Geological marvels, hallowed shrines and unification of people of India

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Spectacular landforms and extraordinary geological features sculptured by uncommon earth processes occur in different parts of the Indian subcontinent. Presumably, unable to unravel the mysteries of their origin, and realizing that singularly odd features located in picturesque places attract believers and non-believers alike, the leading lights of the society of ancient India invested them with the aura of divinity and established shrines of the commonly venerated deity. Influencing convincingly people belonging to diverse racial-ethnic groups inhabiting different parts of the country, speaking languages belonging to disparate groups, indulging in different socio-cultural practices and eating and dressing differently, to go on regular visits to these hallowed sites or seats of deity, the visionary sages and seers of the ancient India endeavoured successfully to promote interactions of visitors to these geological marvels located in different parts of the country and bring about cross-fertilization of thoughts and cultural elements, and thus the unification of the largest section of the population.

Keywords: Geoparks, national integration, Shivalingam, uncommon earth processes.

SINGULARLY spectacular landforms and extraordinary geological features formed by uncommon earth processes may be called geological marvels, documenting memories of events of great moments that happened in the past. They evoke not only awe and admiration of discerning naturalists including earth scientists, but also fire imagination of perceptive people who ponder on evolution of landforms and on creation and the creator. They may also be called geoparks in the sense that they are geological heritage enhancing the geographical character of the places where they are located.

In the ancient times, the explorers, including wandering sages and saints, who travelled across greater India saw in the geological marvels more than what the earth scientists see. Presumably, unable to unravel the mystery of their origin and regarding them to be the nature’s singular rather fantastic handiwork, they imparted to them an altogether new meaning by investing them with the aura of divinity. To illustrate the point, consider the Om Parvat situated (30°11’56’’:81°01’52”) not far from the India–Tibet–Nepal trijunction to the west of the route to Kailās–Mānsarover. Visible from Nābbhidhāṅg, the 6191 m high peak in the Tethys Himālayan terrane is made up of fossiliferous Triassic–Jurassic rocks folded twice in a manner that the depressions within the arms of overturned folds are filled round-the-year with ice and snow, giving rise incredibly to a figure stunningly similar to the letter ‘om’ (ॐ), with even a dot atop (Figure 1). Nature seems to have crafted the letter ‘om’ in all its perfection! How can one not be impressed, if not awed, by this geological marvel! Another example is Amarnath, the exquisitely spectacular ice stalagmite resembling a Lingam in a cave within the Triassic limestones in the Kashmir Himalaya. It is therefore understandable that the wandering sages and saints (rishi and maharshis) of the ancient times who had identified the geological wonders or marvels in all parts of the country – in the north, south, west, east and many places across the country, regarded them as special creations of God – as His hallowed shrines. These have been described in the Purānas and the epic Mahābhārata, both authored by Krishna Dwipaṇy V’yās. The original Purāna was penned before the Mahābhārata War and the epic Mahābhārata sometime after that debilitating event1. The war occurred in 3478 BP (ref. 2), that is, approximately 3500 BP (ref. 3).

Visionary leaders of the society in the Purāna times recognized the geological marvels in different parts of the country and regarded or designated most of them as holy shrines, perhaps in an attempt to glorify their venerable icon or deity so that the devout, the credulous and the curious would flock to them. One may dismiss the Purāna and the epics such as Mahābhārata as works of fiction, but one cannot deny that the geological marvels regarded or designated as shrines are indeed located precisely where these ancient texts describe, the narratives perfectly matching with the reality.

