AD-A165 894 STUDY OF THE EFFECT OF FLOCS ON ACOUSTIC SCATTERING AND TRANSMISSION IN SEAWATER(U) DELAWARE UNIV NEWARK COLL OF MARINE STUDIES R J GIBBS 14 FEB 86 N00014-83-K-2019 1/1

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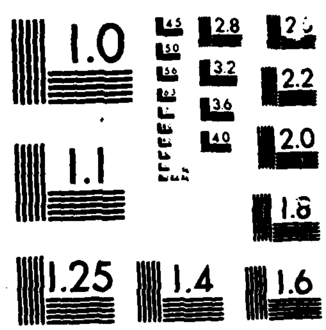

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FINAL REPORT

ON

CONTRACT N00014-83-K-2019

14 February 1986

STUDY OF THE EFFECT OF FLOCS ON ACOUSTIC SCATTERING AND TRANSMISSION IN SEAWATER

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INTRODUCTION

The purpose of this research was to determine the feasibility of examining the effect of particles and flocs on the attenuation and scattering of sound, and is an extension of previous research on the same topic. The early aspects of our work were reported in the Final Report for Contract N00014-81-C-2212, which described the techniques used and also indicated that the effect of flocs on acoustic sound is a significant process worthy of further research. The second contract on which we are now reporting continued the feasibility study to determine whether the techniques were indeed valid, since the initial study revealed shortcomings that require further consideration.

FOCUSED ACOUSTIC STUDIES

In the focused acoustic study, we attempted to measure the acoustic scattering from individual flocs of known sizes. For this we used two 5-megahertz transducers, both focused on a very small volume (approximately 800 microns on a side) in the center of a water column about 2-3cm from each transducer. One was a descending transducer and the other received the scattering acoustic signal. The experiment was conducted such that we began by measuring the acoustic scattering from a number of very small flocs, and allowed the flocs to increase progressively in size with time until we finally measured the scattering of flocs many hundreds of microns in size. The accompanying graphs show the pulses that were received as individual flocs passed through the focused acoustic sensing volume.

Dr. Jarzynski of the National Research Laboratory presented the results of this work at the 108th Meeting of the Acoustic Society of America in October 1984, and the abstract for this paper is included herein. The overall results indicated that the acoustic scattering from flocs having a 90-95% water content was approximately what would be calculated on the basis of the physical knowledge of this type of density medium. We are presently attempting to complete the publication of this manuscript on focused acoustics in cooperation with the personnel of NRL.

TUESDAY MORNING, 9 OCTOBER 1984 LINCOLN ROOM, 9:00 A.M. TO 12:05 P.M.

Session D. Physical Acoustics I: Acoustic Scattering

Wayne M. Wright, Chairman
Department of Physics, Kalamazoo College, Kalamazoo, Michigan 49007

Chairman's Introduction—9:00

Contributed Papers

9:05

D1. Long-wavelength acoustic propagation in ordered and disordered suspensions. Lawrence M. Schwartz and David L. Johnson (Schlumberger-Doll Research, Ridgefield, CT 06877-4108)

Multiple scattering theory is used to study the propagation of compressional waves in systems comprised of spherical solid grains embedded in an inviscid fluid. In the case of primitive ordered cubic suspensions the problem reduces to a system of coupled equations whose solution is shown to have the form predicted by Biot; i.e., a single *geometrical* parameter α, characterizes the suspension. By contrast, in disordered suspensions, we show that the Biot formula is not rigorously applicable. We argue that a proper theory must treat *fluctuations* in the environment of a typical grain. (This is analogous to calculating corrections to the local field in a polarizable media.) These effects introduce dependence of the long wavelength sound speed on (1) the radial (i.e., pair) distribution function and (2) higher scattering multipoles. The extent to which various approximation schemes include these fluctuations is discussed and illustrative calculations for the case of densely packed composites are presented. We point out that the available acoustic data are based on suspensions in which the fluid–solid density contrast is not great enough to distinguish between competing approximations.

