REMOTE SEABED SEDIMENT CLASSIFICATION AND SEDIMENT PROPERTY ESTIMATION USING HIGH RESOLUTION REFLECTION PROFILES

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LONG TERM GOALS

The long term goals of this program are to develop normal incidence FM acoustic reflection techniques for remotely measuring the physical and acoustic properties of ocean sediments and to improve our understanding of seabed acoustics.

SCIENTIFIC OBJECTIVES

- Develop signal processing techniques for inverting normal incidence acoustic data to calculate vertical profiles of acoustic and physical properties such as acoustic impedance, compressional wave attenuation, bulk density, mean grain size, etc.
- Determine interrelationships between directly measured acoustic properties and other acoustic and physical properties such as sound velocity, shear strength, grain size, porosity, gas concentration.
- Develop acoustic models of sound interacting with the seafloor to provide a theoretical basis for signal processing techniques and property interrelationships.

APPROACH

In order to achieve our goal of automated sediment property prediction, we have developed several signal processing techniques for estimating the geoacoustic properties of the seabed. Those signal processing procedures use expert knowledge, fuzzy logic and genetic algorithms to provide inverse solutions that work well under adverse conditions. We collect normal incidence acoustic data over a wide range of depositional environments and calculate vertical profiles of acoustic and physical property and compare those profiles with insitu and core data.

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WORK COMPLETED

During the past year, we developed a new technique for measuring the surficial and interlayer reflection coefficients of the seabed. The technique involves increasing the -3dB bandwidth of the acoustic transmissions from 1 to 2 octaves which allows the system band to be broken into several independent frequency bands which can be independently processed. When the independent inversions agree between the bands for each acoustic record (ping), the amplitude and phase of the interlayer reflections are frequency independent and are not corrupted by scattering.

RESULTS

Multiband processing of the chirp data improved the accuracy of sediment property prediction substantially. Chirp sonar data with a band of 1.7 to 12 kHz, collected along the Chesapeake Bay Bridge Tunnel, was analyzed to show that increasing the acoustic bandwidth from 1 octave to 2 octaves substantially reduced the error in calculating the phase of subsurface reflectors and that multiband processing allowed identification and rejection of the acoustic reflections that contained interference from inversion calculations. The technique consistently allowed the correct identification of a sandy silt layer that was 5 meters under a silty sand layer at Chesapeake Bay Bridge tunnel boring sites.

Reflection coefficient studies along Southeast Florida in medium to fine grain sand showed that the reflection coefficient was frequency dependent and that the rms error in the reflection coefficient decreases as the frequency band is lowered. Reflection coefficient measurements were approximately 20 % less than expected, and agreed with porous solid acoustic propagation models predictions of the seabed reflection coefficient.

IMPACT/APPLICATIONS

Sediment classification procedures have been developed to predict the acoustic and physical properties of the seabed using normal incidence reflection data collected by FM subbottom profilers. This development provides a cost effective method of surveying the top 10 meters of the seabed and obtaining vertical profiles of attenuation, acoustic impedance, volume scattering. From these acoustic property profiles, vertical profiles of physical properties such as bulk density, grain size, and porosity can be estimated.

TRANSITIONS

The chirp sonar, which evolved out of this program, was transitioned to industry in the early 1990s and has become the standard ocean industry instrument for conducting high resolution ocean surveys. The transition of sediment classification procedures to industry (Edgetech, formerly EG&G Marine Instruments) was completed in February 1996. Edgetech has provided an alpha (preliminary) release of the software to FAU for testing. The sediment classification technology is currently being transitioned to

NAVFAC via a SBIR for the purpose of providing the Navy with rapid seabed assessment capability for amphibious forces.

RELATED PROJECTS

Core data for this project has been provided by the Coastal Benthic Boundary Layer Program (Dr. Richardson) and NFESC (H. Herrmann).

REFERENCES

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