Antecedent Rivers

Ganga Is Older Than Himalaya

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It seems like a case of the daughter being older than her father! For, the Puranas describe Ganga as the darling daughter of Himavant, the 'Nagadhiraja' or the king of mountains! (*Figure 1*). It so happens that the majority of Ganga's sisters – the rivers of the northern mountain realm – are older than the Himalaya in whose lap they were born.

The Sindhu, Satluj, Ganga, Karnali, Kosi, Arun, and Brahmaputra rivers, among the scores of mountain rivers, had established their drainage networks well before the Himalaya came into existence as a mountain barrier. These rivers were past their youthful stage when the mountain ranges began rising across their paths.

What is the basis of the statement that these rivers are older than the mountains they cross?

Sources Beyond Highest Mountain Barrier

Practically all major rivers of the Himalayan province spring from sources lying beyond the highest mountain barrier – the

Figure 1 Snout of the Milam glacier – from which emerges the Gori, a tributary of the Kali (Ghaghara). It lies north of the NandaDevi (7,817 m) of the Himadri domain (the 'Daughter' and the 'Father').

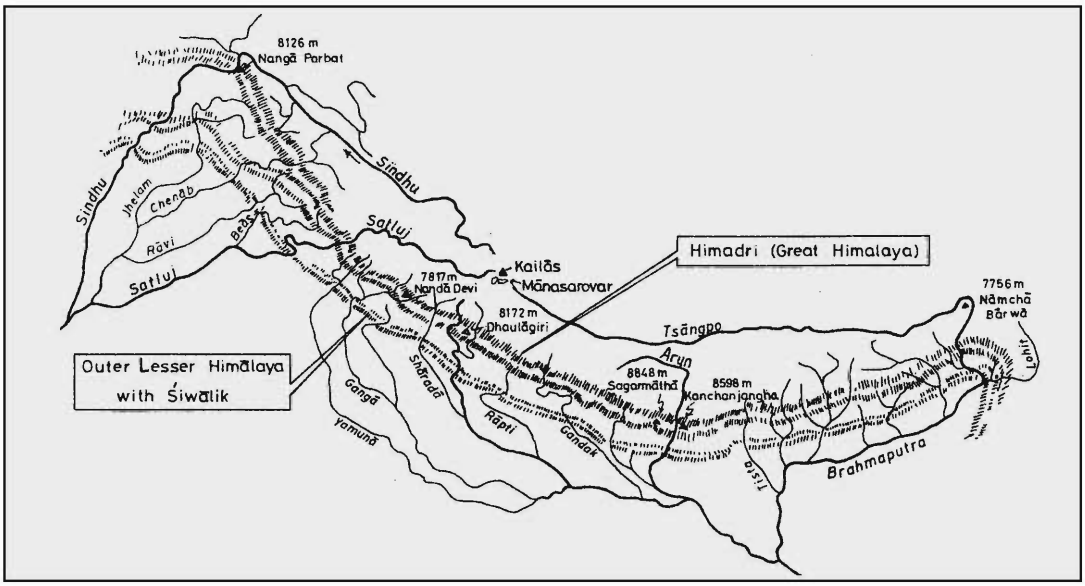

Figure 2 Himalayan rivers spring from sources located north of the highest mountain rampart (5,000-8,000 m or more) in the belt not higher than 4,500 m.

Himadri or Great Himalaya (*Figure 2*). The Himadri ranges rise to an elevation of 5,000 to 8,000 m or more while the river sources are located in the belt only 4,000 to 4,500 m above sea level. The waterdivide is thus at a level lower than the terrain through which the rivers have made their channels (*Figure 3*).