9:20

D2. Scattering of ultrasound from flocs. Lohit Konwar, Ronald J. Gibbs (College of Marine Studies, University of Delaware, Newark, DE 19711), and Jacek Jarzynski (Naval Research Laboratory, Washington, DC 20375)

In the oceans the primary particle size of the sediments in the water column and on the bottom is 1 to 2 μm in diameter. However, in the high salt concentration of the ocean these primary particles are attracted to each other to form flocs. The effect of these flocs on the scattering and transmission of sound in the ocean is unknown. This paper presents laboratory measurements of scattering of ultrasound from flocs at various stages of formation. These data are used to estimate the effect these flocs have on sound transmission and scattering, and to evaluate the possibility of using sound to study flocs in the oceans.

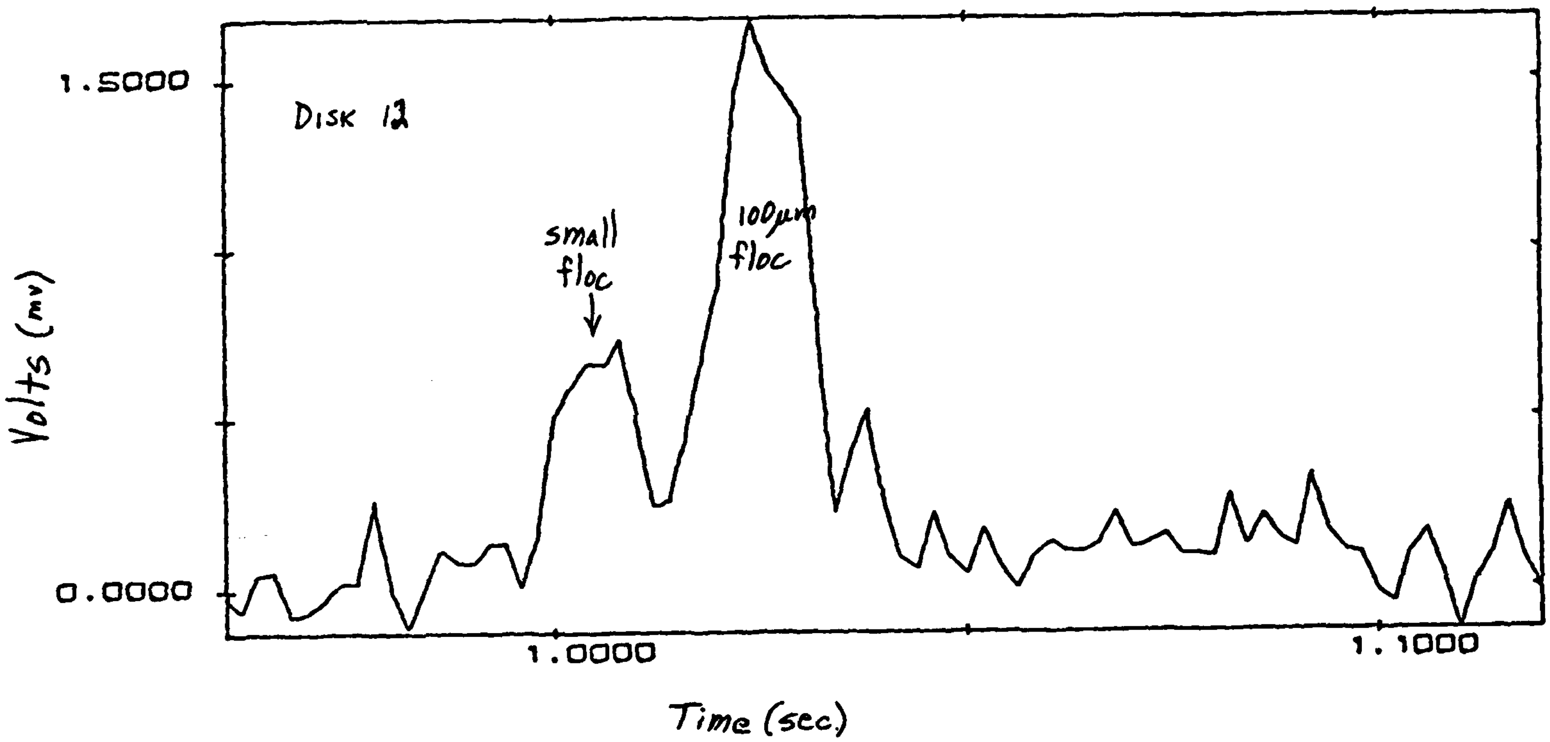


Figure , Response from focused acoustic system showing flocs being sensed

ACOUSTIC REFLECTION STUDIES

A number of researchers in the past have utilized acoustic reflection systems in order to determine the position of and the concentration of various particles in water. These acoustic studies ranged from using standard depth recorders of various frequencies (usually 50-200 KH_z) to those of other researchers such as Orr et al. (1980) and Proni et al. (1976) who have utilized custom-assembled systems having higher frequency signals. All of these techniques suffer from the same interaction of concentration and particle size on the signal received. Generally, particle size varied and was not known. The acoustic signal should vary with the particle radius to the fourth or sixth power depending on the relationship of the wavelength and the size of the particle. In either case, a change from 2μm (the average size of muds in the ocean) to 200μm (the size of flocs observed in the coastal ocean and near bottom) would result in a high impact of size that would probably dominate over a small concentration change.

The acoustic equipment utilized in preliminary tests was as follows:

Norland 3106R oscilloscope, terminal and keyboard

Norland 3001 microprocessor (multiple channel)

Norland 3701 diskette drive

HP-182A oscilloscope

FG-504 40 MHz function generator

Matec broad-band received, Model 625 (2 to 200 MHz)

Model 240 LRF power amplifier, 50 DB, 20 KHz to 10 MHz

Figure , Typical size distributions from coagulation experiment with natural sediments

