulations of unconsolidated fluvial deposits derived mainly from the Himalayan and Peninsular river systems, particularly the Yamuna River and its tributaries. The lithological framework consists predominantly of clay, sand, and silt, with their various combinations, while isolated occurrences of older consolidated rocks, such as quartzite, sandstone, and conglomerate, are exposed in the southwestern part of the district. This lithological diversity provides valuable insights into the depositional history, geomorphic evolution, groundwater potential, and environmental characteristics of the region.

The most extensive lithological unit in the Agra district is clayey sand, which covers a large portion of the district. This unit represents alluvial deposits laid down by river systems during repeated episodes of flooding and channel migration. Clayey sand consists of sand-sized particles mixed with varying proportions of clay, resulting in moderately permeable sediments. These deposits form the extensive alluvial plains that dominate the landscape and support intensive agricultural activities. The widespread occurrence of clayey sand indicates fluctuating depositional environments in which both high- and low-energy fluvial conditions prevailed. During periods of stronger river flow, sand was deposited, while finer clay particles accumulated during quieter hydrological conditions.

Another important lithological unit is clay with sand and silt partings, occurring extensively along river valleys, floodplains, and low-lying regions. This lithology is composed predominantly of clay interbedded with thin layers of sand and silt. Such deposits are characteristic of floodplain environments where fine-grained sediments settle from suspension during flood events. The presence of sand and silt partings reflects periodic fluctuations in flow energy and sediment supply. These clay-rich deposits generally exhibit low permeability and play an important role in groundwater confinement and soil formation. Agriculturally, these areas often possess high moisture retention capacity and support the cultivation of water-demanding crops.

Localized patches of sandy clay are also present within the district. Sandy clay represents an intermediate lithology containing substantial proportions of both sand and clay. These deposits commonly occur in transitional zones between active channels and floodplain environments. Their mixed texture provides moderate drainage characteristics and contributes to the development of fertile agricultural soils. The occurrence of sandy clay indicates repeated shifts between depositional settings influenced by changing river courses and seasonal flooding.

In several areas, particularly associated with palaeochannels and active drainage systems, deposits of gravel, sand, and silt are observed. These coarse- to medium-grained sediments represent higher-energy depositional environments such as river channels, channel bars, and alluvial fans. Gravel and coarse sand are deposited during periods of strong flow velocity, while silt accumulates as flow energy decreases. Such deposits are highly permeable and often constitute productive aquifers with significant groundwater storage potential. Their

occurrence demonstrates episodes of vigorous fluvial activity and channel migration during the Quaternary period.

The southwestern part of the Agra district exhibits exposures of sandstone and conglomerate, representing older consolidated geological formations that predate the extensive alluvial cover. Sandstone consists of cemented sand-sized particles, whereas conglomerate is composed of rounded pebbles and gravel embedded in a finer matrix. These rocks were deposited in ancient fluvial or shallow marine environments and subsequently lithified over geological time. Their limited surface exposure indicates that they are largely buried beneath younger alluvial sediments. Nevertheless, these formations provide important evidence of the region's pre-Quaternary geological history.

Associated with these older formations are isolated occurrences of massive quartzite, a hard, resistant metamorphic rock formed by the recrystallization of quartz-rich sandstone. Quartzite is highly durable and resistant to weathering, allowing it to persist as isolated uplands or structural highs within the landscape. The presence of quartzite suggests a Precambrian geological heritage and indicates the existence of ancient basement rocks beneath the younger sedimentary cover. These rocks are significant from both geological and geomorphological perspectives because they influence local topography and drainage patterns.

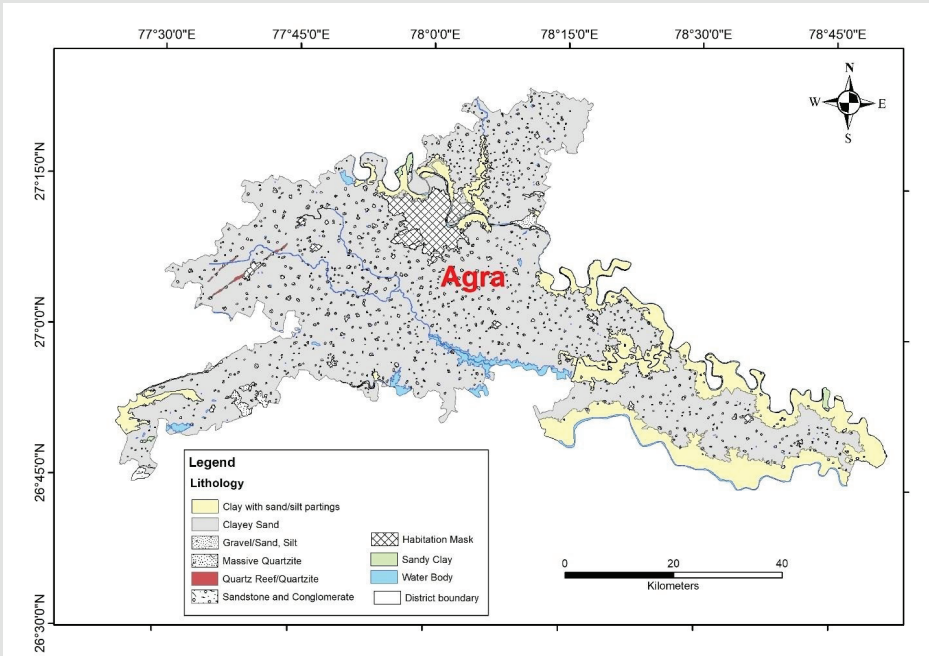
A notable lithological feature in the southwestern sector is the occurrence of quartz reef or quartzite ridges. These linear bodies consist predominantly of silica-rich quartz and quartzite and represent resistant structural features within the older geological framework. Their elongated nature suggests structural control, possibly related to fractures, joints, or ancient tectonic processes. These quartz-rich formations stand out from the surrounding alluvial terrain due to their resistance to erosion and provide valuable insights into the region's tectonic evolution.