The rivers originating from the Kailas-Mansarovar region in southwestern Tibet (*Figure 4*) bear eloquent testimony. At the

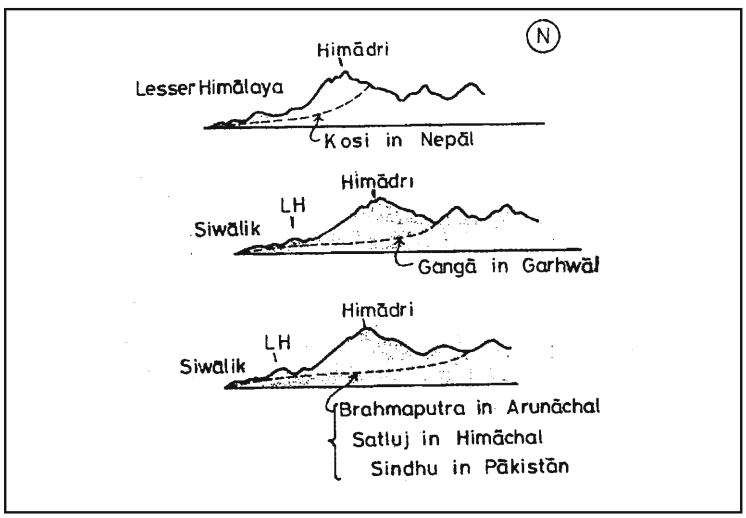

Figure 3 Majority of Himalayan rivers originate either on the northern flank of the Himadri (Great Himalaya) or the southern slope of the Indo-Tibetan border ranges. Notice the steep gradient in the uplifted Himalayan terrain.

foot of Mount Kailas (6,714 m) is Lake Mansarovar (4,557 m), far north of the high NandaDevi (7,817 m) – Api Nampa (7,132 m) range of the Himadri. The Sindhu flows northwestwards, the Satluj goes west, the Karnali takes the southerly course and the Tsangpo flows east. These rivers flow through their pristine channels, carved out at the very outset about 50 to 55 m.y (million years) ago. The Matsya Purana describes the descent of 'Divya Ganga' near Bindusar Sarovar (lake) nestling between the Kailas, Mainak, Hiranyashringa mountains, and taking three different paths as Tripathaga – the tripath gamini Ganga. The 'Tripathaga' had established the drainage well before the mountain barriers were raised successively as a result of tectonic movements.

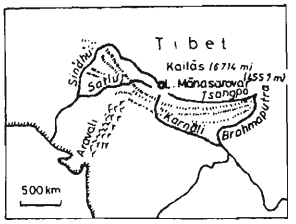

Figure 4 Sindhu, Satluj, Karnali and Brahmaputra have their sources in one region embracing Mount Kailas and Mansarovar lake. The 'Divya Ganga' of Matsya Purana took three paths as 'Tripathaga' – eastward as Brahmaputra (Tsangpo), southwards as Karnali and westwards as Satluj and Sindhu.

A significant feature of these rivers originating north of the lofty Himadri is that their beds are not more than 900 to 1,200 m above sea level at the points where they rush through the 6,000 to 8,000 m high mountain barrier (*Figure 5*). For example, southeast of Gilgit in northwestern Kashmir, the Sindhu flows on a bed 1,100 m above sea level, as the Nanga Parbat (8,126 m) looks down across a sheer wall more than 6,000 m high! Similarly, the Tsangpo in the east flows in the 5,000 m deep canyon cut through the 7,750 m high wall of the Namcha Barwa (*Figure 3*).

These rivers seem to have maintained their levels, while the mountain barriers rose higher and higher.

Figure 5 Canyon course of a tributary of the Ganga in Kumaun Himalaya. The more than 6,000 m high peak looks down on the bed of river flowing at 2,600 m level.

