DOI: 10.37102/1992-4429_2023_43_01_05

EVALUATION OF THE POSSIBILITIES OF INVERSION OF MARINE SEDIMENT PROPERTIES FROM THE RESULTS OF ACOUSTIC PROFILING

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In 2023, Sevastopol State University will start operating the small-tonnage research vessel "Pioner-M". One of the scientific programs is the study of the seabed and bottom sediments of the Black Sea using a profiler. The objective of the study is to develop an adequate method for inverting the acoustic and physical properties of marine sediments based on the results of profiling. Currently known empirical and theoretical models are analyzed that relate the normal reflection coefficient and the physical properties of marine sediments. Formulas are given that implement the pore-acoustic approximation for calculating the reflection coefficient. A new theoretical GSED model of elastic wave propagation in marine sediments is proposed. The model takes into account two types of losses: viscous and internal friction. Good agreement between the GSED theory and experimental data is shown. The GSED model and pore-acoustic approximation are used to invert some sediment properties from bottom profiling results. It is shown that the porosity uncertainty is the main contributor to the uncertainty of sound velocity recovery in marine sediments. An example of the inversion of the bottom properties according to the measurement data of the reflection coefficient taken from open sources is given. For this, a database of precipitation properties accumulated by the authors is used.

Keywords: acoustics of marine sediments, acoustic profiling, reflection coefficient, pore-acoustic approximation, compressional wave, speed of sound, attenuation coefficient

References

1. Vuzy rf ot kaliningrada do dalnego vostoka planiruyut uchastie v ekspeditsiyakh na Pioneer m [Universities of the Russian Federation from Kaliningrad to the Far East are planning to participate in expeditions to Pioneer m]. URL: sevsu.ru/novosti/item/vuzy_rf_ot_kaliningrada_do_dalnego_vostoka_planiruyut_uchastie_v_ekspeditsiyakh_na_pioner_m / (date of assess 23.08.2022).

2. Jackson D.R., Richardson M.D. High-Frequency Seafloor Acoustics. New York: Springer, 2007.

3. LeBlanc L.R., Mayer L., Rufino M., Schok S.G., King J. J. Acoust. Soc. Am. 1992. Vol. 91. No. 1. P. 107–115.

4. Walree P.A, Ainslie M.A. Simons D.G. J. Acoust. Soc. Am. 2006. Vol. 120. No. 5. P. 2555–2566.

5. Tseng Y-T., Ding J-J., Liu C-S. IEEE J. Ocean. Eng. 2012. Vol. 37. No. 3. P. 533–543.

6. Rakotonarivo S., Legris M., Desmare R., Sessarego J-P., Bourillet J-F. Geophysics. 2011. Vol. 76. No. 4. P. T91–T99.

7. Schock S.G. IEEE J. of Ocean. Eng. 2004. Vol. 29. No. 4. P. 1200–1217.

8. Schock S.G. IEEE J. of Ocean. Eng. 2004. Vol. 29. No. 4. P. 1218–1230.

9. Chiu L Y C, Chang A, Lin Y-T and Liu C-S IEEE J. Ocean. Eng. 2015. Vol. 40. No. 1. P. 222–236.

10. Stoll R. D. Sediment Acoustics. New York : Springer, 1989. 153 p.

11. Williams K.L. J. Acoust. Soc. Am. 2001. Vol. 110. No. 5. P. 2276–2281.

12. Bonomo A.L., Chotiros N.P., Isakson M.J. J. Acoust. Soc. Am. 2015. Vol. 138. No. 2. P. 748–757.

13. Camin H.J, Isakson M.J. J. Acoust. Soc. Am. 2006. Vol. 120. No. 5. P. 2437–2449.

14. Buckingham M.J. J. Acoust. Soc. Am. 2000. Vol. 108. No. 6. P. 2796–2815.

15. Buckingham M.J. J. Acoust. Soc. Am. 2007. Vol. 122. No. 3. P. 1486–1501.

16. Lisyutin, V.A. Physical Oceanography, [e-journal]. 2019. Vol. 26. No .1, pp. 77–91.

17. Lisiyutin V.A., Lastovenko O.R. Acoustical Physics 2020. Vol. 66. No. 4. P. 401–415.

18. Lisyutin V.A. Prostaya akusticheskaya model nekonsolidirovannykh morskikh osadkov s vnutrennim i vyazkim treniyem [A simple acoustic model of unconsolidated marine sediments with internal and viscous friction]. Ekologicheskiy vestnik nauchnykh tsentrov CHES. 2018. Vol. 15. No. 3. P. 39–51.

19. Lisyutin, V.A. and Lastovenko, O.R. Physical Oceanography, [e-journal]. 2021. 28 (1), P. 90-103. doi:10.22449/1573-160X-2021-1-90-103.

20. Williams K. L., Darrell R. J., Thorsos E. I. et. al. IEEE J. Ocean. Eng. 2002. Vol. 27. No. 3. P. 413–428.

21. Hines P. C., Osler J. C., Scrutton J. G. E., Halloran L. J. S. IEEE J. Ocean. Eng. 2010. Vol. 35. No. 3. P. 502–515.

22. Wan. L, Badiey M., Knobles D.P. J. Acoust. Soc. Am. 2016. Vol. 140. No. 4. P. 2358–2373.

23. Yang J., Tang D. IEEE J. of Ocean. Eng. 2017. Vol. 42. No. 4. P. 1102–1109.

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Recommended citation:

Degtyar A.D., Lisyutin V.A., Lastovenko O.R. EVALUATION OF THE POSSIBILITIES OF INVERSION OF MARINE SEDIMENT PROPERTIES FROM THE RESULTS OF ACOUSTIC PROFILING. Underwater investigations and robotics. 2023. No. 1 (43). P. 50–59. DOI: 10.37102/1992-4429_2023_43_01_05. EDN: QPPRSA.