

# Short Communications

## Acoustic Masking Due to Gases in Shallow Seismic Profiling on the Shelf Off Bombay

H N SIDDIQUIE, D GOPALA RAO, M VEERAYYA &  
B G WAGLE

National Institute of Oceanography  
Dona Paula, Goa 403004

Received 7 June 1979

Shallow seismic profiling on the inner shelf off Bombay indicates 25-35 m thick acoustically transparent clays covering the seabed. At depths of 22 to 30 m and 50 m the profiles and echograms are marked by turbidity resembling inverted U- or mushroom like features which extend from the underlying reflector, i.e. sand and reach within 5-10 m of the surface. These features resemble the acoustic masking due to gases reported in shallow seismic profiles and echograms from estuaries and bays elsewhere. The gases may have originated due to the biogenic degradation of organic matter or seepage from greater depths because these occurrences lie in a basin with known oil and gas fields.

Occurrence of acoustic masking in seismic profiles and echograms has been reported from lakes<sup>1,2</sup> while Schubel<sup>3</sup> has documented its presence in estuaries and bays. The anomalous high seismic velocities and structures in the deep sea sediments of Blake-Bahama ridge<sup>4</sup>, the Bering Sea<sup>4</sup> and the continental margin off

Africa<sup>5</sup> have been interpreted as due to gas-rich sediments. Shallow corings and detailed studies confirm the occurrence of gases in acoustically turbid zones in the Chesapeake Bay<sup>3</sup>, while Deep Sea Drilling on the Blake outer ridge confirms the occurrence of gases in sediments marked by unusually high seismic velocities<sup>6</sup>.

*RV Gaveshani* has been carrying out a systematic survey of the western continental margin of India on tracks spaced at about 20 km normal to the coast. The surveys comprise echosoundings (Kelvin and Hughes MS 45-30 kHz), side scan sonar (EG & G - Mark IB, dual channel recorder 259-3 and tow fish 272), shallow seismic profiling (Huntec Hydrosonde M2A, main pulse 5 kHz) and magnetics followed by sampling with grabs, snappers, dredges and corers. Surveys carried out during the last 3 yr have covered wide areas of the continental shelf off Bombay, between Ratnagiri and Mormugao and from Karwar to Cochin.

*RV Gaveshani* during the 4th and 5th cruises surveyed the continental shelf off Bombay extending from a depth of 10 to 80 m. The shallow seismic profiles on the inner shelf between 22 to 30 m and at about 50 m depth indicated extensive acoustic masking (Fig. 1). The inner shelf in this area is marked by even

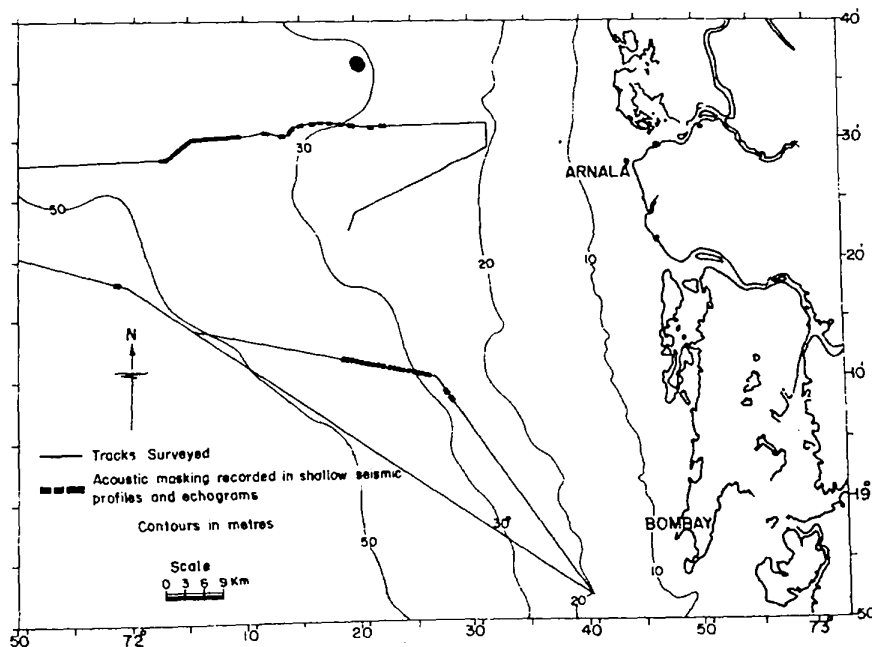


Fig. 1—Tracks surveyed with echosounder, side scan sonar and shallow seismic profiler on the inner shelf off Bombay

