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**SURFICIAL GEOLOGY OFF KARWAR, CENTRAL WEST COAST OF INDIA:  
ITS IMPLICATIONS FOR OFFSHORE DEVELOPMENTAL ACTIVITIES**

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**SYNOPSIS**

The results of the marine geophysical investigations revealed that the water depths in the surveyed area vary from <2 to 16 m with a gentle slope towards offshore. The seafloor topography is characterized by shoals, of which some are uncharted hitherto, in the vicinity of Anjadip, Round, Button Rock and Kwada Islands. Seismic studies showed 10-40 m thick sediments on the Precambrian crystalline basement. Sonographs depicted the areal extent of rock outcrops off the mainland promontories and offshore islands. Magnetic studies indicated N-S, NW-SE, NNW-SSE and E-W trending dike-like 10-15 m wide intrusive bodies buried 35-100 m below the seabed. A thorough study of the geophysical data suggested that Binge Bay south of Karwar Head, is suitable for the construction of jetties and other offshore structures. The northern segment joining Binge Point and Anjadip Island and the NW-SE segment joining Arge and Round Islands are favourable for the alignment of breakwater structures. The central region with smooth seafloor topography underlain by soft clays off Binge is a favourable site for anchorage point for shallow as well as deep draught vessels.

## INTRODUCTION

Major ports and harbours were developed on the coasts of India for export and import of commercial cargo. Rapid exploitation of living and non-living resources available on the west coast and its offshore regions demand construction and development of jetties and allied structures at strategic locations. Karwar, being centrally located on the west coast of India and easily accessible, Government of India proposed to construct a harbour for civil/defence purposes. At their request, the National Institute of Oceanography surveyed extensively its offshore area (Figs. 1 and 2) using various geophysical techniques during 1988-'89 to decipher the geological environment for planning engineering structures.

## METHODS

An Atlas DESO 10 echosounder (30 and 210 kHz), EG&G side-scan sonar (105 kHz), ORE sub-bottom profiler (3.5 kHz), and EG&G high resolution sparker/boomer (40-2000 Hz) were deployed for obtaining depth to the seabed, and surface and subsurface geological information. Proton precession magnetometer (G- 801/3) was used for measuring earth's total intensity magnetic field. The positions during the surveys were obtained with Motorola Miniranger MRS III.

The geophysical data (1350 line km of echosounding, 620 line km of side-scan sonar and magnetics and 1850 line km of high resolution seismic reflection profiling) were collected onboard M. V. *Shanta Durga Prasan*. A track spacing of 25 m was maintained with a number of tie lines (Fig. 2). The echosounding data were corrected for tidal variations and reduced to Chart Datum. The sonographs were corrected for lateral distortion. The seismic profiles were interpreted using the sound velocity of 1500 m/sec. The depths thus obtained are apparent only. The offshore bore hole data was used to infer the subsurface geology.

## RESULTS AND DISCUSSION

The depths in the survey area range from <2 m to >16 m. The minimum being recorded along Binge and Kwada Bay shores, in the vicinity of Manzil creek and in the proximity of offshore islands (Fig. 1). In Kamat Bay the depth varies between 1.5 and 14.5 m and the seafloor is smooth and slopes gently towards the west. The northern and southern Binge Bay are characterized by smooth and gently sloping topography. The central corridor about 0.5 km on either side of Round Island is incised by a series of shoals (Fig. 3) resulting in complex seafloor topography. One of the shoals located at 0.6 km NE of Anjadip Island is uncharted (6.5 m water depth) hitherto (Fig. 3c). The echograms also revealed that the seafloor in the vicinity of Kwada and Button Rock islands is uneven with a relief of 4-10m. A large area in the central part of north Binge Bay is characterized by smooth topography with 7-9.5 m water depths.

The sonographs showed rock outcrops in Central Binge Bay (Fig. 4a) near offshore islands viz. N and NE and southern tip of Anjadip (Fig. 4b), Round, Arge, Button Rock and Kwada Islands, and in the offshore areas near mainland rocky shores of Baitkal and Binge Points, Arge Cape (Fig. 1), Edge Rocks and Rounded Rocks (Kwada Bay). These (Fig. 4b) confirmed the presence of uneven topography/shoals recorded on echograms (Fig. 3c).

