THE USE OF A DUAL FREQUENCY ECHO SOUNDER IN SOUNDING AN IRREGULAR BOTTOM

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SYNOPSIS

The normal purpose of a dual frequency echo sounder is to aid in discriminating between hard bottom and silt deposits. This paper describes an application in which the instrument was adjusted to distinguish between true depths and side echoes.

INTRODUCTION

A survey was recently carried out within the Kwajalein Atoll, in the Marshall Islands. This is a typical Pacific Atoll with a highly irregular bottom composed of coral, coral sand and shell. The normal depth is 20 to 30 fathoms but occasional coral outcrops come close to the surface. The purpose of the survey was to find a route for a number of underwater cables which are to join certain of the fringe islets. Coral outcrops can cause considerable physical damage to cables and a very close grain survey was required to detect all irregularities. The specification for the survey called for 100 percent bottom coverage of a strip extending 300 feet each side of the proposed routes.

DESCRIPTION OF ECHO SOUNDER

The echo sounder used for the survey was an ATLAS-DESO An 6014 (see figure 1). This is a high precision hydrographic instrument with a number of advanced features, among them being the facility to provide, with an additional unit, a digital output for use in data processing. The particular feature that is of interest here, however, is that it utilizes two

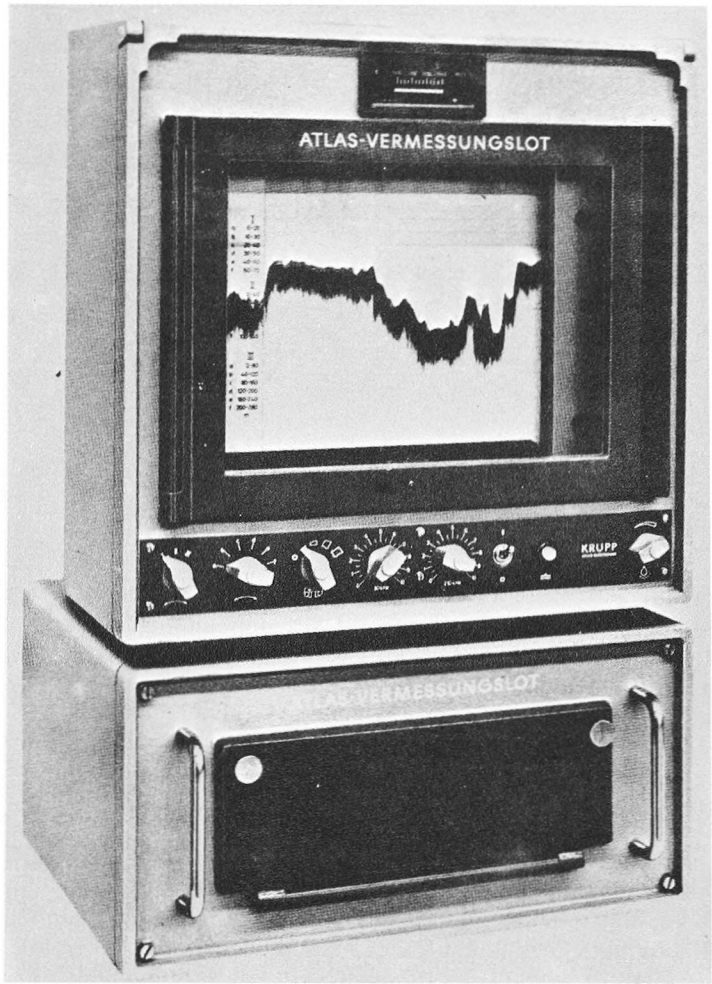

FIG. 1. — The Atlas AN 6014.

transducers operating on different frequencies — normally 30 kHz and 210 kHz — and the records of both frequencies are displayed simultaneously on the recorder. This is achieved by means of "greyness" controls by which either frequency may be displayed as a light grey shade while the other is adjusted to make a dark grey record, close to black. Obviously the light grey cannot be seen through the dark, and the set is normally adjusted so that the high frequency makes the light grey shade while the low frequency makes the dark. Thus a layer of mud or silt over a more solid bottom will appear as a light grey ribbon representing the mud, above the dark grey solid bottom (see figure 2). This is due to the fact that the penetrative power of a sound transmission varies inversely as its frequency, so that the 210 kHz gives an excellent reflection from the first bottom, whatever its nature, but has little penetration, while the 30 kHz has the power to penetrate the bottom for 10-15 feet and give an indication of any layers that may exist there. It should be noted in passing that the layers merely indicate materials which have a velocity

