

Underwater investigations off Mahabalipuram, Tamil Nadu, India

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Mahabalipuram, the famous centre of Pallava art and architecture, is situated on the coast of Tamil Nadu. The local traditions and the foreign accounts vividly refer to the submergence of six temples out of seven that existed here. Recent underwater archaeological explorations in the area have revealed many structural remains including fallen walls, scattered dressed stone blocks, a few steps leading to a platform and many other structural remains. The structures were badly damaged and scattered owing to strong underwater currents and swells. Due to thick biological growth, engravings on the stone blocks, if any, could not be noticed. Based on its alignment and form, they are considered to be of man-made in origin. Based on the archaeological evidences on land, the earliest possible date of these structures is estimated to be around 1500 years BP. The major cause of the submergence of these structures is severe coastal erosion prevailing in the region.

MAHABALIPURAM, situated on the sea shore about 55 km south of Chennai (Figure 1), is well known for its architectural marvels and is recognized as a world heritage monument by the UNESCO. Shore Temple, *Rathas* (Chariots) carved out of a single rock, *Arjuna's Penance* and several other cave temples are some of the famous wonders. Mahabalipuram was a place of pilgrimage even before the Pallava period and the Pallava king Narasimha Varman built these beautiful temples, including the present Shore Temple, during the 8th century AD¹. Mahabalipuram was well known to earlier mariners as 'Seven Pagodas' since very early times ('pagodas' refer to the top-most part of a temple, i.e. *kalash*). It is generally believed that out of a total of seven temples originally constructed, all but one have submerged in the sea over a period of time and what is now known as 'Shore Temple' is remaining. European travellers in the 18th and 19th century have recorded this folk tradition¹.

Mahabalipuram was also a famous centre of Pallava art and architecture and is said to have been a seaport right from the beginning of the Christian era. An 8th century Tamil text written by Tirumangai Alvar who described this place as Kadal Mallai, 'where the ships rode at anchor bent to the point of breaking laden as they were with wealth, big trunked elephants and gems of nine varieties in heaps'².

The epigraphical sources also say that the Pallava kings had active overseas contacts with Ceylon (Sri Lanka), China and the Southeast Asian countries. A few Roman coins of Theodosius (4th century AD) were found³, which suggest that Mahabalipuram had trade contact with the Roman world around the Christian era. Pallava king Sihnvarman led two expeditions by embarking two ships from Mamallapuram—Pallava embassy and *Vajradanthi*, the famous Buddhist monk (who introduced Mahayana Buddhism to Sri Lanka) sailed to China from Mamallapuram port². Archaeological excavations near Punjeri village, about 1.5 km west of Mahabalipuram revealed the remains dating back to the early historic and medieval periods. The excavator³ has suggested that this place could have served as an ancient port.

We report here the findings from the underwater investigations off Mahabalipuram carried out jointly with the Scientific Exploration Society, UK. The study has revealed several interesting findings such as long walls, steps lead-

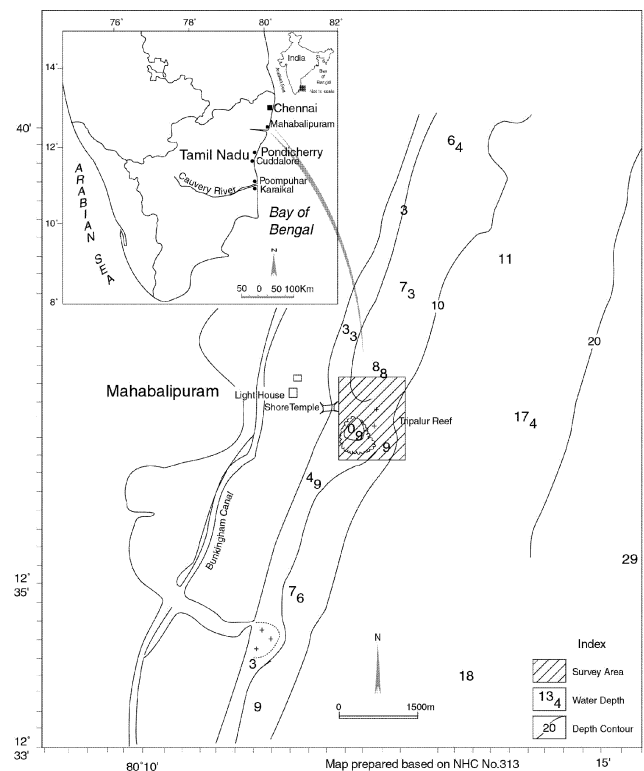


Figure 1. The survey area at Mahabalipuram.