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Hallowed geological marvels

Perusing the map (Figure 2) showing location of 12 Jyotirling\(^2\) and a few other shrines established in the Purâna times, two facts emerge. (i) They are located in all parts of the Indian subcontinent—reaching out to all ethnic groups living in the country Bhâratvarṣ. (ii) their situations happen to be of great geodynamic significance, particularly related to evolution of the Indian landmass\(^1\). The then leading lights of the society must have realized that only spectacular features, particularly if located in picturesque places, can attract people—even those who are non-believers or agnostics. The geological marvels or wonders were thus chosen as the seats (dham) of, for example, the Lingam of Shiva, the then most venerable icon of the largest section of the population of India. Other important shrines such as Kailās and Amarkantak are also located in geomorphically and geologically singular places.

Himalayan province

Across the Himālaya in southwestern Tibet is situated the many splendidly Mount Kailās, a massif in the Ladakh-Gangdese Range. Its location is unique in many ways. (i) It is situated just north of the geological junction of the Indian and Asian plates, described as a zone of continental collision (Figure 3 c). Known as the Indus-Tsangpo Suture, it is a narrow belt of multiple deep thrust faults of great lateral dimension. It is indeed a zone formed by the docking and eventual welding together of northward moving Indian landmass with the Asian continent. As India persistently pressed hard against mainland Asia, the leading frontal edge of the Indian plate buckled up (Figure 3 d) giving rise to a huge dome-shaped antcinal\(^5\), and heavy dense ultrabasic material from the upper mantle beneath the crust was squeezed up and out and emplaced along the great tectonic divide\(^6\). (ii) The Tibetan crust was torn apart by the NW–SE trending Karakoram Fault, along which at present the Tibetan crust is extending eastwards\(^7,8\). (iii) Four great rivers originate from this dome-shaped crustal upwarp (Mount Kailās–Gurūlā Mândhātā) and flow in four different directions—the Sindhu (Indus) flows northward, the Satluj (Shatadru) takes southwesterly course, the Saryu (Karnâli–Ghâghărâ) descends southwards and the Brahmputra (Tsângpo) takes the easterly direction (Figure 3 a).

The Kailās massif is made up of 2000 m thick pile (Figure 3 b) of ungraded pebbly askosic sandstones and conglomerates intercalated with maroon shales\(^6\). Resting on the basement of granites, the Kailās sediments were laid down by a river that meandered sluggishly and alternately flowed swiftly as a braided system\(^7\). The shales of the same formation elsewhere in Ladakh contain fossils of 23 to 27 million year-old plants rosewood and palms\(^10\) implying that the climate then was warm and moist and the terrain not higher than 2100 m above the sea level (compared to more than 5000 m at present). In the Sindhu valley in Ladakh, the same Kailās horizon has yielded remains of deer, goat, rodent, python-like snake\(^11\) and small rhinoceritoid mammal Juxia\(^12\). All these facts indicate tremendous geodynamic-geomorphic changes that took place here.
A massif of exquisite splendour and beauty (Figure 4a and b), Mount Kailās is regarded as the preferred abode of Shiva, the supremo or icon of the Kirāt tribes that inhabited the entire northern Himalaya. Although it is not included among the Jyotirlingas, the Kailas shrine is nevertheless religiously visited year after year by thousands of devout Hindus, Jains and Buddhists as the holiest of the holy shrines in the Indian subcontinent.

A close look reveals that the Kailās resembles a stupendous Lingam surrounded by a circular depression with an outer rim of hills, the latter resembling the Yoni (Figure 4a).

At the foot of the imposing 6940-m Kedārnāth peak and nestling in the picturesque amphitheatre-like glacial valley flows the Mandākini River (Figure 5a). Not far downstream of the terminal moraine of the Chorabari...
Glacier is located *Kedārnāth Jyotirling*. It is from the Chorabari Glacier that the Mandakini River emerges. The Mandakini is a tributary of the Ganga. The glacial valley is filled with the debris deposited by the glacier that has presently receded far behind the shrine. Among the moraines is a huge exotic block left behind by the retreating glacier (Figure 5b). This exotic block protects the temple against floods and avalanches. In 2013, while the entire Kedārnāth township was wiped out by devastating flood, the temple of Kedārnāth remained unscathed because of the protective wall formed by this exotic block.