The seismic profiles are characterized by 3-4 prominent subbottom reflectors around 1.5 - 2 m, 4-6 m, 8-10 m and at deeper levels. The first two reflectors which are parallel to the seabed are comprised of sands / silty sands near the shore confining their lateral extent up to about 8 m depth contour. In the offshore area the topmost 1-2 m thick clayey horizon is underlain by sandy/ silty clays. Stiff clays occur occasionally below 8 m. This horizon is underlain by a well defined acoustic basement marked by sudden deepening and shallowing (Figs. 5&6). The offshore bore hole data complimented the mapped acoustic basement as fresh granite. The seismic profiles off north of Arge Cape-Button Rock Island showed a typical subbottom penetration of 5-10 m and a maximum of 45m

(Fig.6). The isopachs (total sediment thickness) revealed a minimum sediment thickness of <1 m on the rock exposures to more than 40 m in the basement depressions, the average being 10-12 m. The bedrock level contour pattern depicted an irregular basement terrain characterized by deep erosional features resembling valleys/depressions, later filled with recent sediments (Fig. 6). Several N-S, NW-SE, NNW-SSE and E-W trending intrusives/dike like features 35-100 m below the seabed were identified with magnetic studies (Fig. 1). The area between north and central Binge Bay is relatively stable due to the absence of major structural lineations.

### CONCLUSIONS

1. The Binge Bay is ideal for planning offshore installations and harbour approaches.
2. The extent of rock outcrops mapped northeast of Anjadip Island and west of Binge Point may be considered for planning northern breakwater alignment.
3. The central part of Binge Bay with appreciable sediment thickness and stable basement could be considered as anchorage point.
4. The area lying between Round Island and uncharted rock outcrop located 600 m NE of southern tip of Anjadip Island may be suitable for approach channel alignment as it is characterised by 8-10 thick sediments below the seafloor.
5. The rocky terrain close to the eastern shore of Arge Cape can be utilized while planning for jetties, wharfs and allied structures.

