

21796

**GEOMORPHOLOGY AND SHALLOW STRUCTURE OF THE DIRECTION BANK OFF
BOMBAY, WESTERN CONTINENTAL MARGIN OF INDIA: ITS IMPLICATIONS
FOR OFFSHORE EXPLORATION**

Dr. M. Veerayya
Scientist

Dr.V. Subrahmanyam
Scientist

National Institute of Oceanography, Dona Paula, Goa 403 004

SYNOPSIS

The Direction Bank located 40 km SSW off Bombay trends NNW-SSE and is approximately 50 km long. The bank is marked by uneven topography with relative variations of about 1 m, while the topography is fairly even beyond the northern edge of the bank. The sonographs show 50-400 m wide, ENE-WSW trending sand ribbons, low amplitude sand waves and/or gravel filled depressions and these corroborate the presence of uneven topography on the bank. The seismic records indicate a maximum penetration of 100 m. A prominent subbottom reflector 5-35 m beneath the seabed indicate the presence of acoustically transparent clays, the maximum being in the southern part of the bank. The clay thickness decreases from the axis of the bank towards the east as well as towards the north. Bore hole data reveal that the clays are occasionally underlain by 5-12 m thick weakly cemented carbonate sands below which again thick stiff calcareous clays occur. The southern part of the bank shows acoustic masking (25-900 m wide) due to gases which even reaches up to < 15 m below the seafloor. On the other hand, the area beyond the northern

edge of the bank is characterized by 1-2 km wide and 20-35 m deep numerous buried channels which probably represent Late Pleistocene erosional surfaces later filled with Recent sediments.

The study provided an insight into the character of the seabed and its shallow structure which revealed some important geological features such as uneven topography, gas-charged sediments and buried channels. The demarcation of these specific regions would be useful in evaluating the seabed conditions to ensure safety for structures and related developmental activities.

INTRODUCTION

The western continental shelf of India is divided into four major offshore sedimentary basins from north to south: the Kutch, Bombay, Konkan and Kerala (RAMASWAMY and RAO 1980). Since last two decades, the offshore engineering activities in the Bombay harbour and surrounding areas witnessed remarkable growth. The National Institute of Oceanography, Goa, carried out several high-resolution geophysical surveys and provided the engineering project designers with the required subsurface geological information. Several workers have studied the subsurface geology, acoustic maskings in sediment, occurrence of sand waves and ripples on the seabed and seabed conditions for offshore constructions on the northwestern continental shelf of India. Magnetic anomalies over the Direction Bank (SUBBA RAJU and SUBRAHMANYAM 1988) reveal that the bank is a faulted structure. The offshore structures, Bombay high and Bassein have been explored in detail for oil and gas and exploration is continuing on the Direction Bank structure. This kind of developmental activities in the offshore regions required a study of the environment, surface and subsurface geological features of the seabed for the safe deployment of drilling rigs, platforms, single buoy moorings, wellheads and pipelines. This paper describes the results of detailed geological and geophysical surveys carried out on the Direction Bank and their implications.

METHODS

The positions were obtained by Decca 80309 A Receiver, Mini Ranger and Shoran systems. The bathymetric data were collected using Kelvin & Hughes MS-45 echosounder (30 KHz) and corrected for the tides. An EG&G mark IB side-scan sonar (105 kHz) was used for seafloor mapping. A Huntec Hydrosonde M2A system (main pulse: 5 kHz), EG&G sparker (40-2000 Hz) and ORE sub-bottom profiler (3.5 kHz) were used for inferring the subsurface geology. About 1000 line km of echosounding, 200 line km of side-scan sonar and 1700 line km of shallow seismic profiling data (Fig. 1) collected onboard R.V. GAVESHANI were used for interpretation.

RESULTS AND DISCUSSION

Bathymetry: The depths vary from 38 m on the southern part of the Bank to 65 m in the northwestern part (Fig. 2). The crest of the bank is about 3 to 5 km wide and has a uniform depth of about 40 m. The depths increase from the crest of the bank to the west as also to the east. The western flank is narrow and relatively steep than the eastern flank, the gradients range from 1:900 to 1:400 and 1:800 to 1:1200 respectively. The depths increase towards the north to about 60 m beyond 18°40'N. The seabed beyond the northern edge of the bank is fairly even (Fig. 3a,b) and slopes gently to the north (Fig. 2) with gradients of 1:1200 to 1:1000 and become almost flat for over 10 km. The topography over the bank is uneven (Fig. 3c,d) and is marked by ENE-WSW trending linear depressions which are prominent with 1 m relative elevation. The depressions are broad and widely spaced on the southern part whereas they are narrow and closely spaced on the northern part.

