Gulf of Mexico Gas Hydrate Joint Industry Project Leg II:
Walker Ridge 313 Site Selection

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Introduction

Gas hydrates at the Walker Ridge site were first hypothesized in 2002 using exploration 3-D seismic data in which en-echelon bright spots were interpreted as free gas trapped by overlying sediments containing gas hydrate at depths consistent with the estimated base of gas hydrate stability (BGHS) (McConnell and Kendall, 2002). Subsequently, it was shown that phase reversals occurred at the location of the bright spots, further strengthening the interpretation of gas hydrate (McConnell and Zhang, 2005). The Walker Ridge (WR) 313 #001 well (Figure F1 and Table T1) that was drilled by Kerr McGee in 2001 provides basic log data used to support the evaluation of the seismic data. This well is located updip near the edge of the Terrebonne minibasin, and many of the units present in the middle of the basin are thinning towards the well. Neither gas nor gas hydrate are interpreted to occur in any significant form at the location of the WR 313 #001 well, which was drilled for exploration of conventional hydrocarbons. In this report, the site is called WR 313 even though the site selection analysis includes portions of lease blocks WR 269 (northwest), WR 270 (northeast) and WR 314 (southeast).

During the Gulf of Mexico Gas Hydrates Joint Industry Project (JIP) site review process, the WR 313 site was evaluated by the Minerals Management Service (MMS) using conventional 3-D seismic data acquired by Veritas. These data enabled the regional mapping of amplitudes that showed strong structural conformance of the location of phase reversal (Figure F2).

WesternGeco reprocessing and hydrate analysis at the WR site involves the first use of new-generation Q data in prospecting for gas hydrate. Q data differ from conventional multichannel seismic data in that each hydrophone is recorded separately, and can then be combined or summed into channels based on optimizing resolution of specific depths or features. Conventional multichannel data sum sets of hydrophones into channels prior to recording the data. The cube of 3-D data is rotated ~45° from normal lease block orientation. The Q-data were shot for deep sub-salt imaging. Consequently, the survey did not acquire near-offset data, which diminishes the reliability and utility of s-wave data used in the inversion for gas hydrate saturation.

This report summarizes salient points about the WR 313 site and its five drilling targets. The geologic setting of the Terrebonne minibasin is representative of the kinds of minibasins found throughout the slope of the northern Gulf of Mexico (Figure F3). The drilling targets were chosen to maximize the likelihood of successfully penetrating gas

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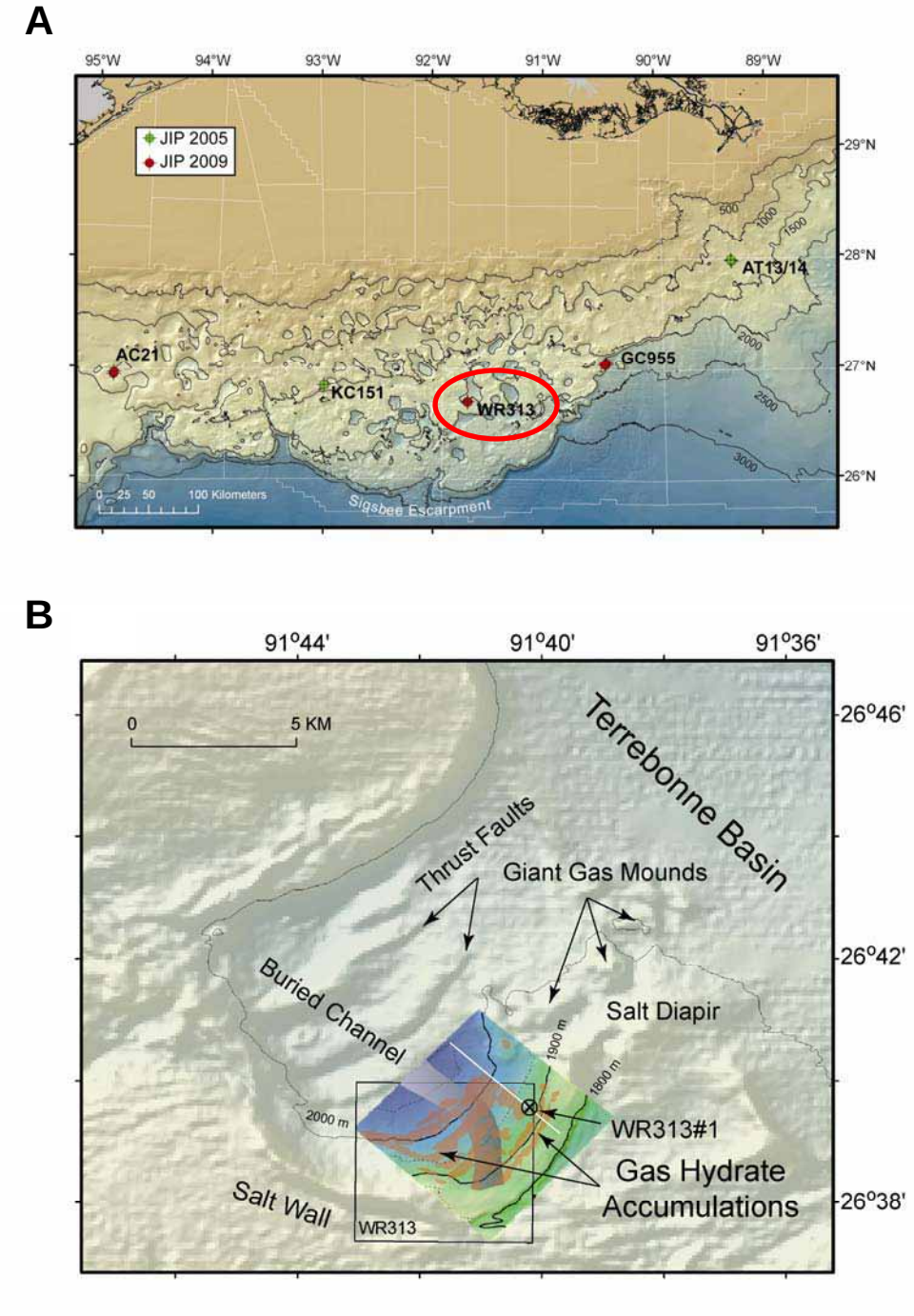

Figure F1: *(A) Location map of the northern Gulf of Mexico showing the proposed 2009 JIP sites (red) and 2005 JIP drilling locations (green). Red circle surrounds location of WR 313. (B) The WR 313 site. Shaded relief bathymetry from NOAA Coastal Relief Model is shown in tan, high-resolution bathymetry from the WesternGeco 3-D seismic cube is shown with blue to green colors. 3-D seismic cube is angled relative to lease block WR 313. Various geologic features are noted. The location of mapped gas hydrate accumulations are shown in brown, and the position of the channel associated with horizon "orange" is also shown. Colored bathymetry in subset image provided by Schlumberger.*

