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## SURVEYS FOR MARINE INSPECTION NEAR THE BOMBAY HARBOUR AREA

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### ABSTRACT

Side scan sonar surveys in combination with shallow seismics are carried out over the existing submarine pipelines on different tracks along and across the direction of their alignment between Trombay and Butcher islands near the Bombay harbour area. The surveys have demarcated the extent of pipelines' exposition on the seabed and indicated that the clays in which they are buried, have thickness ranging from 4 to 9 m and resting on an uneven and hard subbottom. The exposure of the portions of pipelines might be due to interaction of currents and topography leading to the erosion of sediments surrounding them.

### INTRODUCTION

Side scan sonar surveys are used throughout the world to detect the objects on the sea floor ranging from debris to shipwrecks (Kunze, 1957; McGhee et al., 1968) and even in the location of well-heads within the small area on the seabed (NIO Tech. Rep., 1977). Side scan sonar surveys along with shallow seismic profiling are also used to find out the seabed conditions in the Arabian Sea (Siddiquie et al., 1985). Besides these, quite a few harbours of the country have also utilised these surveys for better understanding of the nature of geology of the channel floors and their deeper formations (Veerayya et al., 1985). In this paper, the extent of usefulness of these surveys in finding out the exposed portions of the pipelines laid between Trombay and Butcher islands (Fig. 1), is indicated.

### SURVEY SYSTEMS

**Side scan sonar system:** A side scan sonar system with a dual channel recorder and a tow fish are used for the surveys. The tow fish is operated with the inbuilt transducers set for 10° beam depression and 20° vertical beam width. the principles and operation of which are described by

Fleming(1976). The short length of the acoustic pulse and the beam shape resolve the presence of even small topographic irregularities (Almeida and Bhattacharya, 1980; Vora et al., 1980) or objects (NIO Tech. Rep., 1980) present on the sea floor. Projections above the bottom of the floor are good reflectors and represented by 'darkening' of the record where as depressions and scourings by 'lightening'. The range of the recorder is set at 50 m minimum to get the objects/topographic irregularities present on the sea floor, as small as 25 cm in length, recorded in the sonograms.

**Shallow seismic profiling system:** A shallow seismic profiling system comprises an energy source, an energy transmitter, a reflected signals receiver and a recording unit (Siddiquie et al., 1982). Since the accuracy of the required bottom and subbottom information depends upon the ideal filter settings for low and high cut frequencies, a few trial runs are made in the area before coming to an optimum filter setting. The sweep rate of the recorder is set at 1/16 sec TWT for getting the better resolution of the pipelines and the clay layer in which they are buried.

#### METHODOLOGY

These surveys are carried out simultaneously taking care that the tow fish of side scan sonar system and the energy source of shallow seismic system are not entangled each other while both towed astern the boat. Because of the shallow depths, the tow fish is allowed to go hardly 1 m below the water level while towing, by adjusting the speed of the boat and the length of the tow cable. The catamaran-fixed energy source and the polyurethane made signals' receiver of the profiling system are kept floating.

#### RESULTS AND DISCUSSION

Side scan sonar surveys, carried out along six lines parallel to the pipelines' alignment between the two islands, indicated exposure of the portions of pipelines on the channel bed over which they are laid. A number of cross lines across the pipelines' alignment are also run in those areas where the pipelines recorded exposed in the sonograms obtained in the surveys carried out in the direction of their alignment. The exposed portions of the pipelines in various lines have matched closely with each other during the analysis of sonograms. The position and the exposed portions of the pipelines are shown in Fig.2.

From these results, it is obvious that the pipelines are exposed in the midst of the channel in two separate zones, A and B (Fig.3), between the two islands. In zone A, portions of the three pipelines are exposed and the length of the longest exposed portion of the pipeline is nearly 215 m. In zone B, portions of two pipelines are exposed and the length of the longest exposed portion of the pipelines is about 40 m. Exposed portions of the pipelines in latter zone are about 90 m away from those exposed in the former.

A white patch observed in the sonograms (Pl.1) along the exposed portions of some of the pipelines represent scouring on the channel bed and suspension of those portions of pipelines without any support below, the instances of which are well known elsewhere (Belderson et al. 1972).

Shallow seismic surveys along the cross lines have showed that the thickness of clay was variable and range between 4 and 9 m and the subbottom

topography was comparatively hard and uneven(Pl.2). Apart from the sonograms showing the exposition of the portions of three pipelines in zone A, shallow seismic records have confirmed that these pipelines were portions of only those pipelines spaced unevenly and laid between the islands (Pl.3).

The pipelines are exposed in the midst of the channel where it is shallow. The Naval Hydrographic Office charts show an ENE-WSW bottom currents in the area and the velocity of them, between 2 and 3 knots in one direction and only 2 knots in the opposite. Parallel trends across the pipelines recorded in sonograms (Pl.1) are surmised to be lineations in the sediments representing the predominant current directions. The scouring in the sediments due to the erosion is caused by unequal bottom currents existing in the opposite directions and whenever their effect is abnormal in the channel, sediments are scoured and the pipelines are exposed above the channel bed without any support below them.