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ing to the raised platform, scattered rectangular dressed stone blocks and a broken stone statue which appeared to be a lion figure³.

Background information

Europeans referred to Mahabalipuram as Mavalipuram, Mavalivaram, Mavellipore, Mauvellipooram and Mahabalipur. It is also known by several other names such as Mamallapattana and Mamallapuram. Believed to be 'the city of great wrestler' (Mahabali). The Pallava kings ruled Mahabalipuram from Kanchipuram; the capital of the Pallava dynasty from the 3rd century to 9th century AD. Mahabalipuram literally means 'city of the Great Bali' in memory of tradition when *Vamana* (Vishnu's Dwarf *Avatar*) humbled the demon king Bali and caused his splendid beachfront palaces to collapse beneath the sea⁴.

Another name by which Mahabalipuram has been known to mariners, at least since Marco Polo's time is 'seven pagodas'⁴. Carr⁵ refers to the account given by Chambers⁶ after his second visit to Mahabalipuram in 1776 that 'according to the natives of the place, the more aged people among them, remembered to have seen the tops of several pagodas far out in the sea, which being covered with copper, probably gilt, were particularly visible at sunrise as their shining surface used to reflect the sun's rays, but that now the effect was no longer produced, as the copper had since become incrustated with mould and Verde grease'. Similarly, there is another interesting narration referred by Ramaswami² on Robert Sotheby's *Curse of Kehama* about the submerged remains of Mahabalipuram.

The hinterland around Mahabalipuram is mostly covered by charnockite and migmatite group of rocks. Discrete bodies of granites are seen in some parts of the area, including the granitic promontories on the shore of Mahabalipuram. These outcrops may belong to the same age group of granitic activity that occurred in the central part of Tamil Nadu during the Proterozoic⁷.

The river Palar joins the sea on the southern side of Mahabalipuram near Sadras. The geomorphic feature like the Buckingham canal, is a backwater body located about 1.5 km west of Mahabalipuram, with outlets at Covelong on the north and Kalpakkam in the south. This area has contemplated stretches from Covelong on the north to Vayalur on the south with hinterland area of Vasavasamudram, a flourished port town during the early centuries of the Christian era⁸.

The coastline of Mahabalipuram region consists of long open beaches with casurina plantations. The shoreline is long and is oriented approximately N-S with a slight inclination to the coast. The beaches are appreciably straight, open and continuous. These exposed beaches have large subaerial and subaqueous sand storage⁷. In the near shore zone off Mahabalipuram, the seabed is uneven with rocky outcrops of granitic boulders with occasional sand patches

and it gradually slopes down towards east. There is a shoal called Tripalur reef, which is in the form of submerged rocks. A ridge is noticed to the southeastern side of the temple in about 8–10 m water depth that extends from South and narrows towards North and is more than 2 km in length and 0.5 km in width. At some places the top of ridges gets exposed during the lowest low tide and form a wave breaker zone.

Magnetic studies over the inner shelf of Mahabalipuram have delineated folded and faulted basement⁹. The inner shelf in this region is mostly covered with sandy sediments¹⁰. The continental shelf of Mahabalipuram has two-fold morphological divisions separated by a terrace around 120 m water depth¹¹. The shelf off Mahabalipuram is about 40 km wide and the shelf break occurs around 135 m depth and is covered by carbonate-dominated sediments in the outer shelf and sandy silt and silty clay in the other parts¹².

Methodology

Information on submergence of temples was collected from the local mythology and traditional beliefs. The offshore exploration involved both geophysical and underwater visual survey. Initially the geophysical survey comprising of echo sounder and side-scan sonar was carried out between 6 m and 15 m water depths on the northeastern side of the Shore Temple to obtain the profile of seabed and some anomalous features, if existed, followed by underwater visual survey.

Initially diving was carried out at 6 m water depth at a location about 500 m northeast of the Shore Temple. Subsequently, it was extended towards eastern side of the temple between 6 m and 15 m water depths. Each dive covered an area within a circle of 50 m radius and 124 dives were carried out in the area totalling 108 h. Whenever any underwater structure was located, a buoy was tied with a rope and designated with a specific number. When more structures formed part of a same complex, they were considered to be part of the same site. During the survey five such sites were identified. In site 1, a datum line was fixed in physically on ground in N-S direction and distances and bearing were measured with reference to this datum line. The underwater structures were documented by photography and videography and their positions were marked using a GPS. For some sections detailed sketches were prepared.