Lease Block No.	WR313
Well name	WR313#1
Water depth (ft)	6289 (1917 m)
Base of gas hydrate stability (ft)	9049 (2758 m)
Seafloor to base of gas hydrate stability (ft)	2759 (841 m)
Thermal gradient (mK/m)	~19
Target facies sampled at the well	Ponded sheet sands, levee, and overbank deposits

Table T1: *WR 313 #001 well information*

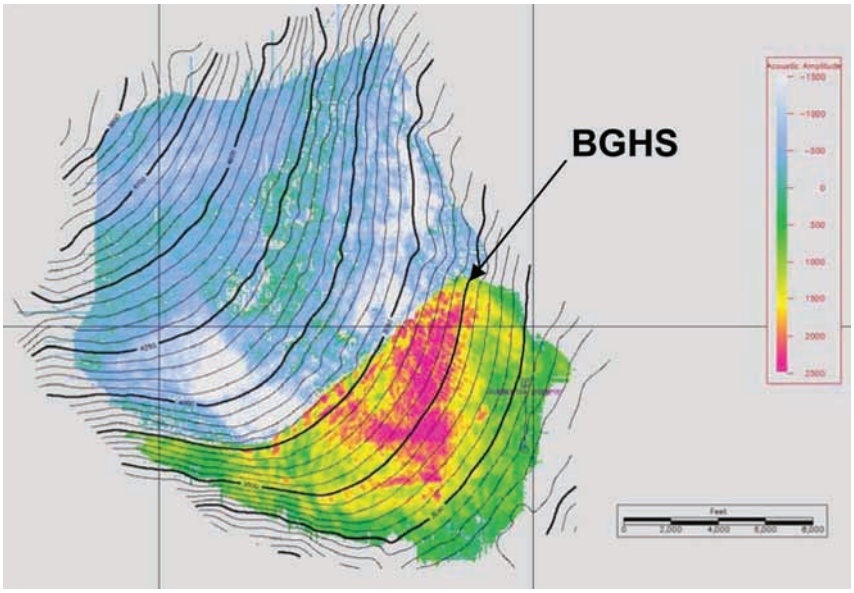

Figure F2: *Modified after Shedd et al. (2009). A structure map on the top of the blue horizon contoured in two-way travel time with superposed amplitudes ranging from -1500 (white) to + 2500 (red). White to blue colors represent trough events associated with interpreted gas below GHSZ; green to pink colors represent peak events associated with potential hydrate-bearing deposits above BGHS. The BGHS is the boundary between the two color bands. The BGHS is subparallel to isochrons on the west and southwest, as would be expected if the BGHS is subparallel to the seafloor, but diverges and cuts across structural contours toward the east. This divergence may be explained by nearby recent seep activity associated with the surficial giant gas mounds (McConnell and Kendall, 2002). Image copyrighted by Veritas.*

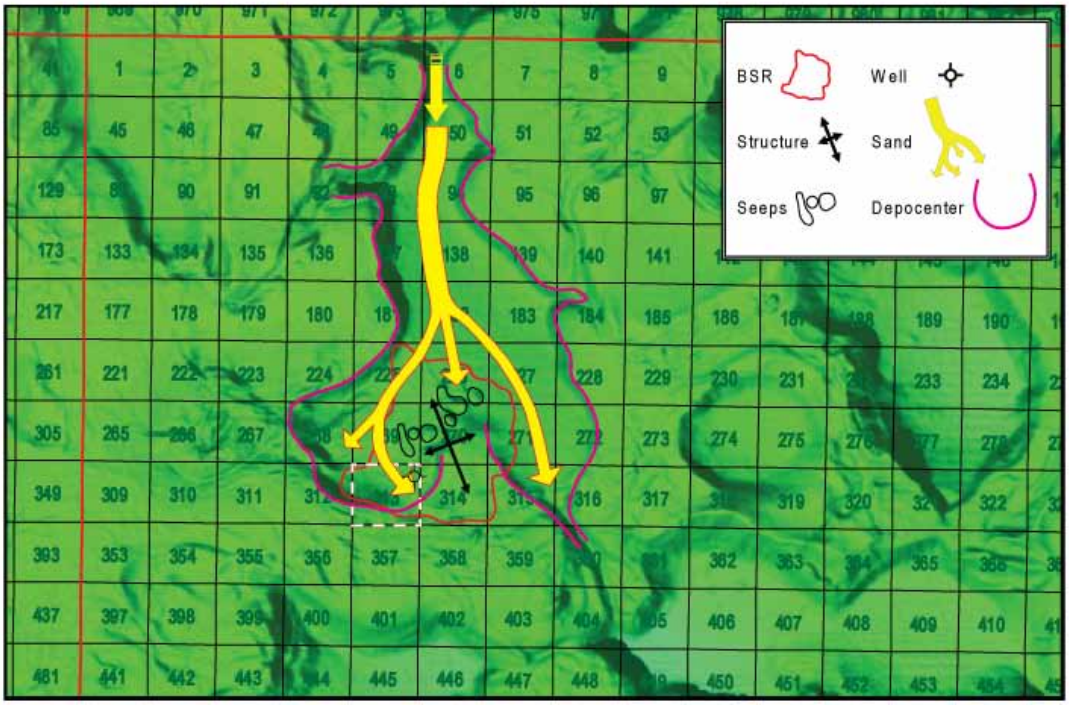

Figure F3: *General geologic setting of the Terrebonne Basin (pink) and lease block WR 313 (white outline) superposed on shaded bathymetric map.*

hydrate deposits in sands intermixed with silts and muds, and collecting sufficient logging measurements about the deposits to test the models of gas hydrate saturations, thicknesses, and lithologies to justify returning in a future program to core and recover gas hydrate.

All of the saturation anomalies at WR 313 are strongest near the inferred BGHS and generally weaken as traced up-dip, consistent with the interpretation that the source of gas is migrating upwards along stratigraphic horizons and is therefore most highly concentrated near the base of hydrate stability. However, these anomalies also show strong variations along dip, and the general distribution is therefore also consistent with the alternative interpretation that reservoir quality (and therefore S_h) is greatest downdip and generally deteriorates up-dip. Fault structures that might serve as transport pathways, although present in the data, are not abundant.