The district also contains numerous water bodies and channel deposits associated with modern fluvial activity. These areas are characterized by unconsolidated sediments ranging from clay and silt to sand and gravel. Continuous sediment transport and deposition by the Yamuna River and its tributaries result in frequent lithological modifications. Such environments are highly dynamic and contribute significantly to groundwater recharge and sediment redistribution.

From a hydrogeological perspective, the lithological composition of the Agra district plays a crucial role in groundwater occurrence and movement. Sandy and gravelly deposits function as productive aquifers due to their high porosity and permeability, whereas clay-rich units act as aquitards that restrict groundwater flow. The alternation of permeable and impermeable layers creates a complex groundwater system that supports domestic, agricultural, and industrial water demands across the district.

The lithology of Agra district is dominated by Quaternary alluvial sediments consisting of clayey sand, clay with sand and silt partings, sandy clay, and gravel-sand-silt assemblages. These deposits reflect prolonged fluvial sedimentation by the Yamuna River system and its tributaries. In contrast, isolated exposures of sandstone, conglomerate, quartzite, and

quartz reefs in the southwestern region represent remnants of much older geological formations. These lithological units record a long history of sediment deposition, tectonic influences, erosion, and river migration, making Agra a classic example of an alluvial plain underlain by an ancient geological basement. The lithological framework not only governs the geomorphology and groundwater resources of the district but also provides valuable insights into its geological evolution from Precambrian times to the present day.



Lithology of the Agra district

Biodiversity and Environmental Importance of the Yamuna River valley

The region is mainly covering tropical mixed deciduous elements, composed of *Azadiracta indica*, *Prosopis* sp., *Bombax ceiba*, *Syzygium cumuni*, *Embllica officinalis*, *Butea monosperma*, and *Calotropis gigantea*. Marshy and Aquatic taxa are luxuriantly growing in and around the annual and perennial waterlogged systems, such as natural wetlands, lakes, and streamlets. The dominant taxa of the different species of *Poaceae*, *Cyperaceae*, *Polygonum* sp., *Nelumbo* sp., *Nymphaea* sp., *Potamogeton* sp., *Lemna* sp., *Trapa* asp., and algae.

Among wildlife, *Boselaphus tragocamelus* (Nilgai), *Cervus* sp. (Deer), *Vulpes* sp. (fox), *Sciurus* sp. (Squirrels), *Herpestes* sp. (Mongoose), etc, along with different types of avian

namely *Pavo cristatus* (Indian Peacocks), *Antigone antigone* (Sarus cranes), *Zenaida macroura* (mourning dove), *Psittacula krameri* (rose-ringed parakeet), along with Rhesus macaques (monkeys), are commonly seen in the region. In addition, the national Chambal Sanctuary is one of the attractive places to visit to learn about the *Gavialis gangeticus* (Gharial), tortoise (*Batagur kachuga*), and Ganga dolphin (*Platanista gangetica*) in relation to the current ecosystem.

Palynology and Palaeoecological Reconstruction

The region is one of the most challenging site for understanding vegetation succession and climatic amelioration in relation to human adaptation and civilization, based on biotic (pollen and NPPs) and abiotic (geochemistry, isotopes) proxies during the Holocene period. To date, few studies have been carried out, but further investigation and palynological work are needed to better understand the palaeovegetation and climatic changes in the region and to correlate them with other parts of the Indian subcontinent.



Conclusion

The Yamuna River valley represents one of the most significant Quaternary landscapes of the Indian subcontinent, where interactions among climate, fluvial dynamics, ecology, and human societies have shaped the environment over thousands of years. The combined study of the Yamuna River valley along with other parts of the Indian subcontinent will provide a comprehensive understanding of the region's geological evolution, palaeoenvironmental history, biodiversity, and cultural development.

The study of the natural lakes and wetlands of the Agra District will provide significant information for reconstructing palaeoenvironmental and climatic changes in relation to human civilization. The multi-proxy analysis from such wetlands contributes significantly to regional palaeoclimatic and palaeoecological reconstructions. However, generating this regional data will be helpful for the details of the linking geological processes, environmental evolution, ecological diversity, and human civilization in the Indian subcontinent. Integrated multidisciplinary research involving Quaternary geology, geomorphology, archaeology, palaeoecology, and conservation science is essential for understanding past environmental changes and for promoting sustainable management of this culturally and environmentally important landscape.



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View of the Taj Mahal, Agra



A close up view of the Taj Mahal



View within a campus of the Taj Mahal



A view of Yamuna River



A view of the Yamuna River near the Taj Mahal



View of a Baby Taj Mahal (Monument name)





A side view of the baby Taj Mahal



A view during discussion in the office with the authority of the Archaeological Survey of India



Team members with the authority of the Archaeological Survey of India



Team members with the authority of the Archaeological Survey of India



A view during inspection for food facility located in the Lucknow-Agra expressway



View during inspection for food facility located in the Lucknow-Agra expressway



*Inside view of the food Plaza, Lucknow-Agra
expressway*



*An overview of a road side vegetation in the
Lucknow-Agra expressway*



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.







Scan for
Field Guide Book



Contact Details:

INQUA Secretariat

Birbal Sahni Institute of Palaeosciences (BSIP),
53, University Road, Lucknow-226 007 U.P, India

Email: inqua.india@gmail.com | inqua.india@bsip.res.in

Phone: +916386696896 | +916392507990