

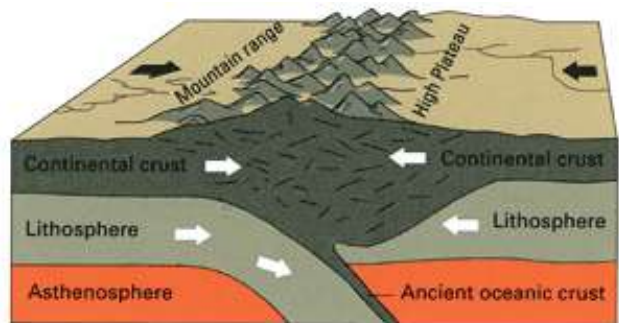
2025 : “The Himalaya is still rising.” Expand this statement and describe the processes involved in it with suitable sketches and diagrams.

Introduction Unlike older, relict mountain systems like the Appalachians or the Urals, the Himalayas are young fold mountains born out of a colossal tectonic collision. The Himalayas and the Tibetan Plateau to the north have risen very rapidly. In just 50 million years, peaks such as Mt. Everest have risen to heights of more than 9 km. The impinging of the two landmasses has yet to end. **The Himalayas continue to rise more than 1 cm a year** -- a growth rate of 10 km in a million years! Scientists believe that the Eurasian Plate may now be stretching out rather than thrusting up, and such stretching would result in some subsidence due to gravity..

The Tectonic Setting: Continent-Continent Collision

The primary driving force behind the continuous rise of the Himalayas is explained by the theory of Plate Tectonics.

- The Mechanism: The Himalayas are located at a convergent plate boundary, specifically characterizing a continental-continental collision between the northward-moving Indian Plate and the relatively stationary Eurasian Plate.
- The Tethys Ocean Squeeze: Before the collision, the Tethys Ocean separated the two landmasses. As the Indian plate drifted north, the oceanic crust subducted beneath the Eurasian plate. Once the ocean closed, the two buoyant continental masses collided.
- Crustal Shortening and Thickening: Because continental crust is too buoyant to subduct deeply into the mantle, the intense compressive forces caused the crust to crumple, fold, and fault. This led to massive crustal shortening and a doubling of the crustal thickness (reaching up to 70–80 km beneath the Tibetan Plateau), forcing the landmass upward.



Continental-continental convergence

Geological Processes Driving the Uplift

The continuous vertical growth of the Himalayas is sustained through a combination of structural faulting and deep-seated crustal dynamics:

A. Major Thrust Fault Systems

The immense compression has sliced the northern edge of the Indian plate into massive rock slices bounded by south-verging thrust faults. As the Indian plate continues to push north, it slips underneath these faults, stepping up and lifting the mountain blocks above them. From north to south, these zones include:

- **Indo-Tsangpo Suture Zone (ITSZ):** The structural line marking the initial zone of collision.
- **Trans Himalayan Fault (THF):** The line between Trans Himalayas and Himadri
- **Main Central Thrust (MCT):** An older fault zone that propelled the crystalline rocks of the Greater Himalayas upward.
- **Main Boundary Thrust (MBT):** The fault zone primarily responsible for the uplift of the Lesser (Middle) Himalayas.
- **Main Frontal Thrust (MFT) / Himalayan Frontal Thrust (HFT):** The youngest, southernmost fault system where the Shiwaliks (Outer Himalayas) meet the Indo-Gangetic plains. Active slip along the MFT is the principal contributor to the current rising of the outer mountain ranges.

B. Isostatic Rebound

- The towering Himalayan peaks undergo intense denudation (erosion) driven by glaciers, heavy monsoon rainfall, and powerful river systems.
- As massive amounts of rock and sediment are stripped off the mountain tops and transported to the plains, the load on the underlying crust decreases.
- To compensate for this loss of mass, the Earth's mantle pushes the deep, buoyant continental "root" of the mountains upward to maintain isostatic equilibrium (akin to a ship rising in water as cargo is unloaded). This interaction between surface erosion and deep crustal processes accelerates the uplift.