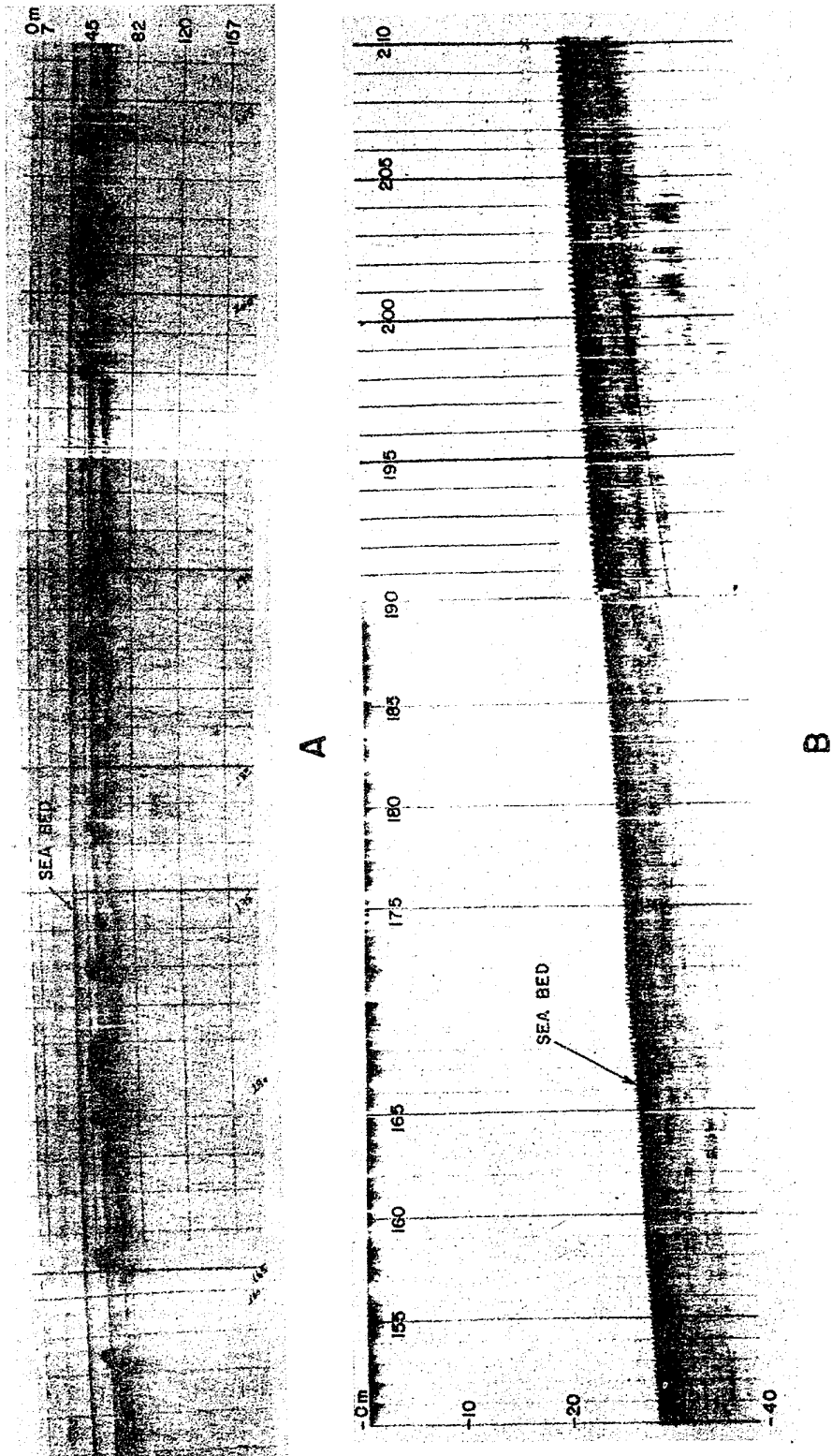


Fig. 2—(A) Shallow seismic profile of a part of the track shown in Fig. 1 [The record represents only some portions of the profile shown in Fig. 3 and in echogram below. The profile shows transparent clays overlying a sandy horizon. The reflector within the clay represents a change in lithology from clays in the upper part to sandy clays with shells in the lower part. The vertical scale is shown on the profile while the horizontal scale is 200 m between fixes]. (B) Echogram showing topography in the area [Because of lower frequency some subbottom penetration is also achieved. The echogram also shows similar acoustic masking as in seismic profiles due to gases, it is more pronounced between fixes 200 and 205]

