AAPG HEDBERG CONFERENCE
"Gas Hydrates: Energy Resource Potential and Associated Geologic Hazards"
September 12-16, 2004, Vancouver, BC, Canada

USING SEISMIC INVERSION METHODS TO CHARACTERIZE THE EXTENTS OF GAS HYDRATE TRAPS IN NORTHWEST WALKER RIDGE- DEEPWATER GULF OF MEXICO

DAN McCONNELL[1] and BETH KENDALL[2]
[1]AOA Geophysics Inc., Houston, Texas
[2]Kerr-McGee Oil and Gas Corp., Houston, Texas

Elastic inversion methods may be able to detect buried gas hydrate deposits in the tophole section in certain deepwater settings (the tophole section of a deepwater well is typically defined as the upper 450 m of sediment). To date, there are few instances of using inversion methods to characterize the distribution of gas hydrates in deepwater settings so there is great value to industry and academia in applying these techniques to image the distribution of known or suspected buried gas hydrate deposits. Employing inversion methods to characterize gas hydrate deposits, if successful in the deepwater Gulf of Mexico, would (from the geohazards perspective) be a significant advance for the planning of deepwater exploration and development wells. Buried gas hydrates in the tophole section in deepwater wells can, at a minimum, adversely affect wellbore stability, the quality of cement job, and integrity of the casing shoe. Inversion methods, once developed and successful, may also be used to evaluate the resource potential of gas hydrates in different geologic settings.

In this paper, inversion methods are applied to image the lateral and vertical extents of the gas hydrate traps identified by McConnell and Kendall (2002) in northwest Walker Ridge in the deepwater Gulf of Mexico (Figure 1). In the prior work, McConnell and Kendall identified a series of gas accumulations without structural or stratigraphic control that were suspected to be trapped by gas hydrate at the base of gas hydrate stability (Figure 2). After the exploration well was drilled, the checkshot survey (for depth/pressure control) and analysis of well logs (for gas composition) established that the distribution of gassy sediments in the area is consistent with gas hydrate prediction theory. Seismic amplitude data in this area show the base of gas hydrate stability by proxy, but do not image the inferred gas hydrate deposits updip from the base of gas hydrate stability. A critical question that this paper intends to address is the lateral and vertical extent of the gas hydrate traps near the base of gas hydrate stability in the northwest Walker Ridge area. The distribution of gas hydrates near the base of gas hydrate stability in Walker Ridge and elsewhere is an important, but poorly understood, issue for deepwater oil and gas operators.

The two fundamental models for gas hydrate formation in deepwater settings are the in situ model (where methane produced by bacterial processes is converted to gas hydrate within the gas hydrate stability zone) and the upward migration model (where fluids moving from beneath the hydrate stability zone convert to gas hydrate as fluids pass into the gas hydrate stability zone). Inversion methods have been used to image gas hydrates in a few studies. Lu and McMechan (2002) successfully invert high-resolution seismic data to show the distribution of gas hydrate in Blake Ridge (where gas hydrate formation is dominated by in-situ processes). Dai and others (2004) invert seismic data to show the extent of possible gas hydrate traps in Keathley Canyon area of the deepwater Gulf of Mexico based on high-amplitude terminations that are presumed to delineate the base of gas hydrate stability that are similar in character to those in Walker Ridge. Because of the additional data from the exploration well in northwest Walker Ridge that help constrain the physio-chemical model for gas hydrate formation, the buried gas hydrates in Walker Ridge merit further work using inversion methods.

Initial inversion results in the Walker Ridge area show high-impedance interpreted gas hydrate deposits updip from the trapped gas consistent with the interpreted gas hydrate distribution model. A more robust inversion will be made in the spring of 2004 and the results will be discussed and presented in this paper. Because of the regular distribution of gas traps across the uplifted mini-basin and well data (even though not specifically acquired to test the presence of gas hydrate), the Northwest Walker Ridge example is an excellent setting in which to test the ability of inversion methods to characterize the extents of gas hydrate traps using typically available data.

Cited References:

Dai, J., H. Xu, F. Snyder, and N. Dutta, 2004, Detection and estimation of gas hydrates using rock physics and seismic inversion: Examples from the northern deepwater Gulf of Mexico: *The Leading Edge*, v. 23, no. 1, p. 16.

Lu, S., and G. A. McMechan, 2002, Estimation of gas hydrate and free gas saturation, concentration, and distribution from seismic data: Geophysics **v**. 67, n.2, p. 582-593.

McConnell, D. R. and B. A. Kendall, 2002, Images of the base of gas hydrate stability, northwest Walker Ridge, Gulf of Mexico: Proceedings, Offshore Technology Conference, Houston, 6-9 May 2002, OTC 14103

