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Imprints of Chilika Lake in the offshore region – a geomorphologic evidence

Chilika Lake is the largest lagoon in the subcontinent along the east coast of India, situated between lat. 19°28' and 19°54'N, and long. 85°05' and 85°38'E. It is a shallow, brackish-water lake formed due to the silting action of the Mahanadi River, which drains into the northern end of the lake, and the northerly currents in the Bay of Bengal, which have formed a sandbar along the eastern shore leading to the formation of a shallow lagoon. During the Pleistocene, the coastline was at the western shores of Chilika¹, and the entire northeastern region above Chilika was under the sea. Since then, the coastline has moved considerably eastward due to sea-level regression. Studies^{2–12} related to the occurrence of topographic highs and relict sediments on the eastern continental shelf of India indicate the presence of different still stands of lower sea levels during late Pleistocene–Holocene due to sea-level oscillations. Three prominent still stands¹³ of the sea level were identified at depths of 30, 100 and 120 m. In particular, the regions off Gopalpur, Orissa coast have revealed^{2,3} the occurrence of some still stands up to a water depth of 120 m. However, the lowest strandlines around 130 m water depth off Mahabalipuram¹² and Visakhapatnam¹¹ are reported to have been formed during the Pleistocene. Many lagoons seen today were formed as a result of a worldwide rise in sea levels over the last 6000–8000 years. There was a pause in the rise in sea level about 7000 years ago, when a sandy beach might have formed near the coast at the southern sector. As the sea rose further, this sand beach grew gradually and progressed northeast, to form what is now the spit of Chilika. A shell of *Ostrea Virginiana* from the southwestern edge of

the spit has been dated at 3750 ± 200 years BP by the radiocarbon method, which indicates the age of the lagoon¹. The spit of Chilika is constantly changing. Due to widening of the sand bar, the position of the mouth has been constantly shifting, moving generally towards the northeast. The mouth connecting the channel to the sea is close to the northeastern end of the lagoon. A 32 km long, narrow outer channel connects the main lagoon to the Bay of Bengal.

The inlet to a lagoon is a product of interaction between waves, currents and sediments. The tidal fluctuation in Chilika Lake is about 0.2 m during non-monsoon periods, driven by a tide in the Bay of Bengal ranging from 0.9 to 2.4 m. Chilika

Lake also receives the benefit of the Mahanadi River flow in keeping the tidal inlet open.

In order to study the morphology of the seafloor over the shelf region between Gopalpur and Paradip, bathymetry data were collected along 12 coast perpendicular traverses within water depths of 40–2300 m (Figure 1), on-board the research vessel *Gaveshani* by National Institute of Oceanography, Visakhapatnam. The echo-sounding records have been digitized at close interval in order to resolve minor topographic variations. The digitized data have been plotted along the survey traverses and a stacked bathymetry profile map has been prepared (Figure 1). Further, the data have been contoured at

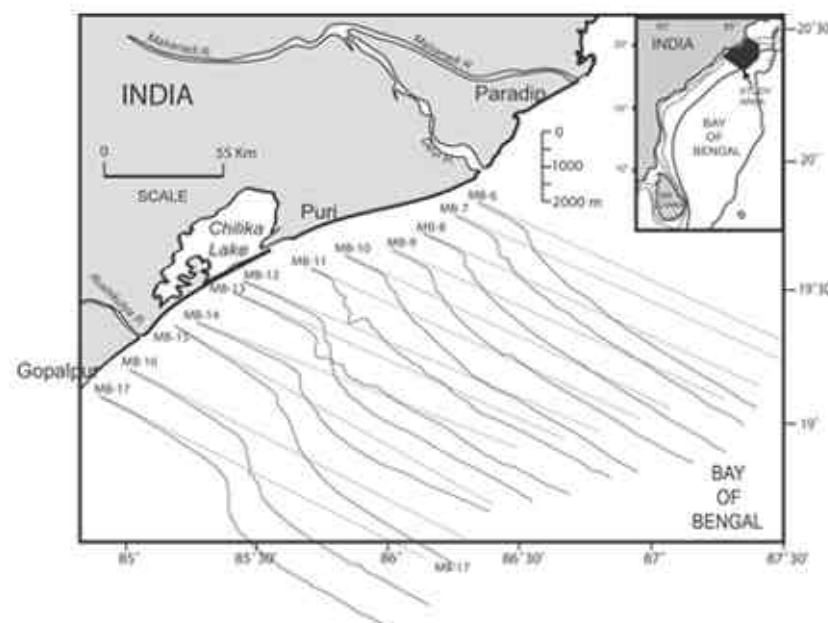


Figure 1. Map showing survey traverses. Bathymetry profiles are shown along the traverses.