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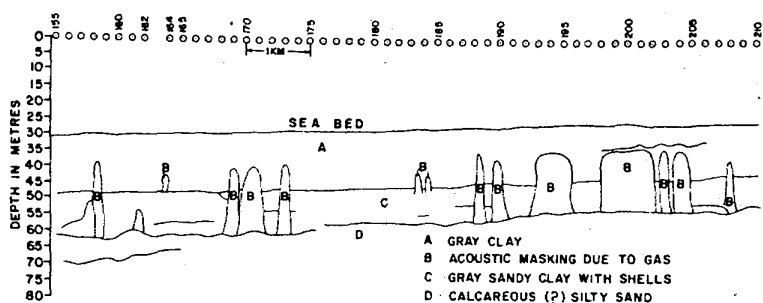


Fig. 3—Interpreted profile based on echograms and shallow seismic records shown in Fig. 2 [Mark the numerous acoustic maskings due to gases in the profiles, these appear to originate below the underlying reflector]

topography and is covered by clays. Shallow seismic profiles indicate that acoustically transparent clays ranging in thickness from 25 to 35 m cover the seabed. Shallow bore hole records in the adjacent area to the northwest indicate that a well defined reflector within the acoustically transparent clays separates the top 15-20 m thick clays from the underlying sandy clays with shells. These clays are underlain by calcareous silty sands which may change to terrigenous sands to the east towards the shore. At some places these acoustically transparent clays are marked by a sudden appearance of turbidity resembling inverted U or mushroom like features which extend from the underlying reflector which is sand and reach within 5-10 m of the surface. The sides of these turbid zones are almost vertical. Their top edges are round or flat in some cases (Figs 2 and 3). These features are not only confined to the shallow seismic profiles but are seen in the echograms also, thereby confirming that they do not represent instrumental interference but are the features within the sediments (Fig. 2). The records resemble some of the published records of gaseous sediments reported from other localities<sup>3,4</sup>. The gas apparently is not under sufficient pressure or concentration to reach the seabed. This is indicated in the shallow seismic profiles and in echograms and confirmed by side scan sonar records which do not indicate any pockmarks or gas bubbling characteristic of gas seepages on the seabed.

The occurrence of gases in the inner shelf sediments of this area is interesting as the area lies in the vicinity of the well known offshore oil and gas fields of Bombay High and Bassein.

Bhattacharya<sup>7</sup> and others detected gaseous hydrocarbons in the sediment cores from the Bombay High. Gases in marine sediments, according to Kaplan<sup>8</sup>, could be from 4 different sources, viz. atmospheric, biogenic degradation of organic matter, upward diffusion by thermocatalytic cracking of more complex compounds and submarine volcanic or geothermal processes. Evidently additional data are

required to confirm a specific source. The terrain probably indicates 2 possibilities, i.e. bio-degradation of organic matter or thermocatalytic cracking of more complex compounds. The organic matter in the recent sediments of the northwestern continental shelf of India<sup>9</sup> ranges from 0.42 to 3.86% (av. 1.64%). The concentration of organic matter in the recent sediments is comparatively low and lower than the world average of 2.5% for the nearshore sediments. However, it is possible that even this quantity of organic matter, because of rapid sediment deposition, is being slowly degraded to form gas which is trapped as minute cavities in the clay. Since the gases are emanating from depths below 5 m, it is evident that these may be the products of organic matter deposited during an earlier period of sedimentation, i.e. lowered sea levels. Perhaps, during this period the area formed a shallow bay or estuary on the shelf. Possibly productivity of water and also the supply of terrigenous organic matter were high at that time as explained by Emery<sup>5</sup> for the West Coast of Africa. The possibility of these acoustic maskings representing seepage from greater depths is not precluded as the sediments lie in a basin with known oil and gas fields. However, deeper cores are required to confirm the composition of gas and its origin.

The extensive occurrence of these features over a large area of the inner shelf off Bombay demands further detailed surveys. A demarcation of the extent of the gaseous sediments in the area and a study of the nature and origin of the gases by obtaining deep cores appear to be necessary.

The authors are grateful to Dr S. Z. Qasim for critically going through the manuscript.

References

- 1 Glangeaud L, Leenhardt O & Serruya C, *C R Acad Sci, Paris*, **258** (1964) 4816.
- 2 Serruya C, Leenhardt O & Lombard A, *C R Seances Soc Phys Hist Natur, Geneve*, **19** (1966) 179.
- 3 Schubel J R, in *Natural gases in marine sediments*, edited by I R Kaplan (Plenum Press, New York) 1974, 275.

