

Surficial Geology of the Environs of the Kachchh Tidal Power Project, India

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Synopsis

The results of the echosounding and shallow seismic surveys carried out in the inner Gulf of Kachchh indicate that in the inner Gulf i.e. the Sara, Sanu, Phang, Kandla and Hansthal creeks, bed is generally shallow and uneven while in the outer anchorage area of Kandla port the depth is about 18 m and the bed is smooth and even. It is inferred that while inner Gulf is witnessing erosional environment, the outer area is undergoing depositional phase.

The need for search of renewable energy resources, untapped so far, can never be over-emphasised. Like sun and wind, ocean too has capabilities to provide energy which can be harnessed in number of forms such as tidal power, thermal energy etc. Tidal power generation is more promising and feasibility of power generation through such a project has been proved by existence of two such plants operating in France and U.S.S.R. Apart from this, number of sites including Severn barrage in U.K. and Bay of Fundy are being investigated for the feasibility and many others are in various stages of consideration (Charlier, 1982)

In India, three sites have been identified to have potential for power generation from tides. Gulf of Khambhat, Gulf of Kachch, in Gujarat and Sundarban, in West Bengal (Wilson, 1979). The Central Electricity Authority (CEA), after conducting pre-feasibility studies, selected Gulf of Kachchh site for multi-disciplinary investigations to assess the techno-economic feasibility.

The feasibility studies involved various investigations necessary for the planning and designing of the projects and were undertaken by different agencies. The marine geological and geophysical investigations formed the vital part of the study, as information on the nature of sea-bed, soil characteristic and stability of the seafloor is essential, especially, when tidal range is very high and associated currents are very strong. National Institute of Oceanography carried out marine geological and geophysical investigations in the inner gulf of Kachchh to decipher the regional surficial geology, the results of which form the basis of this paper.

The surveys were carried out in the Kandla, Sara, Sanu, Phang and Hadkia creeks, Littel Gulf and Outer Anchorage area of the Kandla port. The surveys consisting of more than 200 kms of echosounding and sub-bottom profiling each were carried out, supported by

side scan imageries from selected places and seabed sampling (166 nos) from the area.

These studies are in line with investigations carried out for the Bay of Fundy project (Swift and Lyall, 1968; Pelletier and McMullen, 1972; Knight et al. 1978; Amos, 1979) and Severn Barrage project (Hamilton, 1979; Evans, 1982).

The Area

Environment

The gulf has tidal range over 4 m at Kandla and Navlakhi which increases further towards the north. Tidal currents in the gulf varies from over 2 to 3.5 knots (Sharma and Devasahayam, 1985).

Physiography

The gulf of Kachchh is an E - W indentation in the coastline of India at the western extremity. The inner gulf is, however, oriented NE - SW. The gulf of Kachchh presents a complete set up of a macro-tidal region marked by existence of shoals, channels, inlets, creeks and islands. The inner-most part of the gulf has intricate creek system, of which, the Kandla, Hansthal, Sara, Sanu and Phang creeks are prominent (Fig. 1).

Geological Set Up

Geological formations from middle Jurassic to Holocene over a crystalline basement are reported to be present in the area surrounding the gulf (Biswas, 1982). The study area is bordered by the most conspicuous sedimentary formations, predominantly marine, tidal, littoral or sub-littoral fluvial and aeolian deposits of quaternary age.

The prominent sub-bottom features in the gulf are oriented in E - W and are reported to be produced by (i) tectonic movement along the fault line (Biswas, 1982) and (ii) current scouring along the zone of tectonic weakness