Side-scan sonar: The sonographs indicate sand ribbons, low amplitude sand waves and/or gravel filled depressions (Fig. 4). These are 50 to 400 m wide, 1 km long and trend ENE-WSW. The sand ribbons are wider on the southern part and narrower in the northern part and are superimposed by mega ripples.

Shallow seismics: The seismic records indicate a maximum penetration of about 100 m. A prominent reflector occurs between 5 and 35 m and often surfaces up at a few locations. Further, in most of the lines reflectors at 40-45 m and 70-75 m have also been traced for a considerable length. The reflectors largely dip to the west. The records of the northern portion of the bank show 1-2 km wide and 20-30 m deep numerous depressions filled later with acoustically transparent clays (Fig. 5a). These are frequent immediate north of the bank but less frequent and wider further north. On the other hand, the records of the southern part of the bank show acoustic masking (Fig. 5b) due to gases, which are concentrated on the crest and the western flank. The maskings are inverted U-shaped with almost flat tops and steep sides (Fig. 5). These are 25-900 m wide and extend from a prominent reflector which is about 30-35 m deep and reach within <15-20 m of the seabed. The isopachs (Fig. 6) show 35 m thick sediments at the southernmost part of the bank and the thickness decreases towards the flanks. The thickness gradually decreases along the axis of the bank to the north. The clay thickness is fairly uniform in the north (5- 10 m). Bore hole data confirmed that the clays are underlain by 5-12 m thick weakly cemented carbonate sands below which again thick stiff calcareous clays occur.

Based on the above inferences it is concluded that demarcation of such regions would be useful in evaluating the seabed conditions and geo-hazards to ensure safety for structures and related developmental activities.

ACKNOWLEDGEMENTS

We thank Dr. B.N. Desai, Director and Dr. R.R. Nair, National Institute of Oceanography, Goa for their interest in the work. The Oil and Natural Gas Commission, Government of India sponsored the surveys.

REFERENCES

- RAMASWAMY, V and K.L.N. RAO (1980) Geology of the continental shelf off the west of India. In: A.B. MIALL (Editor), Facts and Principles of World Petroleum Occurrences. Can. Soc. Petro. Geol., pp: 801-821.
- SUBBA RAJU, L.V. and V. SUBRAHMANYAM (1988) Marine magnetic anomalies over the Direction Bank, off Bombay, western continental shelf of India. J. Assoc. Expl. Geophys., V. IX, No. 4, pp: 173-180.