Geologic Setting

The Walker Ridge site occurs within the tabular salt province of the lower slope of the northern Gulf of Mexico approximately 90 km north of the Sigsbee Escarpment (Figure F1A). WR 313 lies within the Terrebonne minibasin at about 2000 m water depth (Figure F1B). One arm of the Terrebonne basin extends southwestward, but has no outlet indicating a reversal of depositional gradient with resultant ponding of gravity-driven depositional systems. A salt wall forms the southern portion of this arm, and salt probably crops out on the seafloor. Evidence for recent uplift and extension comes from faults that extend to the seafloor above a salt diapir at the northeast end of the salt wall. The minibasin has also undergone a recent episode of compression, because thrust faults associated with the compression have morphologic expression on the seafloor (McConnell and Kendall, 2002). The compression is likely the result of recent north-to-south movement of salt on the northern side of the minibasin.

Several large mounds stand above the sea floor in the northeast portion of WR 313 (Figure F1). The largest of the features is nearly 3 km long and 600-800 m wide.These mounds represent fluid expulsion features above fluid migration pathways, and individual mounds may actually represent an amalgamation of several smaller mounds. These features were examined using Alvin in 2006 at their northern occurrence in WR269 (TDI Brooks, 2006).

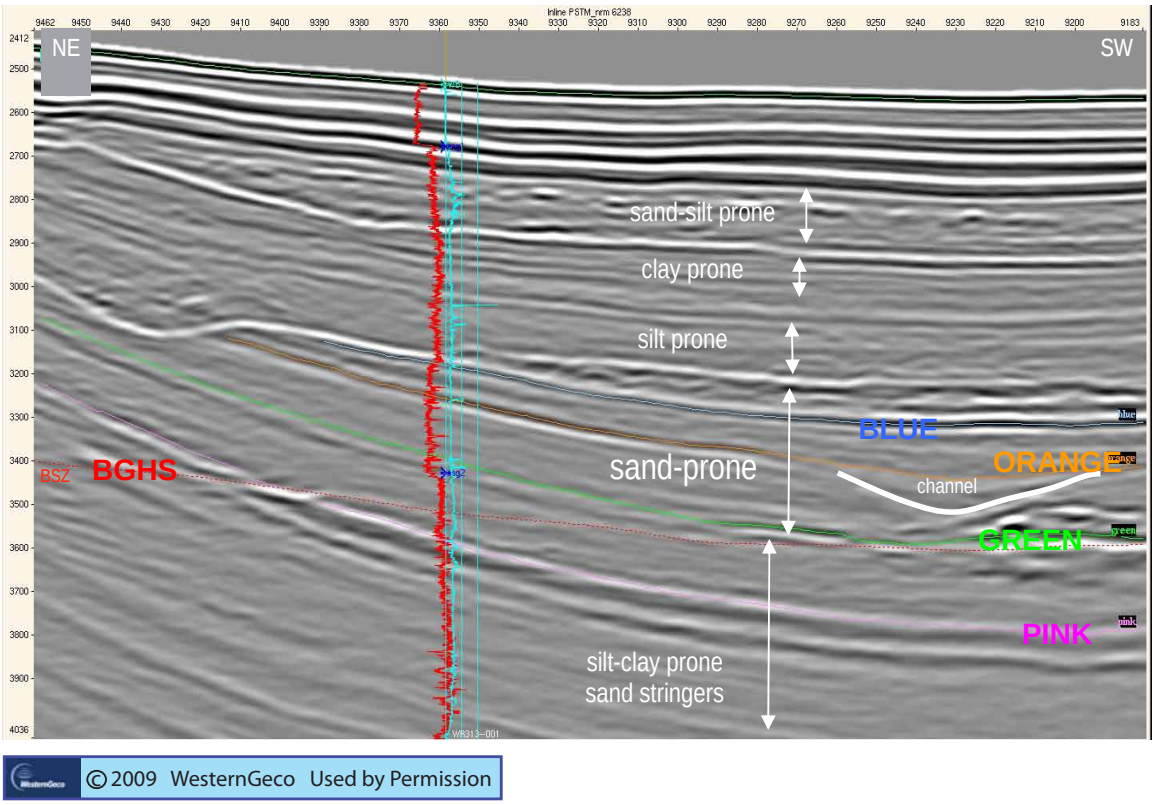

Figure F4: *Seismic reflection profile through WR 313 #001 showing interpreted lithologies and the blue, orange, green and pink horizons. BGHS – Base of Gas Hydrate Stability. Northeast is to the left. Seismic data provided by WesternGeco.*

Like many minibasins in the Gulf of Mexico, the seismic stratigraphic interpretation relies on areally extensive continuous and semicontinuous reflection packages that are consistent with deep-water sedimentation cycles (Figure F4). Seismic expression of the BGHS in WR 313 is a series of discrete bright spots that, when connected, mimic the geometry of the seafloor (see cross line seismic data displayed in Appendix 1). This style of BGHS is called a segmented bottom simulating reflection (BSR, Shedd *et al.*, 2009). The WR 313 seismic cube shows that the segmented BSR forms a plunging syncline with the updip regions associated with shallow salt around the basin (Figure F5). The stratigraphic horizons are based on the MMS interpretation of named blue (young), orange, green, and pink (old) horizons that project into the WR 313 #001 well between ~8200 and 9050 ft below the seafloor.

At the WR 313 #001 well, the blue-to-pink section is ~850 ft (257 m) thick and dips westward as it thickens into the basin. The tie between well logs at WR 313 and the seismic data is estimated to be within 20 ms (18 m, ~60 ft). Gamma ray data indicate that these sands are interspersed with shales, as would be expected in a deep-water depositional environment that includes debris flows, turbidites, and hemipelagic clays. Mapping also shows the existence of at least one buried channel and associated levee system on the orange horizon (map view – Figure F6; profile view – Figure F4). The integrated interpretation of this basin setting is that coarse-grained permeable sands entered this subbasin through channels (like the one imaged on the orange horizon), and spread outwards as fans or sheets that covered much of the basin floor. The blue-to-pink horizons provide markers for the reservoir section containing potential gas hydrate deposits. Deposits near the blue horizon are generally associated with the maximum concentrations of gas hydrate. The size, shape, and geology of the WR 313 site are representative of minibasins throughout the northern Gulf of Mexico. The segmented BSR is particularly well developed at WR 313 with a sharp boundary at which amplitudes reverse polarity across the BGHS. This reversal is compelling evidence for free gas below the BGHS. Many other minibasins have potential to have similar characteristics to WR 313.

