

The ‘mystic’ sand dune-covered temples of Talakad, Mysore district, Karnataka: evidence of earthquake-related destruction

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Low-lying sediment mound, known as Talakad sand dunes, on the left bank of the meandering Kaveri River at Talakad, Mysore district, Karnataka, is an enigmatic geomorphic feature. Archaeological excavations in the area revealed the presence of a cluster of ancient temples, mostly in dilapidated condition, which were presumably built during the time-period dating back between 6th and 17th century AD. It is generally believed that the temples were entombed under a pile of riverine sand dunes during the ‘eco-disaster’ that lashed the region in the 17th century. Our field studies coupled with archaeological reports on excavations indicate that the mound is not entirely made of dune sands. Virtual absence of sand deposits over some severely damaged temples occurring near the top suggests that destruction could not have taken place only because of the load of the overlying sands. On the other hand, the scale of destruction witnessed in some of the affected temples can only be explained by the incidence of earthquakes of high magnitude. Additional proof of earthquake-related destruction comes from the occurrence of sedimentary layers (beds) containing fragmented pieces of building materials like bricks and stones in silt and clay-bearing flood plain deposits at the sites of the destroyed temples and other buildings. Historical records of repeated renovation or rebuilding of temples at the same place provide further proof of recurrent incidence of earthquake-related destruction. Geomorphic changes manifested in the form of shifting of river courses consequent with the rise of the sediment mound also indicate uplift-related earth movements which must have ensued repeated earthquakes in the region.

Keywords: Ancient temples, disaster archaeology, neotectonic landform changes, palaeoseismicity, sand dunes.

A huge pile of sediment covering an area of around 4.5 sq. km forms a low-lying ridge-like hump on the left bank of the meandering Kaveri River at Talakad in the Mysore District of Karnataka. The unique geomorphic feature, popularly known as the ‘Talakad sand dunes’ is said to have engulfed a cluster of ancient temples, which

were built during the time-period between 6th and 17th century AD. Archaeological excavations provided information on the existence of much older megalithic culture in the area. The anthropological congeniality of Talakad and surrounding regions is proved by the discovery of Neolithic–Chalcolithic culture at a locality called Hemminge on the right bank of the river about 3 km NNW of Talakad¹.

Scientific interest over the Talakad sediment mound was greatly enhanced following archaeological excavations carried out by the Directorate of Archaeology and Museums, Government of Karnataka in association with the University of Mysore during the early nineties of the last century². Excavations followed by historical studies confirmed that the temples were built over a period of about 1000 years during successive regimes of different rulers on the left bank of the meandering Kaveri River at Talakad². Apart from historical information, the excavations elicited inquisitiveness amongst earth scientists to understand the origin of the Talakad mound while viewing from different perspectives. The most significant of these is the study³ emphasizing on the special geomorphic conditions leading to the formation of ‘sand dunes’ of Talakad. Valdiya^{4–6} in a series of publications highlighted the tectonic aspects especially referring to the importance of Late Quaternary lineament-controlled deformation that grossly changed the landform pattern in the region. Significant inputs also came from Rajani *et al.*⁷, who have highlighted aspects that would be useful in exploring the sediment mound from the archaeological point of view. Not to underrate in this regard is the suggestion of the possible anthropogenic cause in the process of destruction of an active and vibrant temple city on the banks of the Kaveri, now lay buried under dune sands⁸. Picking up pieces from these studies, we undertook a study to have a relook at all these issues hinging on geological factors that contributed to the formation of the enigmatic sediment mound in this part of the Kaveri basin, and the real cause of destruction of the entombed temples.

Geomorphologic background

We studied in detail the satellite imagery which is found to be educative in understanding the geomorphologic

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setting of the area. This was followed by field investigations mainly around the excavated sites. An important aspect of our study involved determination of spot heights using GPS as well as satellite imagery to find out the relief pattern in and around Talakad. Regionally, the area around Talakad has a wider spread of flat alluvial ground of the Kaveri Basin (bluish-grey colour in Figure 1) than that in the surrounding hilly tracks (in brown shaded areas in Figure 1) through which the Kaveri River flows. Because of this, the region is also nicknamed as Mysore ditch².

