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Field vs. laboratory analysis of sound velocity of sediments from Huanghai and Bohai

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Sediment acoustic properties are of great importance in the study of acoustic transfer theory, which includes the parameters of sound velocity, shear wave velocity, sound attenuation, etc. In various fields such as marine engineering construction, marine geological hazards and marine resource exploration, the knowledge of the seabed acoustics is essential. The three methods used in the study of seabed acoustics are in-situ measurement, deck measurement, and laboratory measurement. Laboratory measurement of acoustical properties of sediment samples collected from different sea or river areas is preferable due to the favourable and controlled test conditions. Comparatively, laboratory-based acoustic measurement method of seafloor sediment has significant disturbances due to transportation, temperature, and pressure; application of in-situ acoustic measurement equipment of seafloor sediments can reduce or even eliminate the disturbances, which can allow measurement of the acoustic properties in the actual state of the marine sediments. Deck measurement has a higher accuracy than laboratory measurement but a lower accuracy than in-situ measurement, which can be less influenced by temperature and transportation.

One popular method to obtain the acoustic parameters of seabed sediments is by measuring sound velocity of sediment samples in the laboratory using acoustic test equipment. However, the effect of environment variation and physical perturbation on the acoustic properties is always neglected in the application of the measured acoustic parameters. Sediment samples were collected from Huanghai and Bohai using gravity sampler and box corer, to conduct sound velocity measurements at the frequency of 25-250 kHz both in the field and laboratory using digital sonic measuring system for this paper. In addition, sediment composition, physical and mechanical properties were measured in the laboratory together with microstructure observation. Sediment samples can be classified as five types which are silty sand, sandy silt, silt, clay silt, and silty clay, with the average grain diameter ranging from 3.3 to 8.8 µm, sand content ranging from 0.9 to 62.4%, clay content ranging from 7.3 to 51.5%. Laboratory measurements indicate that sediment wet bulk density is 14.7 - 19.5 kN/m^3, dry bulk density is 10.8 - 16.9 kN/m^3, water content is 29.7-71.9%, porosity is 0.34-0.82, penetration resistance is 0.3-10.2 N and the undrained shear strength is 1.4-11.0 kN. Sound velocity both measured in field and laboratory ranges from 1450 - 1670 m/s at the measuring frequency range. Sound velocity comparison between field and laboratory measurements indicates that laboratory measurements of sound velocity are generally higher than field measurements with the difference close to 30 m/s due to the water loss and the densification. The discrepancy ratio of sound velocity measured in laboratory and field is different for the sediment samples of different types, and the ordering can be demonstrated roughly that silty sand and sandy silt has the maximum discrepancy ratio, silt takes second place, clay silt takes third place, and silty clay has a very low discrepancy ratio. In terms of overall trend, the discrepancy ratio goes up with the increasing average diameter and sand content but decreasing clay content. Another interesting finding is that the absolute difference in sound velocity between field and laboratory measurements increases with measuring frequency but the discrepancy ratio changed gently with the measuring frequency for the different sediment types.