DIRECTION IAS

Geological History of India

Geological history of India corresponds with that of the earth. Rock formations ranging from Pre-Cambrian to recent times, are found in the country. The geological records of the world are classified on the basis of geological scale devised in Europe. The geological history of the earth is divided into five eras: (i) Neozoic, (ii) Cainozoic, (iii) Mesozoic, (iv) Palaeozoic, and (v) Protorozoic. However, the geological records of India do not fully conform with European. **Sir T. Holland** of the Geological Survey of India has suggested four geological ears (Aryan, Dravidian, Purana and Archaean) on the basis of major unconformities between them.

The complex and varied geological history of India begins with the first formation of the earth's crust and extends upto the recent laying down of alluvial deposits. **R.L. Singh** (1971) has recognised the following major geological phases in India:

1. The first phase is characterized by the cooling and solidification of the earth's crust during the Pre-Cambrian era (600 million years ago). Archaean gneisses and granites exposed on the peninsula, were formed during this phase. Aravallis were folded at this time.
2. The second phase is marked by the undulations and crumpling of the Dharwarian sediments along with igneous activities and intrusions.
3. The third phase is characterized by deposition of calcareous and arenaceous sediments in the Cuddapah and Vindhyan basins bordering or lying within the ancient landmass and its upliftment during the Cambrian period (500 million years ago).
4. During the fourth phase, Permo-Carboniferous glaciation and extensive glacio-fluvial deposition in the depressions and their subsequent faulting marked the formation of Gondwana rocks (270 million years ago) which contain 95% of the coal resources of the country.
5. During the fifth phase, the Gondwanaland was ruptured and the Peninsula drifted northward (200 million years ago). This led to the uplift of the Vindhyan sediments and the formation of the Western Ghats.
6. Cretaceous lava flows led to the formation of the Deccan Trap (135 million years ago).
7. Tertiary orogeny due to the collision of the Indian Plate with the Asiatic Plate took place in three phases, thereby forming three parallel ranges of the Himalayas – (i) Himadri or Greater Himalayas during the Oligocene (25-40 million years ago), (ii) Himanchal or lesser Himalayas during mid-Miocene (14 million years ago), and (iii) Siwalik or outer Himalayas during post Pliocene (750 thousand years ago). The Indo-Gangetic trough was also formed during this phase.
8. During the Pliocene-Holocene, sedimentation occurred in the Indo-Gangetic trough.
9. The Pleistocene period is characterized by many geological events, e.g. down warping of the Rajmahal Garo gap or the Malda gap, upheaval of the Indo-Ganga divide (Potwar Plateau), which disrupted the old channel of the Indo-Brahma or Siwalik river and led to the evolution of the present drainage pattern of the Northern Plains of India, and the formation of the Narmada – Tapti troughs; and the foundering of the west coast.

STRUCTURAL DIVISIONS OF INDIA

On the basis of above lithological, sedimentational and tectonic history, Wadia recognised three distinct structural units in India – (i) the Peninsular block, (ii) the extra Peninsula (Himalayan region), and (iii) the Indo-Gangetic trough (Plain).

(i) The Peninsula

Stratigraphicaly, speaking, the Peninsula represents an old stable mass, which has existed since the Cambrian period. It has never been submerged beneath the sea except locally or temporarily. Tectonically speaking, the Peninsula is composed of ancient complex rock beds that rest upon a stable and firm foundation unaffected by the great revolutions of the earth's surface. Mountain building forces could not displace the original basement of the Peninsula. However, the Deccan has experienced fracturing and vertical movement of blocks due to tension and compression. Physiographically speaking, the Peninsula exhibits a topography marked by relict mountains, denuded hills and huge rounded 'tors'. The Peninsular rivers have flat and shallow valleys with low imperceptible gradients and their channels have reached the base level of erosion. Overall, the Peninsula may be described as a 'horst', i.e. a solid and stable land mass of great rigidity. During the Gondwana period, however, the Peninsula experienced block movement resulting in the formation of fissures or faults.