The mound of sediment heap commonly known as ‘Talakad sand dunes’, shows a biconvex lens-shaped outcrop pattern trending NW–SE in the map. It is bounded in the east by the low-lying flat ground having an average elevation between 630 and 635 m amsl, and by the slightly elevated abandoned Kaveri River channel in the west (Figure 2). The average height of the ridge ranges between 647 and 658 m. On the eastern side, the ridge is between 6 and 9 m above the flat ground level. The elevation is lower on the western side, where the ridge borders the gently tilted east bank of the river consisting mainly of point bar sand deposits on the concave side of the river meander. The study of satellite imagery helped confirm that the earlier course of the Kaveri channel was close to the temple town³ (Figure 2). The present channel of the river is because of southeasterly shift of its course. It has been suggested that the eastern part of the town was itself on the flood plain⁷.

The Talakad sediment mound is sharply divided into two parts marked by straight-running tree line, which marks the trace of a fault⁷. The sand-covered area lies on the eastern half, which can be identified in the satellite imagery by the dominance of the light yellow-brown shades wherever the vegetation cover is sparse. The western half is dominantly a tree-covered zone. From the arc-shaped outline of the western ridge-boundary and the nature of vegetation cover, the half-lens shaped outcrop of the ridge looks like a slice of an older flood plain of the Kaveri meander.

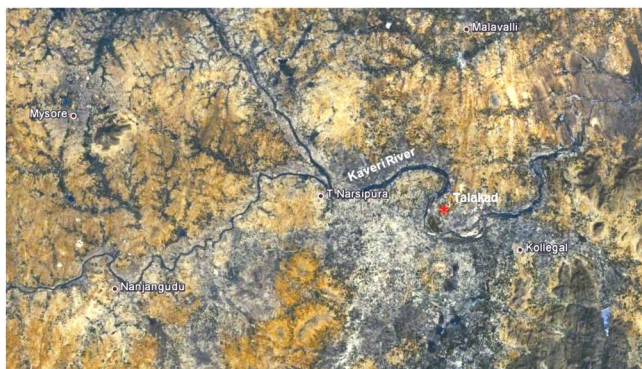


Figure 1. Google satellite imagery showing the nature of the terrain through which the Kaveri flows. The bluish-grey colour shows the extent of flood plain of the Kaveri Basin amidst hilly tracks (brown shaded areas).

Origin of Talakad sediment mound

Not much information is available about the lithological character of the Talakad sediment mound, except the general belief that it is made of riverine sand dunes. It is thought to have originated due to an ‘eco-disaster’ that lashed the region during the 17th century⁸. That was the time when the normal flow of the Kaveri River was impeded because of the construction of a dam on the upstream side, north of Talakad and subsequent diversion of water in a different direction. As a result, the water level at the point bar on the concave side of the Kaveri meander southwest of Talakad was significantly lowered leading to the buildup of sand at this place. The accumulated sand was then actively reworked and carried by the northeasterly monsoon winds, which were subsequently deposited around Talakad engulfing the temples and other settlements in the region³. The yellow coloured, uniformly fine-grained and homogeneous nature of the sand without any clay material in it provides further proof that the air-borne sand deposited as dunes (Figure 3 *a* and *b*).

The process of formation of sand dunes at Talakad suggested by Srikantia and Anantharamu³ satisfies two of the three essential prerequisites for such formation – availability of sand and deflation and transportation by wind. The hint for the third requirement comes from the suggestion that the deposition of sand took place on the eastern leeward and the western windward sides of a pre-existing topographic high at Talakad. Such a depositional situation could not have been developed without the presence of any topographic high.

