

# OFFSHORE EXTENSION OF GOMATI RIVER, DWARKA

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## SUMMARY

*The onshore archaeological evidence for the submergence of a protohistoric settlement at Dwarka, to begin with, had raised hopes of finding remains of a large port town in the sea itself. To identify the location of the submerged town in the Arabian Sea off present day Dwarka, a careful study of the marine geological environment was considered necessary as a follow up of detailed diving explorations by Marine Archaeology Unit (MAU) at National Institute of Oceanography since 1984.*

*Based on about 40 line-kilometres of echosounding, Side Scan Sonar and Shallow Seismic Profiling carried out in December 1989, underwater extension of the river Gomati has been mapped. The Gomati channel continues for about 1.5 kms and is about 400 m wide. The channel is deeper and narrow nearshore but widens out towards offshore. The channel is considered to be filled with fine sand having boulders, but detailed diving may provide useful information.*

*The submerged part of Gomati channel has much important roll to play in the reconstruction of history. Rao (1990) has attempted to identify the submerged extension of Gomati river by diving inspection and based on the results obtained such as findings like stone and iron anchors, circular bastions, etc., he has prepared the site plan of Dwarka. While many features reported earlier are confirmed, present survey has provided direct evidence on the channel alignment and therefore more reliable site plan can be constructed now.*

## Introduction:

A basic information is provided by epics or folklore to marine archaeologists who are in search of clues for locating submerged ports or structures. Mahabharata mentions about prosperous port city Dwarka said to have been founded by Lord Krishna but subsequently inundated and submerged by the sea. Mahabharata period is variously dated between 1424 B.C. and 3102 B.C. The con-

sensus date is 1500 B.C. (Rao, 1990). It is also believed that the Krishna Temple popularly known as the Dwarkadhish Temple was built seven times.

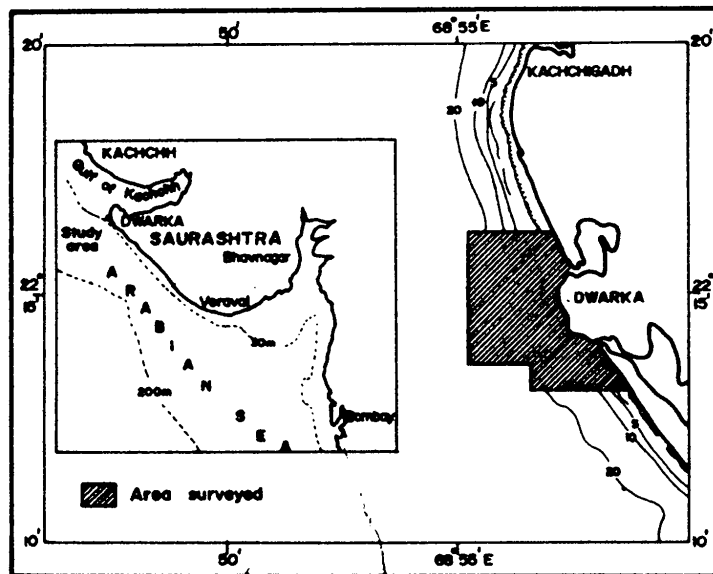
Famed archaeologists have attempted to throw light on various related issues by taking up variety of excavations. Inspired by the findings, detailed onshore and offshore investigations were taken up by marine Archaeology Unit (MAU) in Dwarka and Bet Dwarka

since 1983 (Rao, 1987). The achievements, mainly by diving team, established the presence of submerged stone wall and bastion as well as found different types of stone anchors in the water depth upto 6 m off Dwarka, raised hope for finding of remains of a submerged city. This necessitated scientifically planned offshore exploration programme with state-of-the-art equipment for marine geological investigations.