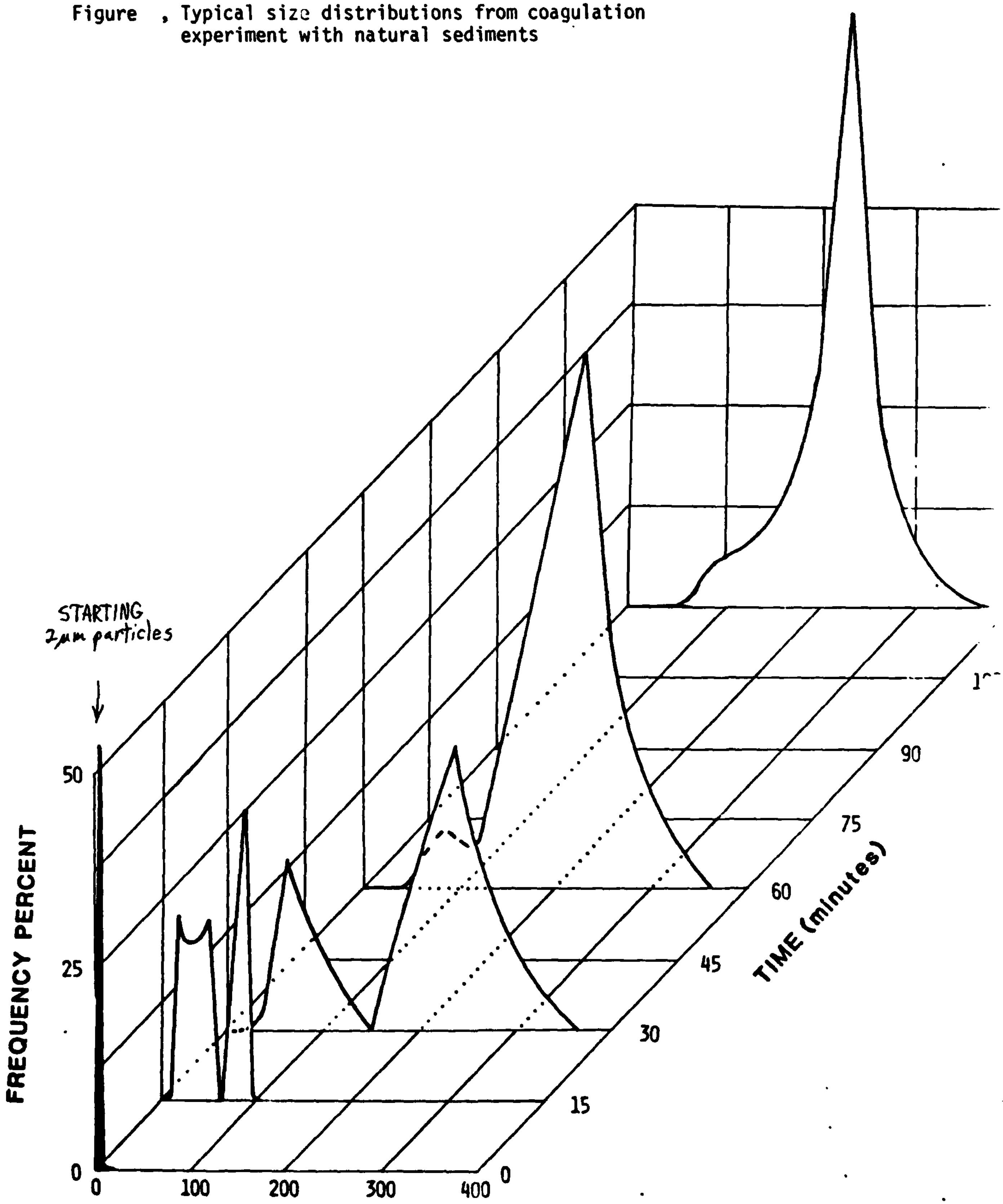