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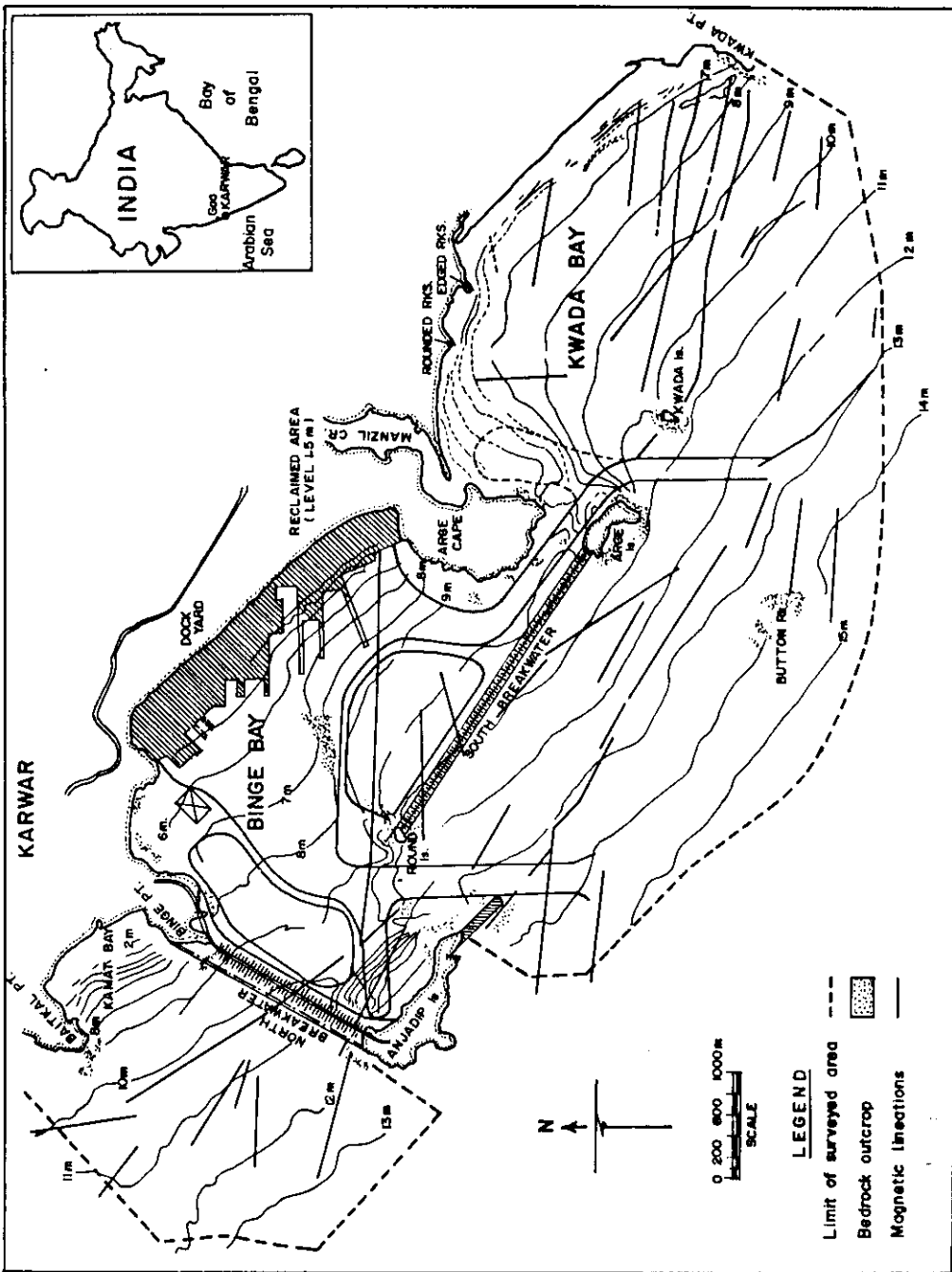


Fig. 1 Map showing the geophysical survey coverage off Karwar. Bathymetric, side-scan sonar and magnetic survey results are also depicted.