As with the other JIP sites, the Walker Ridge site satisfies the conditions of an active petroleum system. There are faults in

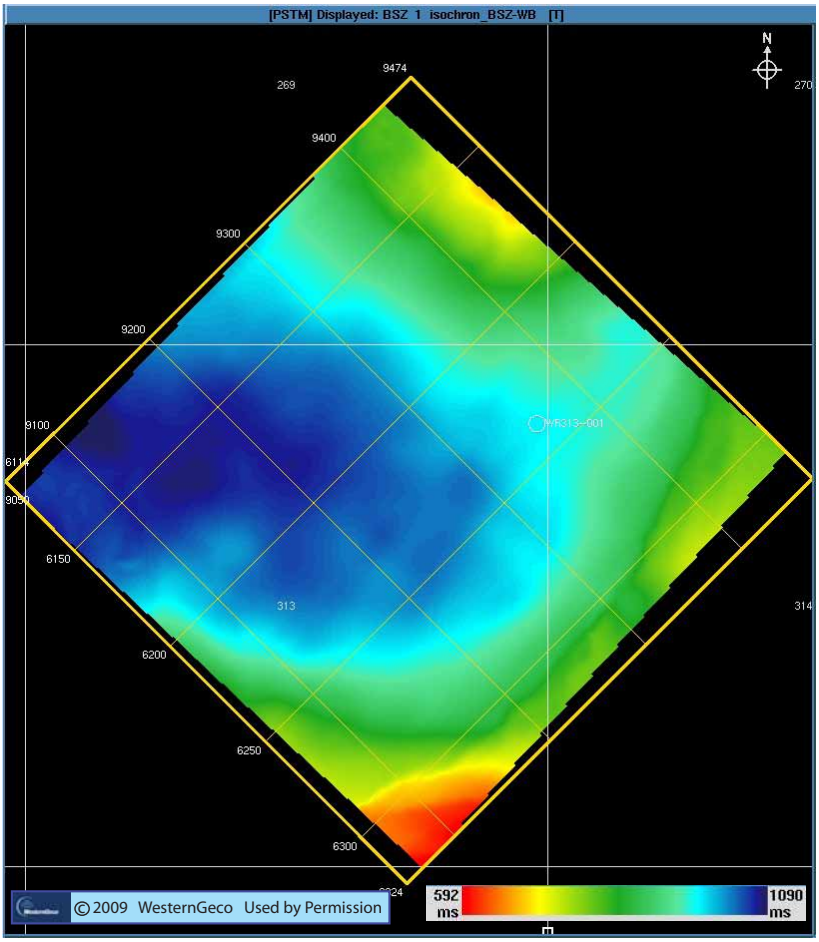

Figure F5: *Map showing the syncline shape of the BGHS. Data plotted are isochrons of two-way travel time between water bottom and BGHS. Colors range from .592 sec (red) to 1.090 sec (dark blue). The shallower (red/yellow) areas are where shallow salt underlies the rims of the basin. Image provided by WesternGeco.*

the cube (both extensional above salt and compressional in the middle of the basin); active fluid expulsion is evidenced by the large mounds on the sea floor near the drill sites; the lithologies within the minibasin are consistent with sand (or sand-silt) units acting as the reservoir, and shallower shale units act as impermeable seals to the system. One of the unique aspects of the Walker Ridge site compared to the other proposed JIP drill sites is that that the cyclical stratigraphy with alternating coarse and fine-grained units leaves open the possibility that methane-charged fluids can migrate updip along stratigraphy, not just along structural faults or fractures. This may tend to concentrate accumulations of gas at the flanks of the syncline.

Pressure-Temperature Conditions

Estimates of the pressure-temperature conditions at the WR site have been made by McConnell and Kendall (2002). The check shot survey at the WR 313 well was used to estimate depths to BGHS. With assumed parameters of pure methane, normal salinities (35 ppt) and a bottom water temperature of 4 °C, the equilibrium temperature for BGHS at the position where the various horizons intersect BGHS yields thermal gradients of 18.8 °C/km to 20.3 °C/km with an average geothermal gradient of 19.6 °C +- 0.5 °C/km. This gradient is at the low end of gradients known to exist within the northern Gulf and is the reason that the five proposed drill holes in the WR site are so deep. Estimates for the pressure-temperature conditions at BGHS for each proposed drill hole are given in Table T2.

McConnell and Kendall (2002) also show good evidence for deflection of the BGHS in the vicinity of the surficial fluid expulsion mounds. The BGHS is subparallel to the seafloor along the blue (youngest) mapped horizon except where it nears a surficial mound, where it is deflected to the east (Figure F2). This geometry, together with the occurrence of strong seafloor amplitudes on the mound at this same position is interpreted to show that the most recent

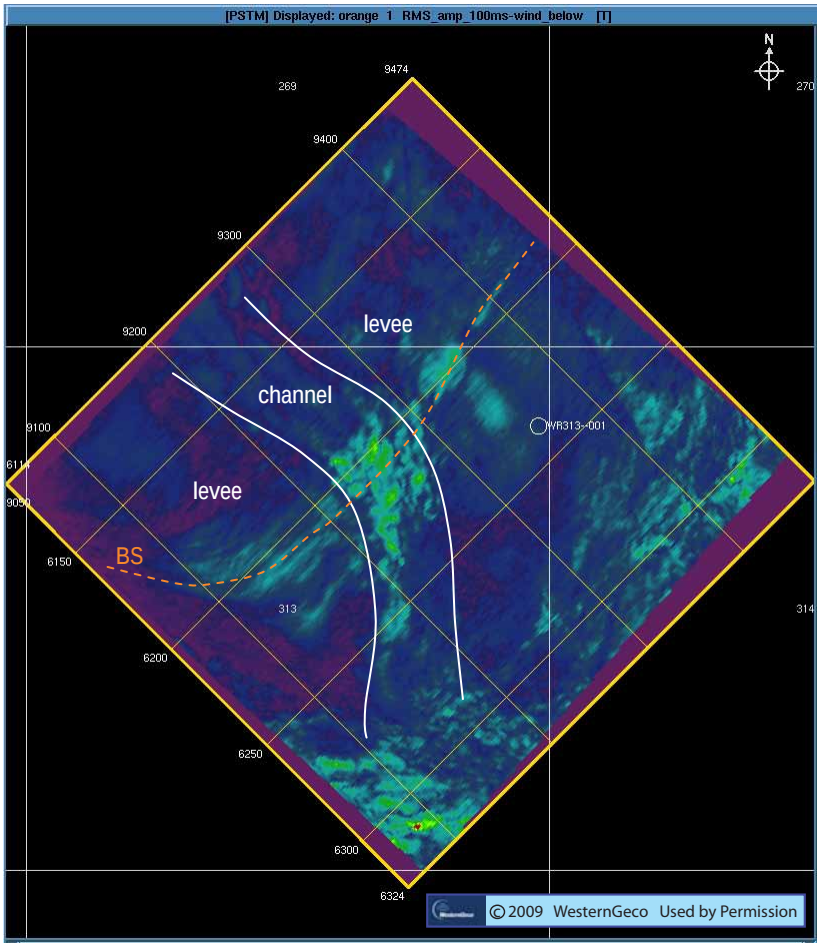

Figure F6: *RMS reflection amplitude map of a 100-ms window beneath the "orange" horizon showing the interpreted channel/levee structure. BS is BGHS at the orange horizon. Image provided by WesternGeco.*

