

Sea bed morphology off Krishna-Godavari delta with special reference to paralongitudinal channel in abyssal plain

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Study of sea bed morphology off Krishna-Godavari delta reveals 3 distinct geomorphic units, viz. shelf, slope and abyssal plain. The shelf breaks at 100 m isobath and after the slope the plain commences from 2200 m. Various physiographic signatures on the sea bed have been identified. Prominent channels flowing SSE and coast-parallel lineaments, may be expressed as faults, have been identified within the slope. Three paralongitudinal channels, characterised by elevated barriers on the valley floor, inward inclination of subparallel strata and faulted channel walls, are recorded from the abyssal plain. Subsurface undulatory reflections below the channel course indicate lateral movement of the channel. Elevated levees of the channel point to a turbidity-like current flowing through it.

The Bengal Fan is the largest known submarine fan. It extends from lat. 20°N to about 10°S. Geology of Bengal Fan has been studied in great detail^{1,2}. During the Pleistocene low stands of the sea level, huge sediments from the confluence of Ganges and Brahmaputra rivers have drained into the 'swath of no ground submarine canyon' giving rise to a number of turbidity current submarine channels³. These channels have been found to continue into the Indian Ocean up to the south of Sri Lanka. The Geological Survey of India has embarked upon a systematic survey of the Bay of Bengal seafloor within India's EEZ limits. Detailed analysis of the bathymetric data of one such cruise (SM-34A) off Krishna-Godavari delta, has revealed a number of geomorphic features, structural elements and the nature of submarine channels.

Methods

A 3.5 kHz Raytheon LSR on CESP mode recorded the bathymetry from the mothership *R V Samudraman* during January 1987. About 54,000 km² was surveyed with a line run for 4197 km bounded by lat. 15°16' to 14°22'N and long. 84°48' to 83°24'E in the east and lat. 16°16' to 15°36'N and long. 82°20' to 80°54'E in the west. Continuous records were obtained along 12 long and 1 short transects planned approximately normal to the coastline in the study area (Fig. 1). Bathymetric data were processed and plotted on corrected locations on 1 : 7,50,000 scale (NHO Chart 32). Bathymetric profiles on selected parts of the transects were drawn on 1 : 50,000 vertical scale and bathymetric contour map (Fig. 2) was also

prepared on the same linear scale incorporating details of sounding analogues (LSR records) as far as possible.

Results and Discussion

Physiography—Sea floor in the Bay, off Krishna-Godavari delta (Fig. 3), exhibits 3 major well defined physiographic domains, viz. continental shelf, continental slope and abyssal plain between depths of 100 m to 3200 m. The first break is usually recorded at an average depth of 100 m in this area. The shelf widens up to 40 km in between Machilipatnam and Narsapur. Gradient is very gentle (< 0.5°). Steeper gradient ranging between 2° and 2.8° beyond 100 m isobath indicates the slope area and it continues up to 2200 m. The gradient increases a little over 3° between 1100 and 1700 m lying between lat. 15°40' and 16°25'N. Tributaries of Krishna and Godavari in the form of shallow channels appear to have continued offshore in the slope area between 300 and 1300 m

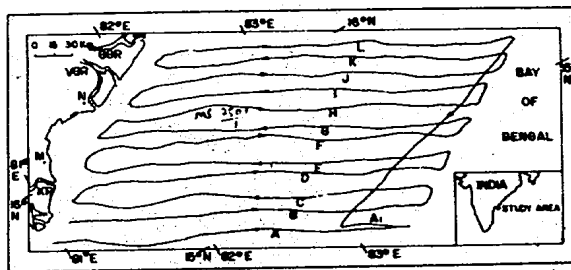


Fig. 1—Location map showing cruise tracks and transects from A to L [KR - Krishna River, VGR - Vashishtha Godavari River, GGR - Gautami Godavari River, M - Machilipatnam, N - Narsapur]

isobaths around $15^{\circ}45'N$ lat. (Fig. 2). These gentle gradient channels (1:40) are separated by a 15 km wide flat topped floor. Sea bottom topography in the 75 km wide slope region is characterized by undulatory surface, boe-ties and a number of sudden breaks in acoustic profiles resembling step structure. Two such prominent step structures are picked up at 2 depth levels on every transect—one between 800 and 1000 m and the other between 1500 and 1600 m. When these locations are transferred to the profile sections, their dispositions portray lineaments which are likely to be of tectonic (Fig. 2).