At present about 10 m thick deposits of dune sands occur in the eastern middle part of the sediment mound where the Old Talakad town existed. The thickness of the sand body shows gradual reduction both in the upward as well as sidewise directions. Near the top of the sediment

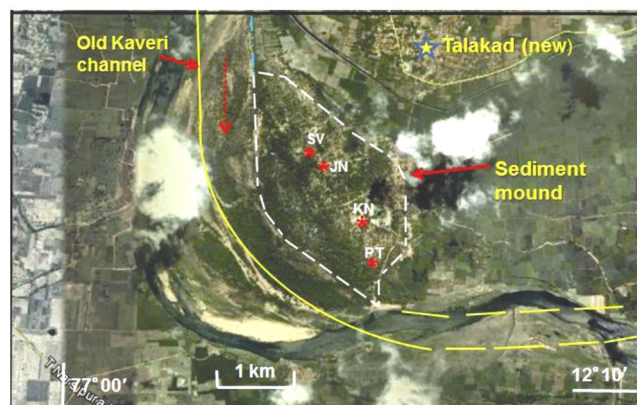


Figure 2. Google satellite imagery indicating the lens-shaped outcrop of the sediment ‘heap’ (marked by discontinuous white line) in the Talakad region. Location of some ancient temples exhumed from sediment cover is shown: PT, Pataleshwara temple; KN, Kirtinarayana temple; JN, Jain temple and SV, Shiva temple. Discontinuous blue line marks a fault.



Figure 3. *a*, Spread of dune sand at old Talakad. *b*, Close-up view of the uniform, fine-grained sand materials exposed in a section cut at the Kirtinarayan temple.

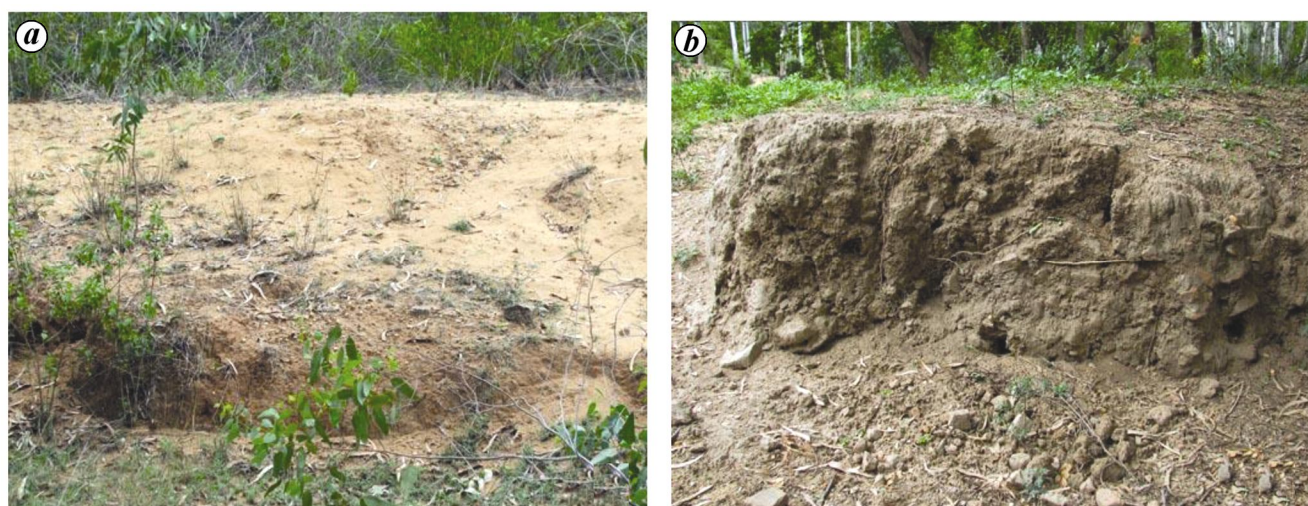


Figure 4. *a*, Thin (about 1 m) envelop of yellow coloured dune sand overlying the reddish-brown coloured rock at an excavation site. *b*, Exposed rock without any sand cover.

mound, the sands constitute only a thin envelop covering the rocks below (Figure 4 *a*). The sand cover is virtually absent at several places near the top close to the excavation site of an ancient Jain temple². Instead some harder, grey to brownish-red coloured rock masses made of clay–silt mixture containing broken fragments of rocks and bricks are seen in that part of the sediment mound (Figure 4 *b*).

Destruction of Talakad temples: search for possible causes

The entombment of temples and other structures under thick piles of sand cannot be the complete story of the destruction of the historical Talakad temples. This is

because the sand cover over the temples close to the top of the mound (Jain and Shiva temples, for example, Figure 2) is either lacking or forms only a thin veneer (Figure 4 *a* and *b*). Even at places where the sand cover is present, it occurs above the debris of the already destroyed temples. Evidently the destruction noted in these temples cannot be attributed to the load of the sand cover.