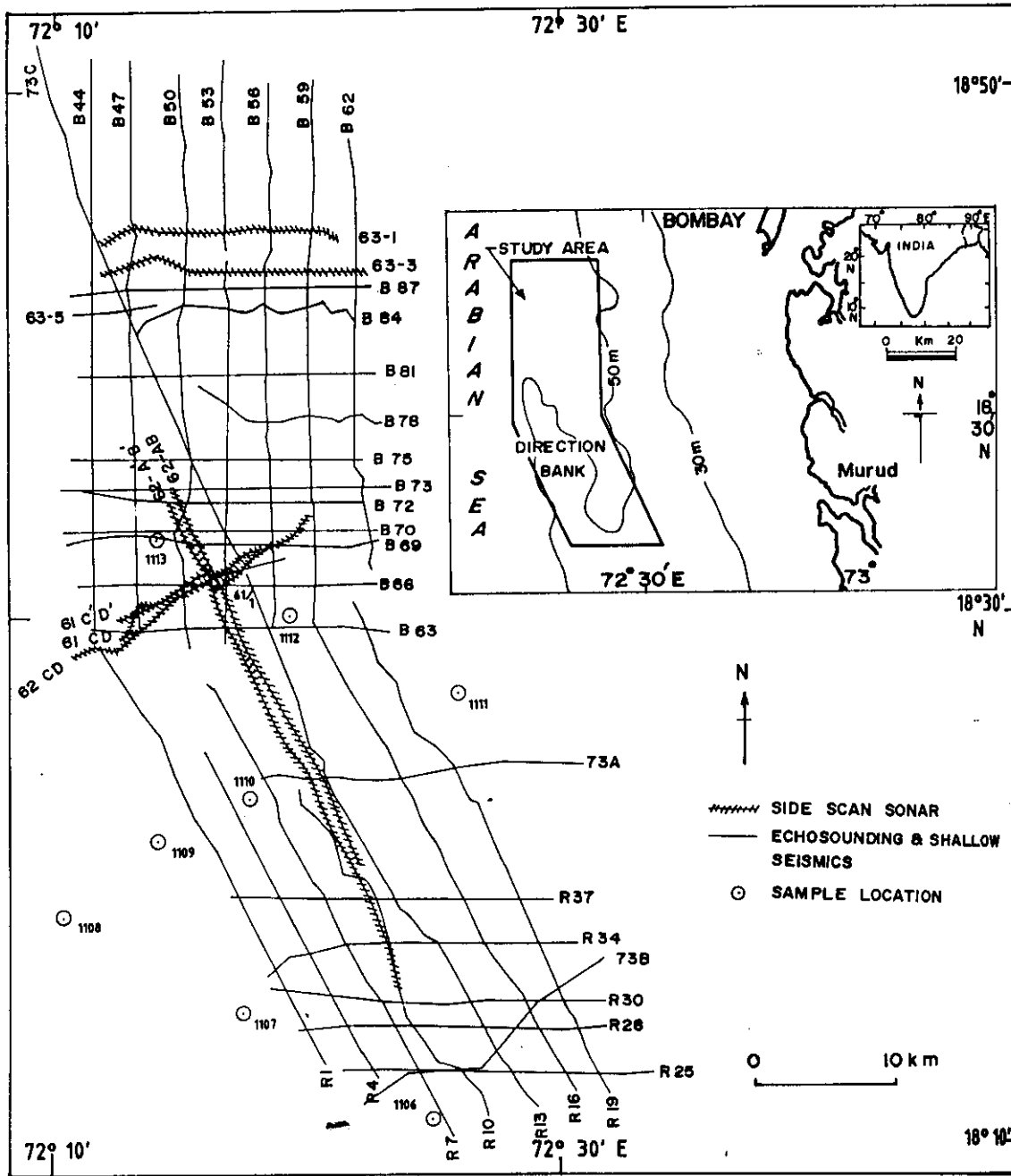


Fig.1 MAP SHOWING SURVEY TRACKS

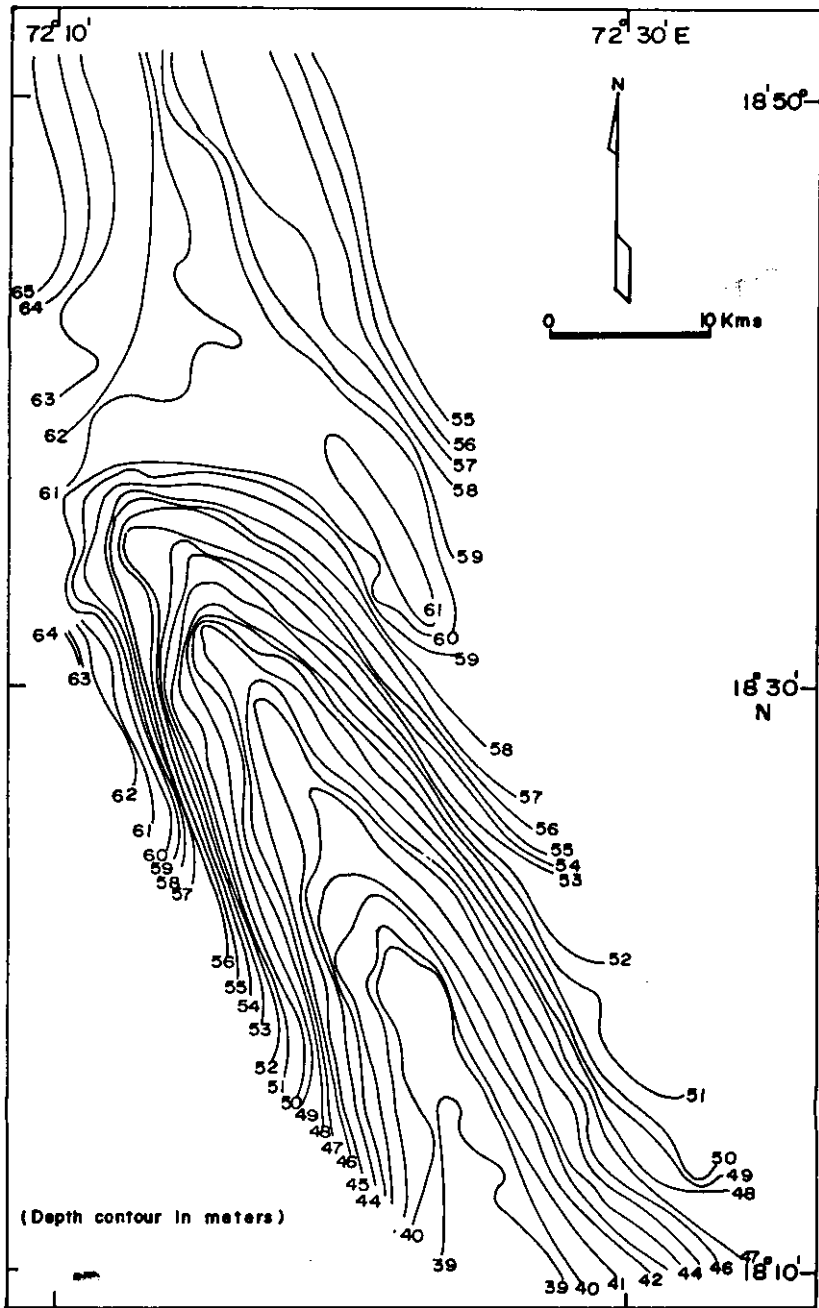


