

Recent tectonic movements in the Kaveri catchment, Southern India

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Karnataka Tableland: Successive Uplift

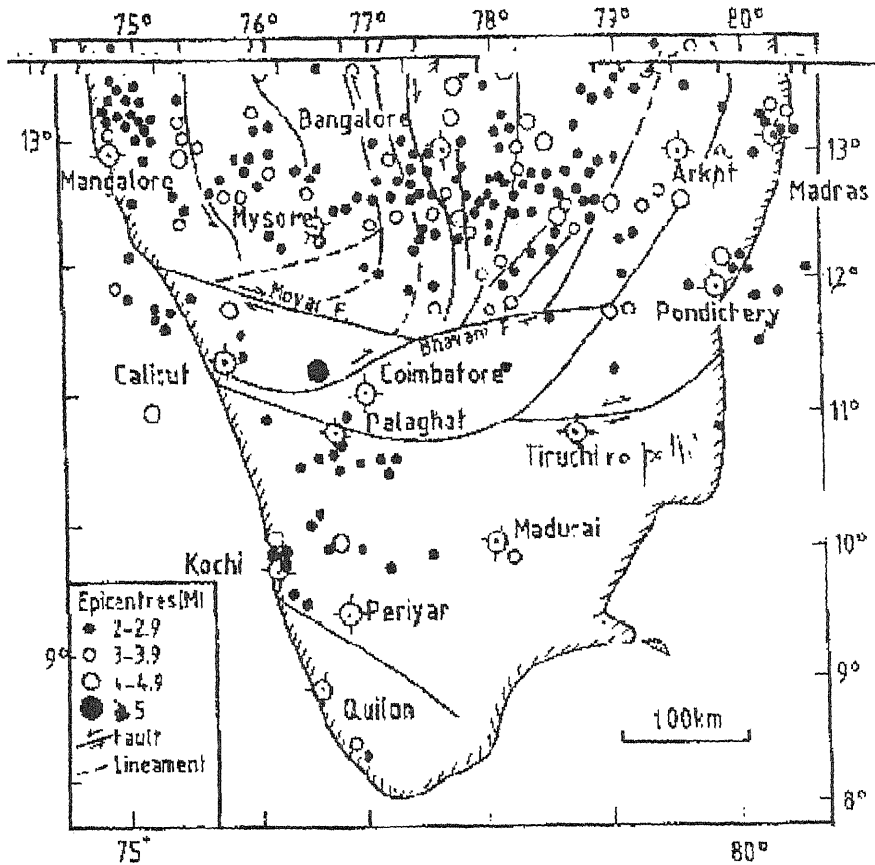
The Southern Indian Shield was regarded as a stable landmass, unaffected by crustal disturbances for a long period of time spanning several hundred million years. This myth was rudely shattered on 30th September, 1993 when an earthquake of magnitude 6.3 hit the Latur area in Maharashtra. The distribution of the epicentres of small and moderate earthquakes (Figure 1) makes it abundantly clear that the interior of the Southern Indian Shield is continually relaxing its strain engendered by the tectonics of the Peninsular India.

The Karnataka plateau is a tableland characterized by three prominent and extensive surfaces of peneplanation – the surfaces worn down to the base level of erosion nearly to the sea level. These peneplanation surfaces now rise to elevation of approximately 900 m (Bangalore Surface), ~600 m (Mysore Surface) and ~450 m (Krishnagiri Surface). These peneplanation surfaces are demarcated by sharp slope-breaks trending nearly north–south, which are commonly marked by escarpments. The many surfaces of peneplanation imply as many spurts of uplift of the Southern Indian Shield since the formation of red soil capping the tableland.

Three pulses of uplift of the Bangalore Surface in the Holocene (in the last 11000 years) is testified by three levels of gravelly terraces lining streams and rivers as seen in the tributaries of the Jayamangali (northwest of Bangalore), Northern Palar (southeast of Bangalore) and Shimsha (south of Bangalore). These terraces indicate that the Bangalore region experienced three spurts of mild uplift in the geologically very recent time. The uplift caused perceptible rejuvenation of the geomorphically mature terrain.

