Gas hydrate characterization from a 3D seismic dataset in the deepwater eastern Gulf of Mexico

Principal component analysis of spectral decomposition results combined with amplitude and frequency seismic attributes derived from 3D seismic data are used for the identification and characterization of gas hydrate deposits in the deepwater eastern Gulf of Mexico. In the central deepwater Gulf of Mexico, logging while drilling LWD data provided insight to the amplitude response of gas hydrate saturation in sands, which could be used to characterize complex gas hydrate deposits in other sandy deposits. In this study, a large 3D seismic data set from the deepwater eastern Gulf of Mexico shows sandy Plio Pleistocene abyssal fan deposits. Faults from basement through the Cretaceous penetrate into the thick Neogene fan deposits and provide conduits for fluid and gas migration into sandy reservoirs at the base of the gas hydrate stability field. Locally focused high amplitude anomalies, both peak-dominant and trough-dominant, are coincident with a vertical migration conduit. The velocity cube used for the time and depth migrations indicates a vertical low velocity field associated with the interpreted conduit for vertical fluid and gas migration. No bottom-simulating-reflector (BSR) is seen in the data, nor is there a BSR proxy such as an unambiguous depth to top-most free gas present. The seismic anomalies, however, suggest gas hydrate filled sands

Seismic stratigraphic features are delineated using principal component analysis of the band limited data at potential gas hydrate sands, and compared and calibrated with spectral decomposition thickness to constrain thickness in the absence of well control. Layers in the abyssal fan sediments are thinner than can be resolved with 50 Hz seismic and thus comprise composite thin-bed reflections. Amplitude vs frequency analysis are used to indicate gas and gas hydrate reflections. Synthetic seismic wedge models show that with 50Hz seismic data, a 40% saturation of a Plio Pleistocene GoM sand in the hydrate stability zone with no subjacent gas can produce a phase change (negative to positive) with a strong correlation between amplitude and hydrate saturation. The synthetic seismic response is more complicated if the gas hydrate filled sediments overlie gassy sediments. Hydrate (or gas) saturation in thin beds enhances the amplitude response and can be used to estimate saturation. Gas hydrate saturation from rock physics, amplitude, and frequency analysis is compared to saturation derived from inversion at several interpreted gas hydrate accumulations in the eastern Gulf of Mexico.