#### CONCLUSIONS

- 1) The cost for repairing and padding of such submarine objects as a remedial measure, can be effectively minimised by deploying the above systems and recognising their exposed portions in the sonograms and confirming the same in shallow seismic records.
- 2) Periodic scanning and profiling with the above systems are necessary for safety and intactness of such objects.
- 3) These results reiterate the importance of current measurements, to be carried out before laying down such submarine objects on the channel/ sea floor.

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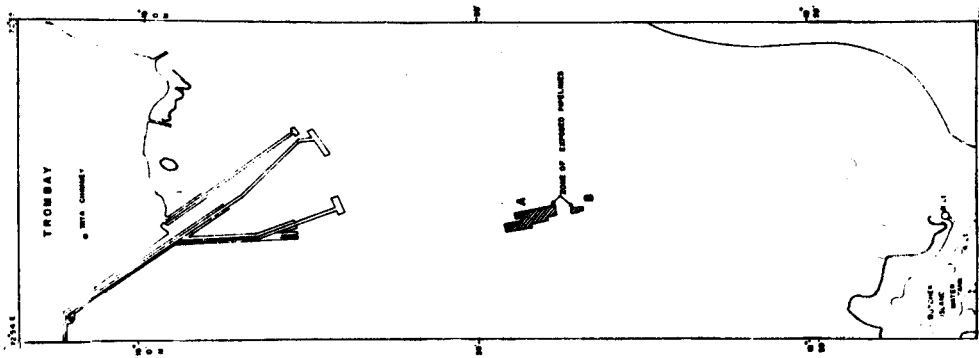


Fig. 3 Map showing the zones of exposed pipelines

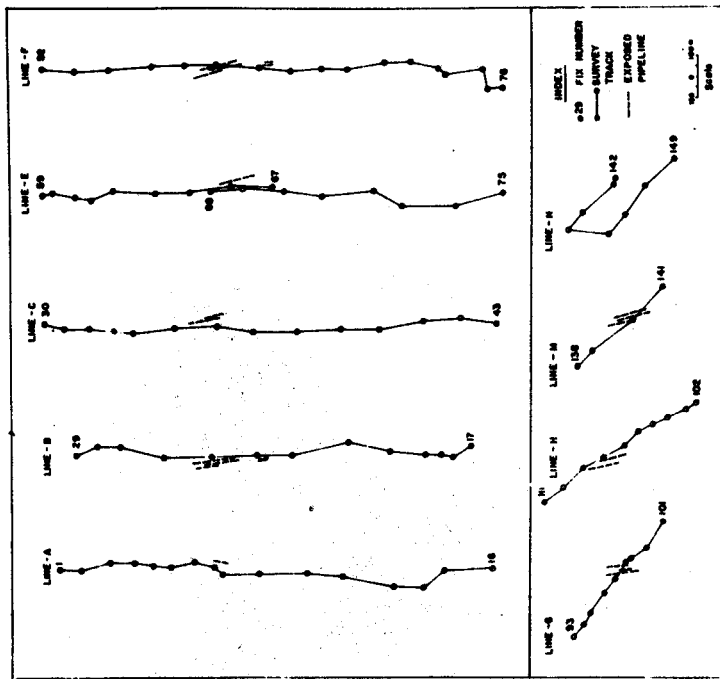


Fig. 2 Map showing the exposed portions of pipelines along and across their alignment