A question often debated is what roll high resolution marine geological - geophysical surveys can play and to what extent in ascertaining the submergence of port or other structure. It is considered that acoustic surveys may provide a clue in the form of some anomaly which may lead to finding of some manmade features. The usefulness or otherwise of such surveys has been summarised with case histories by Jeremy (1987). The relocation of Titanic itself is the proof enough indicating efficiency of such methods. Vora (1987) has located some anomalous features off Tamil Nadu coast mainly based on echo-

sounding and side scan sonar profile. However, the limitations of such surveys like accuracy of location, prevailing geological conditions, type of expected structure etc. are to be considered while evaluating such methods.

The knowledge of prevailing geological conditions like geomorphic features, sedimentological regime, derived/deduced paleoclimate, possible sea-level, expected rate of sedimentation are some of the factors that should be utilised to deduce how the natural phenomena might have influenced the existing human settlement. The geomorphic features, for example, are the product of natural forces that are acting formations of features like scarp, channel, fault or even ripples or sandwaves each represent a typical set of environment which cause them. Similarly the sea-level variations also leave their mark on the seabed and that also have wide ranging implication on human settlement. It is therefore very important for the purpose of marine archaeology to analyse the data critically from



*Fig. 1 : Map showing the area surveyed. Inset shows the location with reference to Arabian Sea and Gulf of Kachch.*

the various angles before arriving at a conclusion.

In view of this, high resolution marine geological and geophysical surveys were taken up off Dwarka (Fig.1) in December 1989. The paper highlights the results of echosounding, side scan sonar and shallow seismic profiling and discusses the occurrence of submerged channel of river Gomati and its relevance to marine archaeology.

### Environment:

Dwarka is situated at the entrance of Gulf of Kachchh, on the western tip of Saurashtra Peninsula facing Arabian Sea. The Gulf itself is running East-West. Tidal range in the area is of the order of 3 m.

The prominent geological formation in the area is Dwarka beds which overlie the Gaj strata. Dwarka beds comprise of gypsiferous clays and sandy foraminiferal limestone probably of Mio-Pliocene age (Krishnan 1968a).

The areas of Kathiawar (Saurashtra) and Kutch were under sea during the whole of the tertiary area and were apparently raised above sea level only, in the Pleistocene (Krishnan, 1968b).

The shoreline from Veraval to Dwarka is remarkably straight and has a dominantly emergent aspect. Shoreward of the coastal margin between Diu and Dwarka adjoining narrow beach ridges, a series of parallel ridges are noticed while landwards of these sand hills, few rocky hills appear (Ahmed 1972).

### Methods and Equipment:

An Atlas Deso-10 echosounder (frequency 210 KHz) was used for the purpose of obtaining bathymetry and accurate continuous seabed profiles. Topography of the area can also be inferred from the echograms.

The side scan sonar (E.G. & G Model 260) was deployed to obtain the plan view of the seafloor. Data on the topographic and li-

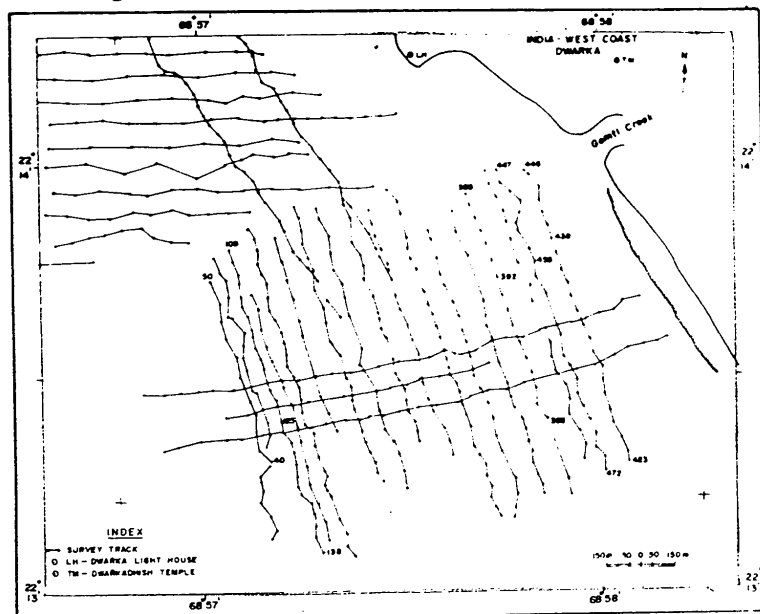


Fig. 2 : Map showing survey tracks and locations of photographs and profiles.