Permit	SF (ft)	BGHS (ft) relative to seafloor	SF-BGHS (ft)	P[1] (MPa)	T_{eq} (° C) at BGHS2	dT/dz (° C/km) for BWT=2° C	dT/dz (° C/km) for BWT=4° C
G	6614	9682	3068	29.7	21.2	20.5	18.4
H	6513	9406	2893	28.9	21.0	21.5	19.2
I	6469	9613	3144	29.5	21.2	20.0	17.9
K	6602	9785	3183	30.0	21.3	19.9	17.8
L	6397	9486	3089	29.1	21.0	20.2	18.1

Table T2: *Estimates for pressure-temperature conditions for proposed holes at WR 313. (SF=Seafloor, BGHS=Base of gas hydrate stability, P=Pressure, T_{eq}= equilibrium temperature, dT/dZ=temperature gradient, BWT=bottom water temperature) [1]Hydrostatic pressure calculated at the BGHS. [2]Calculated using 3.3% NaCl pore waters and methane-only gas hydrate.*

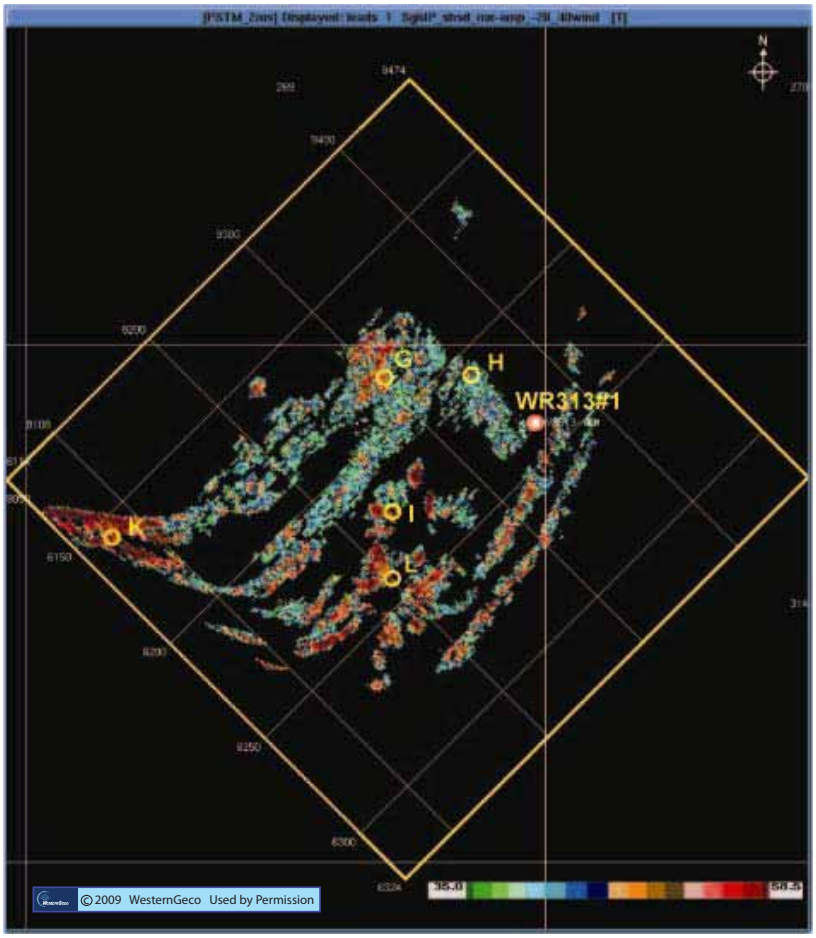

Figure F7: *Map of juxtaposed S_{gh} Maxima for all potential gas-hydrate-bearing horizons (blue, orange, green, and pink) derived from the shale-sand model. Proposed drilling targets G, H, I, K, and L are shown together with the existing WR 313 #001 well. Image provided by WesternGeco.*

episode of fluid expulsion from the mound has probably increased the temperature conditions and pushed BGHS to a shallower subbottom depth.

Gas Hydrate Saturation

Gas hydrate saturations were estimated using the methodology of Dai *et al.* (2008a). The five-step process utilizes seismic reprocessing for highest possible resolution, detailed geological (lithological) interpretation to identify possible gas hydrate-bearing zones, seismic attribute analysis to refine the extent of the gas-hydrate-bearing zones, seismic inversion to estimate elastic parameters in the gas-hydrate-bearing zones, and quantifying gas hydrate saturation using elastic parameters and rock physics models. Gas hydrate saturation (S_{gh}) is given as a percent of pore volume. This model was used to predict S_{gh} at two sites drilled for gas hydrates in the Gulf of Mexico by the JIP in 2005, with encouraging success (Dai *et al.*, 2008b).

Drilling Targets

Five drilling targets in the Walker Ridge site afford the opportunity to penetrate similar horizons at multiple depths and inferred S_{gh} relative to BGHS (Figure F7). These sites and primary objectives are:

- WR 313-G: blue near BGHS (high S_{gh}), orange and green (no gh, below BGHS)
- WR 313-H: orange near BGHS (high S_{gh}), blue (low S_{gh}), green (no gh)
- WR 313-I: channel at orange horizon near BGHS (high S_{gh}); blue (little to no S_{gh})
- WR 313-K: an areally extensive, moderate-to-high saturation S_{gh} anomaly in the blue horizon at the western end of the study area where the stratigraphic units dip most steeply.
- WR 313-L: alternate channel location above BGHS targeting orange; blue (little or no S_{gh}); low S_{gh} in green.

The five proposed holes sample three geologic environments: a pair of holes (G, H) in interpreted levee and other sands near the seafloor indicators of active fluid seep and venting (giant gas mounds at the northern extreme of the seismic cube), a pair of proposed holes in a channel at the position of the "orange" horizon (I, L), and a single proposed hole at the western edge of the minibasin (K).

Consensus recommendation

The pair of holes in this area (G, H) offered excellent compare and contrast opportunities for two different stratigraphic levels (blue and orange) at different positions relative to BGHS. The channel also offered excellent compare and contrast opportunities for two proposed drill holes (I, L), again with multiple stratigraphic levels although expected saturations were somewhat lower. The one hole (K) at the edge of the minibasin was judged to be attractive for the most extensive and highest S_{gh} values, although only a single hole would be drilled. With these ideas, the consensus targets to drill are summarized in Table T3:

Drill site (permit name)	Comment
G	Consensus #1
H, L, or K	Depending on results from G

Table T3: *Recommendations for WR 313.*

Each of the proposed holes fulfills JIP objectives of (a) expecting to find high S_{gh} for future coring; (b) testing the S_{gh} prediction models of Schlumberger; and (c) testing the petroleum system of hydrate formation. The WR 313 targets have migration pathways provided by the dipping bedding, rather than by structure along faults.

