Measurement of *in situ* Physical Properties of Shallow Water Sediments, Using the UW Sand Probe

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LONG-TERM GOAL

My long-term goal is to understand the physical, chemical and geological processes that control the physical properties of shallow water marine sediments. Of particular interest to me are the parameters of compressional wave velocity, density and permeability, and their control on the acoustic properties of sand. These physical property measurements will be used to constrain models of acoustic wave penetration into and propagation within sandy sediments at high frequencies.

OBJECTIVES

We are moving to accomplish the above goals by developing instrumentation that can measure the *in situ* physical properties of sandy sediments. This instrumentation and the associated measurements of compressional wave velocity, density and permeability will be done in conjunction with, and in support of, the ONR High-Frequency Sediment Acoustics Departmental Research Initiative (DRI). The instrumentation that we have developed consists of physical property sensors mounted on a large (14 ft tall and 14 ft between legs) tripod. During the 1999 fiscal year, this tripod was deployed during the two SAX99 (Sediment Acoustics eXperiment) field programs. Prior to these SAX99 deployments, the tripod with Vp, density and permeability sensors was deployed in both 1998 and 1999 on several test/calibration small boat (RV BARNES) deployments within Puget Sound.

APPROACH

During the 1999 season, the UW Sand Probe tripod was deployed twice, beginning in July, 1999 as part of the initial DRI site survey. The purpose of these July deployments was to characterize the physical properties of the upper 1 meter of sandy sediments at the proposed DRI site off Panama City, Florida. For these deployments, we concentrated on measurements of compressional wave velocity at 3.5 and 12 kHz, with harmonics at 11, 33 and 36 kHz. Additional measurements were made of *in situ* density, using a gamma-gamma backscatter logging tool with a Cesium-137 radioactive source. The second deployment was in October 1999, where we concentrated on making measurements *of in situ* permeability, using a newly developed permeability probe in both the active and passive modes.

WORK COMPLETED

During the initial July, 1999 field season, we were severely handicapped by shipping problems, with several pieces of key equipment (including the primary motor for the tripod) being lost in transit to Panama City. We managed to substitute and replace some of the lost equipment, and the critical motor was recovered just before the end of the cruise. With these difficulties, we managed to deploy the

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tripod over a period of about 20 hours at the end of the cruise period, and made several key measurements of Vp and density at the primary site. In addition to the physical property measurements, the video images of the tripod instrument probe, as it hydrojetted into the sediments, proved to be a valuable tool for assessing the site for the DRI experiments

During the October 1999 field program, we concentrated on using the tripod for *in situ* permeability measurements, and these deployments were a dramatic success. Using 3 days of RV PELICAN ship time, we used the tripod to deploy the new permeability probe in a 3-sided box around the DRI high-resolution site.

RESULTS

The measurements of Vp and density carried out in July 1999 were made at the Panama City site, which was not the location of the final DRI High Resolution experiment. The observations of sub-surface shell layers at this site from the tripod video images were a large component of that decision. Because of these images, in spite of a much-shortened cruise, the tripod served as a useful site survey tool. The physical property measurements (Vp and density) from the Panama City site will be analyzed over the next year, for comparison with the Fort Walton Beach site (the final DRI site).

In contrast, the *in situ* permeability measurements that were made in October were done at the final DRI High Resolution site, and will be valuable in assessing the Biot mode as the source of the anomalous acoustic penetration. We were successful in making measurements at 19 distinct sites, and at 4 depths (10 cm intervals) within the sand at each site. The 19 sites were made on 3 profiles, which formed a 3-sided box around the high resolution DRI site.

IMPACT/APPLICATION

These permeability measurements showed a surprising high degree of variability over the small site, and these data will be analyzed in conjunction with the other physical properties made by other DRI investigators. If the variability in permeability as initially interpreted withstands full data analyses, it will have a major impact on the interpretation of the DRI experiment.

In any case, our data are the only *in situ* measurements of permeability that can be used to evaluate the Biot mode for anomalous acoustic scattering at the DRI site.

TRANSITIONS

Our tripod and new permeability probe are being considered for use with the new ONR Mine Burial Program that is currently being developed.

RELATED PROJECTS

A parallel ONR project by Dr. Richard Bennett developed the design of the new permeability probe used in this project. Dr. Bennett designed and built the permeability probe, and assisted in the calibration and testing at our UW lab, prior to the cruise. Dr. Bennett and Jehrome Stockstill (from his lab) participated in the October cruise, and were a major component of the success of the permeability measurements.

REFERENCES

None

PUBLICATIONS

Because the October field season took place only 2 weeks ago, the data have not been fully analyzed. There are, at present, no publications from this program.