ABSTRACT. Geoacoustic models of the seafloor are essential components of underwater and seafloor acoustic studies. Propagation velocities for compressional and shear waves in the seafloor material are important geoacoustic parameters. Previously reported values for shear wave velocities in seafloor carbonate oozes have shown wide disparity. New laboratory measurements of compressional and shear wave geoacoustic parameters have been made as a function of effective stress. Periplatform carbonate samples from the Little Bahama Bank and Exuma Sound in the western North Atlantic Ocean were used for these measurements. Conventional pulse timing compressional wave velocities were measured. Shear wave parameter measurements were made with a new technique using duomorph sensors embedded in the seafloor sample. The resulting compressional wave velocity values are consistent with previously reported measurements for similar material (e.g. Hamilton). The shear wave dynamic property values obtained are more consistent with the lower shear wave velocity values reported, for example by Schultheiss. These lower shear wave velocities also agree with values obtained by pulse timing measurements with bender bimorph transducers in samples from the same seafloor region.

Introduction

Geoacoustic models of the seafloor are basic information required to understand acoustic propagation in bottom interacting situations. A geoacoustic model as defined by E. L. Hamilton (1980) is a model of the real sea floor with emphasis on measured, extrapolated and predicted values of those properties important in underwater acoustics and aspects of geophysics involving sound transmission. Implicit in this definition is the understanding that measured data are frequently not available for modeling and must be estimated and predicted. Valid predictions can only be made when the seafloor properties within the range of interest (i.e. the water-sediment interface to a depth of several hundred meters, depending upon frequency) are well understood. Among the sediment properties required for modeling acoustic propagation are compressional and shear wave velocity as a function of depth or effective stress. The effective stress is the load carried by the sediment particles minus the load-carrying contribution of the pore fluids.

Ideally, velocity measurements should be made in situ. However, due to difficulties obtaining in situ measurements in deep water, for a number of years in situ velocities have been computed from seismic studies (Houtz, 1974, Dobrin, 1976, Gettrust and others, 1988) or converted from laboratory measurements using temperature and pressure corrections. Another method is to apply laboratory consolidation techniques whereby vertical pressure is added to the sample under controlled conditions to simulate in situ pressures, and the properties of interest are measured during the process of consolidation. As part of a larger study, compressional and shear wave
velocity and shear modulus of periplatform sediments were measured in a laboratory consolidation study. Sediment samples for these measurements were recovered from Exuma Sound and north of Little Bahama Bank (Figure 1). The measurement results provide an empirical data base for these acoustic properties of periplatform sediments as a function of depth or effective stress. Regression relations fitted to these data can be applied to sediments in similar environments but in different geographic locations.

Background

Predicting the compressional or shear wave velocity for various subseafloor depths within shallow and mid-water depth carbonates sediments is not straightforward. This is illustrated by the information in Figures 2 and 3. Compressional wave velocity values shown in Figure 2 were measured on board the RV JOIDES RESOLUTION on samples recovered from Ocean Drilling Program (ODP) Sites 627 and 628. The plotted velocity versus depth data can be compared with the solid line which represents Hamilton’s regression equation (1980, Figure 5 and Table IV) predicting expected velocity in carbonate sediments as a function of depth. The ODP measured compressional wave velocity values exhibit almost no depth dependences, diverging increasingly from Hamilton’s predicted values with increasing depth. Hamilton’s regression relation is based on in situ velocity values from sonobuoy measurements while the ODP data are uncorrected values measured under shipboard laboratory conditions of temperature and pressure.

Shown in Figure 3 are shear wave velocity values which were measured, using bender element transducers, in samples recovered from ODP Site 630, Northern Little Bahama Bank. As was true for the laboratory measured compressional wave data, the shear wave velocities in Figure 3 exhibit essentially no dependence on depth below the seafloor from which the sample was

![Figure 1. USNS RV Lynch core locations. (a) Little Bahama Bank and (b) Exuma Sound. ODP Sites are also noted.](image-url)