Fig. 2 MAP SHOWING BATHYMETRY OF THE STUDY AREA

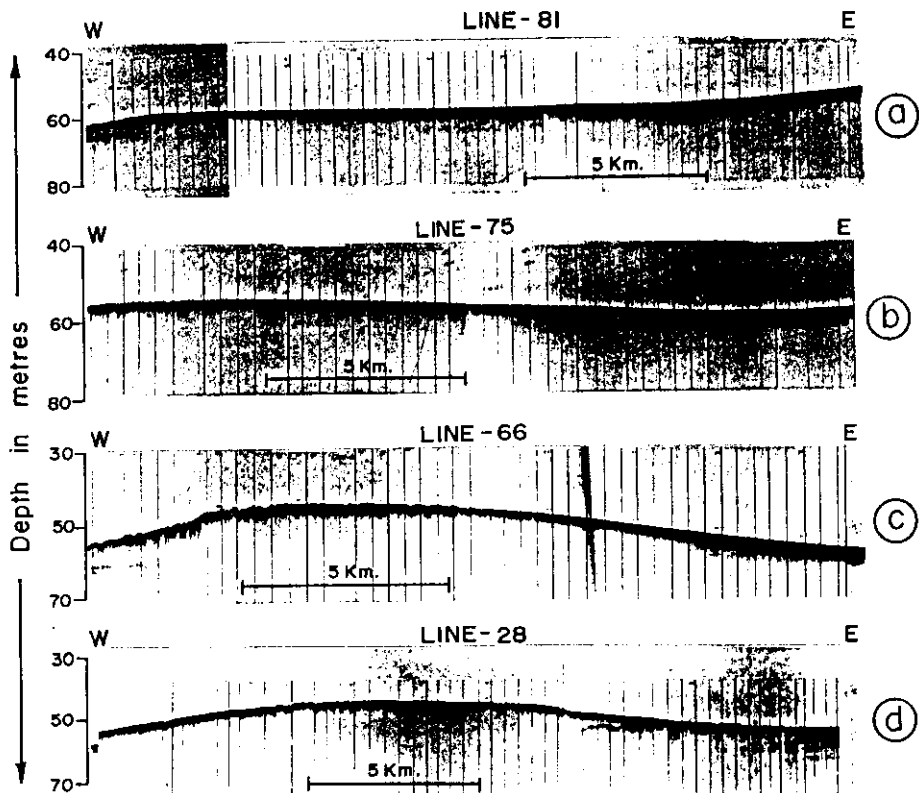


Fig. 3 Echograms showing even (a,b) and uneven (c,d) topography.