Results

The seabed off Mahabalipuram in depth ranging from 6 m to 15 m (Figure 2) is highly undulating with variation in height from 1 m to 6 m. Granitic rocks with patches of coarse-grained sand carpet the floor.

The archaeological findings from the area include the remains of walls, some of them > 10 m in length, rectangular and square-shaped stone blocks, and a rectangular

platform with steps leading to the structure. Most of the remains are disturbed and scattered in a large area. Thick marine growth of sponges, shells, barnacles and mussels are invariably found associated with these structures.

Diving was carried out at 25 locations, which have been divided into five sites where a large number of man-made structures were noticed. The findings from each site are described below.

Site I

The site is comprised of several structures. The main structure is located about 700 m east of Shore Temple, at a depth of 6 m. The upper portion of the structure is generally exposed during the low tide. The structure covers an area of approximately 75 m × 35 m. The structure is broader on the northern side where a heap of stone blocks are also observed, while on the southern side scattered small stone structures of various sizes were observed. The structure has several N-S oriented walls (Figure 3).

The width of the main structure varies from 34 m to 16 m. All the construction work appears to be on granitic stone blocks. A wall, about 25 m in length and 65 cm in width with two to four courses is noticed. The dimen-

sions of the blocks in these structures vary between 95 × 65 × 90 cm and 45 × 50 × 50 cm. Huge rectangular blocks measuring approximately 2 × 1 × 1.5 m were also noticed on the top of the structure along with few blocks showing joinery projections. These structures are covered with thick marine growth; closer observation of some of these blocks after cleaning revealed chiselling marks on them. Another wall, 5.40 m in length was noticed on the northern side. On the southern side of the main structure, two parallel walls with upward leading step-like structure were noticed. A small platform along with a wall was observed towards the northeastern side of the main structure. Remains of the wall on the northern side extended up to 15 m in length (Figure 3).

On the western side of the main structure, remains of wall were noticed on the raised platform. Some of the stone blocks of the western side were also cleaned for closer observations. One of the blocks exhibits joinery projections for interconnecting the blocks (Figure 4). The length of some of these walls varies from 7 m to 32.5 m, but there are also other walls that are much shorter in length. Huge square and rectangular-shaped stone blocks are noticed at the centre of the structure, at a height of 4 m from the seabed. A granite floor measuring 2 × 2.5 m was noticed on the northwest direction of the structure. The entire structure has a thick marine growth of sponges, shells, barnacles and mussels.

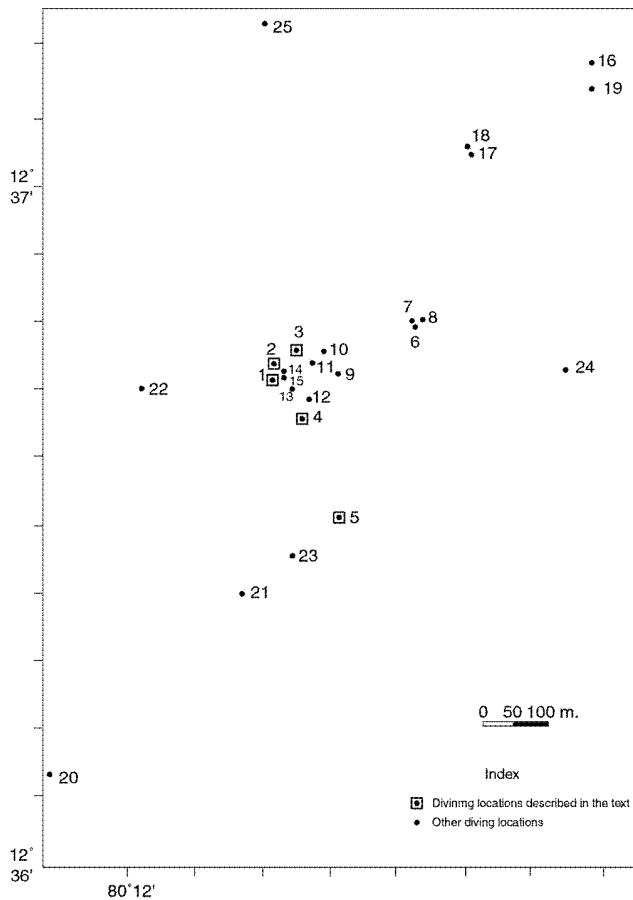


Figure 2. Map showing the diving locations off Mahabalipuram.

