High-Resolution Studies of Hydrates on Blake Ridge

Deep-tow multichannel seismic data are used to obtain significantly improved images and physical property estimates of marine sediments within the upper 1 km of the sediment column. The technology that supports this effort is based on a Helmholtz resonator source (220Hz – 1kHz frequency band, 200 dB // 1 μPa @ 1 m source level) that operates at any ocean depth. The source and 48 independent hydrophones are deployed approximately 300 meters above the seafloor. This system has proven to be optimal for studies of marine hydrates as it provides high-resolution data through the hydrate stability zone (HSZ), including the strong seismic signal from the bottom simulating reflector (BSR) that is related to the temperature-pressure driven phase change from solid hydrate to gas and water.

Data taken with this system (the Deep Towed Acoustics/Geophysics System, or DTAGS) on the Blake Ridge revealed that numerous faults, separated laterally by tens to hundreds of meters and extending from the base of the HSZ to the seafloor are ubiquitous on both the flank and crest of the Blake Ridge. These faults provide more permeable pathways for the flow of water and methane that may concentrate hydrates along vertically oriented paths on the Blake Ridge. Compressional velocity estimates from DTAGS data, suggest that zones of high compressional velocity (consistent with hydrated sediments) are laterally discontinuous and may be consistent with hydrate concentration near these faults.

These seismic data have been the impetus for the development of lattice gas numerical simulations of fluid/gas flow through complex media as a means to better understand hydrate generation, dissociation and movement within sediments. Examples of flow through a geologic fault and flow with multi-component media are presented.

Improvements in methods for determining the location and concentration of hydrated marine sediments may rest with the development of bottom-mounted seismic sources and ocean bottom cables. This combination will allow investigators to observe both compressional and shear seismic data. As laboratory studies indicate that the shear properties of sediments are quite sensitive to being hydrated, observation of shear waves could significantly improve our ability to study the HSZ. An additional benefit results from the fact that shear waves are insensitive to gas content and therefore can be used to confirm that reflections from a horizon identified as a BSR are consistent with a phase change from solid hydrates to gas-water.