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ABOUT THE CONCENTRATION OF THE ACOUSTIC PULSE FIELD ENERGY IN THE SEA MEDIA

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The results of the frequency and spatial transmission loss dependence researches from the nature measuring data on the pneumoacoustic source signal spectra density in the Barents Sea are demonstrated. The measurement was carried out along the 200-km route over the 10-140Hz frequency band. The growth up to 13 dB of the level with acoustics route length increase in the region between 80 and 100km and over the 60-80Hz frequency band was observed.

With propagation of hydroacoustic signals on large distances the major characteristic is the size of the effective factor of attenuation:

$$a(f,r)=[I_o(f)-I(f,r)-10lg(r/r_o)]/(r-r_o), \qquad (1)$$

where I_o and I are the sound intensities at the distances r_o and r respectively; f - is the radiated signal frequencies.

The sound propagation losses depend very strongly on the structure and the physical properties of waveguide borders, which are difficult modeling. In this cause the experiment data have the largest value.

In this paper the results of the frequency and spatial transmission losses dependence researches from the nature measuring data on the pneumoacoustic source signal spectra density in the Barents Sea are demonstrated. The measurement was carried out along a 200-km route over the 10-140 Hz frequency band.

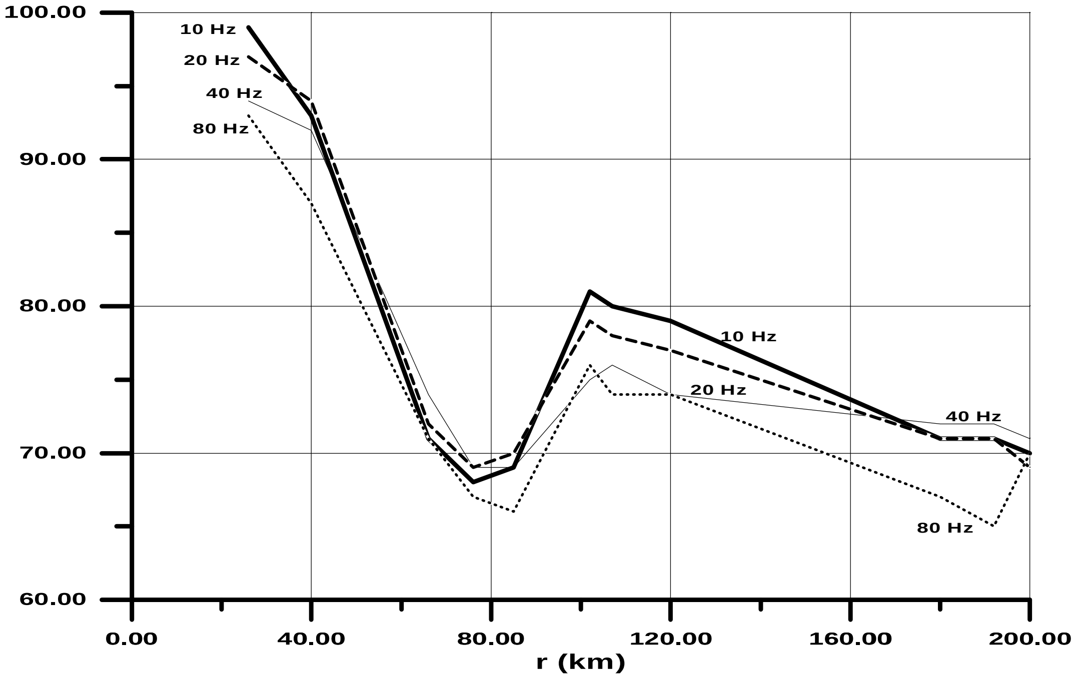


Fig.1. The results of a received signal intensity (in dB) measurements along the 200- kms route on the four frequencies.

The waveguide may be divided conditionally three parts. The primary part from zero to forty kilometers (0< r <40 kms) it had the constant depth about 300 m. The thickness of the higher sediment layer (pelite) in this part is equel to 100 m. The middle part of the route (40< r <115 kms) with appreciable changes of depth is spread by the sediment layer (aleurite) in density r = 1,6 g/cm^3; in a far zone it has less powerful sediment layer (pelite once again) then in the near zone (about 20 m).

Below depths 600 m from a sea level the border of the fundamental rock (r >2.3g/cm^3) passes. The layers between modern deposits and the fundamental rocks make the chalk sediments (r ~2.2g/cm^3). What concerns up to a sound speed vertical structure in water column, it can be extrapolated two lines with negative gradients, which on an initial site of the route (r<70 km) are much lower on the module then on the subsequent site.
The spatial dependence of the spectral density of an acoustic signal at frequencies 10, 20, 40, 80 Hz is given in the Fig.1.

It is uneasy to see three sites with various source field energy losses, which approximately correspond to the specified above breaking to pieces of the route. At first, up to 40 kms, the law of reduction of amplitude of a field is close to cylindrical. Then, with distances 40-80 kms the field intensity falls down faster, than under the spherical law. The distant site of the route (100-200 kms) again has the weakening law close to cylindrical. It is necessary to note the rise on 7-13 dB (depending on frequency) level of the accepted signal at the distances 80-100 kms.