thological variations are obtained in the form of tonal variations. When supplemented with echosounding data, side scan sonar profiles provide complete picture about the surficial features.

Shallow seismic profiler (O.R.E. model 140, frequency 5 KHz) was operated concurrently with a view to have the sub-bottom geological information.

Positions at sea were obtained by shore based electronic position fixing system Mini Ranger MRS III, for which base stations were installed at Dwarka Lighthouse and Dwarkadhish Temple while Range console, Data Processor, Plotter, Printer and Track Indicator along with Omni-directional Antenna were installed on survey vessel. A 12 m long mechanised fishing trawler was used for the survey.

To demarcate the offshore extension of river Gomati 17 survey lines were oriented North-South i.e. parallel to shoreline so as to cross the channel at perpendicular. 12 cross

lines were also run to have control on contouring (Fig.2).

### Results and Discussions:

The survey were carried out in the water depth ranging from about 3 m to more than 20 m (Fig.3). The echograms reveal that the seabed is generally uneven to rough in the area surveyed. The most prominent feature of the area is the occurrence of channel which is observed in the form of symmetrical or asymmetrical cuttings noticed on the echograms.

Figure 4 show typical echograms from selected tracks of the channel in cross section. Nearshore (Fig.4A) the bed only shows a deep wide, symmetrical V-shaped channel, either sides of which are at same elevation and towards south the bed slopes steeply. Westward of this western flank is at a lower elevation. The channel then suddenly narrows down (Fig.4B) and the slope of the bed controls the flanks of the channel. Also a small channel formation is seen towards south. In

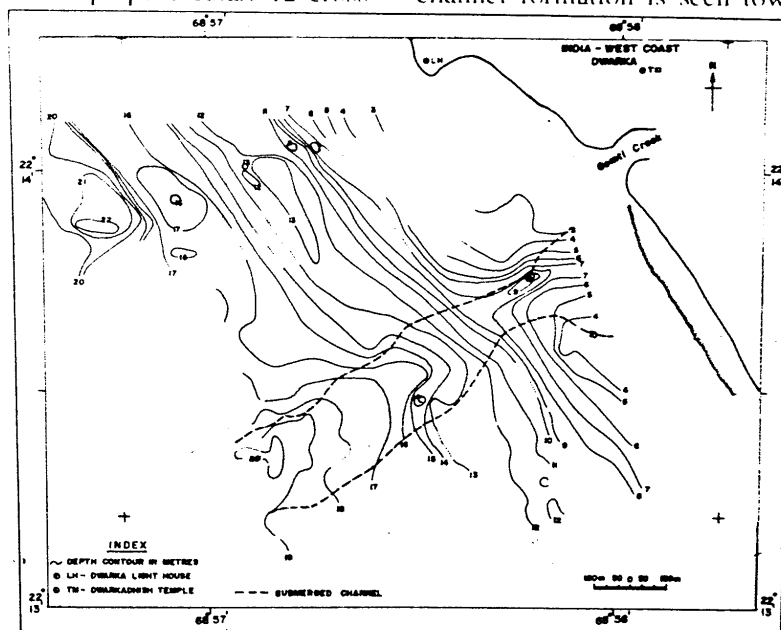


Fig. 3 : Bathymetric map off Dwarka showing alignment of submerged channel of Gomati river.

the central part of the study area (Fig.4C), the channel interestingly shows up prominent V-shape where one flank is steeply sloping. Towards further west, the channel becomes shallower (Fig.4D) as the seabed also showing average gradient markedly gentler than the nearshore.

