Active Heave Compensated Drilling Rig (AHC800)
Cruise KN167 –KN168A/B R/V Knorr

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LONG-TERM GOALS

The continental shelves are of obvious scientific and strategic importance. However, the ability to cost-effectively collect core samples of continental shelf sediments has been limited by technical difficulties. Many sites of scientific interest are too shallow to be drilled by large drill ships, such as the *JOIDES Resolution*, and they are too deep to be drilled economically from jackup platforms. DOSECC's AHC800 drilling system was developed to overcome these obstacles by building a small active heave compensated drilling rig that could be used from vessels of opportunity, in particular the *R/V Knorr*.

Active heave compensated drill rigs are not readily available either in the scientific drilling inventory or in the commercial market. Our long-term goal is the development of an active heave compensated drilling rig (AHC800) that can collect core for scientific study from the continental shelves. We have addressed our long-term goals through incremental improvements and two sea trials of the system. This report covers the second of these sea trails.

OBJECTIVES

The objectives of the September-October, 2002 cruise were a) to continue engineering tests on the AHC800 and b) to collect core off the coast of New Jersey to ground truth the acoustic response of channel structures as part of the Geoclutter Program.

APPROACH

DOSECC's Active Heave Compensated 800 (AHC800) drilling rig specifically designed to collect high quality core samples in the shallow marine environment. Active heave compensation is a unique feature of this rig; there are a limited number (<5) of drilling rigs in the world that have this capability. Most marine drilling is done with passive heave compensation that is adequate for holes in deep water. However, when high-quality core samples are required from relatively shallow water (<200 m), passive systems are not viable.

Figure 1. AHC800 in drilling position on the R/V Knorr

The AHC800 drilling rig is designed to collect continuous core to a total depth of 800 m. Water depths of 200 m and less are optimal; however, with some modification operation in deeper water is possible. The AHC800 senses vessel heave using a constantly tensioned low stretch (Spectra/Dyneema) taut line attached to a seafloor weight. A linear position transducer is attached to this taut line and through the data acquisition system, the ship's distance from the bottom is communicated to the heave compensation computer running the Labview RT operating system and object based software language. This real time control system is used to achieve a 10-millisecond control loop for both data gathering and output functions. The Labview RT system is continuously giving a hydraulic valve response, feeding oil to two hydraulic cylinders that will keep the heave carriage and the drill string at the same reference distance from the bottom.

The AHC800 uses DOSECC's suite of soft sediment sampling tools. These tools have been used successfully for the collection of sediment samples from a number of lakes as well as marine settings. The tools can be deployed by wireline so that they can easily be changed to reflect different drilling conditions. Core with a diameter of 2.44 inches is collected in a standard ODP plastic liner.

The AHC800 system was used on the *R/V Knorr* from 25 Sep to 15 Oct 2002. New features were added and corrections made as the trip progressed. The system still requires some tuning in order for it to move from a research and development stage to production drilling; however, the concept and engineering design are sound.

WORK COMPLETED

Three sites were occupied during the 2002 cruise (Alexander and Austin, 2003, Cruise Report – KN167-KN168A/B). All sites were chosen with respect to a dense and extensive array of ultra-high resolution (<10 cm vertical) chirp-sonar seismic data collected as part of the ONR Geoclutter program. Site 1 was located in 127 m of water, Site 2 in 79 m of water and Site 3 in 75 m of water. At Site 1, a total of 7.54 m of core was collected penetrating the "outer shelf wedge", a dipping series of laminated reflectors. Site 2 was chosen to penetrate a through the entire fill sequence of a shallowly-buried river(?) channel – something that had never been accomplished before. The target depth to the channel base was estimated to be 12 m subbottom and our total penetration was 13.13 m. The target at Site 3 was a channel flank and the underlying "R" horizon, a strong regional reflector whose origin is still being debated. Five cores were collected to a total depth of 7.83 m, and the "R" horizon was penetrated and sampled.

RESULTS

The AHC800 system performed up to and beyond its design specifications. The rig was designed to compensate for 8 feet of heave with an 8 second period. However, during the cruise, the *Knorr's* response was a 6 second period resulting in a significant increase in the required acceleration as well as a faster response time for the system as a whole. We believe this 6-second period resulted from rapidly changing wind and wave conditions caused by the passage of different storm systems. During times when the heave was greater than 8 feet with a 6-second period, the response time of the system was insufficient to keep the drill bit on bottom. However, we were able to continue operation in sea states up to 9.5 feet with periods of greater than 8 seconds.