Concerns about WR 313

The geologic model for WR 313 is a ponded minibasin with channels delivering a mixture of sand and silt-mud deposits, finding impediment, spilling out sheet deposits on the flanks where salt has uplifted the edges. Gas charge is not well defined. A major fault that could be feeding the system in WR 269/270 occurs to the north (in a down dip direction), but no similar fault exists in WR 313.The blue, orange, etc. units intersect this major fault to the northwest, ~6 km outside of the WR 313 boundary in WR 225. The BGHS also cuts across the fault to the north, but the blue horizon is well below the BGHS in WR 225. It is unlikely that gas charge would migrate laterally these great distances. Hence the source of gas charge for WR 313 is unclear.

There is also a question about how clean and how thick the interpreted sand units are. The WR 313 #001 well log is equivocal (Figure F8) with possible mud-weight and hole-diameter changes affecting the interpretation of the gamma ray, resistivity, and density logs. The preferred interpretation by the JIP group is that the key named horizons (blue, orange, green, and pink) most likely represent the top of coarse grained units that are interspersed with finer muds and silts. The base of these units is not resolvable in the data, which could be due to (a) layer thicknesses below the resolution of the data or (b) gradational saturations of gas hydrate that are not predictable with current models. The simplest interpretation is that the "sands" are probably neither clean nor thick.

The seismic inversion yields maximum estimates of 35% to 60% for gas hydrate saturations at WR 313 (Figure F7). These values are generally lower than those at the GC955 and AC 818 sites. One of the difficulties associated with recommending drilling sites at WR 313 is that inversion results identify the horizons that mark the tops of gas hydrate-saturated units (e.g., pink to blue horizons), but not the bottom of these units. Drilling should test whether these horizons are associated with a tuning thickness in the data or whether the intervening low-amplitude intervals are shales or thin-bedded gas-hydrate saturated sands.

The drilling target at WR 313-K will test the differences in the geologic and inversion model. The amplitude signatures in the Q-data (which were inverted) and the Veritas conventional data (which were used in the MMS geologic interpretation) show different results: the Q-data show a higher amplitude anomaly at proposed drilling target WR 313-K than the Veritas data, and the Q-data show high saturations in the inversion. One possible explanation for the amplitude discrepancies in these data is due to acquisition (especially because the Q-data cube lacks the near offsets) and the stacked section does not show all information contained in the seismic data. Another explanation is that because the Q data include longer offsets than conventional data, they may be picking up steeper dips better. It is also possible that because the Q

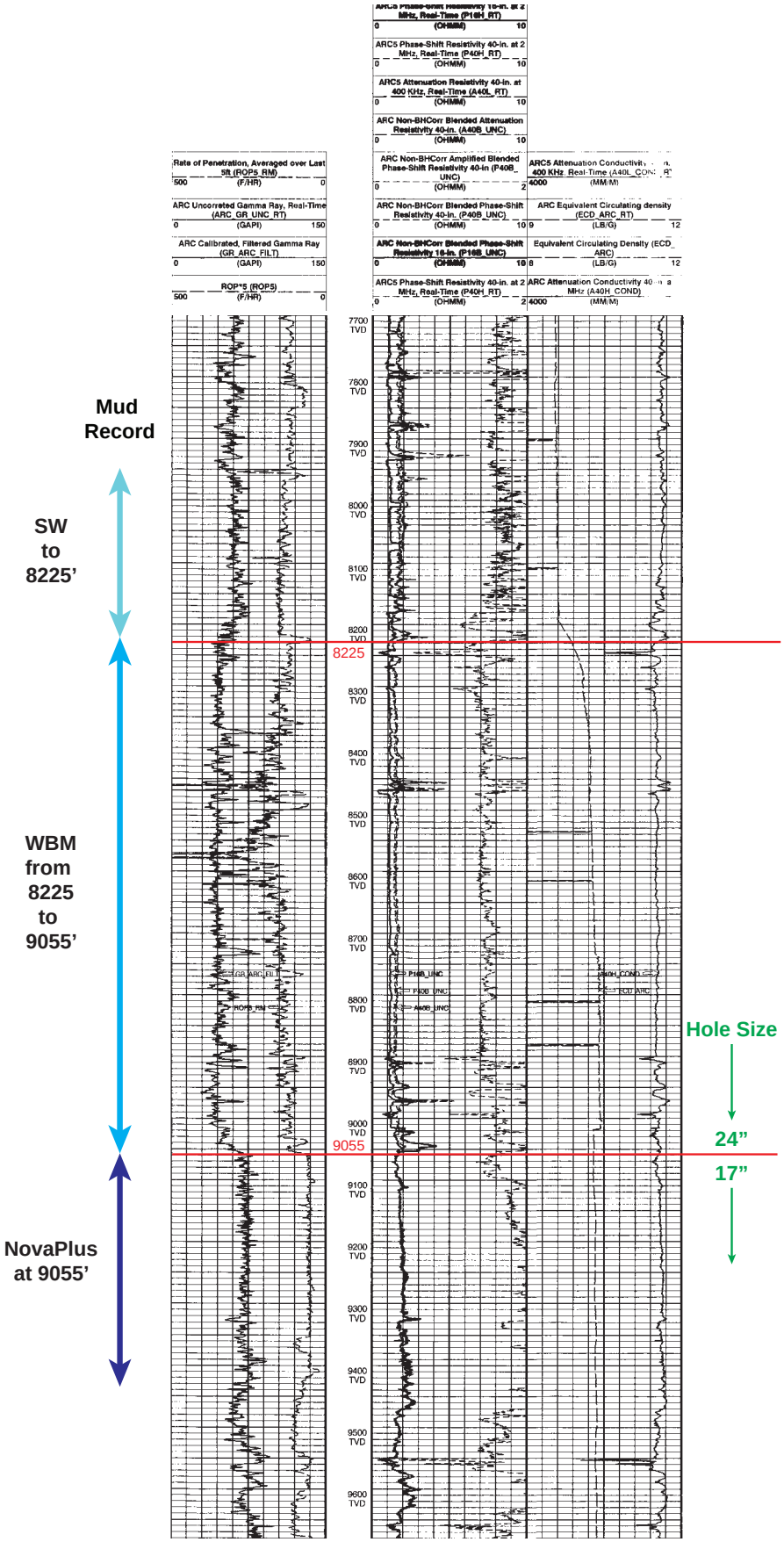

Figure F8: *WR 313 #001 mud record (left; SW= seawater, WBM = water-based mud; NovaPlus = synthetic mud) and well logs at the approximate interval of the blue-to-pink horizons. Major inflections in gamma ray correspond to changes in drilling fluid and are not wholly interpreted as representing lithologic changes.*

data have higher vertical resolution, thin zones of high S_{gh} will be more accurately estimated.