The mountain is made up of high-grade metamorphic rocks, penetrated by 20–22-million-year-old granite occurring as tabular sills of batholithic dimension and network of dykes and veins.13 This is not an ordinary granite. It is an anatectic granite characterized uncommonly by such metamorphic minerals as kyanite, sillimanite, garnet and cordierite. The anatectic granite formed as a result of differential and partial melting at high pressures and high temperatures of susceptible portions of material of high-grade metamorphic rocks. The molten granitic material pervasively penetrated layer-by-layer the gneisses and schists, giving rise to migmatite so intimately associated with the granite.

A glacier-faceted piece of rock left behind by the retreating glacier – an exotic piece – forms the *Kedārnāth Lingam* (Figure 5c). Or maybe it is a block of anatectic granite fallen from the mountain peak and faceted by moving mass of the glacier.

**Indo-Gangetic plains**

The acclaimed and most celebrated *Vishwanāth Jyotirling* is located at Kāshi or Vārānasi on the left bank of the River Ganga. It was a great centre of learning and religious discourses in the ancient time. A close look at the map reveals that the consistently eastward-flowing Gangā abruptly swings northeastwards at Vārānasi and flows in that direction for about 100 km before resuming its easterly direction (Figure 6a). The sharp swerving of the serenely flowing river implies that it was impelled to turn northeastwards. It turns out that a NE–SW trending fault that uplifted the Rāmnagar block to the east of the river (compared to the Vārānasi ground) is responsible for this drainage deflection1.

The northeastward-flowing Gangā between Chunār in the south and Saidpur (Buxur) in the north has a comparatively narrow floodway, not more than 3 to 8 km wide. In the Kāshi–Vārānasi area, the river’s active channel is just a kilometre wide and confined within cliffs which continue almost up to Buxur14. Apart from the Gangā’s narrow entrenched course, the telltale manifestation of neotectonic movement on this NE–SW fault is the 750 m long, 20 m high vertical cliff of the Rāmnagar area, developed on the right bank of the Gangā (Figure 6b) – in the block east of the fault. Considerably affected by gully erosion, the cliff exposes many deformational structures such as reverse faults, fissures, folds and what look similar to soft-sediment liquefaction features15. All these features corroborate the surmise that the fault that deflected the Gangā in the Kāshi region is neotectonically active.

OSL dating of the sediments suggest tectonic movement 40 ka and 7 ka ago – the later event is supposed to be responsible for the uplift of the Rāmnagar block15. Significantly, the top 4 to 10 m sedimentary deposits contain cultural remains of the periods Northern Black Slipped Ware, dating back to the seventh–eighth century BC (ref. 16). Evidently, people lived in the Rāmnagar side of the Gangā some 3500 to 3000 years ago. It remains to
be seen for how long the people have been living on the Kāshi–Vārānasi side of the river.

This fault is possibly the surface manifestation of the NNE–SSW trending transverse undersurface faults delimiting the underground hidden ridge of Precambrian rocks that lie under the very thick pile of sediments of the Ganga plain. The fault is parallel to the subsurface Patna Fault, defining the hidden, undersurface Munger–Saharsā Ridge (Figure 7).

_Vishwanāth Jyotirling_ thus sits in a place which has experienced impacts of recurrent neotectonism and attendant drainage aberration.

**Central India**

The _Amarkantak_ shrine (not a Jyotirling) in northern Chhattisgarh is located on the stupendous Mandla Lobe of the Deccan lavas represented by 1127 m high Maikal Range, a plateau delimited by high scarps. The shrine is the source of the River Narmadā, which not far from its origin tumbles down the high scarp in a series of waterfalls and cascades. The Mandla Lobe is made up of pahoehoe lavas characterized by ellipsoidal and spheroidal bodies resulting from a process in which balloon-like inflation in the mobile lavas played a dominant role.