A number of studies have been made to understand and explain the geomorphic and geologic aspects of the Talakad sediment mound^{3,4,7}. However, an important aspect that seems to have escaped attention of the earth scientists is the fact that most, if not all, of the entombed temples bear evidence of destruction. This has been brought out well during the excavations carried out by the Directorate of Archaeology and Museum, Government of Karnataka, during the early nineties of the last century².

One possible cause of destruction of the Talakad temples could be the flooding of river banks during monsoons. Vulnerability of the temples to the ravages of floods may be a likely suggestion in view of the fact that these were constructed close to the river bank³. However, considering the fact that Talakad is situated amidst a well-spread out flat alluvial plain of the Kaveri Basin (Figure 1), there can hardly be any chance of floodwater becoming a destructive force to cause damage to the temples. The occurrence of small (around 5 mm in diameter) river-worn, well-rounded quartz pebbles embedded in clay-silt matrix reported from several excavated trenches² also implies low-energy water current in the flood plains, which in no way can be a factor causing destruction of the Talakad temples. Similarly, we can also rule out any possibility of mudflow along the course of a meandering river flowing through flat alluvial plain. Mudflows develop when a river follows steep mountain-slopes generally triggered by volcanic eruptions and associated seismicity.

Reporting the tumbledown condition, especially of the Jain temple and the surrounding 'basadi' areas (Figure 5), the archaeologists advocated possibility of 'ransacking' of the temple site inferring possible inter-religious rivalry². However, considering the fact that all the temples in the sand-covered area belonging to different sects are in dilapidated condition, we may also exclude the possibility of anthropogenic vandalism as the cause of destruction of the temples.

Finally, considering the constraints in all the above stated causative forces, the only possibility may be that destructions were caused by repeated incidence of earthquakes. The possibility of earthquake-induced destruction of the Talakad temples is implicit in the geomorphotectonic studies of Valdiya⁴⁻⁶. Such an explanation gets support from the fact that there is a striking similarity in the destruction features observed in the Talakad temples to the earthquake-damaged ruins reported from the Harappan cultural site at Dolavira in the Rann of Kachchh⁹⁻¹¹.

The concept of earthquake-induced destruction of Talakad temples necessarily betrays the common belief that 'the region is quite stable and seismically least



Figure 5. Large blocks of dressed rocks lying scattered on the ground at the Jain temple site.

disturbed'. It is true that little or no historical record is available about the past earthquakes in the region that constitutes a part of the Mysore Plateau. However, enough indications of neotectonic deformation in the recent past exist in the geomorphotectonic analysis of the terrain by Valdiya⁴⁻⁶. Highlighting on the evidences like cascading waterfalls dropping down from the elevated tablelands, gashing of river waters along gorge-like canyons, and abrupt rise of linear, flat-topped ridges showing straight-running steep scarps made of fresh Precambrian rocks, Valdiya⁴⁻⁶ emphasized on the neotectonically induced landform changes in not so distant past (in all likelihood during Late Quaternary and Recent). Similarly, Ravindra and Reddy¹² cited an excellent example of drainage disorganization resulting in merging of river courses during the Late Neogene to very recent time in the Mangalore pediplain region of coastal Karnataka. All these landform changes must have ensued repeated seismic activities in the region.

Ramalingeswara Rao and Sitapati Rao¹³ discussed the past seismicity of the southern peninsular India based on well-documented historical earthquake data. The authors hinted that the seismic activity is still continuing, though on a mild scale. Seismic instability of the southern part of peninsular India finds approval of several other authors^{14,15}. The most significant information on structural instability of the southern Indian crust (that ensued earthquakes) comes from the epicentre map of India and