The WR 313 site provides a potential test of the MMS assessment approach (Frye, 2008). The MMS assessment only assumes biogenic not thermogenic gas. The large gas mounds suggest that the WR 313 site may have a deeper thermogenic source. The assessment tended to look at traps/crests, therefore geometries were important. WR 313 allows a look at a different geometry – near the base of hydrate stability zone where BGHS may be a trap. Collecting a core with a sample of gas hydrate that enables its source to be identified will be crucial to test the thermogenic vs biogenic hypothesis. Therefore, the WR 313 drilling targets provide data for testing petroleum system model and whether Walker Ridge is an appropriate analog for the MMS assessment.

The estimates of S_{gh} from the WesternGeco inversion of seismic data depend on whether sand/shale or shale models are used. WR 313 drilling will test the sand/shale vs the shale model for this region because the models predict similar patterns of saturation, but different values for maximum S_{gh}. The sand-shale model shows saturations of ~35-58%; the shale-only model gives saturations of ~35-71 %. The uncertainty in the assignments of sand and shale comes from two sources: the existing WR 313 well only samples units at their thinning and distal extent (so that the lithologies of the thicker equivalents near the middle of the minibasin are speculative). There is also uncertainty in assigning sand properties (e.g., what compaction model to use).

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Appendix 1: Site and Target Summaries

The following pages provide detailed summaries of each drilling target with four tables of factual information and four figures (tophole prognosis chart [from MMS permitting], map showing the existing well and proposed targets, inline seismic section and crossline seismic section).

Explanation of Terms:

Site Name	the name used during permitting (generally WR313-letter) and the name developed during the site selection process (generally JIP-name)
NAD27	datum used for latitude/longitude values (North America Datum 1927)
BSS	below sea surface
BML	below mud line
TGHO	top of gas hydrate occurrence
BGHS	base of gas hydrate stability
BSR	bottom simulating reflection

Target WR313-G (JIP M4)
Drilling Target Documentation

Table 1: Background Information

General Site Objective	*Sand prone channel overbank & channel deposits*
Drilling target and Specific Hole Objective	*Youngest horizon (blue) at the BSR; older horizons below the BSR* *"Blue" at 2835 ft BML/ 9449 ft BSS (also BSR depth)* *"Orange" at 3383 ft BML/ 9997 ft BSS (below BSR)* *"Green" at 3529 ft BML/ 10143 ft BSS (below BSR)*
Other Drilling in Vicinity	WR313#1 (1.18 mi to the SE)

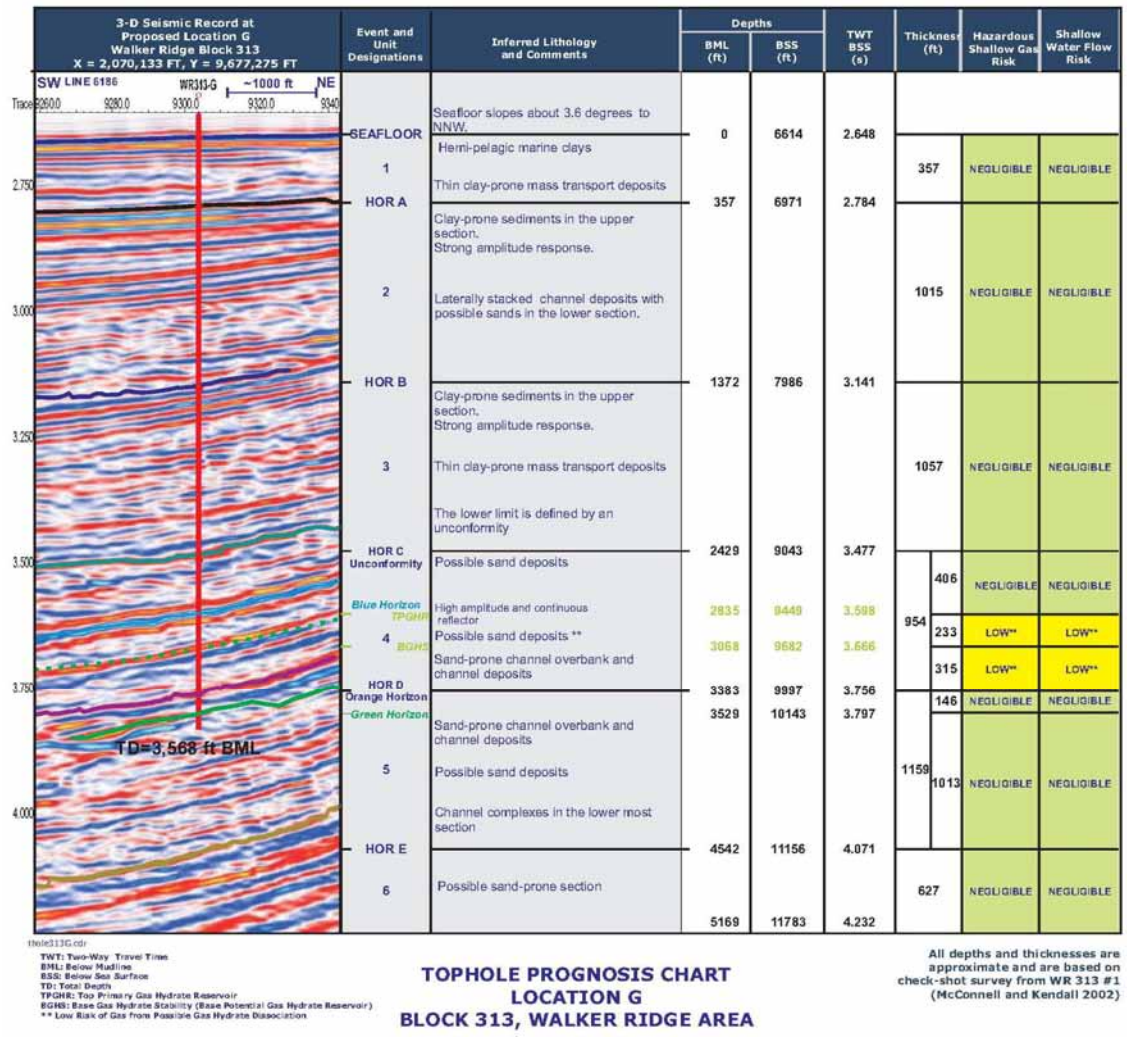
Table 2: Proposed Hole General Information