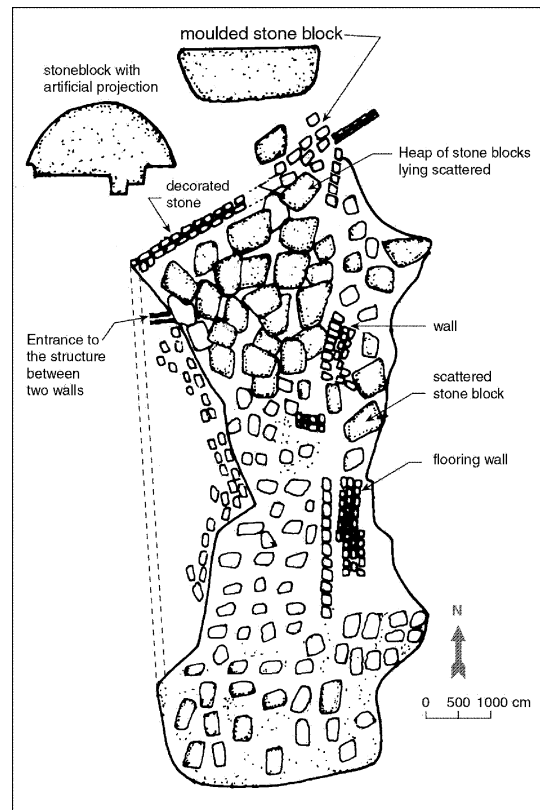


Figure 3. Plan of the underwater structure at site I off Mahabalipuram.

Site II

This structure at this site is about 100 m north of the site I, where the remains of a wall were noticed (Figure 5). The wall is about 50 m and 0.60 m wide, having three to four courses in N–S directions. Many huge stone blocks were also noticed in the vicinity. About 10 cm-thick marine growths of sponges and barnacles were noticed on them. Some natural boulders of large size were also noticed near this structure.

Site III

The structure at this site is located on the eastern side of the site I at a depth of 8 m. This is a huge natural rock, which is more than 100 m² with chisel marks and quarry marks on it. Stone blocks used for construction were probably extracted from here. Another L-shaped wall having two courses was also observed. Three more lines of dressed stone blocks, running towards the northern side of the rock, were also noticed at this site.

Site IV

This site is located about 200 m towards the NNE of site I. At this site, two big reefs of nearly rectangular shape

are visible during the low tide. The water depth varies between 5 m and 8 m. The site has remains of a wall, dressed stone blocks and the natural boulders. Some of the stone blocks appear to have carvings on them, however closer views that would have helped in their interpretation were not possible owing to thick marine growth. A 2 m wide, 5 m long wall running in the E–W direction with many dressed stone blocks scattered around it was noticed. The features observed at this site were similar to those observed at site 1. Huge boulders were noticed near the man-made structures. A rectangular stone block becomes visible during low tide and the wave breaks on that. The height of the structure is right from the seabed to the surface of the water. There are two similar stones noticed at one place within a distance of 50 m. Dressed stone blocks were also noticed on the eastern side of the structure. One of the most important findings is a wall which is more than 10 m with a width of 2.5 m.

Site V

This site is located on the southeastern side of the site I. Water depth varies from 6 m to 8 m. Wall with seven courses of small stone blocks of 1.5 m height and 2 m length with 65 cm width was noticed. Also an L-shaped connecting wall having only one course of about 5 m in length was noticed, which is partially buried in the sediment. Besides the structures, huge flat rocks were noticed, however, owing to marine growth it was not possible to check them properly. Underwater explorations were carried at several places apart from the above locations where dressed stone blocks were noticed (Figure 6).

Discussion

The underwater exploration off Mahabalipuram shows the presence of fallen and scattered long walls and structures. A large number of dressed stone blocks of rectangular and square type of building materials were found at several places; among the find is perhaps a quarry. Many of the structures found during the exploration are man-made. The extension of some of these structures can be noticed at least for a few hundred metres, running parallel to the



Figure 4. Stone block with the joinery projections at site I off Mahabalipuram.