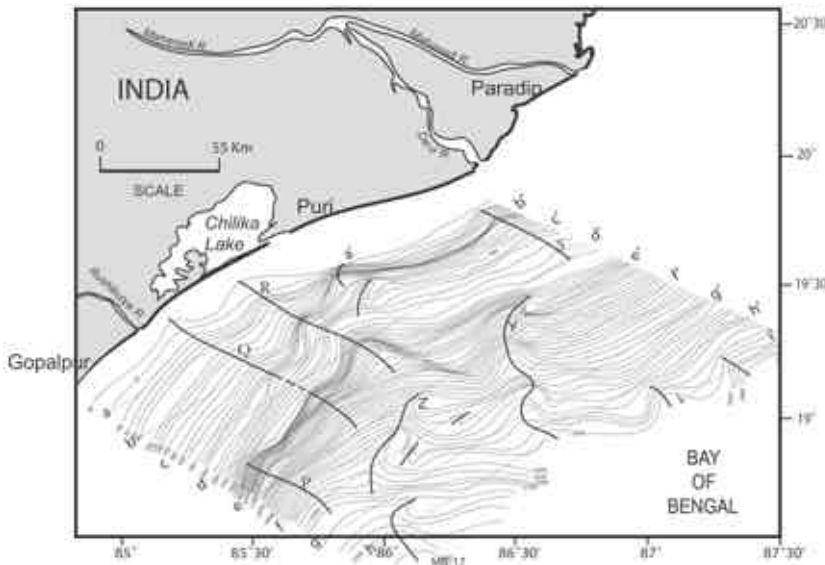


Figure 2. Map showing bathymetry of study area with varied contour interval in metres. Thin dashed lines a-a', b-b', c-c', d-d', e-e', f-f', g-g', h-h' and i-i' indicate coast parallel traverses. Thick solid lines represent channel directions.

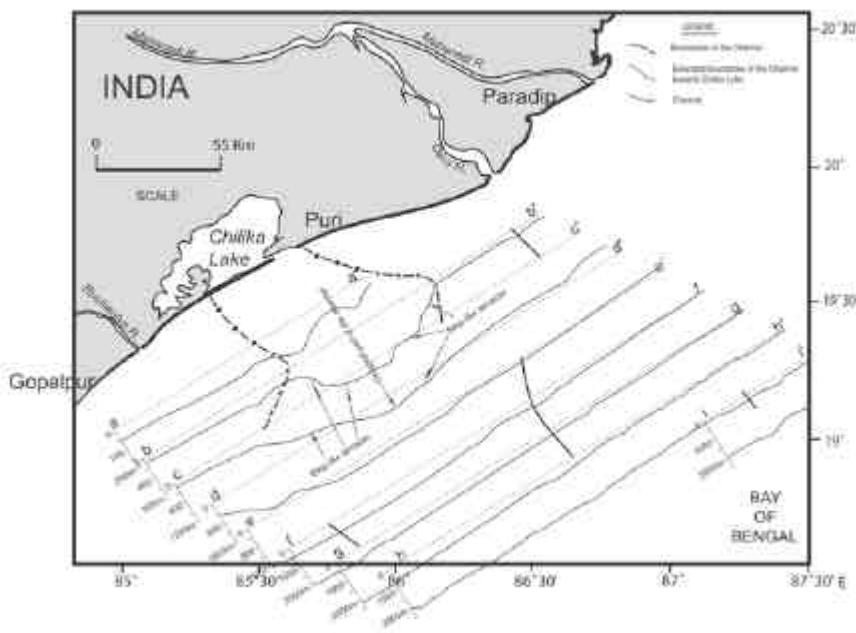


Figure 3. Map showing bathymetry profiles along the coast parallel traverses a-a', b-b', c-c', d-d', e-e', f-f', g-g', h-h' and i-i' selected from the bathymetry map (Figure 2).

a closer interval of 10 m in the near-shore, 20 m in the midshelf and 100 m towards the offshore end (Figure 2), to get an overall view of the seafloor over the shelf.