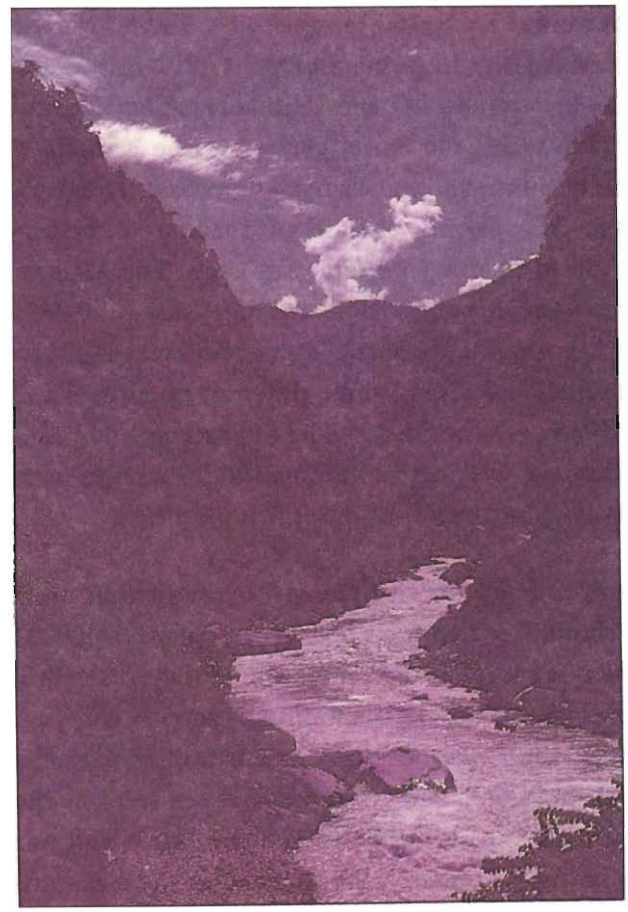

Figure 6 Steep gradient of the river in the Himadri domain characterized by rapids, cascades and waterfalls. Rivers Kali and Gori in Kumaun.

River Gradient

Wherever the mountain ranges are rising at a rate faster than the rivers are able to cut down their channels, waters plummet down as waterfalls and cascades or rush down furiously as foaming-roaring torrents.

Flowing between the Sagarmatha or Everest (8,848 m) and Kanchanjangha (8,529 m) in northeastern Nepal, the Arun drops to 1,200 m from 4,333 m, through a fearsome gorge characterized by rapids and cascades. The antecedent rivers have low gradients of the order of a few metres per kilometre in their upper as well as lower reaches, where they flow sluggishly in their wide valleys in the trans-Himalayan belt in the north and the Indo-Gangetic plains in the south. However, as these rivers cross the Great Himalayan belt, the descent is of the order of 700 to 900 m for every 1,000 m of flow! In the Lesser Himalaya the gradient varies between 20 and 40 m per kilometre. The pronounced steepening of the

Figure 7 A The angle between the two slopes of the V-shaped valley is very acute. Locally the valley slope is convex. River Gori in Kumaun.

gradient of the rivers crossing the Great Himalayan barrier (*Figure 6*) means two things: The uplift of the mountain rampart has been accentuated and/or the uplift is a recent and continuing phenomenon. Wherever the mountain ranges are rising at a rate faster than the rivers are able to cut down their channels, waters plummet down as waterfalls and cascades or rush down furiously as foaming-roaring torrents.

Figure 7B Diagrammatic sketch of an incised valley. The incision or deep cutting is due to uplift of the terrain.

Steep Valley Slopes

The slopes of valleys in the stretches through the Great Himalaya (Himadri) and the outer (southern) front of the Lesser Himalaya are very steep, practically vertical in some sectors (*Figure 7*). It may be mentioned that as the rivers grow

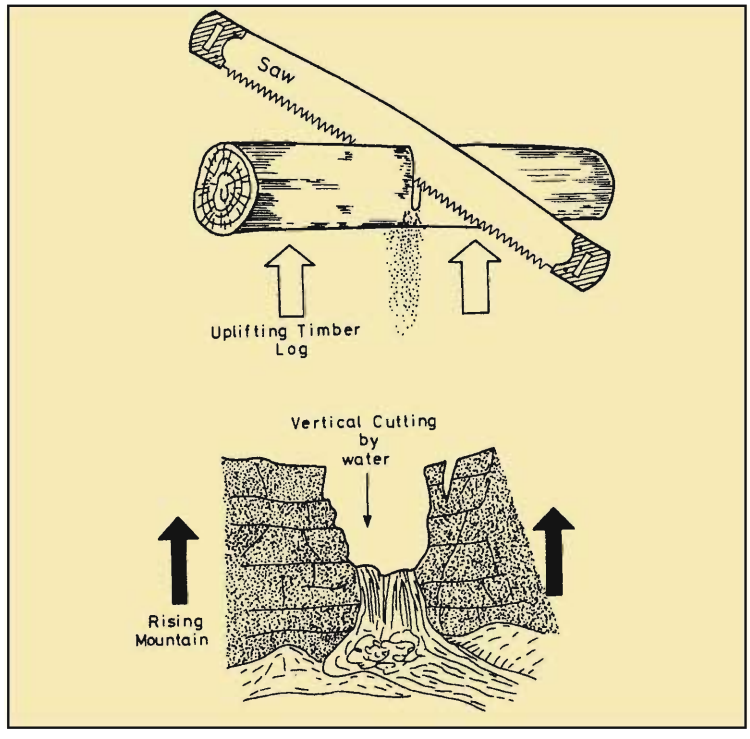

***Figure 8** Imagine a log of wood raised slowly as the saw cuts through a constant level or axis. The result is a vertical groove with two parallel sides. In a similar manner the river cuts a deep canyon with practically vertical walls (valley slopes).*