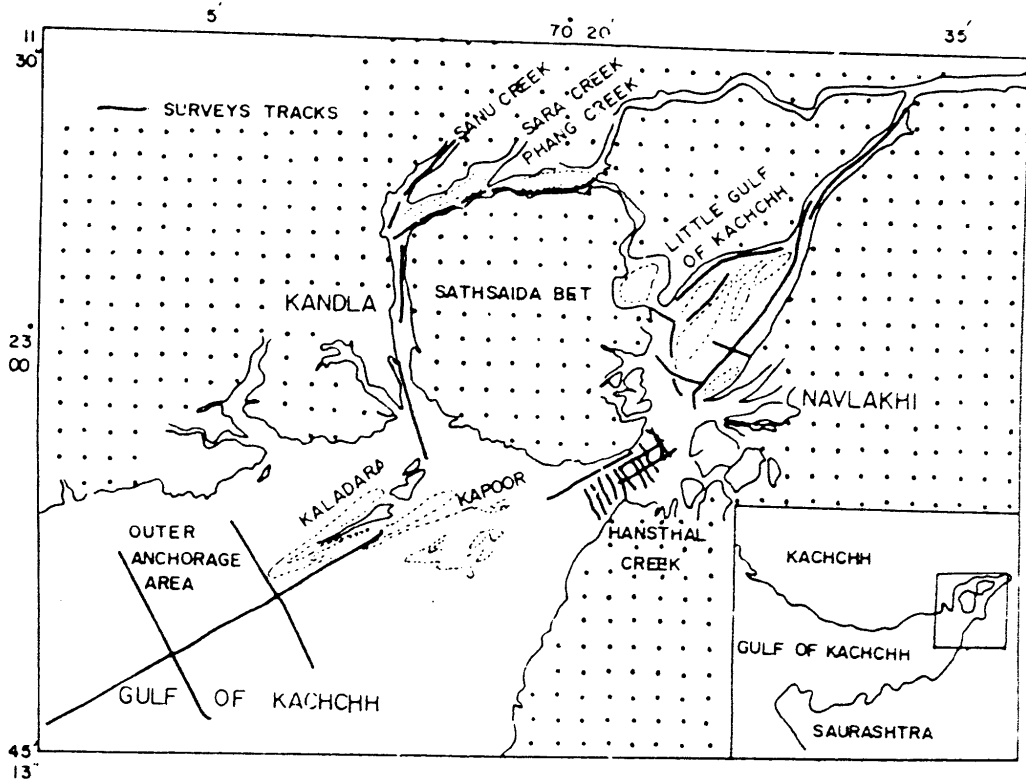


Fig. 1. Location map showing survey tracks.

(Wagle 1978).

The sediments of the Outer Gulf are generally composed of silt and fine sand with shelly material. The sediment distribution in the outer gulf has been described by Hashimi et al. (1979). Vora et al. (1987) have described the geological processes that are operating in the inner gulf of Kachchh.

The gulf is located at the active seismic zone and numerous events of earthquakes have been reported from the area since 1878. The earthquakes are known to have brought major physiographic changes in the region.

Equipment and Methods

A shore controlled radio electronic position fixing system (miniranger MRS III) was used during the survey with microprocessor based peripherals to provide real time position in graphical mode as also hard copy co-ordinates for checking and confirmation. The system has the accuracy ± 3 m with good repeatability.

An Atlas-Deso-10 echosounder was used primarily for bathymetry. The system has dual frequency transducers, (210 KHz and 30 KHz). The echograms were also used to decipher the topography and to some extent the sediment type. The nature

of the bed, i.e. even, uneven or rugged were also inferred from the echogram.

Shallow seismic profiler provides data on spatial and vertical variations in sub-bottom geology. An ORE sub-bottom profiler with variable frequency from 3.5 to 7 KHz and 1 to 10 Kw power was deployed for the purpose. The system, depending upon nature of sediments provided a valuable information down to 15 - 20 m or more.

An EG & G Side Scan Sonar, capable of recording topographical and lithological variations upto 500 m on both sides of the survey track was used to obtain the plan view of the seafloor.

An integrated analyses of these multifrequency, high resolution geophysical data provided the basic geological framework of the area and seabed samples from the area were collected by using a Peterson Grab to confirm the same. Sediment distribution map (Fig. 2) is prepared based on above.

Results and Discussions

The Kandla, Sara and Phang creeks are shallow and are marked by presence of number of scour holes, scour channels, sand waves, platforms