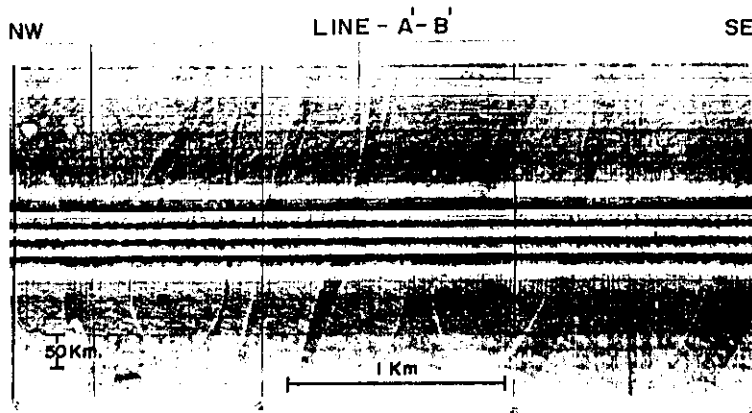


Fig. 4 Sonograph showing sand ribbons on the Direction Bank.

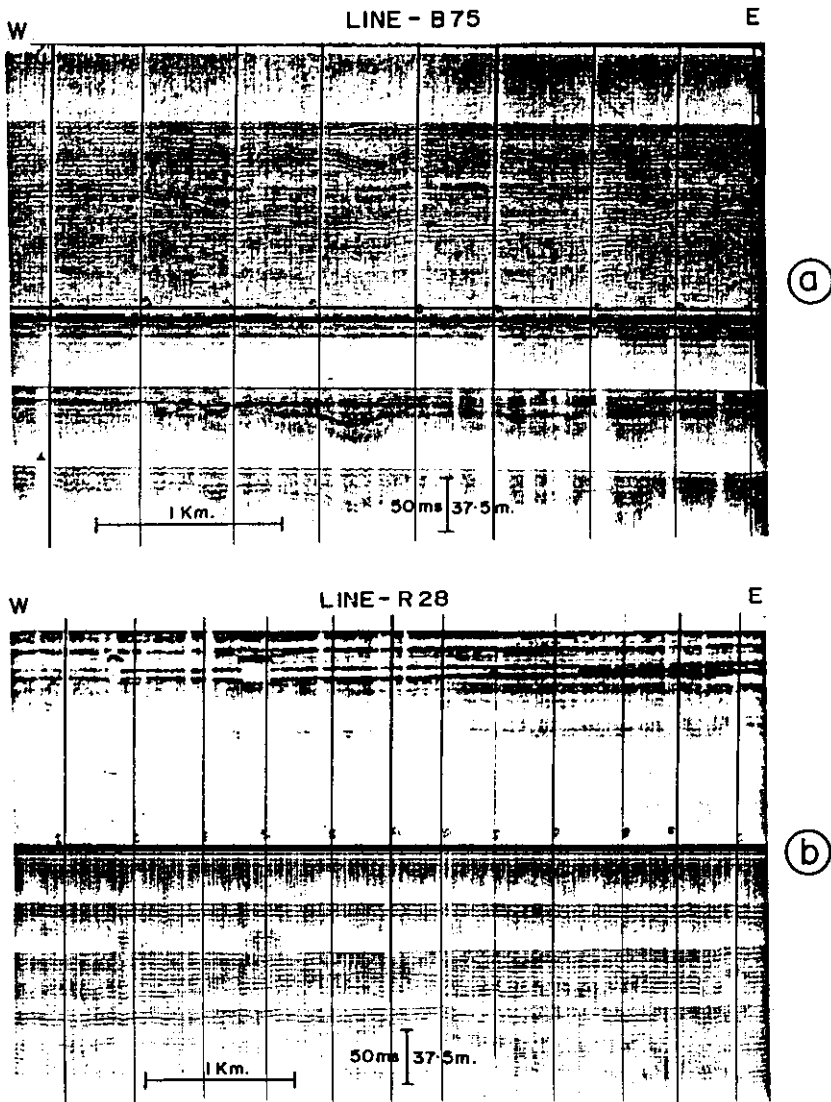


Fig. 5 Shallow seismic records showing buried channels in the northern part (a) and acoustic masking due to gases in the southern part (b) of the bank.