These rivers established their drainage not consequent on the province's physical features as we see today, but following the relief and slope of the land that existed before the mountain was formed. Such rivers as the Sindhu, Satluj, Karnali, Arun and Brahmaputra are therefore called the antecedent rivers.

older and become mature (geomorphically), their valleys become wider with gentler slopes. The angle between the two slopes becomes increasingly obtuse with advancing age. However, this angle in the Himadri and PirPanjal – Mahabharat belts (in the outer Lesser Himalaya) is very acute. In some places, the valley slopes make nearly parallel vertical walls, despite the rivers being 50–55 m.y old. Locally the walls are convex. Obviously, in spite of the great age the rivers are still in their (geomorphically) youthful stage, furiously at work, cutting channel beds, eroding slopes, and denuding watersheds. This ever-youthfulness of the Himalayan rivers is an inherent character due to the continuing uplift of the terrains through which the rivers flow (*Figure 7*).

Understandably, as the Himalayan terrain rose progressively, the rivers kept cutting their courses deeper and deeper. Over the long period of millions of years, deep gorges or canyons

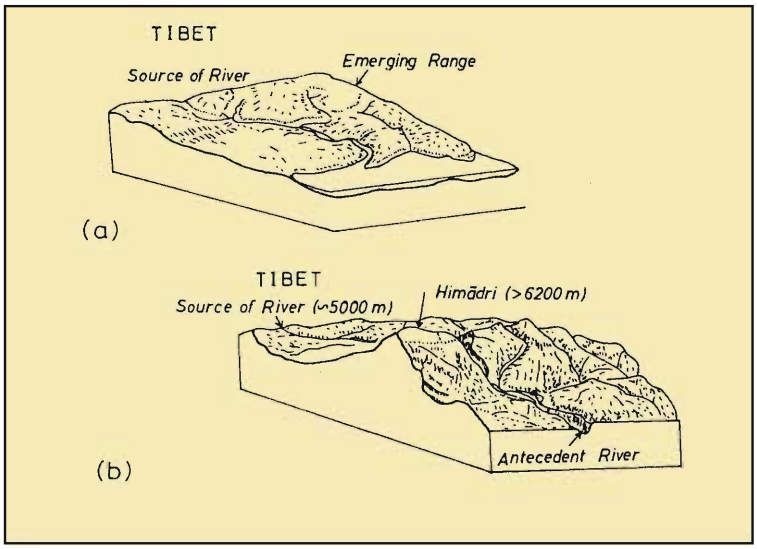

Figure 9A A river establishes its drainage on the recently emerged land that sloped gently southwards.

9B Much later, the mountain barriers rose slowly, and the river kept its channel open by cutting down its course deeper and deeper. This is an antecedent river.

with nearly vertical walls developed in the stretches of impediments (*Figure 7B*). Where the mountain barrier rose at a much faster rate and the rivers failed to keep pace, they dropped in waterfalls and cascades.

Why is the Himalayan terrain rising?

Tectonic Development: Birth of Mountain Ranges

The northward moving India collided with Asia nearly 65 m.y. ago, and the process of welding of the two continents was completed by the Lower Eocene epoch nearly 55 m.y. back. As the Indian landmass pushed northwards, the junction of the two continents buckled and ridged up. The elevated upwarp became the waterdivide of the rivers and streams that came into existence during that period in the pre-monsoon climate. The radial drainage of the soil of the Sindhu, Satluj, Karnali and Brahmaputra rivers was established (*Figure 4*) on that newly emerged land. These rivers established their drainage not consequent on the province's physical features as we see today, but following the relief and slope of the land that existed before the mountain was formed. Such rivers as the Sindhu, Satluj, Karnali, Arun and Brahmaputra are therefore