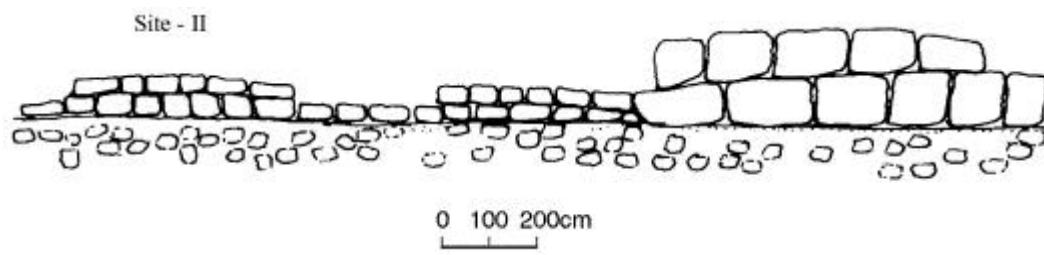


Figure 5. The section of the fallen wall at site II off Mahabalipuram.

shore. These occur at depths ranging between 5 m and 10 m. A few continuous remains of walls have been noticed at all the places (Figure 7). The large number of dressed and regular blocks suggests that they are part of a large building complex. At several places high platforms and steps leading to platforms are also noticed (Figure 8). It is, however, difficult to determine the layout plan for all the sites as the structures have been badly damaged and are covered with thick biological growth. A detailed plan was possible only for site 1 and this gives useful information on the type structures.

The plan of the structure at site I (Figure 3) indicates that this construction could be of a big complex as the huge stone blocks and several fallen walls were noticed *in situ*. The presence of several structures over natural even rock suggests that construction has been carried out on a raised platform with several walls. An opening between two walls with steps has been noticed which pro-

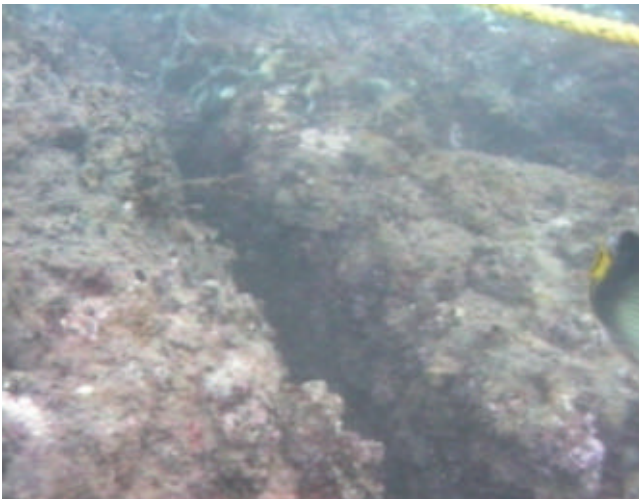


Figure 6. Underwater dressed stone blocks with huge marine growth at Mahabalipuram.



Figure 7. Remains of underwater structures off Mahabalipuram.

bably may be the entrance to the complex from the southern side. The natural rock boulders noticed on the southwest side are similar to those observed on the hills of Mahabalipuram, in shape and size. Similarly, the construction styles of the structures found underwater are identical to those on the land in the adjoining areas. It was not possible, however, to verify the binding material of underwater structure owing to huge marine growth and their damaged condition. Many wall sections were observed at different locations including a quarry area, on a huge rock. The dressed stone blocks required for the construction were probably extracted from this quarry located nearby. In fact, most of the constructions including the present Shore Temple at Mahabalipuram, which were used for religious/ceremonial purposes have been built with granite. The stone was extensively used for the construction of temples during the Pallava regime.

Possible date of the structures

The presence of man-made structures of Mahabalipuram in 6–8 m water depth raises many interesting questions, such as when they were constructed and how and why they happened to be there. Answering this question would have been easier if we had found some artifact or antiquity, which would provide irrefutable clues on the ages. Even some datable sample would have helped in answering this question. In the absence of datable evidences, the structures found underwater can be dated only based on the local traditions and available literature. People of Mahabalipuram believe that five temples similar to the Shore Temple have been submerged in the sea.

On the basis of local traditions

Ancient Tamil literature does not directly mention Mahabalipuram, but a poem, *Perumpanarrupadai* (dedicated to



Figure 8. Steps leading to the platform found at Mahabalipuram.