Linear Ridges: Faulted Margin

One of the prominent and extremely significant features of the physiography of the Bangalore plateau is a series of broadly north-to-south trending linear ridges and isolated hillocks whose peaks rise to nearly 1400 to 1100 m elevation. In structure, composition and age of rocks, these conspicuous hill ranges are indistinguishable from the adjoining flat terrain. The elongate hills are delimited on one side by faults of considerable length (Figure 2). Significantly, the rocks forming these ridges and hillocks are remarkably fresh, in contrast to those of the flat plateau wearing very thick cap of weathered rocks and soil.



Earthquakes from 1968 to 1968

FIG. 1. Southern Indian Shield — until recently regarded as the stablest part of the Indian subcontinent — is relaxing its strain as borne out by the distribution of epicentres of moderate and small earthquakes (Modified after Ramalingeswara Rao, 1992).

This phenomenon is attributed to lifting up of the rocks from depths. Movements on the active faults brought about this uplift. Their uncanny freshness implies that not much time has elapsed since the rocks were lifted up.

The soil mantle at the foot of the fault-delimited hills, such as the Nandi Durga (west of ChickBallapur), the Antarganga-Kendatti (west of Kolar) and the Amba Durga-Bahmangiri (west of Chintamani) are perceptibly tilted, suggesting recent upward movement of the hill blocks. The recent movements on the faults have prompted — rather triggered — severe gully erosion and development of badland topography, the phenomena being restricted to narrow zones of the active fault but discernible nowhere else in the tableland.

Testimony of Palaeolakes

If the faults are indeed active, the continuing movements on them must be manifest in deflection of drainage, change in river courses and ponding of streams, leading to the formation of lakes in the riverine environment. There are indeed scores of palaeolakes to the southwest and southeast of Bangalore. Their origin is related to the movements on active faults. Tilting, uplift and subsidence, and horizontal displacement of ground on the active faults gave rise to the formation of swamps and lakes as the streams got ponded. The lakes were rapidly filled up with sediments, or drained out due to fresh spurt of tectonic movement on the causative faults. The palaeolakes west of Tattikere between Anekal and Harohalli, at Manchenabele in the upper reaches of the Arkavati valley, and east of Solur on the Bangalore–Hassan highway are examples of the palaeolakes born of neotectonic movements.

Deflection and Dropping of the Kaveri

The Kaveri River flows sluggishly in its flood plain on the ~600 m Mysore plateau. The meandering Kaveri is an old mature river flowing in the wide valley until it abruptly swerves northward near Kollegal, as if forced to turn north from its original southeasterly course. There is a yet another deflection southwards at Hogenakal and again at Mettur. It will be quite obvious that the river was constrained to flow straight in the predetermined course or in the channel formed by faulting. The leisurely flowing placid Kaveri of the Mysore plateau rushes along the narrow channel and drops down into a gorge — 78 m and 70 m at Sivasamudram, 15 m at Mekedatu and 40 m at Hogenakal. There are several drops in the long drainage course of the Kaveri.

The Kaveri descends as waterfalls, because the ground in front dropped or subsided as a result of recent movements on the faults (Figures 2 and 3) along which the Kaveri flows hurriedly. The multiplicity of the abandoned channels and the existence of islands before dropping into the gorge are indicators of drainage confusion related to differential movements on the very active Sivasamudram Fault trending roughly north-south, and demarcating the western boundary of the Biligirirangan Hills.

The gorge in which the Kaveri now flows becomes deeper and narrower as it approaches another active fault south of Sangam. At Mekedatu the valley has become so narrow that, figuratively speaking, even a goat can leap across the canyon.

