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Geoacoustic inversion of shipping noise at two closely spaced vertical arrays for estimation of gassy sediment parameters

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Results of experimental research for geoacoustic inversion using low frequency (20 to 500 Hz) shipping noise in shallow water waveguide with gassy sediments are presented. The inversion is based on modal dispersion analysis.

Experiments were carried out in the Sea of Galilee (also known as Lake Kinneret, Israel) having maximum depth of ~40 m and remarkable concentration of methane bubbles in the upper sedimentary layer. Moving R/V "Hermona" was used as a low frequency sound source, having wide-band spectrum. As a receiving system, two synchronized vertical line arrays (VLAs) with 10 hydrophones at each one, spanning the water column with 3 m-interval were used. VLAs were located at the center of the lake (the water depth is ~40 m) with the distance 40 m between them. R/V "Hermona" was moving along straight line joining VLAs, at the range of up to 1 km from the VLA.

A method for extracting the frequency dependence of modal phase speed c_{ph} (modal dispersion curves) from shipping noise recorded by two closely spaced and synchronized VLAs is proposed. Firstly, at each frequency ω, the noise is spatially filtered at both VLAs using ψ-functions calculated by solving the second order differential equation for eigenfunctions, but with only one boundary condition (free release surface) and variable horizontal wavenumber $q=\omega/c_{ph}$. The experimental sound speed profile in the water column is taken into account in the calculations. Secondly, the ratio of complex modal amplitudes at both VLAs is calculated and multiplied by a factor of $e^{iq\Delta r}$. The real part of the resulting two-dimensional (ω,c_{ph}) structure exhibits the modal dispersion curves. The obtained set of dispersion curves are used as an input for geoacoustic inversion. Bottom parameter estimates are compared with those obtained by other methods, including direct core sampling.