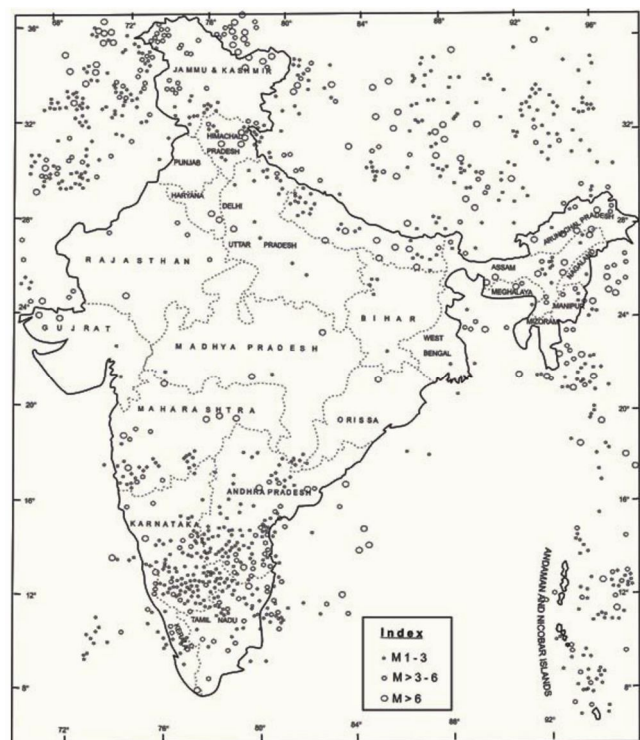


Figure 6. Epicentre map of India and surrounding regions (based on Kumar¹⁵).

surrounding regions compiled by Kumar¹⁵, based on the data compiled by the Bhaba Atomic Energy Commission, and the Meteorology Department, India and the available published information from China till 1993. The map (Figure 6) shows the maximum concentration of low and medium intensity earthquakes in the entire region between 10° and 15° latitude. Focusing attention to the southern Karnataka region, Ramalingeswara Rao¹⁶ prepared an epicentre map showing distribution of earthquake epicentres in the region (Figure 7). Most significantly, the location of Talakad falls within the epicentre swarm shown in the map.

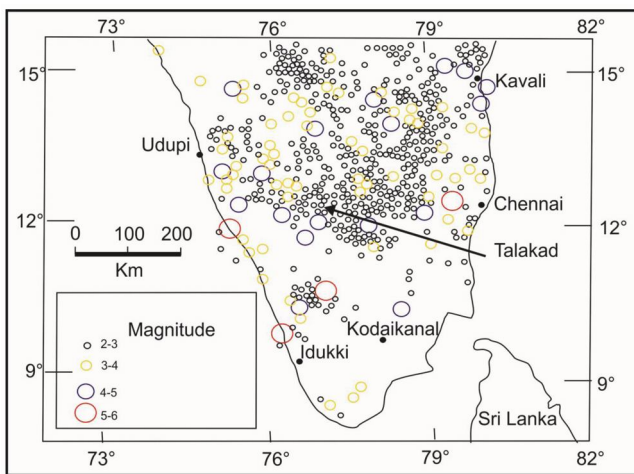


Figure 7. Epicentre map of the south Indian peninsula, showing location of Talakad (after Ramalingeswara Rao¹⁶).

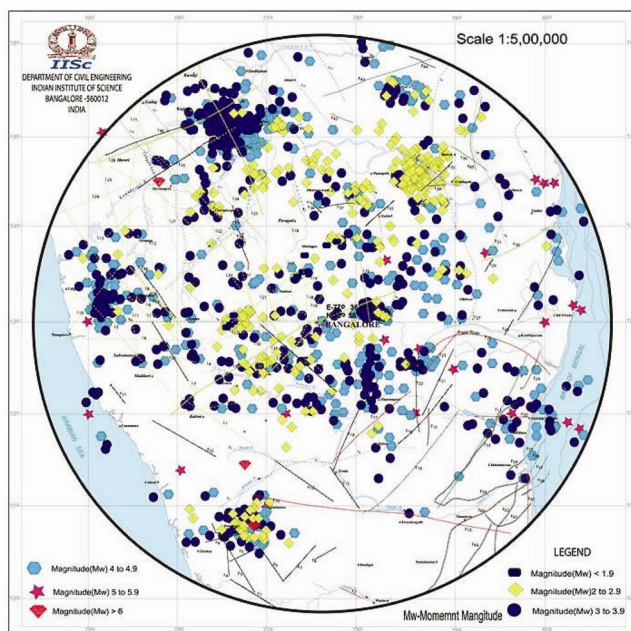


Figure 8. Seismotectonic map of Bangalore and surroundings regions covering Karnataka, Kerala and Tamil Nadu showing orientation of faults, shear zones and lineaments. X mark (in red) shows the location of Talakad (image courtesy P. Anbazhagan).