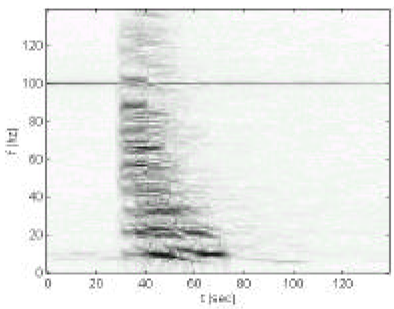
For an explaination of the accepted signal level changing character in given waveguide the acoustic field mode composition study were executed by measuring of time-frequency energy distribution of a received pulse signal:

$$S(f,t) = \left| \int_t^{t+T} u(t)\exp(-j2pft)dt \right| \qquad (2)$$

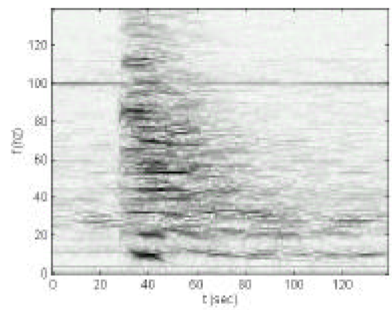
where u(t) is the reciever output voltage; T - is an analysis time interval. The results of the carried out procedure (2) is shown in the Fig.2.

As it was marked in work [3] about transformation dispersion characteristics of the ocean waveguide with variable depths, the form of the frequency-temporary distributions submitted in Fig.2 and especially, in Fig.2(d), over the frequency band 10-50 Hz more correspond to deep water propagation, while higher frequencies (f>50 Hz) recording to the case of the shallow water law dispersion. It is possible to explain this distinction if to assume, that on lower frequencies the channel of propagation is formed similarly by the seafloor structure, while the higher frequencies penetrate into this channel only unsignificantly.

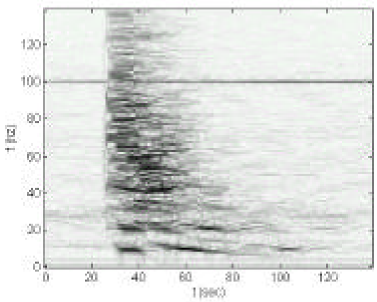
The excitation of the "ground" channel begins only with r>80 kms. A reason of the given phenomenon that at the distances 80-100 kms is observed the growth of the depths which have increased an the effectual angle of the acoustic waves fall.



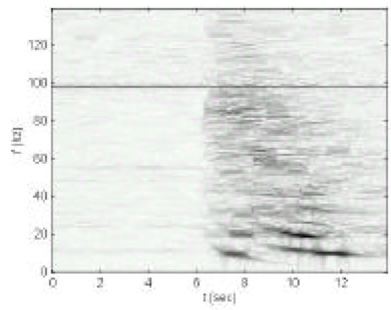
à ***) r = 26 km***



c) r = 76 km



b) r=61 km



d) r=102 km

e) r=120 km *f) r=190 km* *Δt = 14sec*

Fig.2. The time-frequency power distributions of the signals recieved from distances 26<r<190 km. The time realization of a signal is equel 14 sec.

In the paper [2] the explosive sound sources field energy characteristics were analysed in the same region of the Barents Sea. The comparison of the result from the paper [2] with characteristics shown in Fig.1 is shown in the Fig.3.

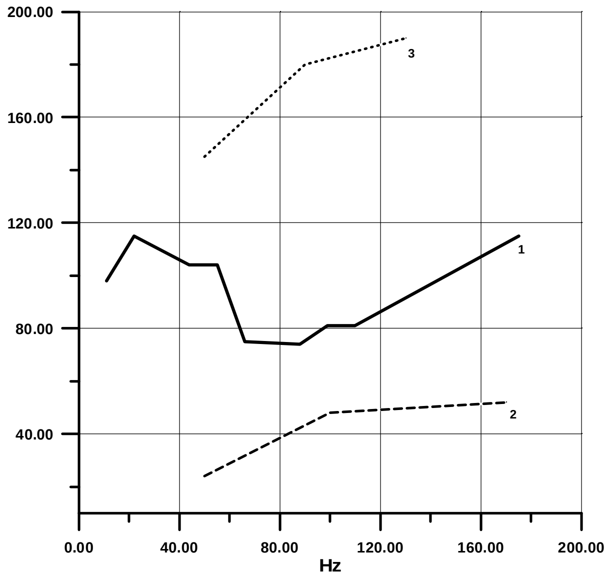


Fig.3. Frequency dependence of the transmission losses coefficient a (f) on the 200-km route (curve 1) in comparison with data [2].

The transmission losses coefficient a (f) in paper [2] have the large sense dispersal between "near" zone (curve 3) and "far" zone (curve 2). Our data (curve 1) take place between the curves 2 and 3.The obvious minimum in curve 1 between 60 and 80 Hz may be expained by the bottom sediment layers as it is in paper [4].

Therefore, as it is able to see in the fig. 1 and 3, the energy of an acoustic pulse is concentrated in region 80< r <100 km from the source and over the frequency band 60< f <80 Hz for the given route.

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