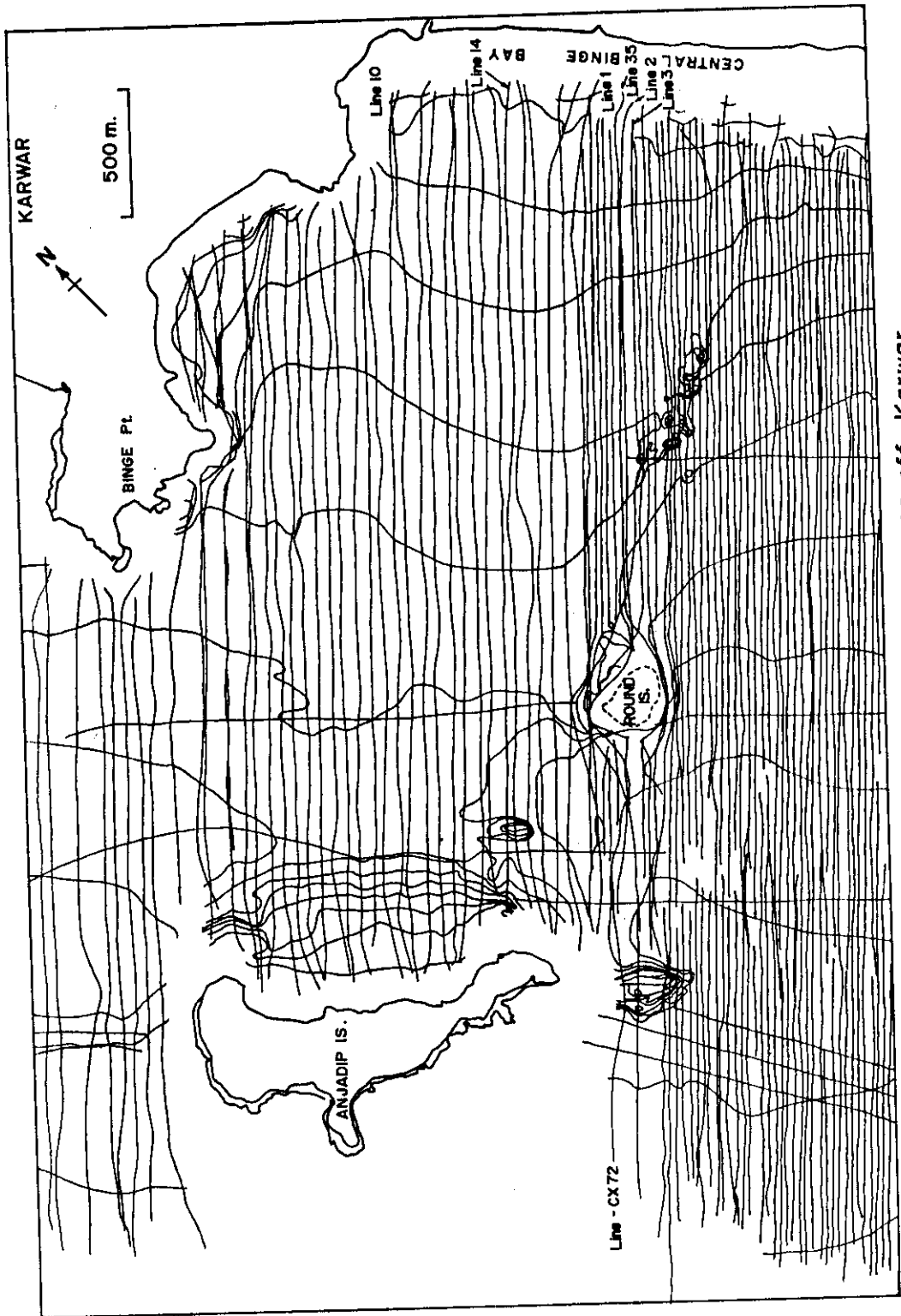


Fig.2 Location of representative tracklines in the survey area off Karwar.