The Peninsular massif, a part of the super-continent of Gondwana land, is formed essentially by a great complex of rocks ranging from the Archaean to the Aryan groups. The Peninsular India has passed through the following landscape cycles, which have greatly affected the geomorphology of this region.

1. **Pre-Dharwar Landscape** – The primeval original solid crustal surface of the Peninsula was exposed to the forces of denudation and sedimentation for a long time. These pre-Dharwarian sediments were buckled, folded and metamorphosed several times and ultimately formed the basal rocks of granites and gneisses. Magma intrusions occurred in these rocks, as preserved in the Charnokites of Nilgiri, Palni and Shevaroy. Five ancient geosynclines are believed to exist before the Cambrian period – (i) Dharwar geosynclines, (ii) Eastern Ghats geosynclines, (iii) Satpura geosynclines, (iv) Aravalli geosynclines, and (v) Delhi geosynclines.
2. **Dharwar Landscape Cycle** – Initial mountains were formed in the geosynclines. Prior to the Pre-Cambrian period, these mountains were reduced to peneplains. The Aravallies were peneplaned during the Mesozoic era. The activities of erosion, sedimentation, magmatic intrusions and lava flows continued for a long time. During Dharwar, there existed three transgressional seas – Cuddapah, Vindhyan and Bijawer.
3. **Cuddapah-Vindhyan Landscape Cycle** – Cuddapah and Vindhyan formations were uplifted. Rivers descending from the Western Ghats and the southern slopes of the Satpuras deposited sediments into the Cuddapah sea, while those originating from the Aravallis and the northern slopes of the Satpuras deposited their sediments into the Vindhyan sea.

4. **Vindhyan Glaciation** – The upper parts of the Vindhyan ranges were covered with glaciers. After the removal of the glaciers, the gneissic peneplain surface was covered by marine deposits due to the transgression of the sea during the Pleistocene period. Raised beaches, sand dunes, lagoons and alluvial deposits were formed in the coastal zone of the Cambay region.
5. **Cambrian Landscape Cycle** – By the end of the Cambrian period, the Vindhyan glaciation obliterated. Aravallis suffered intensive denudation, but could not be peneplained until the beginning of the Cretaceous period. The relief of the Peninsula was significantly reduced.
6. **Carboniferous Landscape Cycle** – Extensive glaciation occurred in the entire Gondwanaland. The axis of this glaciation was over the Aravallis. Sea level also fluctuated many times due to advancement and retreat of ice sheets resulting into transgression of sea on land. The previous cycle of erosion was terminated. Thick boulders were deposited in the Talcher basin. The Hercynian orogeny caused the rupture of the Peninsular gneissic surface. Several tectonic troughs were formed in the basins of the Mahanadi, Damodar and Godavari rivers and sedimentation in these valleys took place.
7. **Gondwana Landscape Cycle** – The Carboniferous glaciation was followed by Gondwana cycle when sedimentation occurred in the tectonic basins. Outpouring of lava caused the formation of the Rajmahal basalt. Much of the Peninsula was peneplained upto the end of the Mesozoic era (early Cretaceous period). The general slope of the Peninsula at this time was from south to north, which later got changed due to tilting.
8. **Post Gondwana Landscape Cycle** – During the mid-Mesozoic era, the Gondwanaland disrupted. Peninsular India drifted northward and joined the Asiatic landmass. Transgression of sea occurred in the marginal areas of the Peninsula. New landforms were created over the Gondwana surface.
9. **Cretaceous-Eocene Lava Flow** – During the Cretaceous period, extensive lava flows occurred in the Rajmahal area covering an area of 3.97 lakh sq km, while another lava flow occurred in Maharashtra region in the Eocene period, covering an area of 5.18 lakh sq km. These lava flows buried the earlier landforms and topography. Denudation of basaltic surface by fluvial processes resulted into the formation of hills, ridges, valleys and plains.
10. **Cenozoic Landscape Cycle** – The Peninsular India was peneplained before the Tertiary epoch. During Cenozoic cycle, the Western Ghats were formed due to subsidence, which also gave birth to the Arabian Sea. Some of the rivers were rejuvenated due to Tertiary upheaval.

