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ON SUPPLEMENTARY POSSIBILITIES OF OCEAN BOTTOM ACOUSTICAL PARAMETERS` INVESTIGATION USING MULTIBEAM ECHOSOUNDER

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The multibeam echosounder of new generation was developed in Oceanology Institute using transmitting block and receiving multielement array of sonar installed at R/V AKADEMIK IOFFE. It had permitted to measure the angular spectrum of sound pulses scattered by ocean bottom. The analysis of spectral records got during the vessel's motion in northern Atlantic showed the possibility to use three times scattered signals (bottom, surface, bottom) for finding the reflection coefficient in case of sound oblique incidence; the common method requires to separate transmitter and receiver. The results of reflection coefficient calculation are shown.

Acousticians of Oceanology Institute had undertaken the vast efforts to upgrade the multibeam echosounder developed by HOLLMING ELECTRONICS and installed at R/V AKADEMIC IOFFE, that was caused by outbreaking of many blocks and by deficiency of its scheme, which didn't permit to measure the bottom sound scattering coefficient. Among the kept blocks were sound transmitter at frequency 15 kHz and receiving multielement array (3x57 elements) imbedded in vessel's bottom; the new received signals` acquisition system was designed and installed. Sine and cosine components of signals from every array element were brought into PENTIUM II personal computer, which found spatial autocorrelation function, fulfilled Fourier transform and computed angular spectrum of received signal with resolution 0.7 deg. for array length 3 m. .

The scattered by flat bottom signals in vertical plane orthogonal to vessel's axisare showed at fig.1. The almost flat plot of bottom was chosen in northern Atlantic. The degree of image darkness characterises the intensity of scattered signal. Fig.1a shows the picture averaged over 50 successive recordings during the linear vessel's movement with speed 8 knots. There are clearly seen the groups of one time scattered signals (they form approximately horizontal stripe) and three times scattered signals from bottom, surface and bottom (in lower part of figure).

When the surface and bottom are rough, it's obvious that for signal received by array from the direction q the shortest propagation path corresponds to one showed at fig.2 (A); here $q`$ -angle of signal departure from transmitter. It's easy to show that minimal propagation time from transmitter to receiver when surface and bottom are horizontal and medium is homogenous equals
where *c*- sound speed in water, *H*-bottom depth. It is seen that the function $t_A(q)$, showed by solid curve at left part of fig.1, well fits the upper boundary of three times scattered signals. If the ocean bottom is flat (absence of scattering), echosounder`s signal propagates along the path showed at fig.2 (B); the propagation time will be This function showed by horizontal line at left part of fig.1.

It may be seen from fig.1a, that the signals on horizontal line are distinguished. It permits to come to the conclusion that some bottom plots are smooth enough and horizontal to ensure the forming of reflected signals that exceed the background level. The realisation at fig.1b is a good example. Here the horizontal boundary is seen more clearly, but scattered signals exist also. Probably it means that flat plot's dimensions are less than ones of enlighten by pulse bottom.

Let's evaluate the scattered signals intensity for sound propagation traces shown at fig.2. For case A the intensity of three times scattered signal $I_A^{(3)}$ may be written in form (omitting unessential factors) $I_A^{(3)} \sim G(q`)|V_b^e(q`)|^2\,|V_s^e(q`)|^2\, m_b(q`,-q)\cos^{-1} q$ (1)

Here *G(q`)*- transmitting antenna gain in the direction $q`$, m_b-bottom scattering coefficient, V_b^e, V_s^e- effective reflection coefficients correspondingly of bottom and surface [1]. We suppose the scattering part of surface is in Fresnel zone of receiver, this assumption take part practically everywhere. For case B $I_B^{(3)} \sim G(q) m_s(q,-q)|V_b(q)|^4 \cos^{-1} q$ (2)