Tondaiman Ilamtiraiyan, a king of Kanchipuram), describes a port called *Nirppeyarvu*, which could either be identified with Kanchipuram or Mamallapuram. Similarly, early foreign travellers also do not mention this site, but the author of the *Periplus of Erythrean Sea*¹³ has mentioned a port known as Sapatma, which could be identified with Sadras, situated about 20 km south of Mahabalipuram which was a small port during early centuries of the Christian era. Ramaswami² mentions that the Pallava king Mamalla who sets his workers working on the rock for the first time here in the 7th century AD, thereafter this place names as Mamallapuram. The name Mahabalipuram, therefore, is of a very late origin.

The local tradition does not mention how old the city is but associates it with the demon Mahabali, imparting the name, Mahabalipuram to this site. Since the early Tamil literature does not mention the name Mahabalipuram, it is reasonable to infer that the submergence of these structures is not earlier than 1000 years or so. If the Shore Temple (about 1200 years old) is the last surviving structure, then it is reasonable to believe that other submerged temples in the sea are also of the same age.

The archaeology of Mahabalipuram commences from the early centuries of the Christian era, as a few Roman and Chinese coins were found². Two Pallava coins bearing legends read as Srihari and Srinidhi have been reported in and around Mahabalipuram³. One of the inscriptions of Narasimha I mentions that he (Narasimha I) is the first person to introduce the construction of caves and temples in granite stones. The zenith of human habitation around Mahabalipuram was during the Pallava dynasty, therefore, and arguably, these temples may not be older than 1500 years BP.

Megalithic burials, cairn circles, jars with burials were observed on the western side of Mahabalipuram. The site is about 1.5 km away as near Mallar region at Punjeri, located on the western bank of the inlet water, Bunkingham canal. The earliest date of Megalithic culture of southern India is not earlier than 1500 years BC and continued till early centuries of the Christian era. Dayalan³ noticed the Early Historic and medieval period habitation from here. Probably the Mallar area could be the ancient harbour on backwaters, which could have been an ideal place for safe landing. The boats may have entered either from Sadras where there is an opening channel between the river and the sea or from the canal opening at 3 km south of Mahabalipuram.

Considering these evidences, it may be concluded that Mahabalipuram was a port before Pallavas. It became the principal port during Pallava rule and they had voyages to Sri Lanka and Southeast Asian countries. The port continued to exist till the early British period, this idea is supported by the mention of a British ship that used to be anchored at Mahabalipuram². All these evidences suggest that Mahabalipuram was an active port since the last 2000 years BP.

It was during the Pallava regime that stone was extensively used for the construction of temples and bricks and wood for residential houses. The earliest stone constructions in India have been reported during the Harappan period¹⁴, especially in Gujarat and other coastal areas. The stone blocks (of the Harappan period?) are not very regular and mud mortar was used for the construction. However, stone pillars and statues were made on finely dressed stones. In Mahabalipuram, the stones are nicely dressed and chiseled properly. So far, the archaeology of Tamil Nadu does not refer to stone masonry older than the 4th–5th century AD. Therefore, the dates of submerged structures may be dated to later than early centuries of the Christian era.

Sea level/shoreline changes and tectonic history of the region

Information on sea level and shoreline changes is critical in determining the dates of the structures. The sea level has fluctuated between 2 m and 6 m about 2–3 times during mid-Holocene period on both the coasts of India¹⁵. The sea level fluctuation has been documented on the East Coast of India for the last 5000 years¹⁶. Krishnan¹⁷ and Mohapatra and Hariprasad¹⁸ point out that the major and important factor affecting Mahabalipuram coast is erosion. Severe erosion at Kalpakkam, south of Mahabalipuram owing to long shore sediment drift¹⁸ has also been reported. A recent study¹⁹ suggests the rate of coastal erosion in and around Mahabalipuram is 55 cm/yr. If the same rate prevailed since last 1500 years, then the shoreline at that time might have been around 800 m eastward and all the structures noticed underwater would have been on the land. If the rate of coastal erosion derived for Poompuhar, located 125 km to the south is 1500 yr BP applied for Mahabalipuram, then the structures in – 5 to – 8 m depth must have been on the land²⁰.