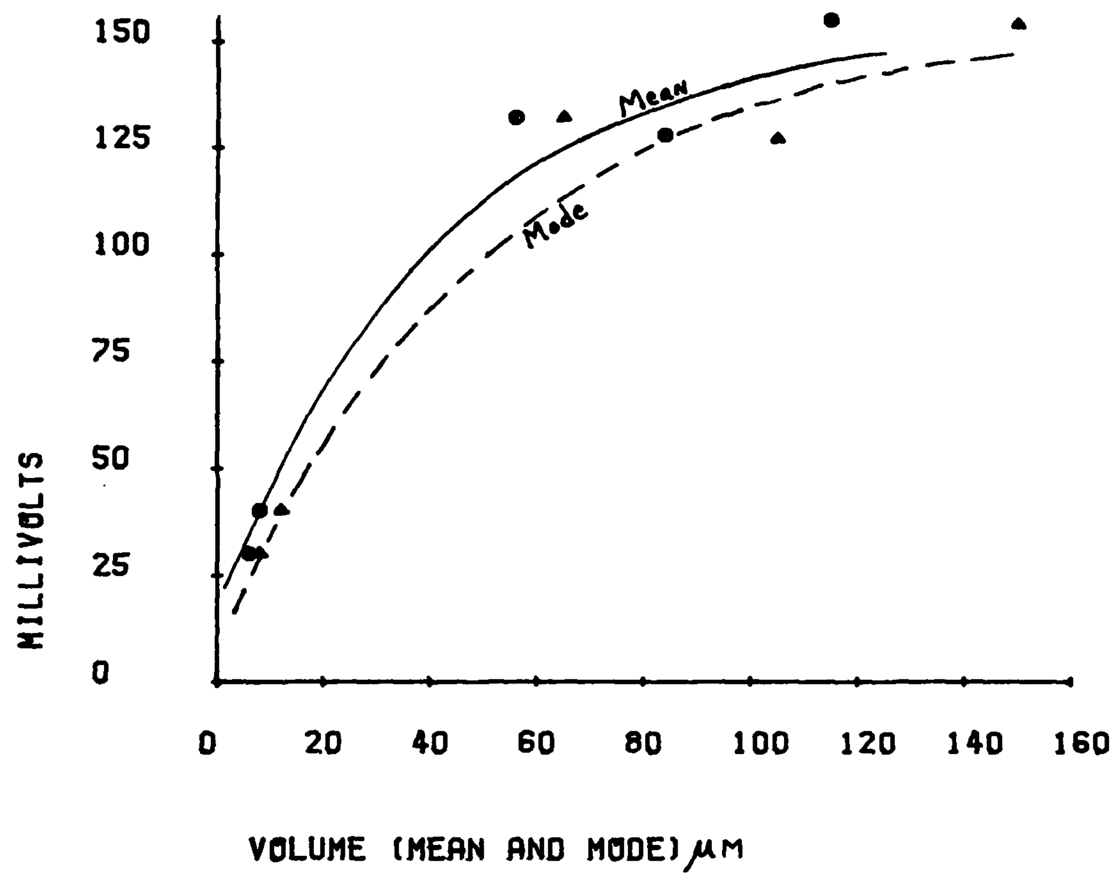