Precise and most critical information about seismicity in the peninsular region of south India, especially for Bangalore and surrounding regions is provided by Sitharam *et al.*¹⁷. The ‘Deterministic Seismic Hazard Analysis (DSHA)’ made by the authors helped in preparing a seismotectonic map of the region by considering the past earthquakes, assumed subsurface fault rupture lengths and point source synthetic ground motion model (Figure 8). The seismotectonic map shows incidence of several low and moderate intensity earthquakes interspersed with a few high intensity earthquakes (between 5 and >6) in the region.

Summarizing, we may conclude that Talakad and surrounding regions must have witnessed a number of earthquakes in the past. Though the seismic (instrumental) and historical records indicate repeated occurrences of low and medium intensity earthquakes, there is enough information on the recurrence of a few high-intensity destructive earthquakes in the region between 6th and 17th century AD (the estimated time-period of construction of the Talakad temples).

Earthquake-related destruction of Talakad temples

Tell-tale evidence of earthquake-induced destruction of the temples and other construction structures is visible on the surface. In case of the Jain ‘basadi’, scattered dressed stones of plinth are seen lying on the ground (Figure 5). A similar situation is noted in the case of the Shiva temple situated nearby, where the entire top part of the temple has collapsed and the wrecked materials have piled up over the basement (Figure 9). Severe damage caused by earthquakes are also observed in a stone structure (possibly forming a part of an annexe temple) and brick structure within the compound of the Kirtinarayana temple (Figure 10 a and b).



Figure 9. Completely ravaged Shiva temple showing fragmented bricks and some dumped stone slabs showing minor deposition of Aeolian sand at the plinth level.



Figure 10. *a*, Dilapidated stone structure (possibly forming a part of an annexe temple) recovered from under the sand dune. *b*, Fractured and sagged gate-like structure made of brick. Both the structures are located within the compound of Kirtinarayan temple.

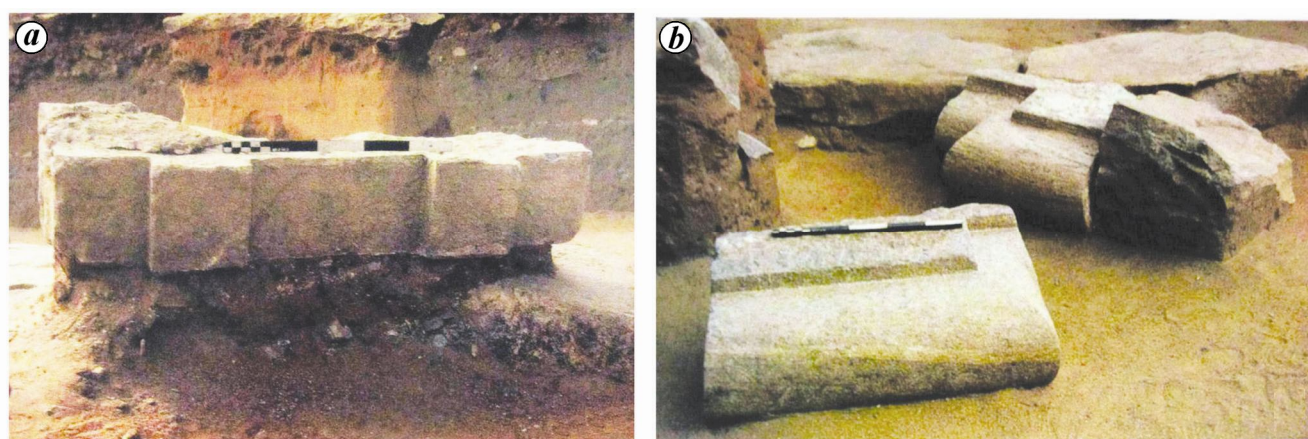


Figure 11 *a, b*. Tumbled-down pieces of plinth stones of destroyed temples lying on the (post-excavation) sand-filled smooth surfaces (reproduced from Devaraj *et al.*²).