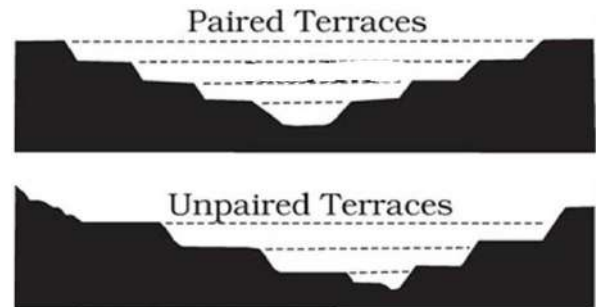
Evidences of Continuous Rise

The assertion that the Himalayas are still rising is supported by robust empirical, geomorphological, and geophysical evidence:

- **Geodetic Data (GPS Measurements):** High-precision satellite data show that the Indian plate is still moving northward into Asia at a rate of about 4 to 5 cm per year. This results in net Himalayan uplift rates ranging between 5 mm to 1 cm per year, depending on the specific structural zone.
- **High Seismic Activity:** The Himalayan arc is one of the most earthquake-prone regions globally (classified under Zones IV and V of India's seismic zoning map). Frequent earthquakes represent the sudden release of locked tectonic stress along active thrust faults, directly resulting in instantaneous physical displacement and vertical uplift.
- **Fluvial Geomorphology:** Antecedent Drainage: Rivers like the Indus, Sutlej, and Brahmaputra existed *before* the mountains. As the land rose, these rivers carved deep, near-vertical gorges

(such as the Indus Gorge) to maintain their original courses, proving that tectonic uplift outpaced the rivers' lateral erosion.

- **River Terraces and Knickpoints:** The presence of unpaired river terraces, steep waterfalls, and hanging valleys indicates structural rejuvenation, proving that the river beds are being uplifted repeatedly.



- **Marine Fossils at High Altitudes:** The presence of *Ammonite* fossils (locally known as Shaligrams) in the high-altitude Spiti Valley and Muktinath (over 3,000 meters above sea level) proves that sedimentary rocks forming these peaks were once part of the marine Tethys ocean floor.

Conclusion The rising Himalayas serve as a living laboratory for structural geology and geodynamics. This continuous tectonic uplift is not merely a geological phenomenon; it actively dictates the South Asian monsoon patterns, feeds the perennial river systems sustaining over a billion people, and shapes the geo-hazard profile (landslides and earthquakes) of the entire Indian subcontinent. Developing infrastructure in this fragile, still-evolving landscape requires a deep synchronization with these ongoing earth processes.

2024 : Discuss the basis of various explanations for the formation of Shiwalik.

Introduction The Shiwalik Range (or Outer Himalayas) represents the southernmost, youngest, and lowest longitudinal tertiary domain of the Himalayan mountain system. Extending from the Indus River in the northwest to the Brahmaputra in the east, their formation during the Late Miocene to Early Pleistocene epochs marks the final major phase of the Himalayan Orogeny.

Unlike the Greater and Lesser Himalayas, which are composed of metamorphosed and deformed ancient basement rocks, the Shiwaliks are entirely sedimentary in origin, made of consolidated and unconsolidated fluvial sediments (molasse deposits). The basis of various explanations regarding their formation stems from lithological, paleontological, structural, and paleogeographical evidence.

The Litho-Stratigraphic and Paleontological Basis

Any valid explanation for the formation of the Shiwaliks must account for their unique physical composition and fossil records:

- **Lithology (The Molasse Facies):** The Shiwalik terrain is composed of a massive thickness (up to 6,000 meters) of sandstones, clays, siltstones, and coarse conglomerates. The sediment coarseness increases progressively from the Lower to the Upper Shiwalik strata. This indicates a transition from low-energy river deposition to high-energy, coarse alluvial fan deposition as the source mountains rose closer.
- **Paleontological Evidence:** The strata are rich in freshwater lacustrine and riverine fossils, alongside an abundant variety of mammalian fossils (*Sivapithecus*, *Ramapithecus*, ancient elephants, rhinoceroses). This proves that the Shiwaliks were deposited in a warm, humid, low-lying sub-tropical foreland basin/floodplain environment, rather than a marine setting.

