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Geophysical Investigations Off Vijaydurg Bay, Maharashtra, West Coast of India

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Bathymetry of the bay indicates a smooth gradient in the sandy zone while steep gradient is marked off cliffs and headlands. In general, the results of the wave action have been seen by the presence of undulation to the level of 3 m in sand covered zones. The extension to the offshore of the existing river channel is also noticed. Seismic profiles display 5 major reflectors which match well with the strata as reported in the bore hole log along the coast consisting of clay, sands, sands and boulders (murrum and sand), altered traps and trap basement. Presence of some faults and intrusions along the reported weak planes, oriented in N—S, NNE and NW—SE has been established on the basis of seismic and magnetic investigations.

Information on the nearshore placer deposits of west coast of India is limited[1-5]. Ever since the report of occurrence of ilmenite-magnetic placers along the beaches of Konkan coast, Maharashtra, much of the work done has been on the economic aspects of mining. Recently, studies on the extension of such placers in the offshore regions have been undertaken by NIO along the Konkan coast. In this communication results of geophysical studies off Vijaydurg bay, south of Konkan coast, are presented.

The Vijaydurg bay (Fig. 1) is an arcuate bay formed at the confluence of Vaghotan river (32 km long) with the Arabian Sea and is marked on both north and south sides by rocky steep head lands of 80 - 90 m high, projecting up to 9 m of water depth. The geological formations on the adjacent land include Kaladgis (Precambrians), Deccan Traps (Upper Cretaceous to Lower Eocene) and laterite (Pleistocene).

Methods

The survey positions were obtained by horizontal angles of 3 triangulated shore stations (central one being the common) using Kelvin Hughes Hydrographic sextants and plotted by a micrometer station pointer on a scale of 1 : 10,000 to an accuracy of ± 10 m. For echosounding, Atlas Deso 10 Echosounder of duel frequency (30 and 210 KHz) with basic scale of 0 - 20 m and maximum range of 280 m was used. The echosounder provided a good resolution and subbottom penetration in clay covered areas. A bar check was usually carried out every day before commencement of the surveys and necessary corrections were made on the records.

High resolution shallow seismic surveys were carried out with an EG & G 3 electrode sparkarray (200-1000 joules) along 3 E-W profiles. For preparing the seismic sections, the velocity of sound in seawater was taken as 1500 m.sec^{-1}. Seabed samples were collected with a Van Veen grab (0.04 m^2) and coring was carried out with a piston gravity corer of 2 m length. The available onshore bore hole data obtained from Ground Water Survey and Development Agency, Maharashtra were also incorporated for interpretation and correlation of the seismic reflectors.

Results and Discussion

Sediment distribution—Analyses of the sediment samples indicate that the seabed is carpeted by medium to fine grained heavy mineral rich sand up to a water depth of about 9 m, beyond which it is covered by silty or clayey sands up to 11 m. In the offshore regions, the grayish black clay dominates below the silty or clayey sand. On coring in the clay covered areas fine silty sand is present underneath the clay.

Bathymetry—The depth in the bay varies from 2 to 19 m with a smooth gradient (1 : 1250, Fig. 2) in the northern part of the bay, where heavy mineral rich sands are concentrated while close to the cliff and head lands the gradient is steep (1 : 10) and sharp. In the southern part close to line 39, presence of topographic high of about 3 - 4 m is a noteworthy feature. In the southwest, off the Danda Creek there is an E-W trending channel possibly representing the remnant of an older river course which is not yet silted off. Drifting of the river course is also evidenced through the curvature observed in the changing channel course, towards the present Vagbotan river, especially at the confluence. This may perhaps be due to pro-