Biligirirangan and Mahadeswaramalai: Block Uplift

The north-to-south-trending active faults which caused the Kaveri to swerve from its original southeasterly course and drop as waterfalls, delimit and cut the mountainous Biligirirangan (BR)–Mahadeswaramalai (MM) terrain (Figure 3). The peaks of the lofty ranges rise as high as 1816 m, 1758 m, 1680 m, 1443 m, etc. The ranges have remarkably youthful landform in contrast to the flat 650–600 m high Mysore plateau covered with thick soil. The elongate mountain ranges are the products of geomorphic rejuvenation prompted by uplift of the land. Flat stretches exhibiting geomorphic maturity and wearing thick soil within the high mountain terrain leave no doubt as to the fact that the eastern

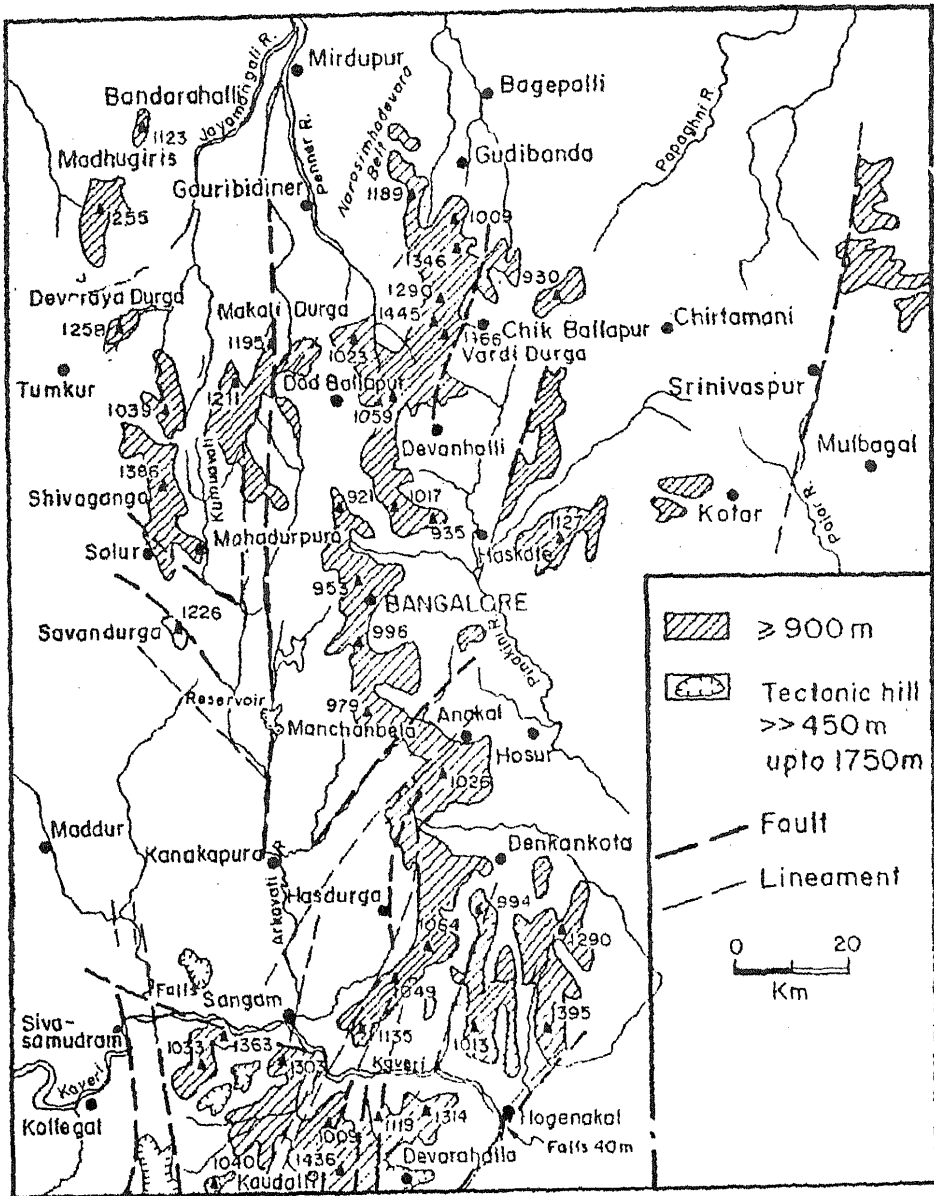


FIG. 2. Linear ridges and isolated hillocks are delimited on one side by faults over considerable lengths (Based on Varadarajan and Balakrishnan, 1982 and author's own field work).