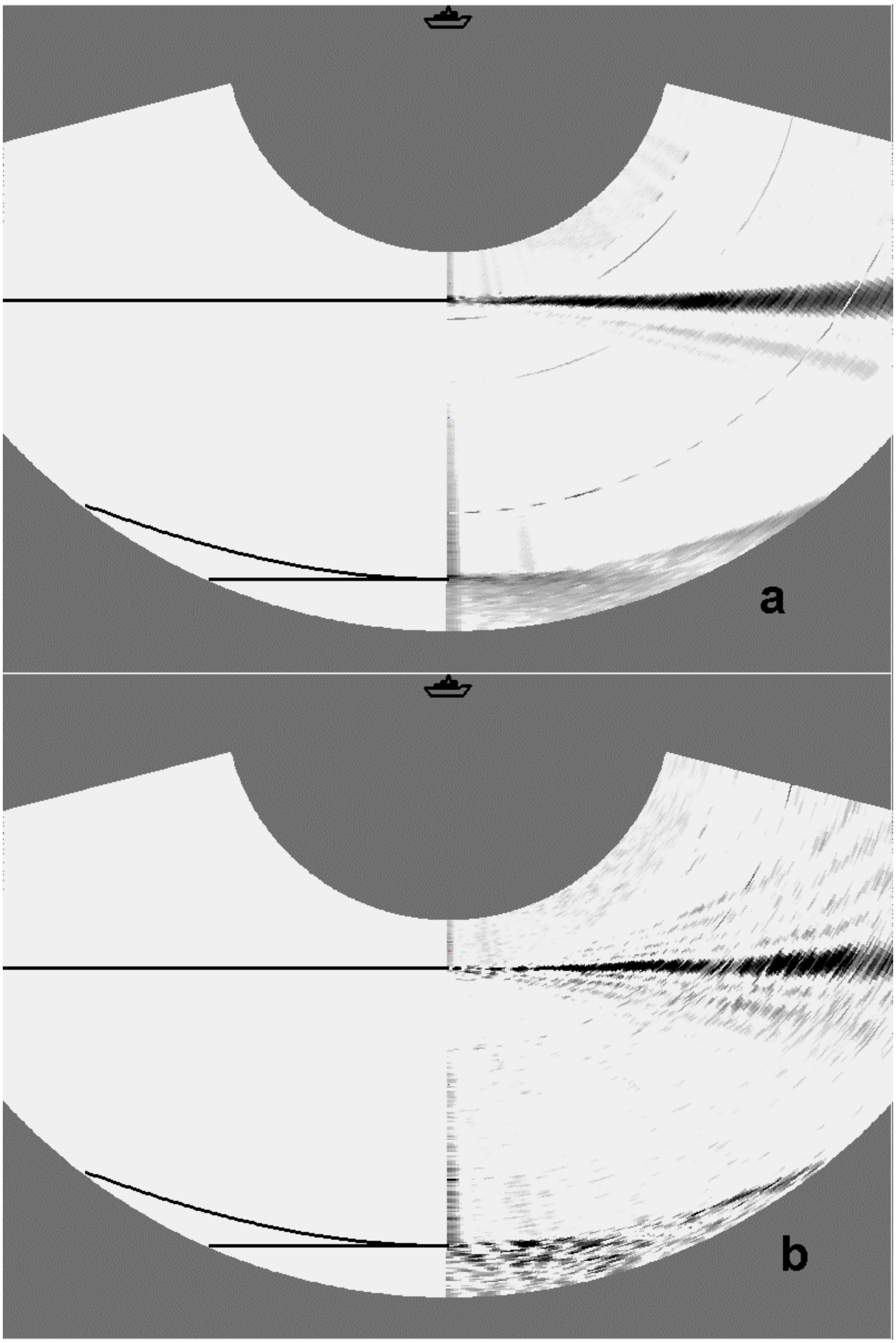

Fig. 1.