(ii) The Himalayas (Extra Peninsula)

Stratigraphically speaking, the Himalayas have remained under the sea for the greater part of their geological history and have been covered by marine sediments of various periods beginning with the Cambrian. Tectonically, the Himalayas represent a weak and flexible unit that has undergone large scale crumpling and deformation. Physiographically, they may be termed as the real or 'tectonic' mountains. The fast flowing rivers of this region are still in their youthful stage of development, and are continuously degrading their channels. These rivers have cut deep gorges through the mountains.

The Himalayas were formed due to the uplift and folding in the Tethyan geosynclinals sediments during the Tertiary period. According to **Chengappa** (1993), the Gondwanaland finally broke away 100 million years ago and coasted northward on the ancient Tethys geosynclines (Sea) at a fast speed of 12 cm annually before crashing into the Asiatic continent. According to **Sharma** of Wadia Institute Dehradun, the first collision took place near Lato in Kashmir region and the Indian Plate rotated in an anti-clockwise direction. The Indian plate is still moving north-eastward at a rate of 5 cm per year.

The deposits of the marine sediments in the bed of the Tethys, accumulated since the Permian period, began to be uplifted and folded due to the northward movement of the Indian plate and consequent shrinkage of the Tethys. This upheaval has been a slow process starting from the mid-Eocene period to mid-Pleistocene period. **Wadia** has identified three phases of the rise (uplift) of the Himalayas – (i) the post-Nummulitic phase culminating in the Oligocene period ridging up the central axis of ancient sedimentary and crystalline rocks, (ii) about the middle of the Miocene period, the second phase saw a movement of greater intensity, and (iii) During the post-Pliocene period, maximum elevation was caused in the central part of the range and outlying zone of the Siwaliks.

According to the recent views, after the first collision of the Indian Plate with the Asian Plate nearly 60 million years ago, the Indian Plate did not slide easily under the Asian landmass. Instead, the intense strain caused upwarping on its northern frontiers. It bent out like an arc, and part of its northern crust buckled under the strain. The fractured sheet was then thrust upwards. The Pressure of the northward movement caused three such fractures. Under the intense compression, the mountains got uplifted. The northward movement of the Indian Plate has caused one more fracture on the outer fringes of the Siwalik Hills. Geologists opine that a newer mountain chain would be formed in the Ganga basin forcing the rivers of this region to migrate southward. The mountain peaks of the Himalayas are raising their heights as a result of the continuing upheaval.

Different views have been expressed about the forces responsible for the uplift and folding of the Tethys sediments. **Suess** suggested compressional force generated by the southward movement of the Angaraland and the stationary nature of the Gondwanaland, whereas **Kober** believed in the movement from both sides and folding in the peripheral areas, with Tibet acting as the median mass.

(c) Indo-Gangetic Plain

Stretching from the Indus basin in Punjab to the Brahmaputra Valley in Assam, the Great Northern Plains of India have been the principal theatre of Indian history. Geologically, however, this unit is the least interesting part of India, as it is of recent origin only. These plains were originally a deep depression lying between the Peninsula and the Himalayas. **Edward Suess** called it a 'foredeep' fronting the high crust waves of the Himalayas. **Burrard** considered it as a 'rift valley' formed due to sinking of a portion of the land between two parallel faults (along the Siwalik and along the northern boundary of the Peninsula). According to **Blanford**, it is a shallow sea surface resulting due to the withdrawal of the Bay of Bengal and the Arabian Sea. According to recent views, this depression is merely a sag in the crust. These plains were formed by the thick alluvial deposits of the rivers of the Indo Gangetic systems, borne down from the Himalayas and deposited at their foot. These plains are covered with a deep mantle of clays and silts.