part of the mature Mysore plateau has been uplifted *en bloc* to give rise to the linear lofty ranges now making the BR-MM massif (Figure 3). It is the recent succession of move-

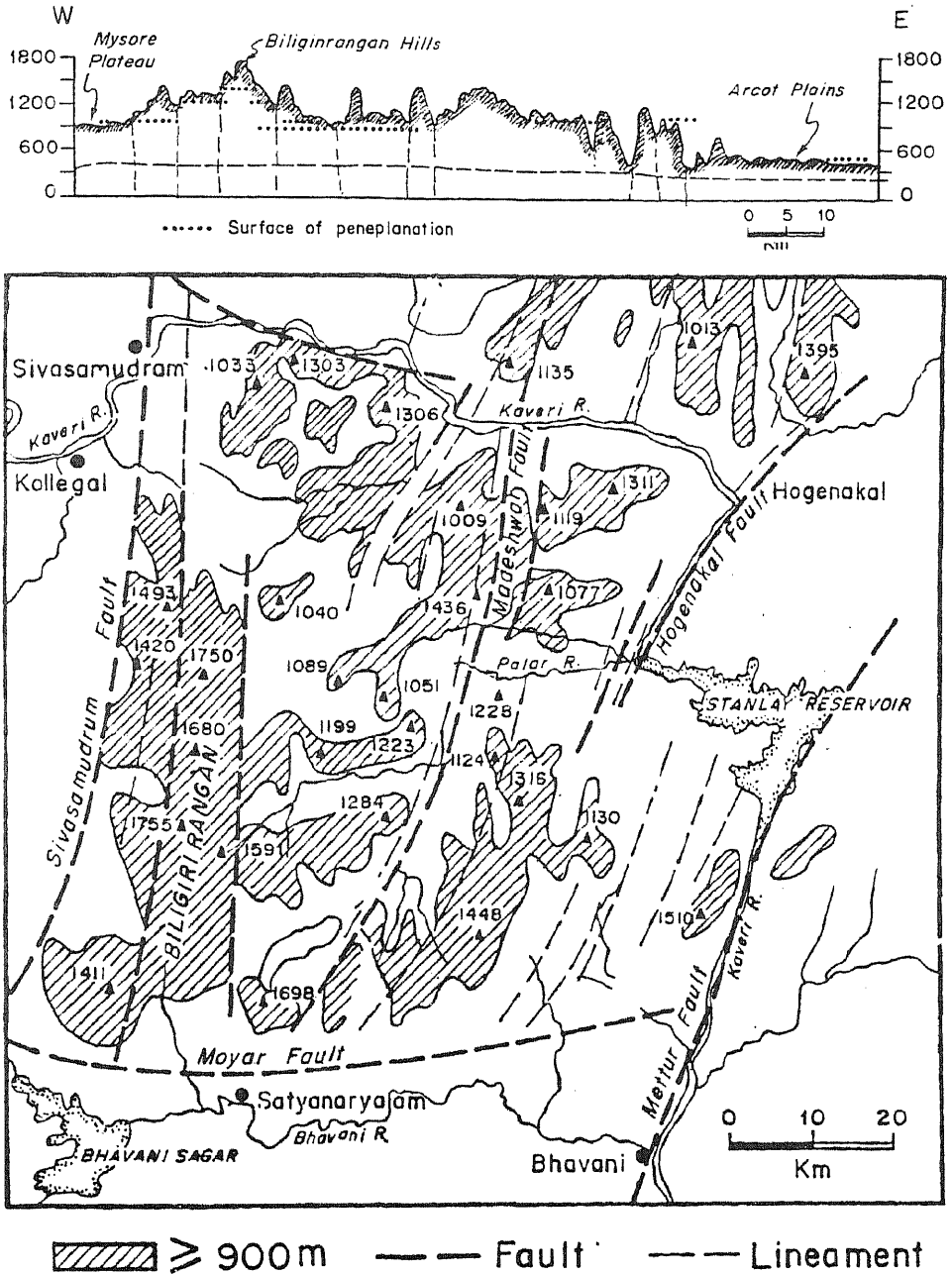


FIG. 3. Mountainous Biligirirangan (BR)-Mahadeswaramalai (MM) terrain is delimited and cut by north-south trending faults of great length. The profile across the BR-MM ranges bring out the horst-and-graben character of the terrain (Based on Varadarajan and Balakrishnan, 1982 and author's own work).

ments on the active north-south-trending faults that delimit and cut the terrain which is responsible for the evolution and very youthful topography of the mountain.

