Seismic Properties of Shallow-Water Sediments: A Component of the STRATAFORM Program.

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LONG-TERM GOAL

My long-term goal is to understand and quantify the effects of seafloor structure on problems of interest to the Navy.

OBJECTIVES

The specific objective of this grant is to measure the shear velocity structure of the top few meters of the seafloor in the STRATAFORM study area off Eureka, CA.

APPROACH

The seafloor shear velocity is determined by the inversion of Scholte waves (interface waves traveling at the water-sediment boundary). These waves were excited by small explosions and observed using Ocean-Bottom Seismometers (OBSs) originally constructed using ONR funding. The key individuals involved were myself and Allan Sauter, the lead OBS engineer. The field work was carried out in collaboration with scientists from NRL-Stennis: Wayne Kinney, Dale Bibee, and Will Avera.

WORK COMPLETED

I have a preliminary shear velocity model (see Figure 1) for one site, the "gassy mud" location at about 200 meter water depth. The analysis is being done using the methods of Nolet and Dorman, 1996. The surficial shear velocity is about 70 m s^{-1}, which is about twice the value found in pelagic sediments, and the gradient is about 5 s^{-1}, about the same as found in the deep sea by Schreiner and Dorman, 1990.

The way in which the waveform fitting is done starts with fitting the amplitude envelope over some bandwidth, then graduating to waveform (wiggly line) fitting. As is usually done, the fitting is started using the low-frequency part of the signal, in this case about one Hertz, and adjusting the model to fit that, gradually increasing the bandwidth. At the present time, the waveform fit is based on one octave bandwidth, from 1 to 2 Hertz. The fit achieved is shown in Figure 2. As is evident, the “cycle matching” is fairly good over the frequency range, but the amplitude match is ragged. After achieving a good fit to the dispersion characteristics of the signal, the known source amplitude constraints will be imposed using the theory developed in Nolet and Dorman, 1996. This will allow determination of the attenuation (Q) structure.

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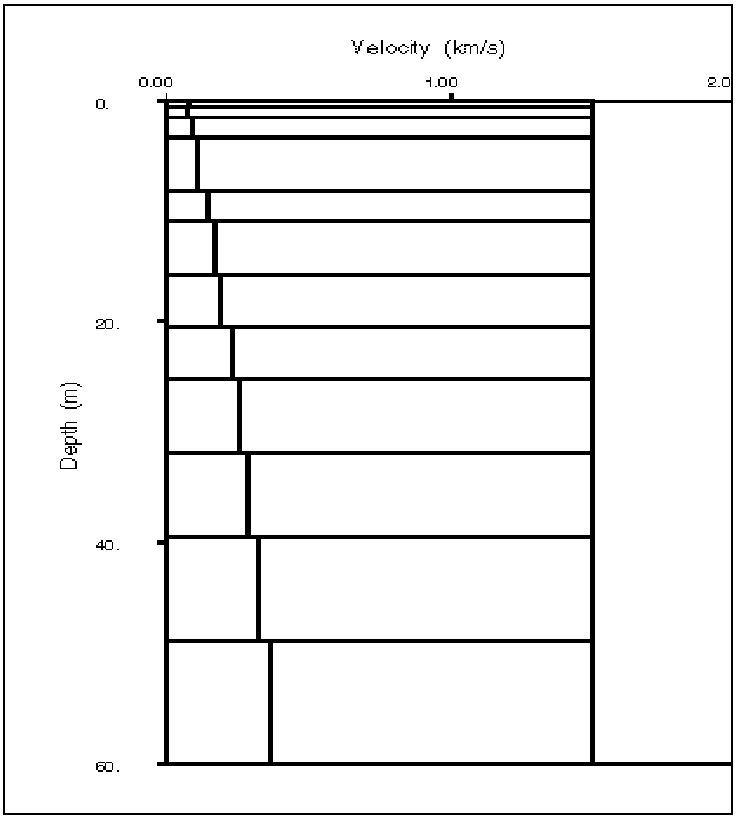

Figure 1. Shear velocity model for the "gassy mud" site off Eureka, CA. The two lines shown are the shear velocity, ranging from 70 to about 350 m s^{-1} at 60 meters depth, the bottom of the figure, and the compressional velocity, which was fixed at 1.5km s^{-1}.

RESULTS

I have begun fabrication of a replacement OBS sensor package to replace the one lost when the OBS was trawled up by a local fisher. This work has been delayed by slowness in the sensor manufacturer (Precision Measurement Devices) in delivering a sensor whose geometry fits a smaller pressure case than we now use.

IMPACT/APPLICATIONS

The preliminary velocity model for this site (at 200 meters water depth) shows shear velocities about twice as high as those occurring on the deep sea floor, but significantly lower than the velocities occurring in shallower water. The velocity gradient with depth is strong, producing pronounced dispersion in the Scholte waves, in contrast with the shallow-water site nearby, which produced little dispersion in the Scholte waves. Strong dispersion increases the effectiveness of waveform matching types of signal processing and allows single-sensor determinations of range to impulsive sources.

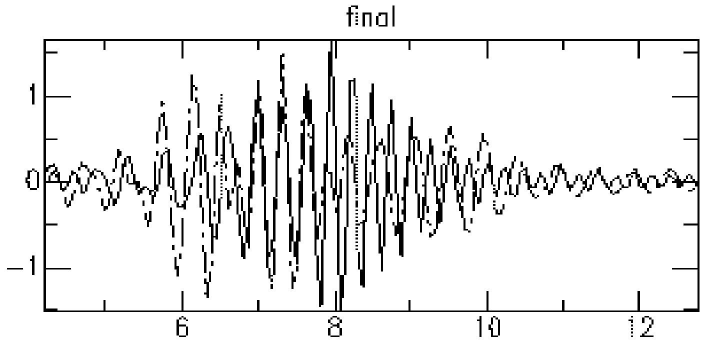

Figure 2. Interim waveform fit. The solid line is the data and the dashed line is the synthetic seismogram. The cycle matching is fairly good, indicating that the velocity structure is basically correct, but the amplitude fit is poor. As yet, no amplitude constraints have been imposed. The velocity dispersion can be exploited in multimode signal processing (data fusion).

TRANSITIONS

In replacing the lost sensor, we are upgrading to a broader-bandwidth device, making the OBS usable to lower frequencies, as well as improving the tolerance to misleveling. The new sensor need only be leveled to 5° accuracy instead of the fraction of a degree necessary with the Mark Products sensor which is currently the standard.

RELATED PROJECTS

We remain in touch with the NRLSSC scientists working with data fusion.

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