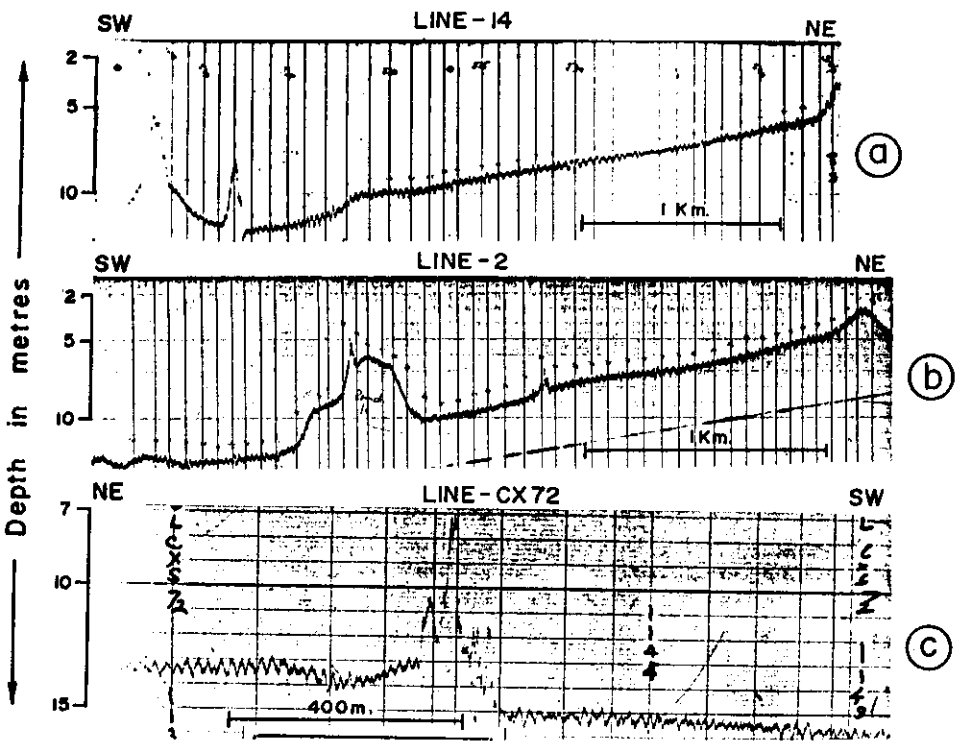


Fig.3 Echograms showing (a,b) steep seafloor near Binge shore (NE) and (c) rugged topography SE of Anjadip Is.

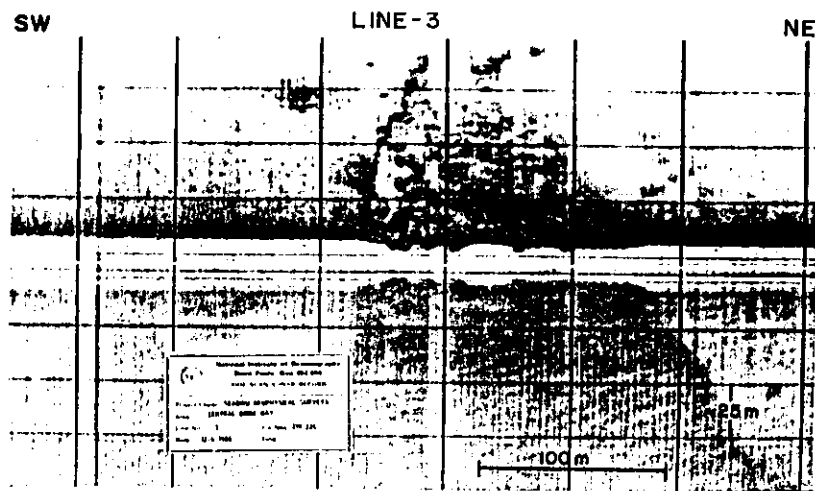


Fig.4a Sonograph showing surface expression of submarine ridge 0.8 km. NE of Round Is.

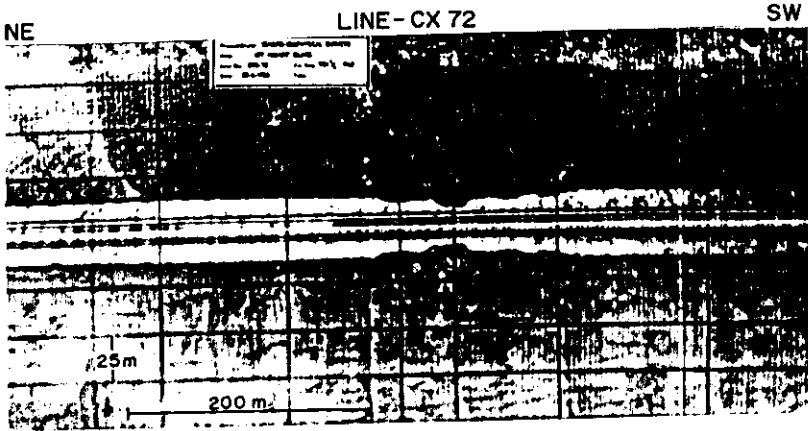


Fig.4b Sonograph showing irregular rocky seafloor SE of Anjadip Is.