During archaeological excavations in the Talakad sediment mound, evidence of damaged structures has been recorded at a number of sites². Among these, details recorded in the case of the excavation site ‘TK-IV’ referred to as the ‘Jaina basadi’ (meaning the site of Jain temple) are significant. It states ‘...much before the beginning of sand deposition ... the basadi must have been destroyed and its plinth was ransacked’. The record continues stating that ‘some of the dressed stones of the plinth are lying helter skelter directly above the sand bed below at the upper levels’. Based on this, it has been stated that the ‘basadi was ransacked again and again’. Though the use of the word ‘ransacked’ implies anthropogenic cause of destruction, our interpretation is that these are earthquake-induced damages because a devastation of such magnitude could not have taken place due to man-made vandalism. In case of trenches at the excavation site ‘TK-V’ about 200 m east Kirtinarayana temple, the

report says that the foundation stone of the temple was either disturbed or lost (Figure 11 *a* and *b*). Layer-4 in this trench provides a striking example of earthquake-induced destruction. A vivid description like ‘Materials such as river sand..., brick-bats (broken pieces of bricks and stones), small, tiny river pebbles, dressed granite pieces, and fine river clay (greenish yellow in colour) are found in lumps intermixed with each other’, clearly informing about the interspersing of earthquake-derived debris with flood water. Similar picture of damages has also been recorded in other trenches at different excavations sites in the sand-covered mound.

Clinching evidence of earthquake-induced destruction is observed in the sedimentary formations that have been deposited over the damaged temple sites and other places. On close examination we find that the deposited sediment contains significant quantity of broken fragments of construction materials like bricks and stones of different

sizes and shapes embedded in fine-grained mixture of silt and clay, which also contain a few well-rounded quartz pebbles (Figure 12). Similar rock formations containing fragmented construction materials along with small river-worn, well-rounded quartz pebbles embedded in clay-silt matrix have also been reported from a number of excavated trenches². We interpret these as ‘erratics’ formed due to intermixing of earthquake debris (Figure 13 *a*) with sediments carried by river water. The deposition of these mixed rocks containing materials drawn from different sources took place in the flood plains, where the flow of water was greatly reduced because of the presence of some blockages which could be the earthquake-damaged temples and other structures. Movement of floodwater was greatly impeded because of these blockages leading to the deposition of the mixed sediment load. Not uncommonly, broken pieces of plinth and other stone structures are observed scattered over such materials (Figure 13 *b*).

It is possible that all other ancient temples at Talakad suffered extensive damage or destruction like those of the Jain and Shiva temples. Historical records indicate that many of these temples like the Pataleshwara and Maraleshwara, have been either rebuilt or renovated erasing all signatures of early destruction. Archaeologists could identify different art styles of architecture in a single reconstructed temple². This information itself speaks of repeated stages of growth of the township. The renovation histories for other temples which have been dug out of the sand cover are not known. The story of the Kirtinarayana temple in this context is intriguing. The temple after its recovery from a heap of sand dunes in the mid-nineties of the last century, collapsed in 2000. We presume that the exhumed temple was in a ‘metastable’, dilapidated condition following its damage due to an earlier earthquake.



Figure 12. Soil profile section at a trench near Jain ‘basadi’ showing cluster of materials, including broken fragments of bricks and stones of different sizes and shapes as well as well-rounded, small-sized pebbles of quartz of varying sizes embedded in fine-grained mixture of silt and clay.

Recurring histories of earthquakes are clearly indicated in the case of the Jain temple, and may be in other temples. The information gathered from the study of different exhumed layers at a number of sites suggests repeated incidence of destructive earthquakes at different times. It is possible that the Jain temple and some other contemporary temples are older in age than those of the eastern series of sand-covered temples. That there were at least two levels of growth of the temple town is proved by the archaeological excavations indicating the presence of some hidden structures beneath the Kirtinarayana temple,



Figure 13. *a*, Earthquake debris mixed with soil. *b*, A broken piece of plinth lying over flood plain deposit mixed with earthquake debris.

built in AD 1116 by the Hoysala king Vishnuvardhana. Deep excavations revealed a wall, stone inscriptions and even drainage pipes, all these occurring about 20 m below the present level of the riverbed sands.