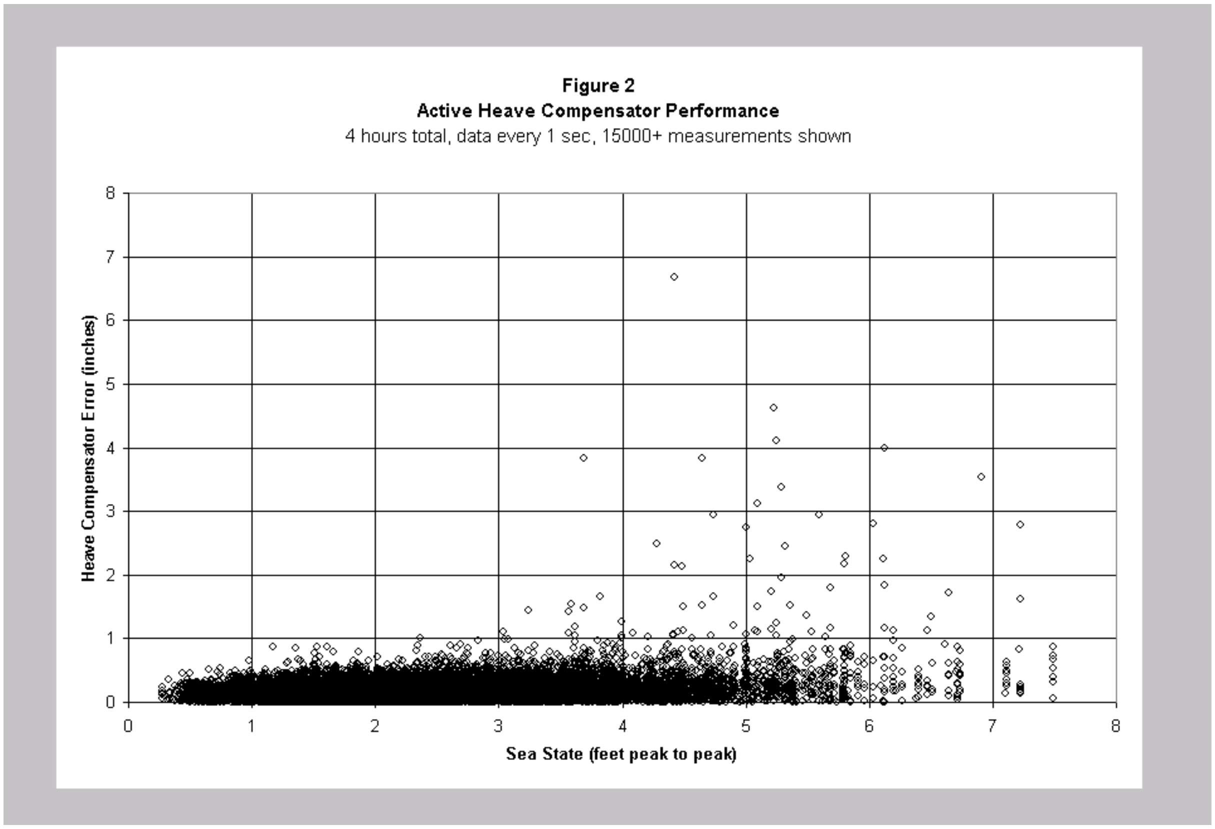

Figure 2. The performance of the AHC800 during a typical 4-hour period during the KN167.168 cruise. This figure plots the sea state, meaning the actual vertical heave of the Knorr (in feet) in response to existing sea conditions, versus the heave compensation error in inches of the AHC800. The "error" represents the amount of heave that the system has failed to remove from the heave of the vessel. Figure 2 illustrates that the error is generally less than 0.5 inch. At heave magnitude greater than 3.5 feet, spurious errors do occur, but we believe that these errors can be reduced through additional system tuning.

IMPACT/APPLICATIONS

There is enthusiasm within the shallow water coastal community for the capabilities of the AHC800. It is apparent that a stand-alone heave compensated system will be required to fulfill future needs of ONR and the rest of the near-shore research community.

TRANSITIONS

We have had several inquiries concerning the availability of the AHC800 both from commercial interests and from the scientific community. As of now these discussions have not gone into the contract stage.

RELATED PROJECTS

DOSECC is involved in an on-going program of scientific exploration of lakes through the NSF and ICDP (International Continental Scientific Drilling Program). This activity uses the same tool suite that we are using on the ONR projects.

The ACH800 is designed to work from vessels of opportunity. Drilling can take place through a moonpool or the rig can be cantilevered over the side of a vessel. DOSECC has acquired a portable dynamic positioning (DP) system that expands our ability to use vessels of opportunity. The DP system is funded through grants from the U. S. National Science Foundation and the International Continental Scientific Drilling Program.