Bathymetry profiles along the survey traverses (Figure 2) show several channels with varied dimensions in the slope region of the seafloor. Step-like terraces in the slope region followed by a V-shaped

channel of 400 m depth, with a width of 9 km was observed along the profile MB-11. Further, along profiles MB-12 to MB-14, sediment slumps/topographic highs are noticed in the slope region with dimensions varying between 5 and 15 m and a relief of 140 to 400 m from the adjacent seafloor (Figure 1).

Bathymetry contour map (Figure 2) reveals several channels and topography

highs trending NW-SE, N-S and NE-SW direction. These features may be indicators of the present-day river flow pattern on the seafloor. These patterns are seen till the offshore end of the study area up to 2300 m isobath. The NW-SE trending channels denoted as P, Q, R and S, are running perpendicular to the coast (Figure 2). Several minor channels are also mapped. Figure 2 shows converging trend of contours (40-1000 m isobath) up to north of the channel R with high gradient depth pattern near the end of traverse a-a', beyond which it shows diverging trend following the coastline. The trend of the bathymetry contours (Figure 2) off Chilika Lake indicates long and broad channel-like features, which give an indication of imprints of Chilika Lake in the offshore region. The rivers Rushikulya (south of Chilika Lake) and Devi (north of Chilika Lake) do not show the presence of channel-like features on the seabed. Bathymetry maps^{14,15} also show landward trend in the 50, 100, 200 and 500 m isobaths resembling arch shape, indicating channel-like features.

In order to trace the offshore extension or imprints of the huge Chilika Lake, nine coast parallel traverses a-a', b-b', c-c', d-d', e-e', f-f', g-g', h-h' and i-i' have been selected from the bathymetry contour map (Figure 2) and the sections have been plotted (Figure 3). This map depicts a number of NW-SE trending channels on the seafloor from near-shore to the offshore end of the study area. A sickle-shaped geomorphic feature (channel) was observed off Chilika Lake in the bathymetry sections a-a', b-b' and c-c'. The width of this feature in offshore varies between 62 and 92 km. It is narrow at the mouth of the Chilika Lake and broad towards offshore. The depth of this feature from the adjacent seafloor varies from 60 to 700 m.

The presence of this geomorphic feature (channel) off Chilika Lake over the shelf region perhaps suggests the imprints of Chilika Lake in the offshore region (Figure 3). Towards north and south of this feature the seafloor is characterized by smooth topography, except for a few V-shaped channels (Figure 3).

The anatomy of the channel suggests that the turbidity sediments are flowing in a semi-circular manner within the channel. When the muddy sediments strike the lobe/wall within the channel, they bounce back, which in turn leads to the formation of step-like small terraces on the lobe of

the channel. The occurrence of terrace-like features in the upper slope area off Chilika Lake, may also suggest intensive slumping and slope erosion due to direct dumping of sediment when the sea level was at its lowest strandlines¹² along the coast.

Contour map indicates converging trend of contours up to northern edge of the sickle-shaped feature with high gradient depth pattern near the end of the traverse a-a' (Figure 2), beyond which it shows diverging trend following the coastline. This high gradient depth pattern and the northern edge of the sickle-shaped feature probably fall in the region of the southern boundary of the Mahanadi offshore basin.

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Correction

The International Linear Collider: A new paradigm for doing science globally

Rohini Godbole

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The budget estimate of TESLA was incorrectly mentioned as 3000 Billion Euros. It should read 3000 Million (i.e. 3 Billion) Euros. A factual error also needs correction. It was stated that Burt Richter prompted the formation of the International Linear Collider Technical Review Committee, whereas in fact it was David Burke who did this. Of course Burt Richter had been the driving force behind the only e^+e^- linear collider that has been built so far, viz. the SLC and indeed was one of the original proponents of International Collaboration on the LC Research and Development.