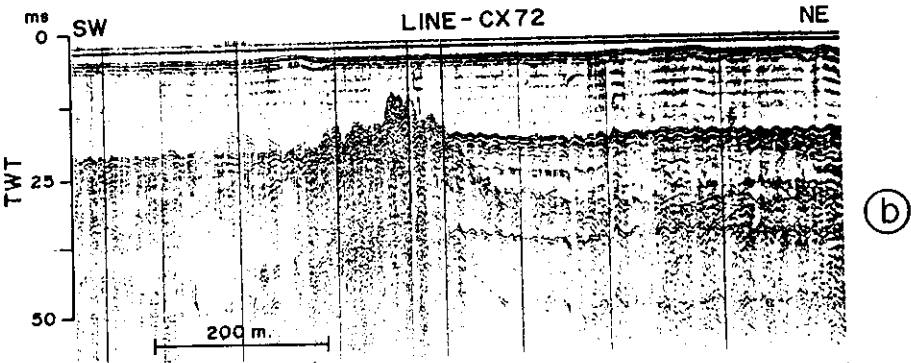
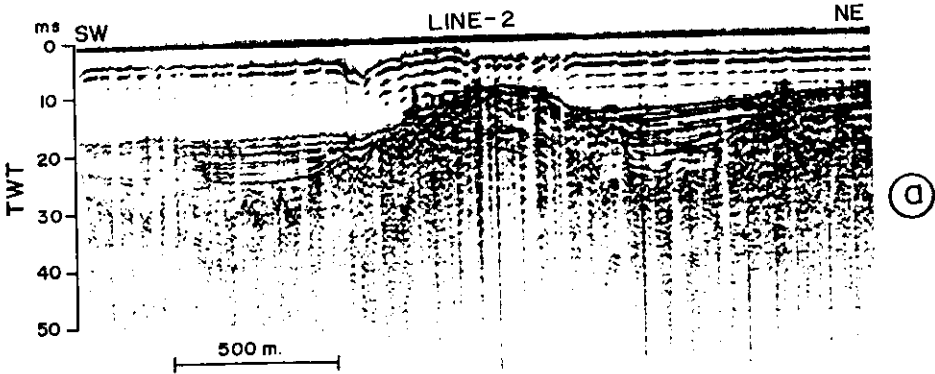


Fig.5 Sparker records showing the surface expression of (a) Round Is. and (b) rock outcrop SE of Anjadip Is.



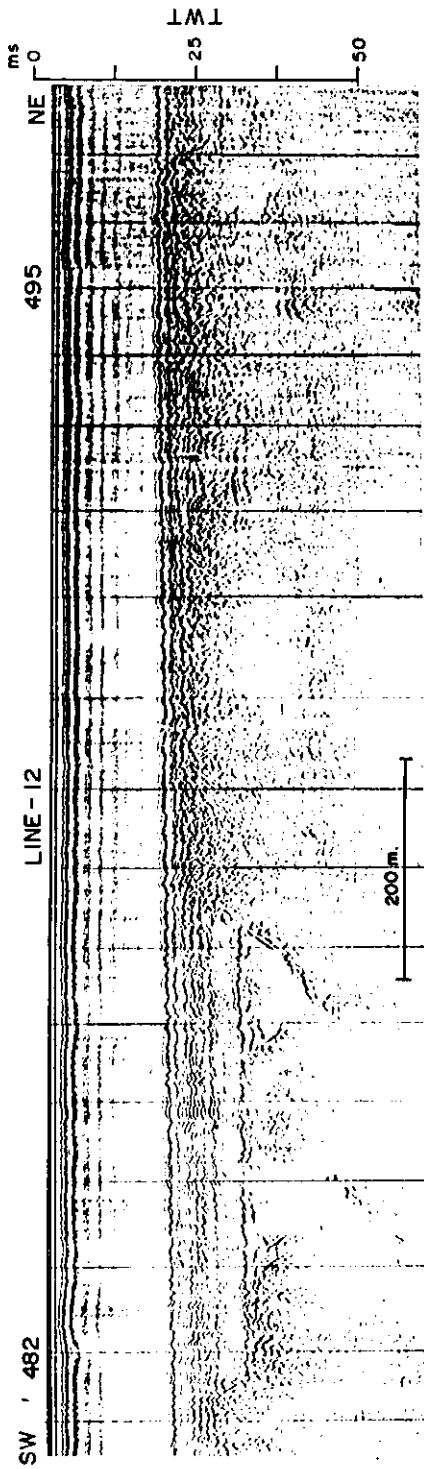


Fig.5c. Sparker record showing stratified sediments, deep in-filled valleys and acoustic basement north of Arge Is.