Bathymetric profiles (Fig.5) clearly indicate the change in the nature of bed from nearshore to offshore. Nearshore, the area is rugged and channel cutting is observed towards north. Towards offshore the profiles show the gradual smoothing of the gradients.

In general, the contours show gradual increase of depth towards north as expected. The bends in contours specially off Gomati Creek (Fig.3) are interesting. Bending of contours in the area in water depths deeper than 13 m towards shore in south west direction perhaps indicate the depositional phase. Contours of 9 to 12 metres are remarkably straight indicating transitional phase, however, all lesser contours very clearly reveal strong erosional activity.

Sonographs from the area are typically marked by tonal variations indicating furrows of various sizes and shapes in different directions. Due to this it is very difficult to isolate any feature which may indicate manmade activity. Even very thin deposition of sediments as well as sea-weeds which are present in plenty on the seafloor can mask such features. However, the sonographs help in demarcating the channel boundary very clearly (Fig.6). The seismic reflection records (Fig.7) do not show significant penetration in general except in channel.

Based on the echograms and nature of bathymetric contours it is possible to identify and demarcate the occurrence of a continuous submerged channel aligned WSW - ENE as

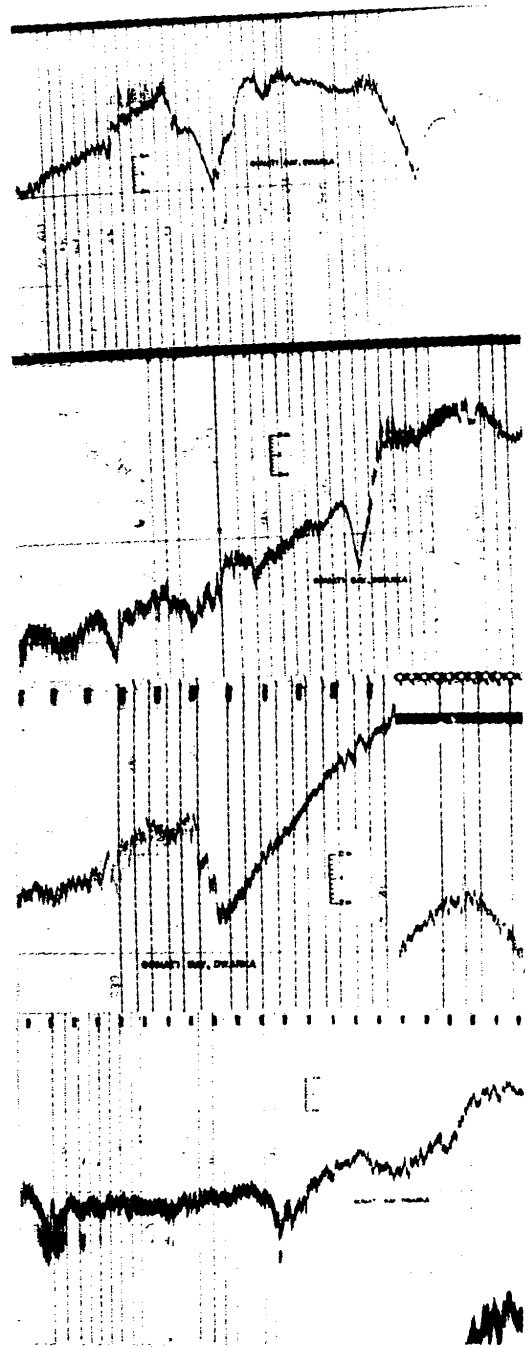


Fig 4 : Selected echograms showing variations in Gomati channel from near shore to offshore.