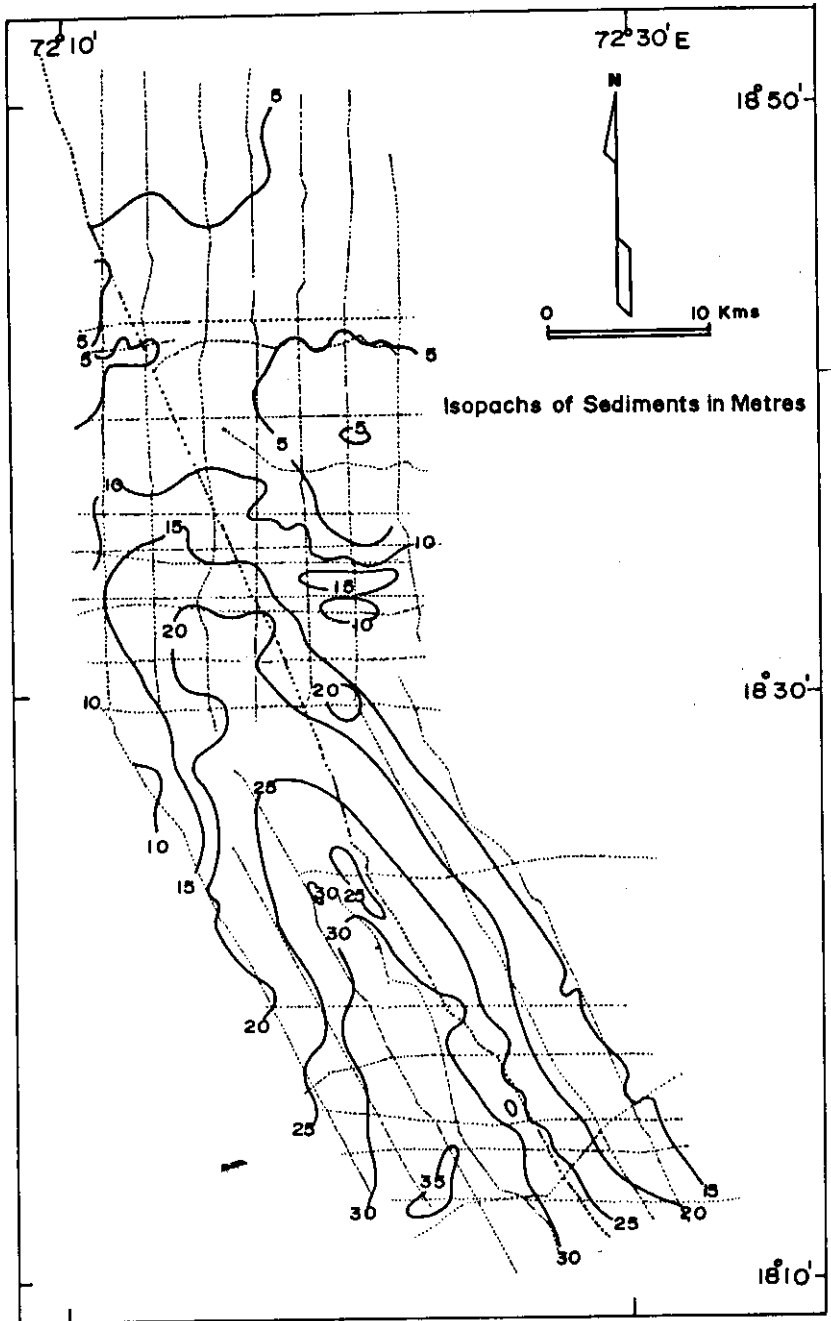


Fig. 6 MAP SHOWING ISOPACHS OF SEDIMENTS