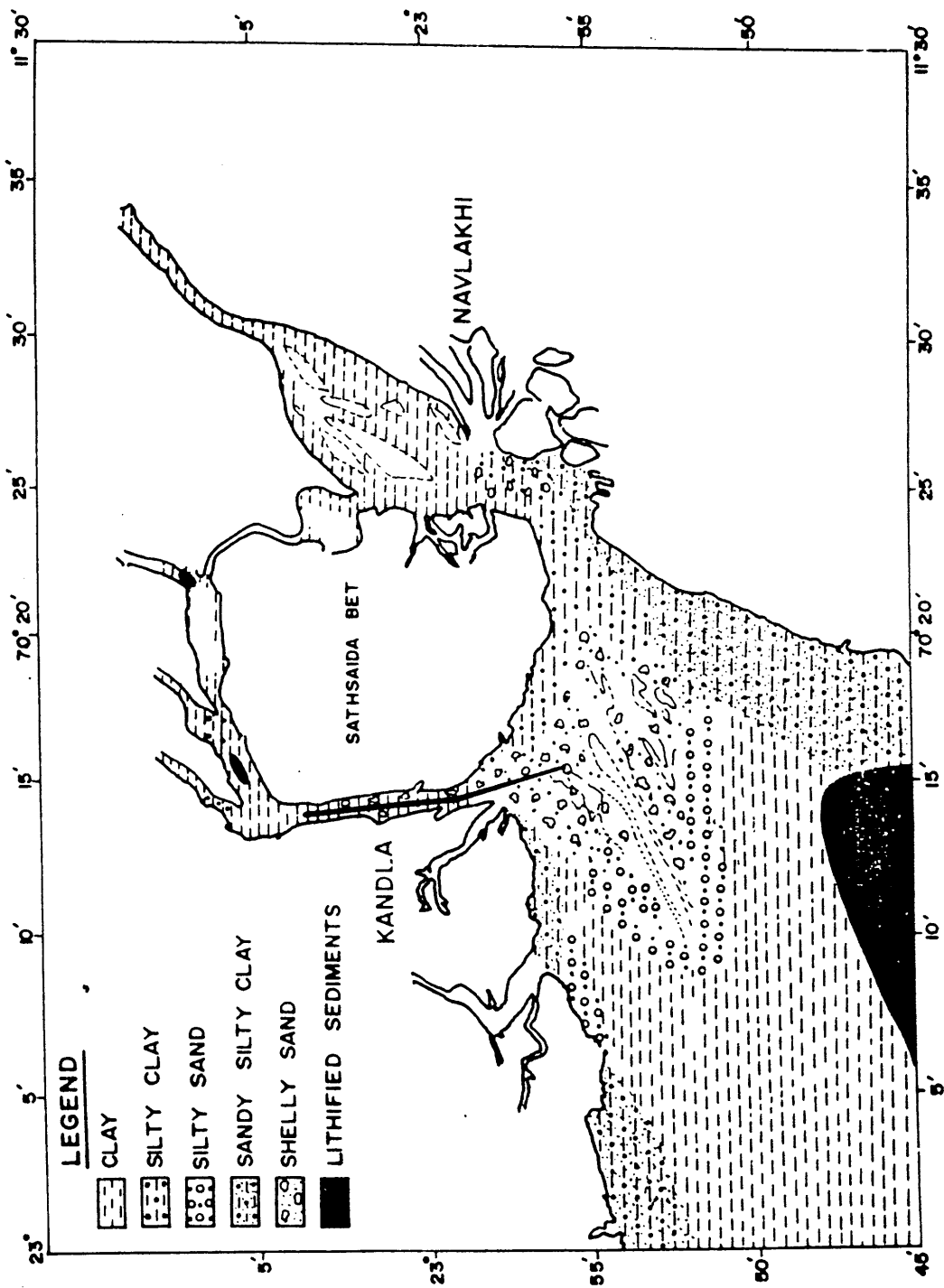


Fig. 2: Map showing sediment distribution in inner Gulf of Kutch.

and pinnacles; typical of macrotidal environment. The scour holes, 3 to 10 m deep are abundant in the Phang, Sara and Sanu creeks. The sandwaves both symmetrical as well asymmetrical observed in the area are varying in height from 3 to 6 m and in wave length from 150 - 350 m.

The seismic profiling in the Kandla creek indicates unconsolidated sediments down to 8 m at the southern end and their thickness gradually reduces towards northern end. The pockets of sediments, about 4 m thick, are observed in Sara and Sanu creeks while the Phang creek has about 10 to 12 m thick sediments. The deep channel cuttings, observed in Sara and Phang creeks, clearly cut through the subbottom reflectors. These cuttings, along with the presence of well marked subbottom reflectors, despite the uneven topography clearly reflects the removal of oberburden by the erosion.

Most of the little gulf area and Chach creek generally remain above the chart datum. The isolated deep V-shaped cuttings observed in the echogram extend through the underlying reflectors. The shallow seismic profiles from the area indicate 6 to 8 m penetration with 3 to 4 reflectors. These reflectors are horizontal and parallel, and the acoustic basement when discernible shows undulations which are indicative of antecedent erosional phase.

