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Use of dual methods to infer methane bubble populations in gassy sediments: Inversion of combination-frequency data

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Bubbles can dramatically change the acoustic properties of their host medium even if they are present in very small amounts. This paper describes the combination-frequency component of tank and field measurements taken using a device which measures bubbles in marine sediments using multiple acoustic techniques (allowing the results of the various techniques to be compared). The combination-frequency method uses the nonlinear scattering property of bubbles when insonified by two primary frequencies. For low void fractions, there is a monotonic relationship between the scattered field and the population of bubbles resonant at either of the primary frequencies or combination of these and/or their subharmonics. This principle is used to infer the bubble size distribution. In contrast to the case of gas bubbles in water, in marine sediments the shear properties of the host medium must be incorporated into the model for the bubble dynamics and a new model for this is presented. This model is then inverted to obtain the bubble size distribution. The predictions of this method were compared with the method of inversion of propagation data (detailed in a companion paper), obtained from in situ experiments on the South coast of England.