- 4 Bryan G M, in *Natural gases in marine sediments*, edited by I R Kaplan (Plenum Press, New York) 1974, 299.
- 5 Emery K O, in *Natural gases in marine sediments*, edited by I R Kaplan (Plenum Press, New York) 1974, 309.
- 6 Hollister C D, Ewing J I, Habib D, Hathaway J C, Lancelot Y, Luterbacher H, Panlus F J, Poag C W, Wilcoxon J A & Worstell P, *Initial Reports of the Deep Sea Drilling Project*, 11 (1972) 9 (U S Government Printing Office, Washington).
- 7 Bhattacharya S N, Chakrabarti S K, Chandra K, Gupta M C & Manju Mathur, *Bull Oil Nat Gas Comm*, 11 (1974) 39.
- 8 Kaplan I R, in *Natural gases in marine sediments* (Plenum Press, New York) 1974, 2.
- 9 Paropkari A L, *Indian J mar Sci*, 8 (1979) 127.

## Distribution of Fe, Mn, Ni, Co, Cu & Zn in Non-lithogenous Fractions of Sediments of Gulf of Kutch

A L PAROPKARI, R S TOPGI, CH M RAO & P S N MURTHY  
National Institute of Oceanography, Dona Paula, Goa 403 004

Received 7 May 1979; revised received 18 August 1979

Contributions made by non-lithogenous fractions of sediments constitute a significant portion of the concentrations of the elements associated with the total sediment samples. The minor differences found in their distribution patterns can be attributed to compositional differences in the individual samples. From an evaluation of the processes of incorporation of elements into sediments in association with non-lithogenous fractions, it is tentatively concluded that the elements particularly trace elements are incorporated more through adsorption on clays than through other processes. However, the absence of covariance among different elements appears to be due to the differential behaviour of elements in regard to adsorption and desorption as a result of the churning of bottom sediments constantly by tidal bores.

Distribution patterns of Al, Fe, Ti, Mn, Ni, Co, Cu, Zn and calcium carbonate in the surficial sediments of the Gulf of Kutch, on the total sample basis, have been reported<sup>1</sup>. In continuation, distribution patterns of Fe, Mn, Ni, Cu, Co and Zn in the leaches of the acid-reducing mixture consisting of acetic acid and hydroxylaminehydrochloride have been studied and the results presented here. According to Chester and Hughes<sup>2</sup>, the amounts of the elements associated with these leaches (non-lithogenous fraction, NLF) would represent those incorporated into the sediments in association with (i) carbonate phase and (ii) ferric and manganese hydroxides and through (iii) adsorption on mineral surfaces including clay minerals, i.e. they would represent the contributions made by these 3 processes to the concentrations of the elements associated with total sediment samples (TSS). An attempt has also been made to evaluate the role of the 3 processes in the incorporation of elements into the sediments.

Suitable aliquots of the representative samples collected from 15 stations during the 2nd cruise of *RV Gaveshani* (February/March 1976) were leached with the acid-reducing mixture and the test solutions prepared as described by Chester and Hughes<sup>2</sup>. The elemental concentrations were measured on Hilger and Watts Atom Speck H 1550. Data obtained are presented in Table 1 and the data on texture of sediments, water depth, calcium carbonate content were same as reported earlier<sup>1</sup>. To understand the inter-relationships among the different elements, correlation coefficients have been calculated (Table 2).

Data presented in Tables 1 and 2 permit the following observations:

(1) Texture of sediments has no appreciable influence on the distribution of the elements associated with the NLF in view of the fact that similar ranges of amounts of the elements are associated with all the 3 types of sediments—(a) silty clays and clayey silts (b) sand-silt-clay and (c) silty sands and clayey sands.

(2) Contributions made by the NLF of sediments constitute a significant portion of the concentrations of the elements associated with the TSS. This is particularly true in the case of all the elements except iron.

(3) Cu and Co exhibit a marginal correlation with Mn and Cu with Ni while others exhibit no relationship either with Fe or Mn or among themselves.

Contributions made by the LF of sediments to the concentrations in the TSS clearly indicate that considerable amounts of the elements are fixed in the sediments in a solid state in association with the lithogenous material. The present studies also indicate that to some extent the elements are incorporated into the sediments either through all the 3 or 1 of the processes that contribute to the amounts associated with the NLF. However, since all the 3 processes cannot be expected to be operating with the same intensity all over the region, an evaluation of the role of these processes is attempted in the following paragraphs from the available data.

*Carbonate phase*—Calcium carbonate content varies between 10 and 50%. The fine-grained sediments are characterised by very low carbonate content while coarser sediments have a relatively high content. Coarse fraction studies by Hashimi *et al.*<sup>3</sup> have revealed the presence of foraminifera and molluscs, and a close relation between the percentage of carbonate material in the coarse fraction and the carbonate content of the sediments has been reported<sup>1</sup>.

Investigations<sup>4,5</sup> on the sediments of the adjacent shelf region have indicated that even in sediments having 75 to 90% calcium carbonate, the carbonate phase is not a significant contributing factor to the