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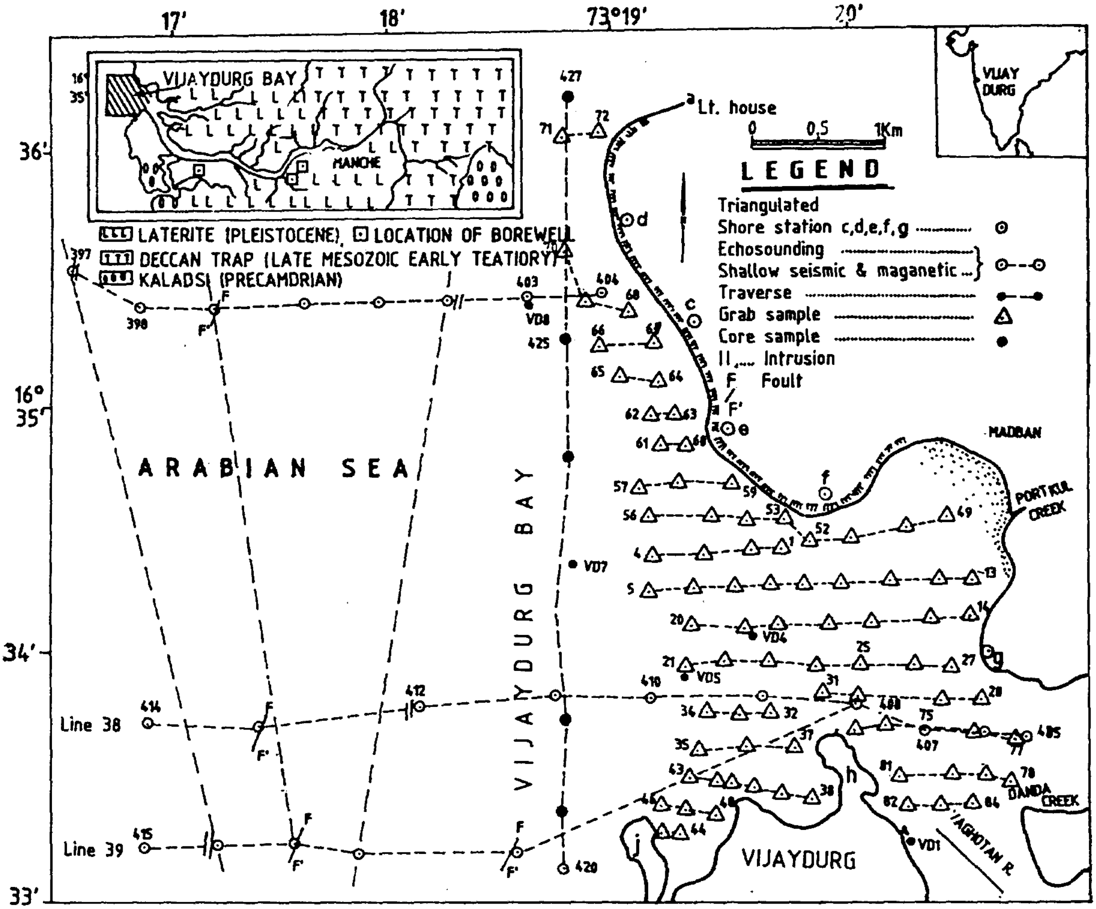

Fig. 1—Location map showing survey tracks, and positions of samples collected and tectonic features noticed (Regional geological set up is indicated in the inset on the top left side)

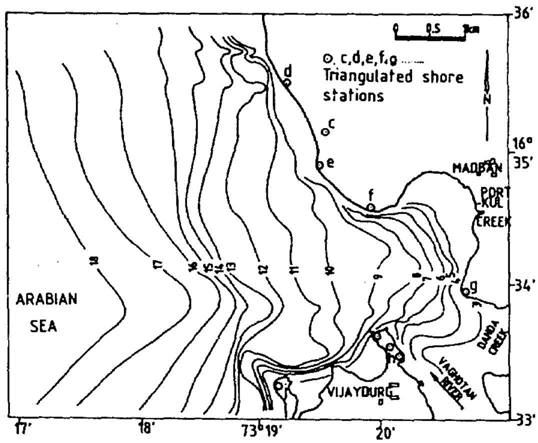

Fig. 2—Bathymetry of Vijaydurg bay (contour interval 1 m)

gressive silting and formation of bar on its northern side. Within the bay up to 9 m the bathymetry shows unevenness of 1 to 2 m. This type of unevenness decreases progressively with depth in the offshore region suggesting reduction in wave turbulence.

A strong acoustic reflector as observed in the echogram (Fig. 3) is due to the presence of heavy mineral rich black sands up to a water depth of 9 m within the bay and is confirmed on the basis of actual sediment samples. Beyond this, it is overlained by acoustically transparent clays (2-3 m thickness) without any disturbance in its nature and is continuous even up to a water depth of 15-20 m.

Seismic results—On the basis of seismic data (Fig. 4) 4 to 5 distinct and continuous reflectors have been identified. An acoustically transparent 1st reflector

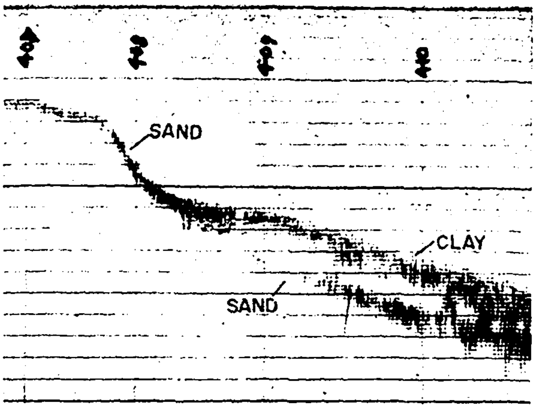

Fig. 3—Echogram showing the continuity of surface heavy mineral rich sand below layer