Gradation from slope to abyssal plain is rather gradual, marked by a total absence of any topographic expression in the profiles drawn. These rule

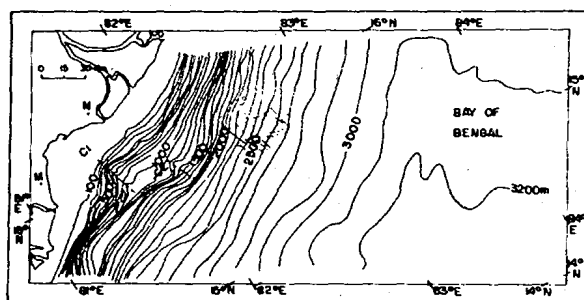


Fig. 2—Bathymetric contour map of the area [C₁ and C₂ are channels]

out the presence of any continental rise in the area beyond 2200 m depth from where the abyssal plain starts. About 25 to 30 km of wide uneven sea floor with very low relief has been regularly reflected from every transect at depths between 2800 and 3000 m. Beyond this the floor is almost flat with contours following general curvilinear configuration of the Bay. Transparent subparallel reflectors defining sedimentary sequences, at least up to a few metres depth from surface, are observed and the surface layers have an overall southerly gradient compatible with that of the sea bottom topography. Submarine channels and meanders are also reflected in the records.

Channel in the abyssal plain—A paralongitudinal channel, about 150 km long, is detected between long. $82^{\circ}40'$ and $83^{\circ}50'E$ within the limited study area, at depths 3000 m. This is considered to be a part of the westernmost channel of the system that falls under the present study. In all transects such channel structures are reflected. Three such channels flow roughly southwards. Passage of the channel is sinuous but sinistral in disposition having at least 2 sinistral breaks in the case of the longest one that appears to have extended both towards north and south. Broadly the channels are V-shaped with wide subrounded to acute hinge. However, detailed studies on the shape and size of the channels, depth of valley, height of levee and some subbottom structures have revealed the nature of the channels.

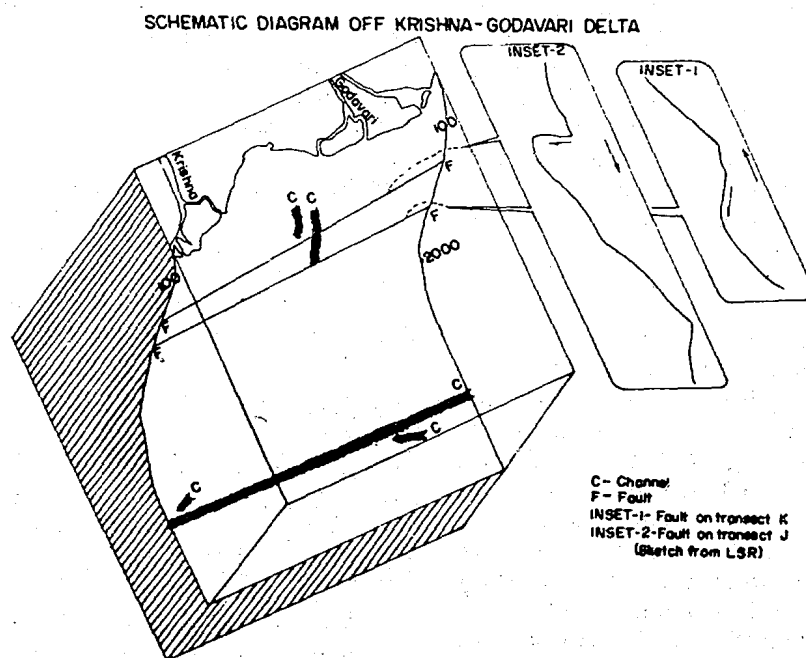


Fig. 3—Schematic diagram of the sea floor of the area

Longest channel is the central one (Fig. 4). Angle of the V of channel floor becomes sharply acute southwards. Channel cutting at its base is occasionally more vigorous forming loops (sections G & H, Fig. 4). An elevated barrier on the broad hinged valley floor (section L, Fig. 4) may indicate either a point bar in the course of submarine meander channel⁴ or slumping of the canyon walls as recognised in Wilmington⁵ or Rhone⁶. Remarkable elevation on both sides of the channel indicates the presence of levee as observed in most sections. At eastern flank of the channel in section G (Fig. 4), a 30 m elevation is certainly significant. Depth of the channel ranges between 30 and 150 m, diminishing southwards. Maximum width is 3 km on the upper part of the valley. Subparallel reflectors in sections E & H (Fig. 4) are abutting against the channel walls. Such reflectors possibly indicate the process of lateral accretion of a channel under submarine conditions⁷. A number of shallow troughs on the sea floor adjacent to the main channel have been reflected in the records. A 40 km