One of these faults of the MM range extending southward crosses the South Palar River near the northwestern periphery of the Stanley Reservoir. Movements on this and the neighbouring faults have caused tilting, folding and thrusting up of the Holocene (Recent) gravel of the river bed. Spectacular loop in the remarkably straight course in the upper reaches of the Palar flowing in the fault valley is a result of right-lateral strike-slip movement on the active fault. In the BR-MM terrain not only were there vertical uplifting movements, but also horizontal northward displacement of the faulted blocks.

Between the active Sivasamudram Fault in the west and the Hogenakal-Mettur fault pair in the east, the BR-MM terrain has not only risen up in the manner of a horst considerably (nearly 1200 m above the Mysore plateau) but also moved differentially northwards *en bloc*. The lateral strike-slip movements were more frequent and/or stronger in the eastern faults, so that the cumulative displacement in the east is of the order of more than 100 km (Figure 4). The senile Kaveri, which had established its drainage southeastwards and matured considerably quite before the BR-MM ranges came into existence (Radhakrishna, 1992), slowly rose up and moved northwards. The river kept its channel open by cutting deeper and deeper as the mountain barrier grew gradually. The movements must have been so slow that the Kaveri continued to flow in its original course which became deeper and deeper. The Kaveri is thus an antecedent river (Radhakrishna, 1992, 1993; Vaidyanadhan, 1971) much older than the BR-MM mountains it crosses.

Tectonics of the Southern Peninsular India

The Southern Indian crust, (Figure 1) which in the very distant past had broken up along the roughly east-west-trending 200 km long Moyar-Bhavani Shear Zone (Naha and Srinivasan, 1996; Ramakrishnan, 1994), rose up against what is called the Dharwar Craton in the north (Ramakrishnan, 1994; Rogers and Maudlin, 1994). There are many tell-tale

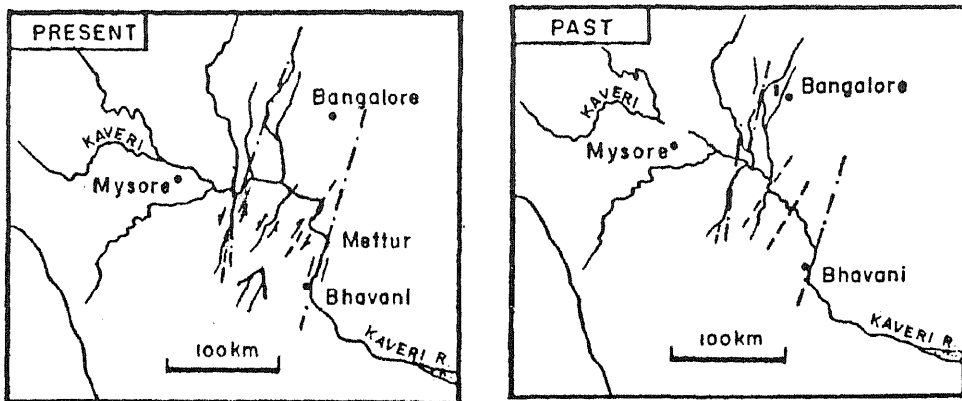


FIG. 4. Lateral displacement northwards of the faulted blocks of the BR-MM terrain is responsible for the northward deflection of the Kaveri from its original southeasterly course.

indications of continuing movement along this thrust zone. The thrust movements on the Moyar–Bhavani Shear Zone must have been transmitted as strike–slip horizontal movements on the north–south-trending faults of the Dharwar Craton embracing the BR–MM terrain. It is evident from the distribution of epicentres (Figure 1) that movements on these faults are continuing in the present. These faults of the Southern Indian Shield are thus releasing now and then the stresses that built up in its interior as a consequence of northward movement of the drifting Indian plate (Valdiya, 1989).

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