mapped in the offshore is confirmed to be of clay, while its equivalent surface reflector in the nearshore is interpreted as heavy mineral rich sand layer on the basis of grab sampling. The same sand reflector in the offshore is traced below the acoustic transparent reflector, beyond 9 m. The 3rd reflector (the 2nd in the nearshore and 3rd in the offshore) is mostly uneven in nature and correlated as the layer of sand and pebbles (bore hole data[1]). The 3rd reflector in the nearshore (4th in the offshore) identified between 20 and 40 m depth is more undulatory in character and is relegated to altered trap. Bore hole data confirm the existence of altered traps up to 30 m along the coast as reported by the Ground Water Survey and Development Agency of Govt. of Maharashtra. The bottom most, 5th reflector, beyond which only multiples are more prominent with no penetration in the subsurface layers is considered as Deccan Trap basalts.

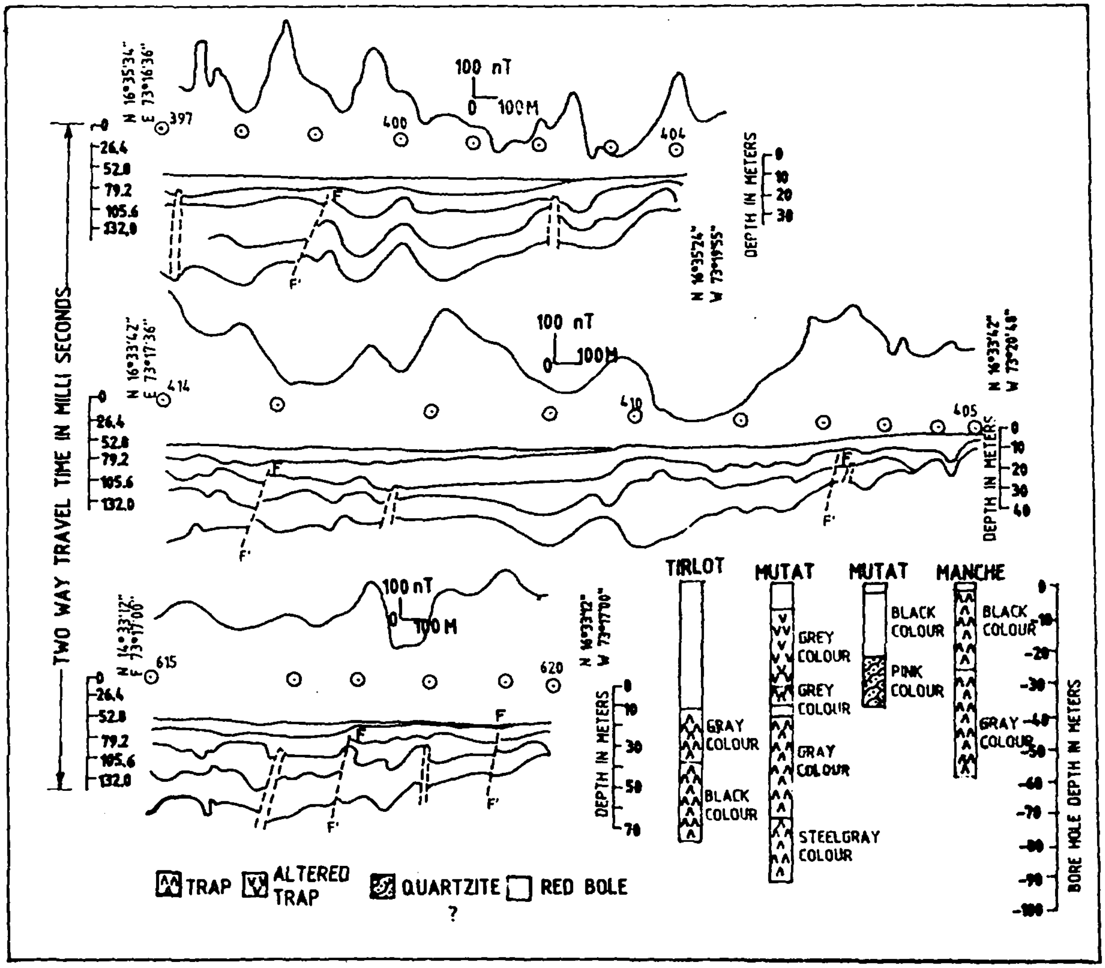

Fig. 4—Interpreted seismic profile with corresponding magnetic profiles and logs of bore holes in the adjacent coastal area