Interestingly, owing to construction of semi-circular breakwater recently, the shoreline over a stretch of 3 km towards north of Shore Temple experiences accelerated erosion⁷. There is an evidence of tectonic activity around Mahabalipuram during early Quaternary period⁹. However, there is no evidence of tectonic activity on the coast during the last 1200 years BP as the Shore Temple has not been affected¹⁸. It is interesting to note here that a 12th century AD city known as Dunwich in Baltic Sea, Europe, is lying between 5 m and 16 m water depths as a result of coastal erosion²¹. From the above discussions, it may be attributed that coastal erosion followed by invasion of sea has played a major role in submergence of these structures and sea level changes might have played a contributory role. However, further data on this aspect need to be collected and analysed to confirm this.

Conclusions

The underwater structures, especially the long walls having 2 to 3 courses, scattered dressed stone blocks of various

sizes and stones having projections are considered to be man-made in nature. The structures found at different locations appear to be similar, but have different dimensions as they were probably constructed for diverse purposes. Some of these structures are observed on raised platforms of existing natural rocks. The structures were noticed mainly in the area close to the reef and are thickly covered with marine growth. These structures may be remains of huge complexes or the temples of seven pagodas. As Pallavas encouraged the temple architecture at Mahabalipuram during 8th century AD, these structures may be assigned to be belonging to the same period. Mahabalipuram has served as a port during the Pallava period. Part of earlier Mahabalipuram town may have been submerged in the sea. The possible causes for submergence of these structures may be shoreline changes owing to erosion. Further, investigations are required to understand the nature of the submerged structures and their dates. Mahabalipuram was famous for its architecture in the past and will continue to be so as a centre for art and architecture, if it will survive nature's fury.

1. Ramaswami, N. S., *2000 years of Mamallapuram*, New Delhi Publication, New Delhi, 1989.
2. Ramaswami, N. S., *Mamallapuram, An Annotated Bibliography*, New Era Publications, Madras, 1980.
3. Technical Report No. NIO/SP-2/2003 on Underwater explorations off Poompuhar and Mahabalipuram, Tamil Nadu, 2002, NIO, Goa, 2003.
4. Rabe, M., *The Great Penance at Mamallapuram*, Institute of Asian Studies, Chennai, 2001.
5. Carr, M. W. (ed), *The Seven Pagodas*, Asian Educational Services, New Delhi, 1869.
6. Chambers, W., In *The Seven Pagodas* (ed. Carr, M. W.), Asian Educational Services, New Delhi, 1869, pp. 1–29.
7. Subrahmanyam, K. S. and Selvan, T. A., *Geology of Tamil Nadu and Pondicherry*, Geological Society of India, Special Publication, 2001, p. 192.
8. Dayalan, D., In Seminar on Marine Archaeology (ed. Kashinathan, N.), State Department of Archaeology, Madras, 1992, pp. 52–56.
9. Murthy, K. S. R., Venkateswarlu, K. and Rao, T. C. S., *Indian J. Mar. Sci.*, 1995, **24.4**, 223–224.
10. Selvaraj, K. and Ram Mohan, V., *J. Geol. Soc. India*, 2003, **61**, 449–462.
11. Mohapatra, G. P., Vaz, G. G. and Rao, R. B. S., *Geol. Surv. India, Spl. Publ.*, 2002, **74**, 24–31.
12. Vaz, G. G., *Curr. Sci.*, 1996, **71**, 240–242.
13. Schoff, W. H., *The Periplus of the Erythrean Sea*, Travel and Trade in the Indian Ocean, Oriental Book, Delhi, 1974.
14. Joshi, J. P. and Bisht, R. S., *India and the Indus Civilizations*, National Museum Institute, New Delhi, 1994.
15. Merh, S. S., *Indian J. Earth Sci.*, 1987, **14.3–4**, 235–251.
16. Banerjee, P. K., *Mar. Geol.*, 2000, **167**, 243–260.
17. Krishnan, M. S., *Geology of India and Burma*, Higginbotham, Madras, 1968.
18. Mohapatra, G. P. and Hariprasad, M., *Gondwana Geol. Mag. Spl. Vol.*, 1999, **4**, 225–233.
19. Ramaiyan, M., Krishna Prasad, E. and Suresh. P. K., In Proceedings of Second Indian National Conference of Harbour and Ocean Engineering, (INCHOE-97), Thiruvananthapuram, 1997, pp. 1177–1182.
20. Sundaresh, Gaur, A. S. and Nair, R. R., *Curr. Sci.*, 1997, **73.7**, 593–598.
21. Bacon, S. R., In *Progress in Underwater Science* (eds Gamble, J. C. and Yorke, R. A.), Pentek Press, London, 1978, pp. 25–32.

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