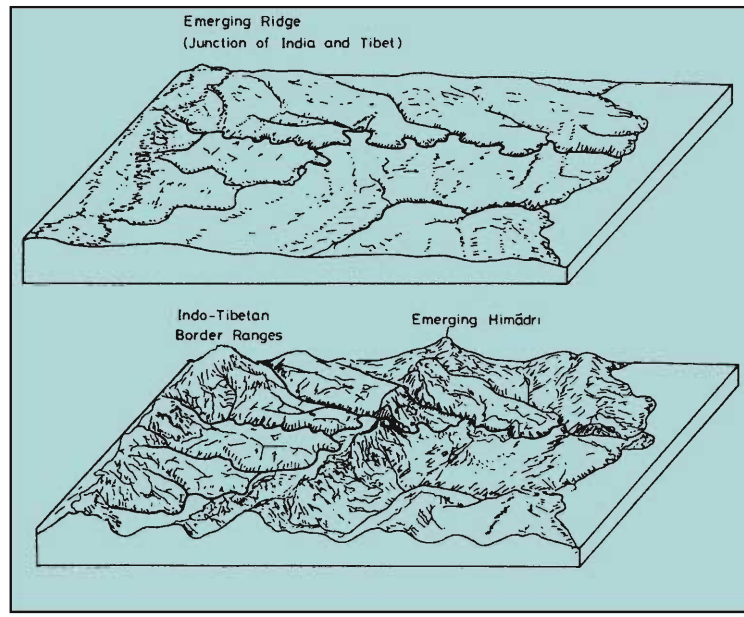

***Figure 10** This is what the Himalayan country must have looked like before and after the main tectonic upheaval that gave birth to the Himalaya mountain.*

called the antecedent rivers. They were flowing through their winding or even tortuous channels in the land that sloped southwards very gently (*Figures 9* and *10*). They continued to flow in the same directions through their old channels even when mountain barriers formed across their paths. The Himalaya rose, but slowly.

Subsequent to the emergence of the Himalaya there was a resurgence of severe tectonic movements. There was a very severe revival of the mountain-building activity about 1.7–1.6 m.y ago.

Then came the climactic, the dramatic phase of the tectonic revolution which threw the whole of northern India into convulsions of deformation. The rock piles were severely compressed and broken. Folds after folds were formed, then faulted along their axial planes and dislocated or uprooted tens of kilometres. Repeated deformation of rocks was accompanied by their differential melting in zones of severe and deep-seated deformation; and widespread granitic activities (25 to 15 m.y. ago) strengthened the structural framework of the Himalaya, particularly in the Himadri domain. In this way the stupendous mountain ranges developed through the middle of the province. In this way, about 25 to 20 m.y. ago emerged the Himalayan mountain in its grandeur and uniqueness. The rivers continued to flow in

the courses they had carved out at the outset, but deepened their channels progressively (*Figure 9*).

Subsequent to the emergence of the Himalaya there was a resurgence of severe tectonic movements. There was a very severe revival of the mountain-building activity about 1.7–1.6 m.y ago. The outer southern front of the Lesser Himalaya was lifted up into the lofty rampart comprising PirPanjal-Dhauladhar-Naina-Mahabharat Ranges, and the Siwalik ranges came into existence. The rivers made still deeper incisions, kept open their channels, and retained their youthfulness. But their gradients became steeper, their valleys deeper and narrower in their lower part, and they rushed through their gorgeous courses characterized by rapids.

These phenomena are seen in all the mountain belts which have risen and gained height in geologically recent times. The Kaveri river, for example, exhibits many of the characteristics of the antecedent drainage in the Biligirirangan Ranges which the Ganga shows in the Himalaya.

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Fungus of Good Fortune ? ...

A small culture of *Penicillium notatum*, mounted in a glass slide, recently fetched £23,000 as a collector's item and must surely rank, on a weight-for-weight basis, as one of the most expensive commodities ever to change hands! It is one of only two or three such preparations by (Sir) Alexander Fleming, dating from about 1948 and bearing as a hand-written inscription 'The mould that makes penicillin', with his name. The international company Pfizer, which assisted Fleming in the development of his discovery, were the buyers.

Mycologist