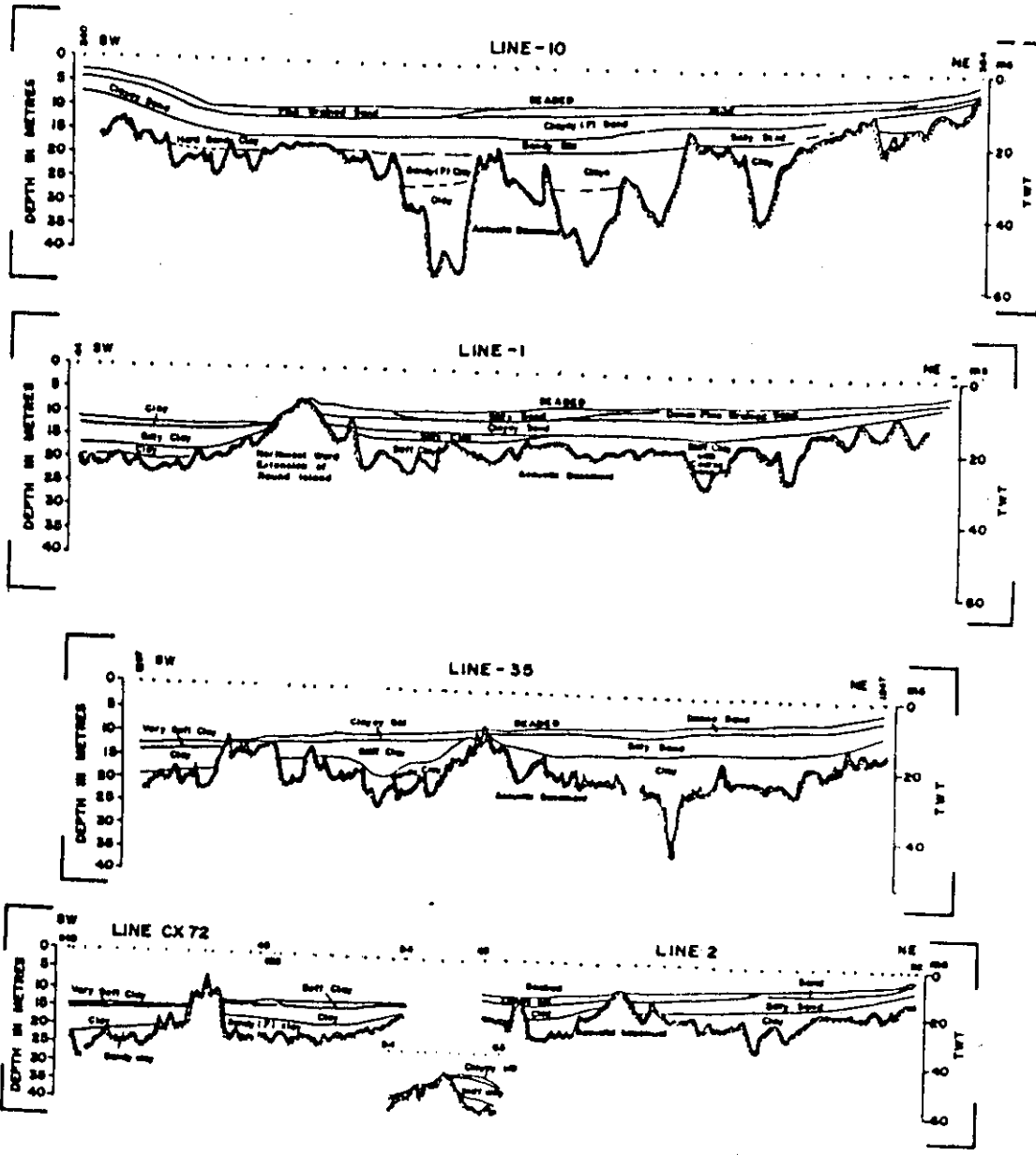


Fig. 6 Typical seismic sections along selected NE-SW profiles showing 3-4 prominent reflectors and basement.