2. Major Explanations for the Formation of Shiwaliks

Geologists and geomorphologists have advanced three primary explanations to explain how these massive sediment fields accumulated and subsequently lifted into mountain ranges.

A. The "Indo-Brahm" / "Siwalik River" Hypothesis (Paleogeographical Explanation)

Proposed independently by Sir E.H. Pascoe and G.E. Pilgrim in 1919, this hypothesis is based on the structural continuity and uniform nature of the Shiwalik sedimentary belt.

- **The Core Argument:** They postulated that during the Miocene epoch, there existed a single, colossal, longitudinal river called the Indo-Brahm (Pascoe) or the Siwalik River (Pilgrim). This river flowed from east to west, running parallel to the rising axis of the proto-Himalayas, emptying into the Arabian Sea.
- **Mechanism of Formation:** This great river carried the immense erosional debris from the newly rising Lesser and Greater Himalayas and deposited it along its vast longitudinal basin.
- **Uplift:** Later, during the Pleistocene post-orogenic movements, the western portion of this basin experienced tectonic upheavals (such as the rise of the Potwar Plateau and the Delhi-Aravalli ridge). This modified dismembered river into three distinct systems—especially Yamuna — while simultaneously compressing, folding, and uplifting the deposited riverbed sediments into the Shiwalik hills.

B. The Geosynclinal / "Foredeep" Deposition Model (Classical Structural Explanation)

Advanced by classical geologists like Eduard Suess and later modified by Sir Sydney Burrard, this explanation is based on crustal loading and subsidence concepts.

- The Core Argument: As the Greater and Lesser Himalayas rose during the Oligocene and Miocene epochs, the immense weight of these mounting rock masses exerted tremendous downward pressure on the northern edge of the Indian shield.
- Mechanism of Formation: This mechanical load caused the crust in front of the mountains to sag, forming a massive, long, and deep synclinal depression known as a Himalayan Foredeep or Foreland Basin.
- Sedimentation and Folding: The numerous perennial rivers originating from the northern mountains dumped millions of tons of detrital materials into this sagging trough over millions of years. As the northward horizontal compressive force of the Indian plate continued, this filled-up foredeep was squeezed against the rigid peninsular anchor, buckling and folding the recent sedimentary strata into the outer parallel ridges we see today.

C. The Modern Plate Tectonics and Foreland Basin Model (Geodynamic Explanation)

Supported by modern geophysicists, this explanation synthesizes plate dynamics with the concept of progressive southward migration of deformation fronts.

- The formation of the Shiwaliks is viewed as a continuous process of the Indian-Eurasian plate collision. The tectonic stress front has systematically stepped southward over time.
- **Mechanism of Formation:**

First, the Main Central Thrust (MCT) developed, uplifting the Greater Himalayas.

As the collision advanced, stress moved south, creating the Main Boundary Thrust (MBT) and uplifting the Lesser Himalayas.

The enormous volume of debris eroded from these two rising chains accumulated in the adjacent Indo-Gangetic Foreland Basin.

- Uplift via the MFT: As the Indian plate continued its northward journey, the outermost edge of this foreland basin became tectonically involved. A new active fault plane—the Main Frontal Thrust (MFT) or *Himalayan Frontal Thrust (HFT)*—developed at the southernmost boundary. The accumulated molasse sediments were scraped off, compressed into tight folds, and thrust upward along the MFT to form the modern Shiwalik Range.

Conclusion

The formation of the Shiwaliks cannot be credited to a single isolated event, but rather to an interconnected chain of geological processes. The basis of their existence relies on Himalayan denudation providing the raw material, a flexural foreland basin - structural trough that forms parallel to a mountain range -acting as the receptacle, and the southward propagation of tectonic stress (MFT) acting as the structural mechanism for their final uplift.

Because the Indian plate continues to move northward at approximately 4–5 cm per year, the Shiwaliks remain tectonically active today, representing the youngest and most fragile frontier of the Himalayan mountain-building cycle.