The nature of the acoustic basement depicts a general N-S and NW-SE trends (Fig. 5) with a progressive deepening from the nearshore to the offshore. The sediment thickness varies from 15-55 m over the acoustic basement. Towards east of line 37 a triangular terrace (basement rise) of about 10 m with a sharp fall on either sides has been observed in the seismic records. The sudden deepening of basement noticed along the line 38 may be caused by the erosion resulting in the basin/depression like structures. The parallel trend of the 40 m contours is suggestive of faulting in the basement. However the high amplitude magnetic anomalies suggest intrusive activity along these fault planes[6]. Such a fault might have aided the formation of the nearshore sedimentary basins that have trapped the recent sediments. Similar observations for sedimentation in the shelf in N-S trending sedimentary basins bounded by fault blocks have also been reported earlier on the basis of geomorphological studies[7].

The seismic records also show the presence of flat-topped narrow intrusive like bodies penetrating through the horizontal reflectors, breaking their continuity (Fig. 6). Such features are interpreted as dykes, on the basis of geometry alone. Minor offsets mapped in the subsurface reflectors are attributed as minor faults. The geophysical studies in the north of present area indicate an association of high magnetic signatures with magnetic lineaments. And these magnetic anomalies are interpreted as due to the mineralization within the identified structures like dykes, fractures, joints and faults[6].

By joining such identical features as shown in Fig. 1 the directions of weak planes appear to be N-S, derived out of the faults present in all the 3 lines in the offshore. Some intrusions are invariably noticed on either sides of fault planes, aligned in N-S and NW-SE. These directions confirm to different lineament directions on land[8-10] and in the offshore[6].

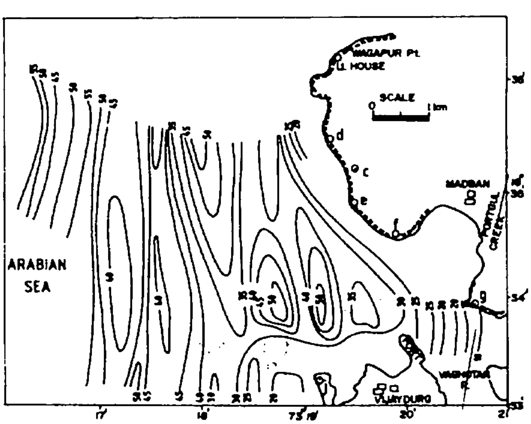

Fig. 5—Isopach map showing the sediment distribution as inferred from seismic profiles of Vijaydurg bay (Isopach interval 5 m)

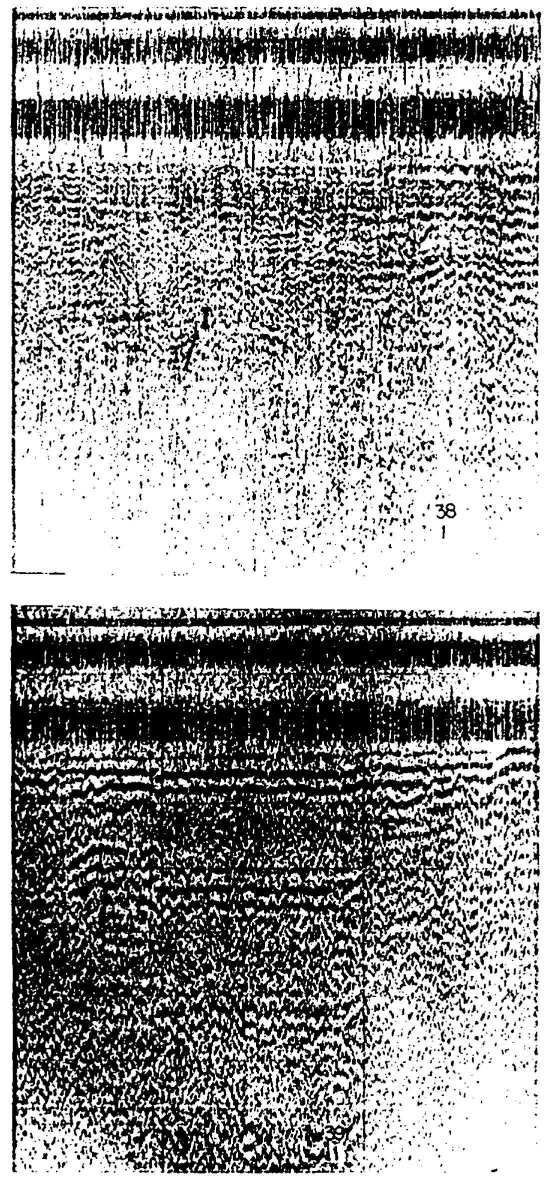

Fig. 6—Shallow seismic records showing probable intrusion (I) and fault (F)

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