West of Hoshangābād (Madhya Pradesh) is located Omkāreshwar Jyotirling on the southern bank of the Narmadā. Remarkably, the Narmadā anomalously breaks into two branches, at this spot, the southern channel being quite straight. Between the two channels is an elongate triangular island (Figure 8a). The channels themselves have islands of sands. The bifurcation of the river suggests recent tectonic movement on presumably the WNW–ESE-oriented lineament. Along one of these oblique faults, the southern branch of the Narmadā has carved its remarkably straight course. The Narmadā, it may be pointed out, flows in a rift valley – an elongate depression formed due to sinking of the ground between two parallel or nearly parallel faults of Precambrian antiquity (Figure 9 inset). The rift is defined by ENE–WSW-oriented faults extending for over a thousand kilometres across central India. Significantly, it represents a great tectonic divide between northern and southern India.

The faults of the rift are quite active, the recent movement on which brought about drainage modification and landform changes. It is suggested that the Satpūra has risen as a high range owing to movement in the later Quaternary time on the ENE–WSW southern faults of the continental divide. This is further borne out by frequent earthquakes that rock the rift valley (Figure 9).

It should be obvious that Omkāreshwar sits in a place on the great tectonic divide between northern and southern India.

**Figure 6.** _a_, Kāshi (Vārānasi) hosting _Vishwanāth Jyotirling_ is situated at the point where the consistently eastward flowing Gangā abruptly swings northeastward (photo: Google Earth); (Inset) Diagrammatic sketch shows how the uplifted Rāmnagar block resulting from movement on the NE–SW trending fault propelled the Gangā to flow northeastwards. _b_, Uplifted Rāmnagar terrace, exposing the fluvial sediments to gully erosion (Photo by Umakant Shukla, BHU, Vārānasi).

**Figure 7.** Underneath the thick pile of the Gangā sediments, there are hidden subsurface ridges and transverse faults, some of them quite active (ref. 17).
Figure 8.  

(a) At the spot where the Narmadā splits into two branches is located the holy shrine Omkāreshwar Jyotirling. The southern branch is a remarkably straight channel, presumably developed along a WNW–ESE trending active fault of later generation. Note the islands of sands within channels (View from North: Google Earth).  

(b) Three spectacular lava lobes make what looks similar to a Trishūl (trident) – the weapon that Shiva wielded. Within the two shāls or blades of the trident is the source of the Godavari River. (View from North: Google Earth).

Figure 9. Narmada rift valley is defined by two major ENE–WSW trending deep faults. Notice the rift valley being cut and offset by more recent active faults transverse and oblique to the trend of the rift. Occurrence of earthquakes indicates on-going movements on faults. Map after Krishnaswamy and Raghunandan, Epicentral distribution after Rajendran and Rajendran. (Inset) Block diagram shows how a rift valley is formed. The Satpura is a horst mountain between the two rifts occupied by the Narmadā and Tāpi rivers. India, witnessing violent as well as quiet tectonic movements.

South of Omkāreshwar in the Deccan Plateau is another shrine of great importance – Trayambakeshwar Jyotirling. In the lava terrain of the Deccan Volcanic Province, three spectacular spurs emerge from a high point represented by the Brahmagiri at the extreme northern edge of the Sahyādri Range. These three spurs make what strikingly resembles a trident – a trishūl, pointing northwards (Figure 8). The spurs formed when the northwards flowing lobes of the lavas froze about 65 m.y. ago. In the amphitheatre-like depression between two spurs – between two shāls (blades of trident) – is the source of the River Godavari. Not far from the springs feeding the Narmadā is the seat of Trayambakeshwar Jyotirling (Figure 8b). The three spurs, make what was presumably regarded as the Trishūl, the weapon that Shiva wielded.

