Research on Factors Influencing the Acoustic Properties of Seafloor Sediments

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Abstract

The acoustic characteristics of seafloor sediments are crucial parameter in the fields of underwater acoustics, geoacoustics, and sedimentary acoustics. The factors such as environmental temperature and pressure, and the detecting frequency, influence the acoustic characteristics of seafloor sediments, necessitating a comprehensive study that combines theoretical analysis, laboratory measurements and in situ measurements. The influences of temperature and hydrostatic pressure were studied on the seafloor surficial sediment by theoretically and experimentally analyzing the sound speed ratio of the seafloor sediment to the bottom seawater in typical environmental conditions. Laboratory environment controlled experiments were conducted to examine the characteristics of the sound speed ratio influenced by temperature and pressure, with the results agreeing with the theoretical analysis using the effective density fluid model (EDFM) and the general model of seafloor sediment (GMSS). With respect to surficial sediments, pore water plays a key role in the sound speed ratio of sediment influenced by different environmental factors. The sound speeds of different types of sediments (sandy, silty, and clayey) change similarly with temperature, but change slightly differently with hydrostatic pressure. The influence of environmental factors on the sound speed ratio of seafloor sediment is independent of the detection frequency. The results show that the sound speed ratio can change up to 0.0008 per ℃ when the temperature ranges from 2℃ to 25℃ and up to 0.00064 per MPa when the seawater depth pressure ranges from 0MPa to 40MPa. The result reveals the sampling-transmitting process and existing-state variation of sediment samples have much greater impacts on the sound speed of sandy sediment in the East China Sea compared to muddy sediment. Overall, EDFM can predict the in situ sound velocity and sound attenuation coefficient under different temperatures and frequencies, with a lower prediction error for sound velocity compared to sound attenuation coefficient.

Keywords

Sound Speed, Porosity, Seafloor Sediment, In Situ Measurement, EDFM, GMSS