long, 2.5 km wide and 25 m deep broad hinged, V shaped channel has been traced to the east of the long one and another 17 km long, 1.5 km wide and 20 m deep similar channel has been picked up to the west. The latter one appears to have taken a dextral shift. Though the sounding data corroborate the possible continuity of last 2 relatively smaller channels with the principal one, yet it is likely that those 3 are the bathymetric expressions of a single channel. A number of ostensible faults running parallel to either of the channel walls appear on the analogues.

Wavy or undulatory reflectors from a depth of about 300 m below the sea floor along the course of the main channel are picked up in the record in transect C (Fig. 4). The amplitude of reflectors ranges from 200 to 270 m over 40 km lateral length of the transect.

Levee deposits, normal to the channel trend, are characterised by regular, continuous subbottom reflections that converge due to thinning away from the channel. Parallel to the channel trends, levee reflections appear as a group of lensoidal package. This geometry indicates that levees are built as turbidity type currents flow through the channel in the submarine environment. Overbank flow tends to infill the low area, creating a lensoidal depositional package.

Correlation—Between lat. 10° and 19°30'N the Bay of Bengal has been structurally divided into 4 zones⁸: When transferred and superposed this uneven sea floor of the abyssal plain to such structural map, it is observed that the former falls on the "Marginal High 'A'" zone of the map. The present LSR, however, do not show any such high topographic relief in this limited area.

Part of the abyssal plain in the area falls in the "Marginal Basin 'B'" zone. In the regional bathymetric contour map¹, a number of channels are shown to emerge in the form of fan from the mouth of the 'swath of no ground'. The westernmost channel of this channel system coincides with the channel that has been located in the abyssal plain, flowing roughly along long. 83°E. Some important features, viz. (a) a number of shallow troughs on the floor close to the channel, (b) subbottom wavy or undulatory features over 40 km lateral length with high amplitude beneath the main channel, (c) slight inclination of subparallel strata towards channel walls, and (d) occasional abutting of parallel strata against the faulted channel walls indicate lateral movement of channel for a long time under submarine conditions. An elevation on the channel floor along the median line of the canyon is detected towards the northern end of the swerving channel (section L, Fig. 4). Development of levees

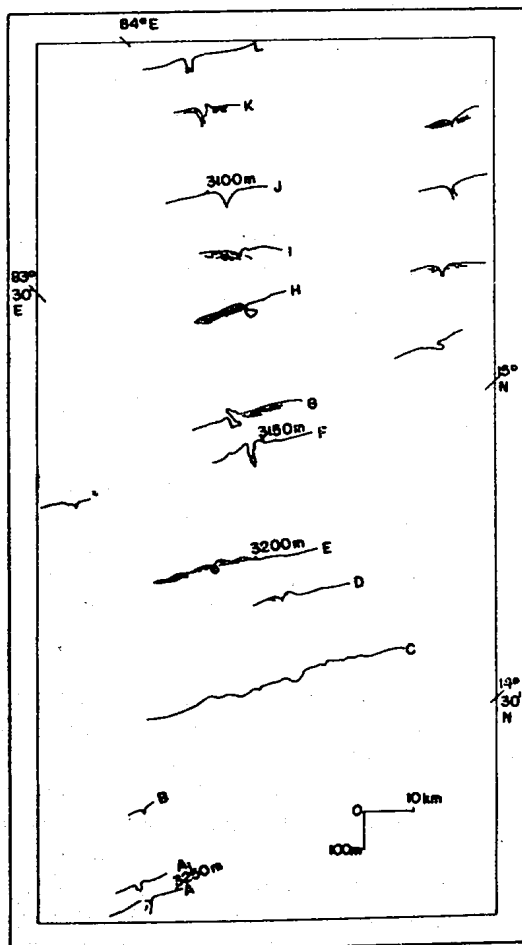


Fig. 4—Profiles of the channels falling on the transects of Fig. 1 on abyssal plain [spot depths in metres shown as 3200]

indicates possible flow of turbidity currents along the channel.

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