Western India

In the western extremity of the Indian subcontinent, Somnāth Jyotirling is situated in Prabhāskhand or Prabhaśkhetra of the Purāṇa times, but today known as Saurāshtra in Gujarāt. The present Somnāth temple is built on the coast not far from Chorwād–Verāwal towns on the Quaternary Milolite Limestone. However, to my mind, it is the Girnār hills adjacent to Junāgarh that conforms to the design and specifications of the geological marvel and of the Jyotirling. The 341-m high solitary eminence in the
midst of plateau of flat lava beds is made up of the upper part of the laccolith 15 km across. The laccolith evolved as hot magma congealed in the form of a bun-shaped body within the layers of Deccan lavas (Figures 10 and 11). The emplacement of the magma pushed up and sideways the lava beds above the bun-shaped magma body (Figure 10 inset), giving rise to a circular rim of hills made up of upturned lava beds. The dark coloured central body (Figure 11 b) – the laccolith – is constituted of heavier olivine-gabbro in the lower part, diorite in the middle and lighter monzonite at the top, implying gravity-induced differentiation of the magma derived from the upper mantle beneath the crust[27,28]. This rim of hills was later penetrated by granophyre and nepheline-syenite forming a ring dyke forming a white garland around the dark coloured Gīrnār.

While the central plug-like top of the Gīrnār laccolith resembles a Lingam, the circular depression with a rim of hills around it made up of upturned lava beds looks similar to a Yoni, the totality giving the impression of Lingam–Yoni pair (Figure 11).

The Bheemeshvar or Bheemashankar Jyotirlinga, at the source of the River Bheemarathi (Bhimā) is situated in the proximity of a precipitous high scarp (Figure 12 a) formed as a result of faulting down a few hundred metres of the larger part of the catchment of the Bhimā River that still has amazingly abundant discharge despite substantial loss of its recharge area. The fault, along with a number of associated NNW–SSE trending faults, seems to have destabilized the Sahyādri Range in this region as borne out by, among others, the July 2014 catastrophic landslide in the Ambegāon tālukā (Pune district) that wiped out Malin village with more than 150 people.

**Southern India**

In southeast Āndhra Pradesh, the generally eastward-flowing Krishnā River abruptly turns northwards, then eastwards and then immediately southwards and finally east–north–eastwards again – making four pronounced rectangular bends. The peculiar sharp bends of the river form a striking box-shaped drainage (Figure 12 b). This drainage pattern gives the impression that the Krishnā River was pushed or driven northwards from its earlier direction. The abrupt swerving of the gently flowing river is attributed to neotectonic movements on the set of two parallel strike-slip faults trending north–south in the Pre cambrian Cuddapah terrane. Interestingly, east of the Srisalām area, in the Eastern Ghat Mobile Belt which is characterized by NNE–SSW and NW–SE lineaments, the Krishnā River flowed in the past through many palaeochannels – abandoning one water course for another, and was deflected from the general easterly to southeasterly course, the deflection caused by what has been described as ‘palaeo-relief’ or ancient high ground[9]. The existence of the ancient high ground has been proved by gravity, magnetic and three-dimensional (3D) seismic data. It is quite evident that the Srisailam feature is just not a geomorphic anomaly but an eloquent testimony to development of considerable neotectonic importance that took

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**Figure 10.** Sketch map of the Gīrnār complex in the Deccan Volcanic Province in Saurāshtra (based on Auden) [27]. (Inset) Diagrammatic profile of a laccolith that the Gīrnār magmatic body is. Notice turning up of the overlying lava beds following intrusion or pushing up of hot magma.

**Figure 11.** a. Satellite imagery of the Gīrnār Hills showing the top of the intrusive laccolithic body resembling a lingam, surrounded by a circular depression with peripheral ring of hills looking like a Yoni. It is the outwardly dipping lava beds that form a ring of hills along the periphery (from Google Earth); b. View of the top of the laccolith in the central part resembling a lingam. (Courtesy: Hetu C. Sheth, Mumbaī).
place in the Krishnā Basin. The incised course of the Krishnā testifies to the uplift of the Srisailam block, atop which sits the Mallikārjun Jyotirling. The Srisailam hill seems to be a horst resulting from uplift and concomitant northward movement of the block between the two parallel faults.

