SOME APPLICATIONS OF THE CHIRP SONAR

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Abstract

A new swept FM, digital subbottom profiler, the chirp sonar, utilizes modern digital signal processing algorithms and hardware (AT&T DSP32C) to generate high resolution images of ocean sediments to 100 meters with 10 cm vertical resolution. Matched-filter processing improves the inband SNR of subbottom returns by at least 20 dB. High SNR allows quantitative analyses such as reflectivity and acoustic attenuation measurements providing surficial and subbottom sediment classification. Reflection profiles showing classified sediments can be used for EEZ, dredging, pipeline, and port and river engineering surveys; geologic studies; and acoustic propagation modeling.

Introduction

The chirp sonar is a towed, digital, swept FM subbottom profiler that generates wideband, quantitative, subbottom reflection data. This quantitative data can be used for generating high resolution images of the water column and/or the underlying sediment structure and for estimating acoustic parameters such as reflectivity, effective attenuation and volume scattering strength of surficial and subfloor sediment layers over a wideband of frequencies. For example, one configuration of the chirp sonar, using a 20 msec 1.5-10 kHz FM sweep, generated images showing a vertical resolution of 15 cm, high spatial resolution(as evidenced by the lack of hyperbole from point scatterers), a subbottom penetration of 62 meters to basement through bay silts and sands, and a dynamic range of 66 dB (measured at the sediment-water interface); and predicted sediment types by calculating the spectrum of subbottom reflections from which the change in acoustic attenuation over the frequency range of the FM sweep was estimated and correlated to sediment type.

High resolution reflection profiles and quantitative measurements, generated by the chirp sonar, are useful for the following applications:

1) geologic, mining, EEZ, port, geotechnical, dredging, environmental impact, deep ocean and hazard surveys requiring wide dynamic range, high resolution images of the seabed and identification of sediment type

2) hydrogeologic surveys requiring porosity and permeability data which can be predicted from attenuation coefficient estimates

3) environmental surveys requiring the detection of thin layers of contaminated sediments or fluidized muds

4) acoustic propagation prediction calculations requiring seabed impedance and acoustic attenuation data

5) water column microstructure studies requiring the spatial variation in the impedance of seawater.

6) sediment gas surveys for mapping the size and spatial distribution of sediment gas bubbles requiring the spectrum of the energy backscattered by the bubbles

7) detecting and imaging buried objects such as archeological artifacts, pipelines and military weapons

8) current scouring surveys requiring a cross sectional image of refilled scour features near bridges, piers and breakwaters

The quantitative chirp sonar was designed and tested at University of Rhode Island under a program sponsored by the Office of Naval Research (Geo-Acoustics/Arctic Sciences Division, Program Manager - Dr. J. Kravitz) to investigate the use of high resolution seismic profilers for remotely measuring sediment properties. The chirp sonar was