Hansthal creek is about 3.5 km wide and is the site for main structure. The creek is about 18 m deep in the axial part and the flanks of the creek are just above the chart datum. The flanks are steeply slopping (gradient 1:250 to 1:50) and generally even while the creek-floor in the axial part is uneven to rugged. The isopach map (Fig. 3) from the area indicates that the thickness of sediments on the flanks is more than 8 m and gradually reduces towards centre. This perhaps implies the erosion in the center with removal of material. The sonograph from the area indicate presence of current furrows on the floor.

Depth in the outer anchorage area is about 18 m. The bed is slopping gently towards south (gradient 1:3500). No pinnacles, dipressions or scour holes are observed in the areas which remains smooth and even. The shallow seismic studies confirm about 18 m thick clays with several closely spaced parallel, horizontal reflectors. The lower-most reflector (acoustic basement) is uneven.

The sediment distribution map (Fig. 2) based on samples collected from the area and shallow seismic data show presence of coarse sand with shells around the mid-shoal. Surficial sediments in the major portion of the Kandla creek comprise of gravelly, shelly sand and pieces of rock. Sanu, Sara and Phang creek show presence of olive gray soft clay and silty clay with shells and mud stone. The outer anchorage area, little gulf and Chach creek are covered by Olive gray soft clay. The Hansthaal Creek comprises of olive gray clay on the flanks while the axial part comprise of sand with shells and shelly limestone.

Conclusions

From the above discussions, two regions where different geological processes are in operation can be demarcated. In the area of intricate network of creeks, the high energy regime is dominating, giving rise to feature like scour holes, sandwaves and abrupt truncations of layers indicating erosion of material. The outer anchorage area where the energy dissipates out due to boundaries of area from narrow creeks show that the depositional phase is prevailing.

To review the condition prevailing in the alignment route of the construction, based on above presentation, it can be said that in the Hansthal creek the structure will cross through flanks where atleast 6 - 8 m thick clay exists. In the axial part the depth is about 18 m and the bed is rugged and comprise of sand with shells. In Sara, Sanu and Phang creek the bed level is about 2 - 4 m only and covered by soft sediments. The possibility of encountering hard sedimentary rocks in Phang Creek is, however, not ruled out.

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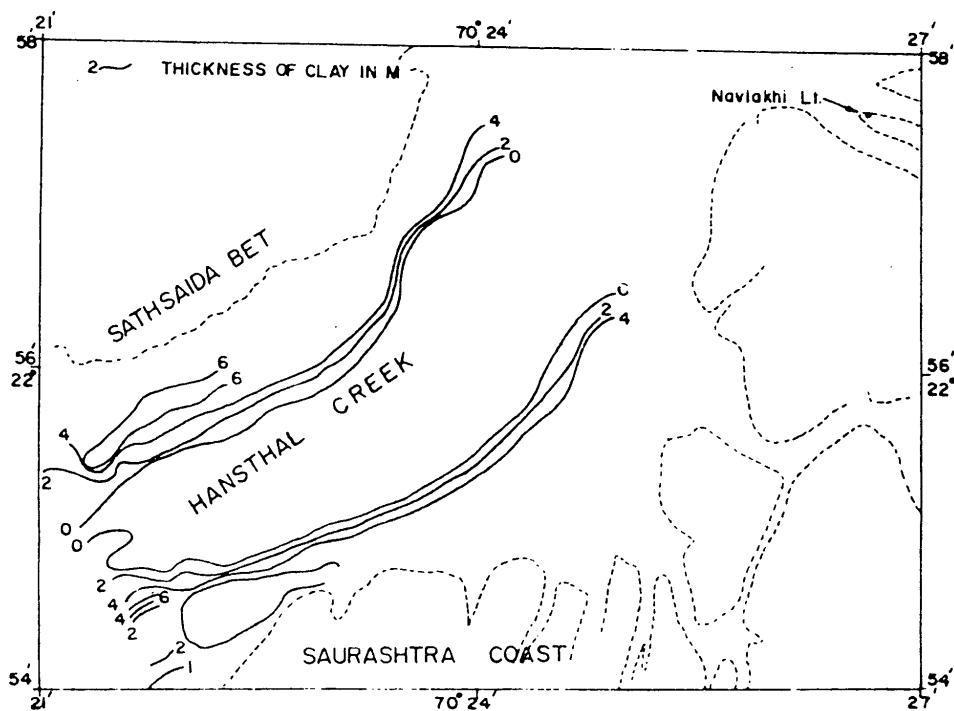


Fig. 3. Isopach map showing thickness of sediments in Hansthal creek.

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