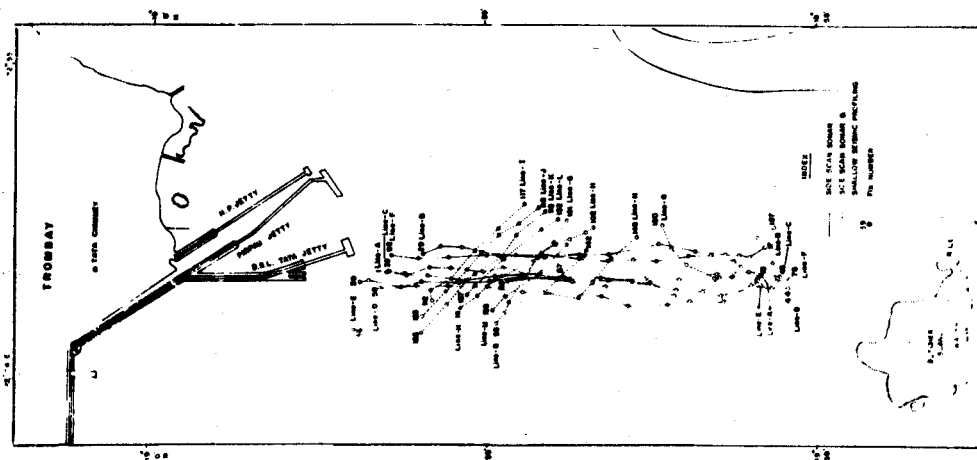
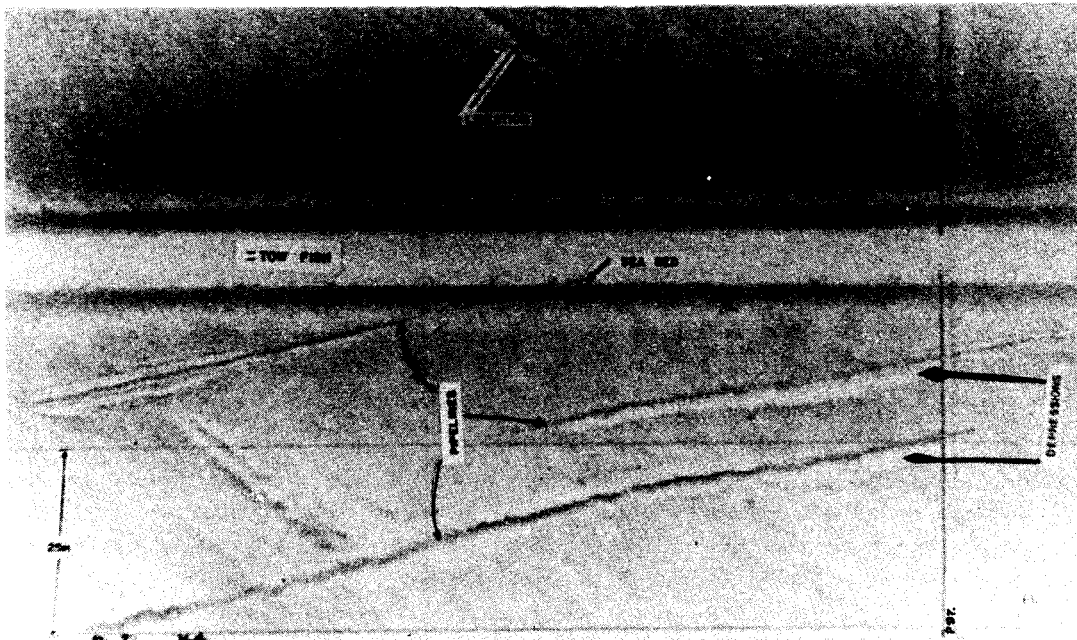
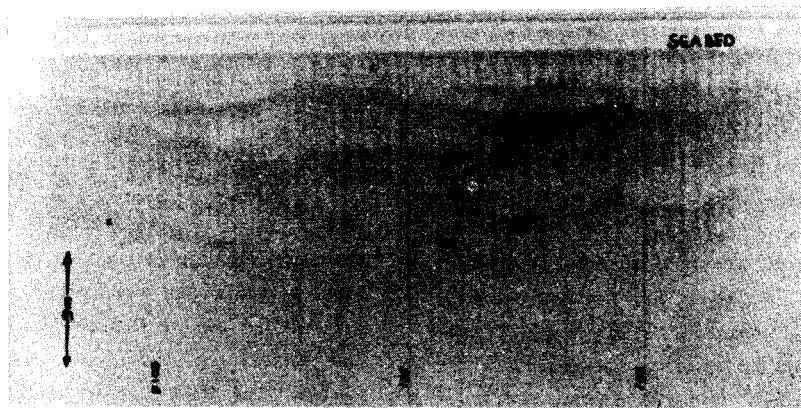


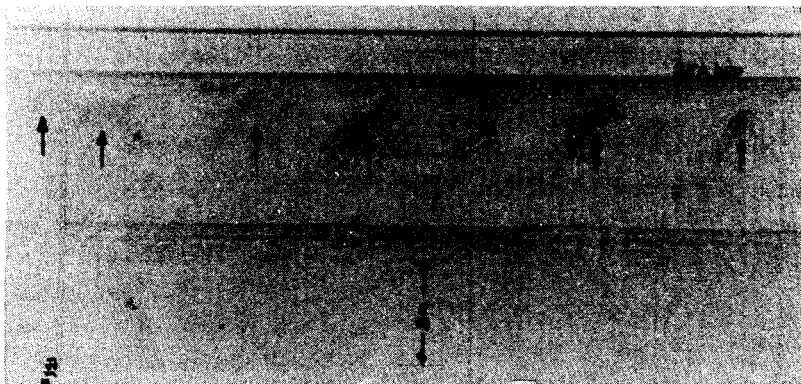
Fig. 1 Map showing the tracks surveyed



Pl. 1 Sonogram showing the exposed portions of submerged pipelines. The white patch alongside exposed portions represents scouring in the sediments on the channel bed beneath the pipelines. Lineations in the sediments due to the currents across the pipelines' alignment are also seen.



Pl. 2 Shallow seismic record showing the uneven subbottom topography over which the clay layer lies



Pl. 3 Shallow seismic record showing the buried pipelines in the clay layer