This shrine embodies both Shiva and his consort Pārvatī – Mallikā = Pārvatī + Arjun = Shiva⁴. Eloquent is the message of this much venerated shrine – Shiva and Shakti (Pārvatī) are inseparable and indivisible. The shrine thus brings the Shaiv and Shākti sects together on one platform.

On the other extremity of Bhāratavarṣh in the Tamil Nādu coast, the islet of Dhanushkoti is the location of Rāmeshwaram. The emergent islet Dhanushkoti is at the eastern end of an underwater chain of coral islands known as Rām Setu or Adam’s Bridge, connecting India with Sri Lanka (Figure 13). The coral islands grew on the foundation of 2.3 m.y. old Jaffna Limestone that occurs both in Tamil Nādu and across the sea in northern Sri Lanka⁵ suggesting geological unity of the Sri Lanka island with the Indian Peninsula. It is well-known that corals grow in warm waters, shallow enough to be illuminated by sunlight. The sea-level rise brought submergence of the coral islands that once were close to the surface of sea and exposed to the atmosphere. Satellite imagery, close-range aerial photographs, bathymetric surveys and bore-hole data clearly bring out the shape and dimension of the coral-island chain. The Dhanushkoti islet (Figure 13) of the island chain Rām Setu is the location of Shiva’s shrine Rāmeshwar Jyotirling.

Effective endeavours for unity

Keen observers and profound thinkers that the wandering-exploring sages and seers (rishis and maharshis) of the Purāṇa and the Mahābhārata times that they were, they realized and recognized the significance of geological marvels. The rulers and the commoners alike were made to go on pilgrimage to these geological wonders, characterized by spectacular landform, by investing on them the aura of divinity. In addition to the 12 holy shrines of Shiva, there were then more than 500 places of pilgrimage located in different terrains across the vast expanse of the country.

The idea behind the practice of visiting shrines and centres of pilgrimage (teerthsthāns) was to persuade and spur the pilgrims and travellers to know people who lived in different terrains, spoke different languages, ate and dressed differently, had different lifestyles and observed different socio-cultural practices. In the period the Purāṇas and epics describe, there was no religion as we understand today. The people followed their duty (dharma) as ordained by their society. Also, pilgrimage or travelling to different terrains inhabited by different groups of people was considered an imperative dharma (duty) – a must at least once in the life of an individual.

The pilgrims criss-crossed the country that spread far and wide. They not only tasted and enjoyed adventures, but also mingled and interacted with people along the routes and around the centres of pilgrimage. The pilgrimage provided a fertile ground for cross-fertilization of thoughts and cultural elements. There was bonding at religious and cultural levels. Presumably, it may have been a movement to promote the idea of One Nation – One India.

This was effective albeit subtle way of national integration – unifying the people of different regions. The
very locations of the Jyotirlingas and establishment of shrines in all parts of the country unequivocally demonstrates remarkable and very effective efforts made in the Purāṇa times for forging unity among the people of the Indian subcontinent.

One may not believe in the divinity of Shiva or even in the historicity of the narratives in the Purāṇas and the epics, but one cannot deny that the locations of most of Shiva’s venerated symbol are places of stunning geomorphic splendour and extraordinary geological features crafted by uncommon earth processes. Such picturesque places attract believers and non-believers alike. They have been attracting people from far and near for thousands of years. Either driven by devotion and religious fervour, or by pure curiosity, the people of the largest and predominant segment of the Indian population living in all parts of the country have been embarking on unending pilgrimages since time immemorial to the seats of revered symbol of divinity, resulting in closer interaction and development of bond of understanding and unity.

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