Seismic Studies on the Blake Ridge Gas Hydrates

Cruise Report for R/V Cape Hatteras Cruise CH 18-95 - Overview

Experimental Overview

Cruise CH 18-95 took place in two legs, with each leg timed to coincide with ODP drilling of holes 994 and 995 on the Blake Ridge. The seismic experiments were designed to provide the maximum flexibility in conducting the two-ship walkaway VSP experiments; i.e., R/V Cape Hatteras could conduct single-channel or OBS profiling in the vicinity of the drill hole while "standing by" for the beginning of VSP operations. The Cape Hatteras also provided transportation for personnel transfers and supplies to and from the Resolution during each leg.

The following studies were conducted during Leg 1 of the cruise:

- A walkaway VSP experiment over Hole 994D in which R/V Cape Hatteras provided the sound source for a three-component seismometer set in the drill hole from R/V JOIDES Resolution, a geometry required to acquire walkaway VSPs.
- Collection of single channel seismic (SCS) profiles to complement other geophysical data associated with ODP Leg 164 drilling.
- Isotope analyses on samples collected by R/V JOIDES Resolution.

The following seismic operations were conducted during Leg 2:

- Two OBS experiments, one in a location in which little hydrate is thought to be present and one over ODP Site 994D.
- A walkaway VSP experiment over Hole 995B.
- The acquisition of additional SCS profiles of the region to complete the series of lines begun on the first leg.

These operations were successfully carried out.

Seismic Source

A generator/injector (GI) gun (Seismic Systems Inc.) was used as the seismic source during the entire cruise. The GI gun consists of two independent airgun chambers configured for a size of 1.7 l (105 in3). The first chamber (generator) produces the primary pulse. The second chamber is fired with a slight delay to suppress the bubble created by the first chamber. A gun phone attached to the GI gun provides information to monitor the nearfield and to determine the optimum delay between the trigger signals for each chamber. *Fig. 1* displays the principal operation of a GI gun.

Delay times were adjusted according to the firing pressure and gun depth. The gun depth was maintained by tethering the gun assembly on three Norwegian buoys. Tests to optimize tuning of the gun using signals from both the streamer and the gun phone were conducted on the first leg. Delays were varied from 30 to 53 ms. A 45 ms delay gave optimal bubble-pulse reduction at 210 bar (3000 psi) pressure and 5 m depth of the gun. No similar tests were conducted on Leg 2 since we used the same source configuration.

Pressure was generated using two compressors which worked almost without problems during the whole cruise. Airgun pressure usually was between 140 and 210 bar (2000 - 3000 psi). The gun was towed approximately 45 m behind the stern of the ship and was boomed out on the starboard side. It was generally fired every 15 s.

Navigation

Three independent systems were used to record navigation: (1) The USGS Rockwell GPS device was able to decode the military GPS fixes (P-code fixes). P-code fixes were recorded directly to a PC using the program debbie5 that logged latitude, longitude, and time every 5 seconds. These navigation files were downloaded to floppy disk at the end of each VSP line. The P-code navigation data are expected to yield positions to an accuracy of ~10m. (2) The shipboard Ashtech GPS (on the bridge) decoded the Coast Guard transmitted differential corrections, when these signals were available, which appeared to be ~50% of the time. We were at the seaward limit of the transmitting beacons' range. The differentially corrected signals have a potential position accuracy of ~1m. (3) The WHOI Ashtech GPS fixes were stored internally of the GPS unit and were downloaded to floppy disk at the end of

each VSP line using the Ashtech hose program. A similar procedure was carried out aboard the Resolution with the aim of performing differential post processing to two walkaway VSP data sets and producing ship-to-ship relative range information with accuracies on the order of ~10 cm. It was noticed that our Ashtech unit was not tracking satellites as effectively as a second Ashtech unit which was on board (being used to power the P-code receivers antenna). Efforts to explain this discrepancy were unsuccessful. Antenna location, antenna type, and GPS power supply were eliminated as possible causes.

Single-Channel Seismic Lines

Two-channel seismic lines were acquired to augment the already existing site-survey data for ODP Leg 164 as well as during the shooting of the OBS lines and during one of the transits of each walkaway VSP line. We refer to those data as single-channel seismic (SCS) lines, because pre-stack information will not be used for further interpretation due to the small distance between both channels.

The Teledyne two-channel streamer consists of two 50 m-long active sections separated by a 25m-long dead section towed approximately 94 m behind the stern of the Hatteras. The streamer signal was passed through a bandpass antialiasing filter with 3 dB points at 5 and 100 Hz with 48 dB/octave rolloff at the low end and 128 dB/octave rolloff at the high end. This signal was then sent to the a2d acquisition software running on the shipboard SUN workstation and sampled at a 2 ms rate. The output SEG-Y files of the a2d software required postprocessing via the processSegy program of T. O'Brien to convert the output to voltages. We note that the final gain settings of the two channels do not appear to be perfectly balanced and should be regained prior to stacking of the channels. Shot numbers originally increased successively without resetting them at the start of each line. After splitting the records into individual lines, we changed shot numbers to start with 1 at the beginning of each line. Further organization of the SEG-Y data recorded on the two legs is discussed further below in the section about data management.