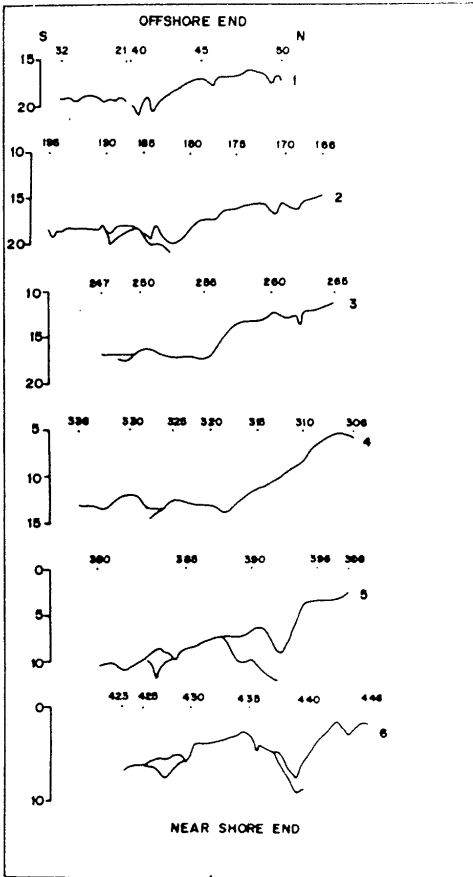


Fig 5 : Bathymetric profiles off Dwarka.

shown in Fig.3. The average width of this channel is 500 metres and total length extends more than 1.5 kms with the possibility of continuation of the channel beyond the survey area. While the depth of channel generally decreases from nearshore to offshorewards, the width increases.

The sub bottom profiles (Fig.7) indicate in general the area comprised of coarse sand, however channel do show 2-3 metres Penetration. In the absence of direct sampling in the area it is inferred on the basis of underway data collected that while the channel may be filled with fine sand and may have some boulders, the remaining area may comprise of coarse sand, corals, rocks, etc.

The alignment of submerged channel does not match exactly with onshore Gomati river. This is perhaps due to construction of retaining wall which was carried out about a hundred years ago in order to provide sufficient water at Gomati Ghat in Gomati Creek for holy bath at any time.

This channel no doubt, is the extension of the river Gomati. As average rainfall in the area is very low (40 cm/yr), this channel may not have come into existence entirely by present day erosional processes. It is probable that when sea level was low, at about 10,000 to 12,000 years B.P., by about 80 to 100m, the submerged part might have been exposed. In view of this, it will be very interesting to



Fig 6 : Typical sonograph showing the channel bed.

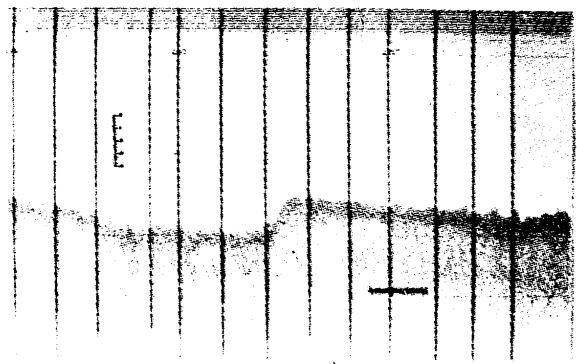


Fig 7 : Representative shallow seismic record from the area.

see its implications from archaeological view point.

It is generally believed that Holocene sea-level rise started about 10,000 yrs B.P. and attained more or less present day level at about 6000 yrs B.P. The time-frame for which archaeologists are interested for Dwarka region is about 4000 yrs B.P. Hence it can be said that significant effect of sea-level changes as such in Dwarka region is not expected. However, the very fact that now the exact alignment of the river Gomati is demarcated, probability of finding artifacts along either banks of the river cannot be ruled out.

Though the results of the survey do not indicate any possibility of identifying submerged part of sunken port, preparation of site plan based on findings by diving like stone wall, bastions, iron anchors, etc. can suitably modified considering the extension of the river Gomati.

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