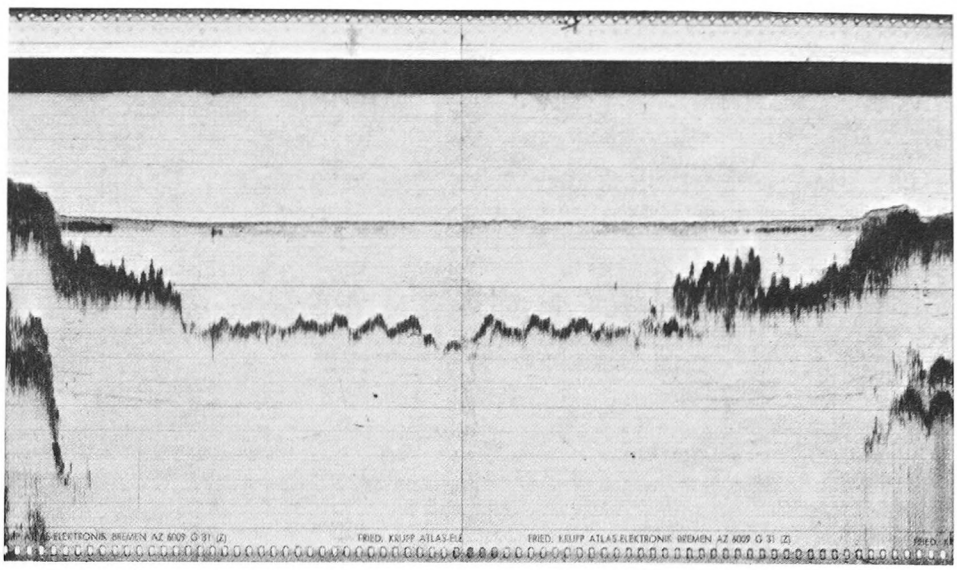

FIG. 2. — Manufacturer's example of silt penetration (about 5 metres) with 210 kHz registering light grey, 30 kHz dark grey.

of sound different from that of the adjacent material. It is not possible to determine the nature of the layers directly but, when allied to suitably located core samples, these dual traces can be of considerable value to a geologist or geophysicist.

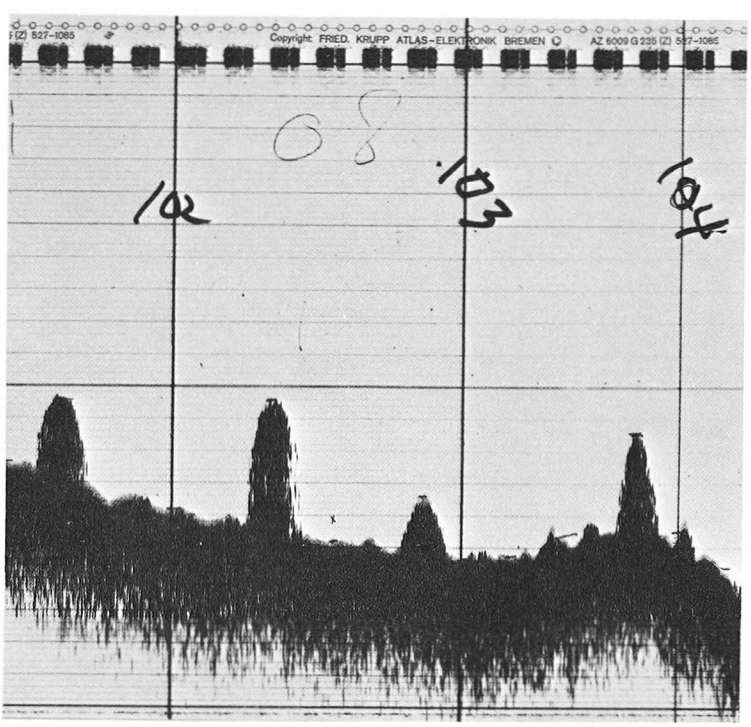

FIG. 3. — Typical side echo responses from coralheads in about 45 metres of water.