Figure . The relationship of acoustic signal (mv) to the volume mean and mode of flocs.

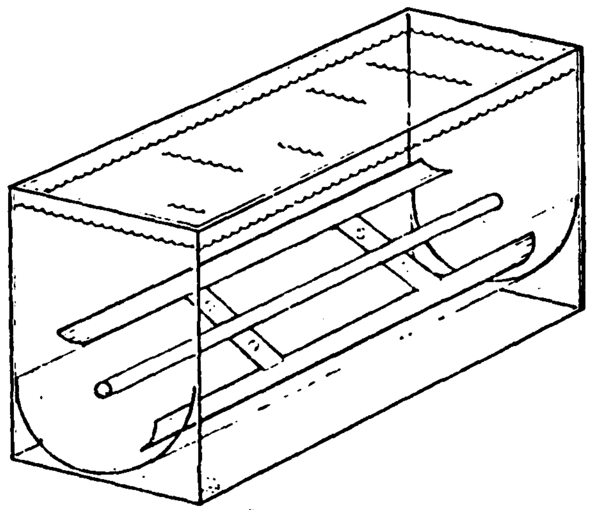


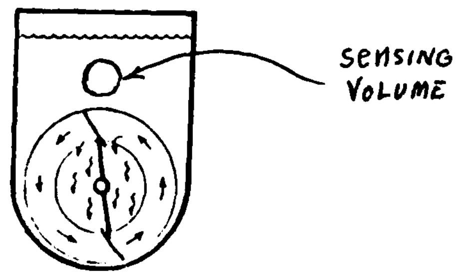
Attenuator 460A (Kay Electronics Corporation)

A variety of transducers.

Coagulation Reactor

The reactor used in these laboratory experiments was a horizontal-axis blade-type reactor of the design shown below.





Experimental results exhibited significant trends when the size of the flocs in the tank at any particular time were compared with the voltage of the return pulses. The accompanying figure illustrates that both the mean and the mode show nonlinear trends of millivolts versus size, with a rapid change that occurs in the region of from 10-20 to ≈60 micrometers, and then plateaus to a much gentler increase of 80-160 micrometers in mean size. It should also be noted that at any particular time, there were flocs up to 500 microns present while the mean was only about 150. These results indicate that, indeed, as particles originally from 2 to 100 microns in size coagulate, a dramatic shift in scattering occurs. The 2-micron particles emit signals of 5-10 millivolts, a better than 15- to 20-fold increase in scattering from the same concentration and material.

CONCLUSIONS

The acoustic reflection study demonstrates that floc size has a tremendous effect on the scattering of acoustic signals, and we will attempt to continue this work if funding can be obtained. It is critically important to floc size even though concentration is similar, for it will greatly affect the acoustic transmission and scattering of sound in the ocean and is a problem that deserves additional research.

The intention of our focused acoustic study was to understand the nature of acoustic signals emitted from various size flocs and, indeed, the collaboration of acoustic signal measurements from individual flocs with floc density contributed greatly to our knowledge of the effects of acoustic scattering in the ocean.

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