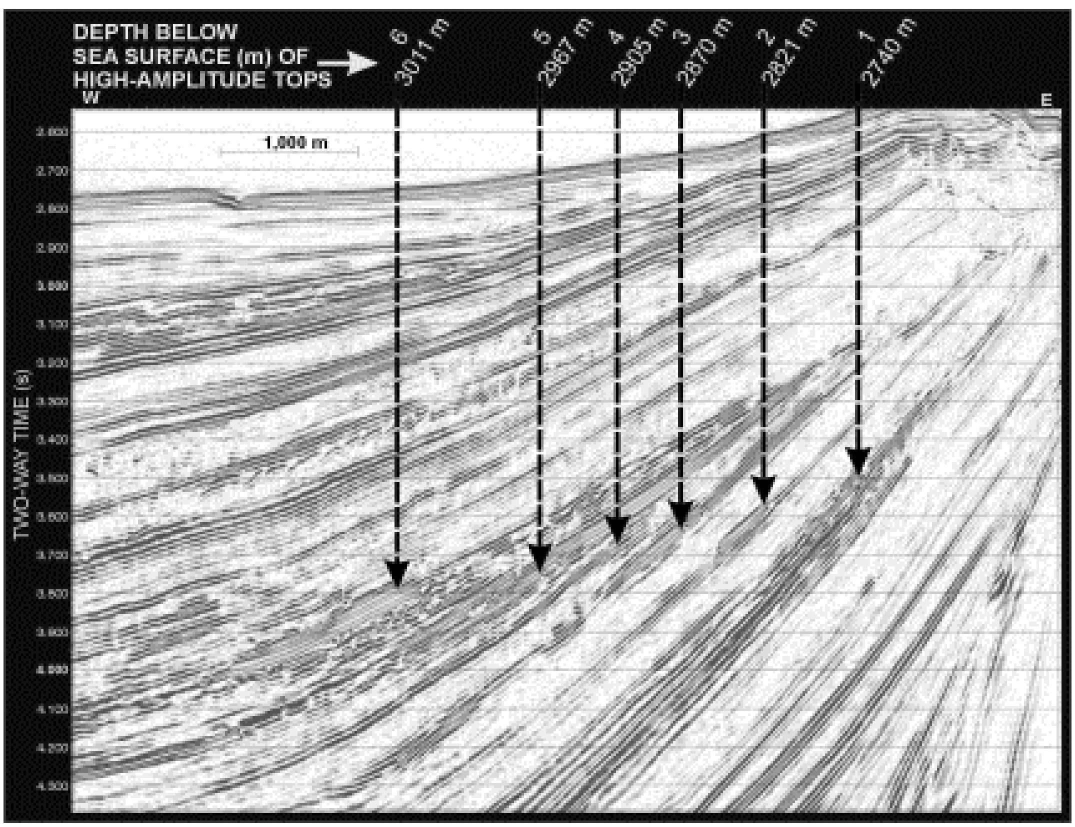

Figure 1. Principal seismic traverse showing high-amplitudes interpreted to be gas trapped by gas hydrate at the base of gas hydrate stability. From McConnell and Kendall, 2002.

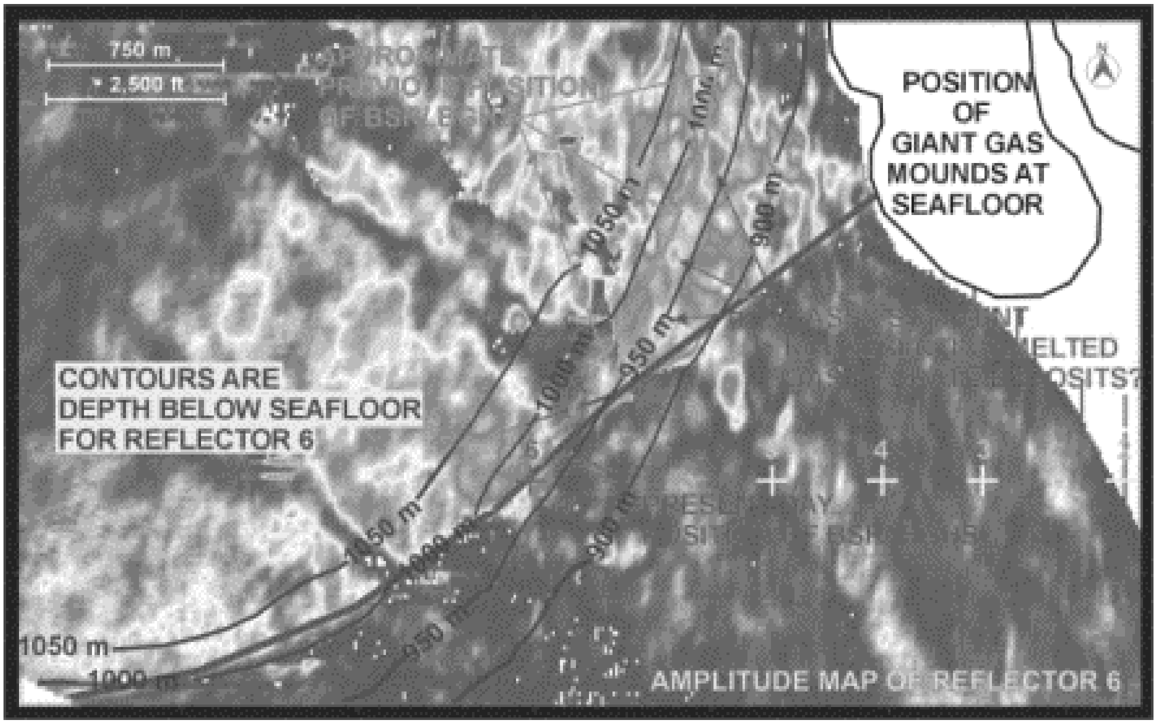

Figure 2. Map-view of reflector 6 showing that the updip amplitude is pressure controlled (at constant depth below mudline) and temperature sensitive as it moves updip with proximity to fluid flow. From McConnell and Kendall, 2002.