ITS USE DURING THE SURVEY

For the first two days' work, the echo sounder was adjusted in the conventional manner, but it was found that it was impossible to distinguish on it any differences of shade which might have been attributed to a change from coral to sand or shell. There were however a considerable number of echoes similar in shape to figure 3. They tended to have a paraboloid shape with a rather wispy texture and did not rise from the bottom in a convincing manner. The conclusion was that they were side echoes, but a quandary remained over how best to deal with them. It was impossible to ignore them since not all were as obvious as those

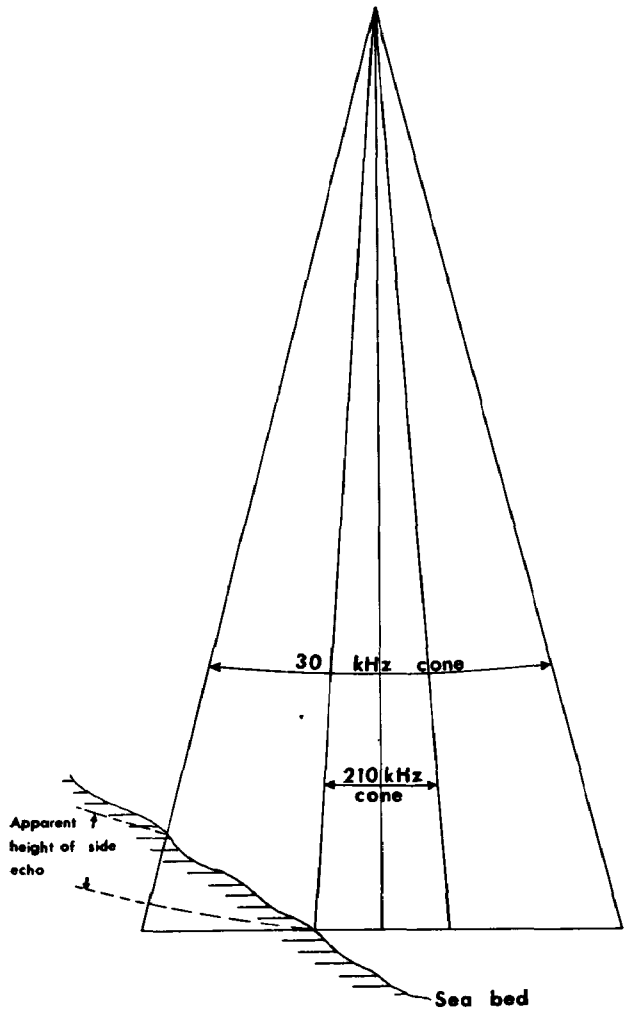

FIG. 4. — Relative cone angles of 30 kHz and 210 kHz transducers.

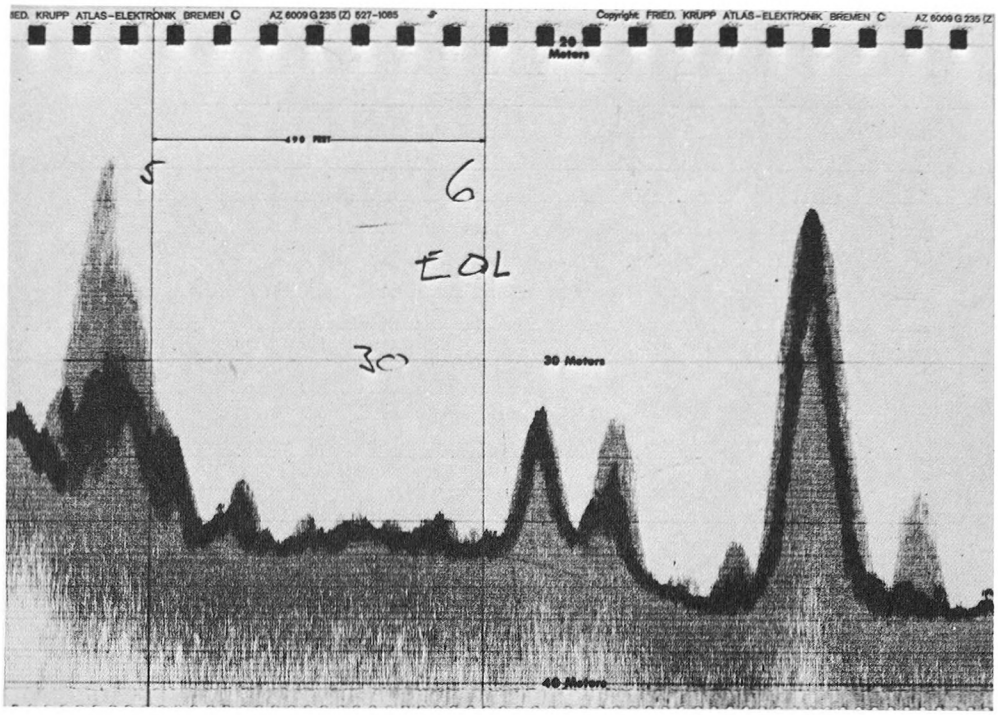

FIG. 5. — Typical trace obtained with 210 kHz registering dark grey and 30 kHz light grey. Side echoes from coralheads clearly distinguished.

illustrated and since the "wispyness" frequently concealed a solid echo. On the other hand if every side echo is inked in as a valid sounding, shoals are made to appear larger than in fact they are; the error is on the side of safety but may not be acceptable when the survey is for a non-navigational purpose.