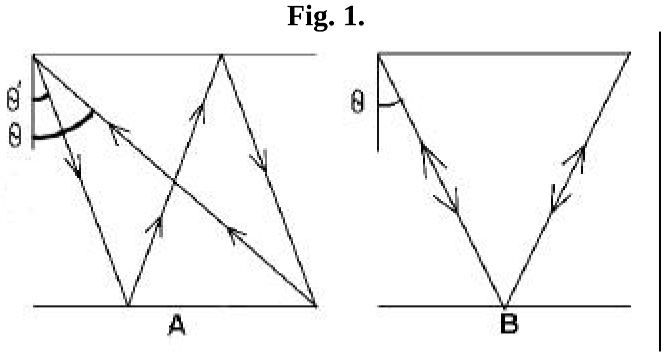

Fig. 2.

The parameters of reflection and scattering from the surface may be considered as known and approximately depending only on the wind speed *v*. It principally permit to find bottom acoustical parameters using measured data $I^{(3)}$. The measurement of $|V_b|$ require the fulfilment of next conditions:

I. $m_s(q,-q)$ must be great enough, this require the large *v*,

II. The reflected from bottom (coherent) signal exceeds the scattered one.

The condition I limits the achieved angular sector q_M, where it is possible to measure $|V_b|$ with given *v*. This angle may be evaluated as $q_M \approx \sqrt{2}d$, where *d*-root mean square surface slope; its empirical evaluation is [1] $d^2 = (3+5v)10^{-3}$, *v* in m/s.

For large *q*, when $q`®q$, it's possible to evaluate $|V_b|$ by means of measuring $I_A^{(3)}$ using (1), where $m_b(q`,-q)$ is substituted by $m_b(q,-q)$; this function may be found from measurements of one time scattered signal $I^{(1)}$. *A priori* evaluation of sector where this way of calculation $|V_b|$ may be used, is difficult and need the comparison with results of standard reflection coefficient measurements.

The validity of condition II is checked by means of reflected and one time scattered from bottom signals comparison.

The experimental intensity $I^{(3)}(t)$ when *q*=23 deg. for a realisation at fig.1b is shown at fig.3, ordinate scale is arbitrary.

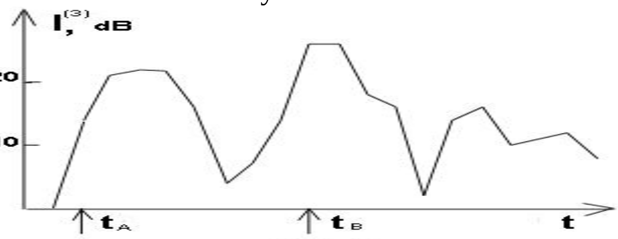

Fig. 3

Arrows show the calculated t_A and t_B. $I_B^{(3)}$ was chosen as $I^{(3)}(t)$ in the vicinity of *t*= t_B. The condition II is fulfilled at *q*£30 deg. for all scattered signal records we have, this corresponds to measured wind speed. Curve $I^{(3)}(t)$ width for *t*> t_B fits the duration of sound pulse that points out the sufficient coherency of signal from bottom.

Fig.4 shows calculated $|V_b|$ from averaged records at fig.1 (A).

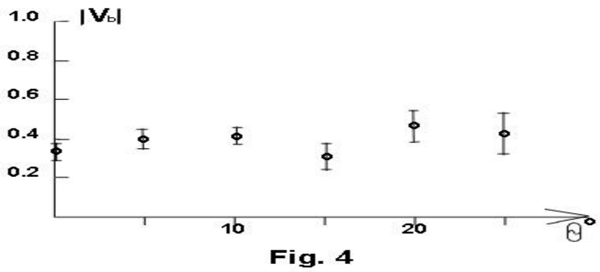

Fig. 4

These numbers are strictly the effective reflection coefficients. When it is necessary, the calculation of reflection coefficient may be done with the aid of formulas from [2]. The included there scattering coefficient may be evaluated from measurements of $I_A^{(3)}(t)$. This problem needs further consideration.

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