Apart from direct evidence mentioned above, the proof of earth movements triggering earthquakes is implicit in the geomorphic changes noted in the region. It has been advocated that the earlier course of the Kaveri channel was close to the temple town, which later shifted south-westward to assume the present position³ (Figure 2). Analysis of satellite imagery helps prove that the shifting of the riverbed is linked with uplift in the river bank on the concave side of the meandering river.

Further proof of uplift comes directly from the occurrence of flood plain-type sedimentary deposits near the top of the sediment mound. The level of occurrence of these sediments is quite striking considering that the top regions of the mound are between 20 and 18 m above the level of the present river bank. The only likely explanation for the occurrence of flood plain deposits at such a height is the elevation of the zone of the sediment heap from a lower level of the river bank. Assuming that earliest human activity recorded in the dune-covered region was during the megalithic period dating about 5000–7000 BC, the total time span for the formation of the Talakad sediment mound would be between 7000 and 9000 years. The rate of uplift in that case will be a little over 2.5 cm/yr. The rate is quite high considering that it is a part of the stable continental area. In other words, the area must have witnessed a large number of high-intensity earthquakes causing gradual uplift of the region from the level of the flood plain to the present level of ridge top.

Summary and concluding remarks

The Talakad sand dunes constitute an enigmatic geomorphic feature on the left bank of the meandering Kaveri River in southern Karnataka. Archaeological excavations revealed the presence of a cluster of ancient temples entombed under the pile of riverine sand dunes². Apart from the mesmerizing beauty and history of the excavated temples, the most significant fact that deserves serious attention is that most, if not all, of the entombed temples bear evidence of destruction to varying extent.

Virtual absence of sand deposits over some severely damaged temples occurring near the top suggests that the destruction could not have taken place merely because of the load of cover sands. The flooding of the river banks during monsoons could be thought as the possible cause of destruction of the Talakad temples³. However, we also need to remember that Talakad is situated amidst a well-spread out flat alluvial plain of the Kaveri Basin. The potency of water current as a destructive force in such a geomorphic condition is likely to be low, especially on

the point bar region of a meandering river where the temples were located. Similarly, we can also rule out any possibility of mudflows developing along the course of a meandering river flowing through flat alluvial plain.

Considering the constraints in all the above-stated causative forces, the only tangible possibility is that the destructions were caused by repeated incidence of earthquakes. The concept of earthquake-induced destruction of the Talakad temples gets support from geomorphotectonic studies hinting at neotectonic movements in the region^{4–6}. The neotectonic movements during the historical and pre-historical times must have ensued repeated earthquakes in the region. Further evidence of past earthquakes in the region is provided by the data on epicentre location and the seismotectonic map of the region which includes Talakad^{13–17}. Though the seismic (instrumental) and pre-historic records indicate repeated occurrences of low and medium intensity earthquakes, occurrence of a few high-intensity earthquakes in the region has also been recorded both in the epicentre and seismotectonic maps prepared for the area.

Geological proof of earthquake-related destruction of the Talakad region comes from the occurrence of sedimentary layers (beds) containing fragmented pieces of building materials like bricks and stones in silt and clay-bearing floodplain deposits at the sites of the destroyed temples and other buildings. Occurrence of floodplain-type deposits mixed with earthquake-related debris at a height between 15 and 20 m above the present-day river channel by itself provides unequivocal evidence for uplift of the pre-existing river bank, where the Old Talakad township was located in geologically recent time. We relate the uplift-related geomorphic changes and the southward shifting of the river course consequent to the rise of the sediment mound as an additional proof of the uplift-related recent earth movements in the area. The evidence of landform changes coupled with records of seismicity data covering a period of over 600 years, and the archaeological record of repeated renovation or reconstruction of temples at the same place provide proof of recurrent earthquake events in the region. In summary, the destroyed temples of Talakad may be considered as a classic case of disaster archaeology.

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