Research in the maker's manual showed that the cone angle of the 30 kHz transducer was about 14° from the vertical whereas that of the 210 kHz is only about 4° (see figure 4), and the idea was conceived of interchanging the greyness controls. This turned out to be most successful, since, as can be seen from figure 5, the bottom immediately below the boat is shown as a continuous dark grey trace while side echoes appear as intermittent protuberances in the lighter color. Thus the chart may be based on true bottom depths while at the same time retaining the assurance that shoals on either side of the track are being detected to the full limits of the echo sounder and the line spacing.

Figure 5 shows that these "side" echoes are sometimes "front" and "back" echoes. The ability to identify these may be valuable in a cable or pipeline survey since they tend to mask the full irregularity of the bottom, particularly over deeps.

The equipment was used in this manner for the remainder of the survey, but, since there were no facilities for modifying the transducer housing, the axis of the 30 kHz cone remained vertical and there was no means of telling whether the echo came from port or starboard.

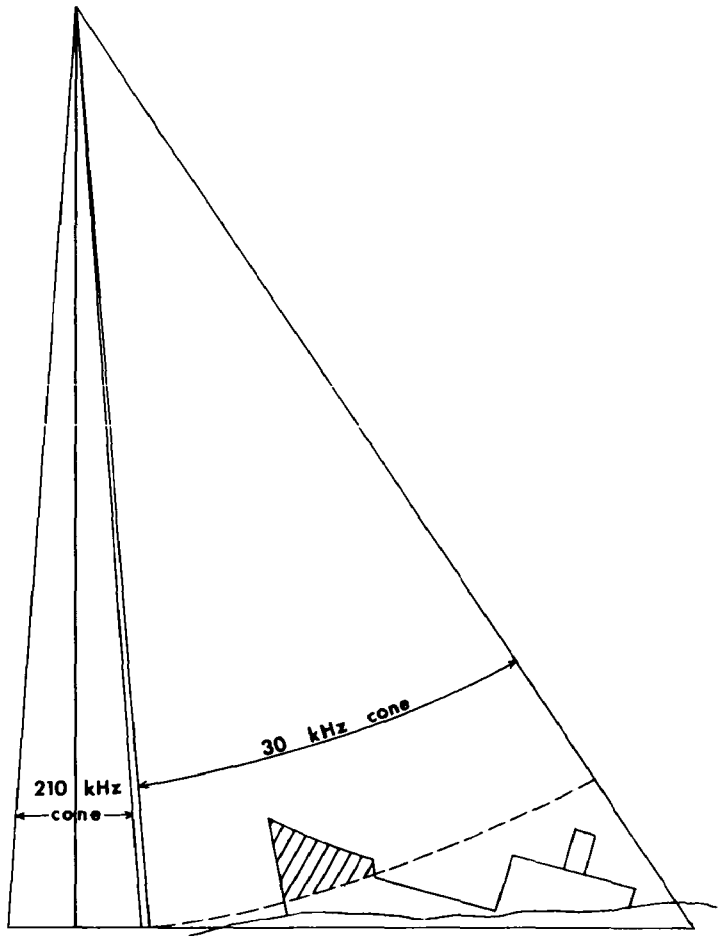

FIG. 6. — Proposed modification to remove ambiguity and increase width swept.

The obvious next step is to tilt the 30 kHz oscillator through 18° so that its cone is not duplicating that of the high frequency oscillator. This has not yet been tried but, as figure 6 shows, it will sweep a wider strip of water while at the same time removing the ambiguity. On the manufacturer's quoted cone angles the width swept should be about 60% of water depth.

CONCLUSION

This method was developed for use over coral bottoms. However it is recommended that its use should be considered whenever there is no requirement for sub-bottom strata identification. Wrecks are always with us, over even the flattest bottom, and an echo sounder of this type greatly increases the chances of detecting them. Some of the advantages

of the sidescan sonar are realized without additional equipment, but, perhaps even more important, they are realized without requiring additional chartroom time to scrutinize the records. If an obstruction exists between the sounding lines its presence will be noted in the normal course of inking in the soundings.