Site Name	Permitted **G**; JIP "M1"
General Area	*Southwest arm of Terrebonne minibasin*
Location	Latitude: *26° 39' 47.434" N* Longitude: *91° 41' 01.878" W*
Coordinate Datum	*NAD27*
Water Depth	*6614 ft BSS*
OPD/Lease Block	*WR313*
Seismic lines at hole	*Inline 6186, crossline 9304*

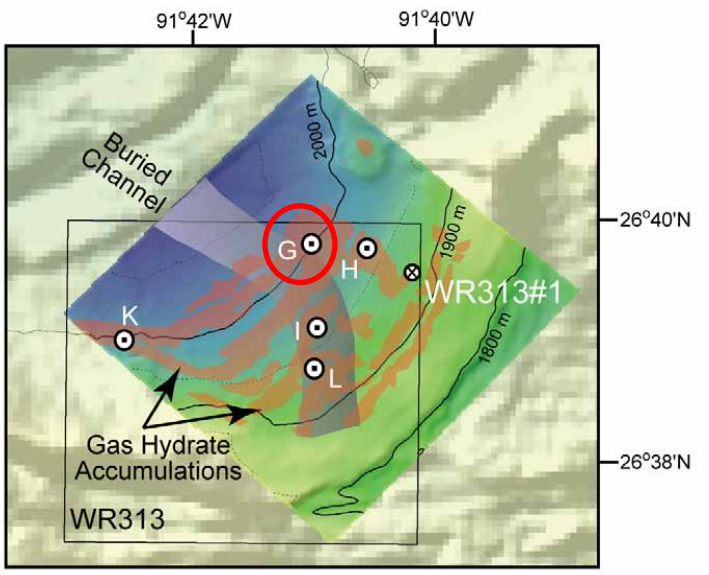
Table 3: Proposed Hole Drilling Information

Proposed penetration	*3568 ft BML 10182 ft BSS*
Seafloor slope	*3.6 ° to the NNW*
Expected lithologies and thicknesses	*357' Unit 1 – Recent mud rich sediments* *1015' Unit 2 – Upper: clay prone seds; lower: laterally stacked channel deposits* *1057' Unit 3 – clay prone deposits in upper part; laterally stacked channel deposits in lower part;* *Major Unconformity* *954' Unit 4 – possible sand* *1159' Unit 5 – possible sand (hole stops in top of unit 5)*
Expected ages/section	*PlioPleistocene*
Estimated depth to TGHO	*2835 ft BML 9449 ft BSS*
Estimated depth to BGHS	*3068 ft BML 9682 ft BSS*
Estimated GH interval	*233 ft thick*
Estimated GH saturation	*%*
Anomalous conditions?	
Other relevant information	*No faults or sea floor features*
Source of Information	*AOA Hazards Summary No. 4021-JIP-GOM-WR313G, 30 April, 2008*

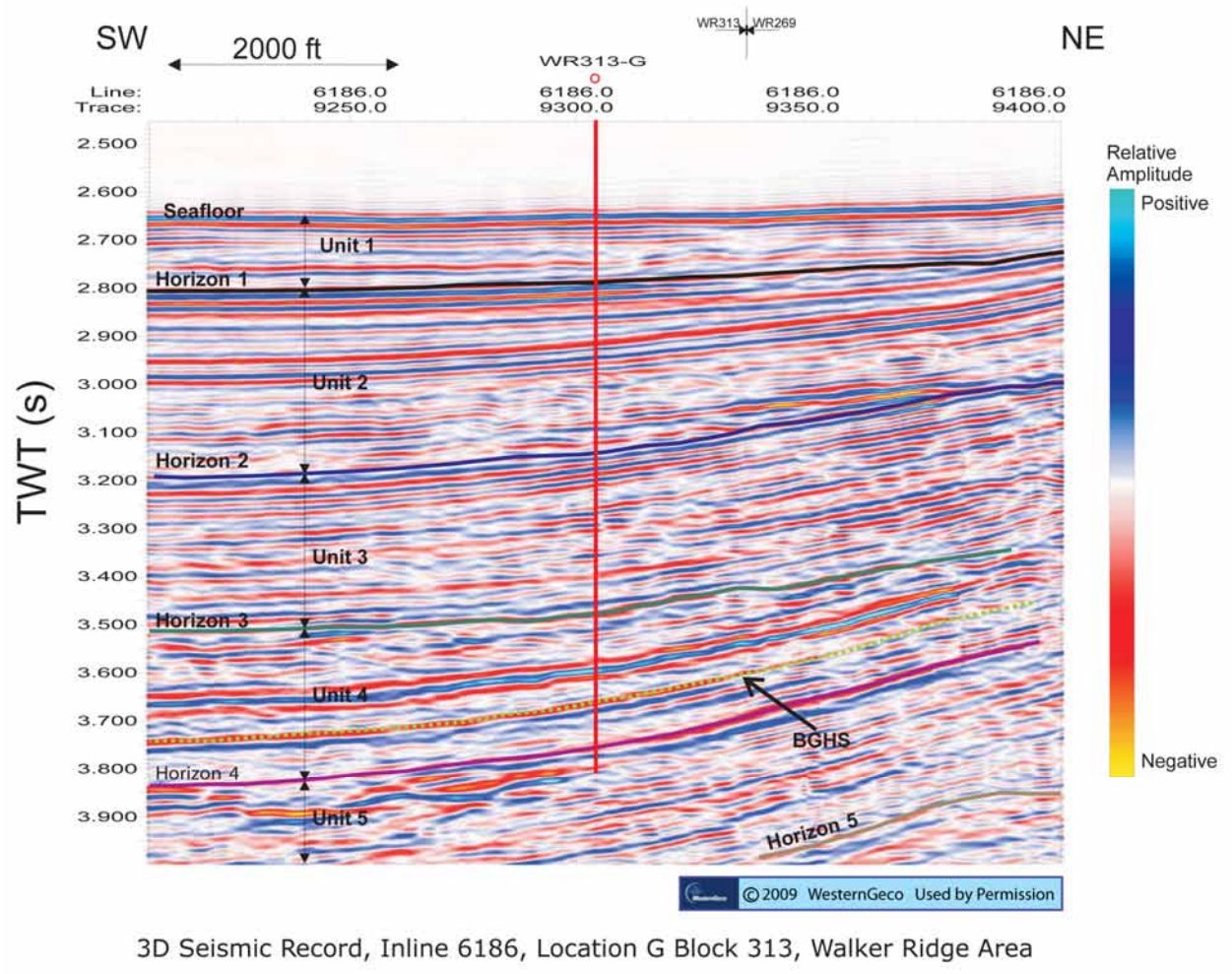
BML: Below Mud Line
BSS: Below Sea Surface
TGHO: Top of Gas Hydrate Occurrence
BGHS: Base of Gas Hydrate Stability



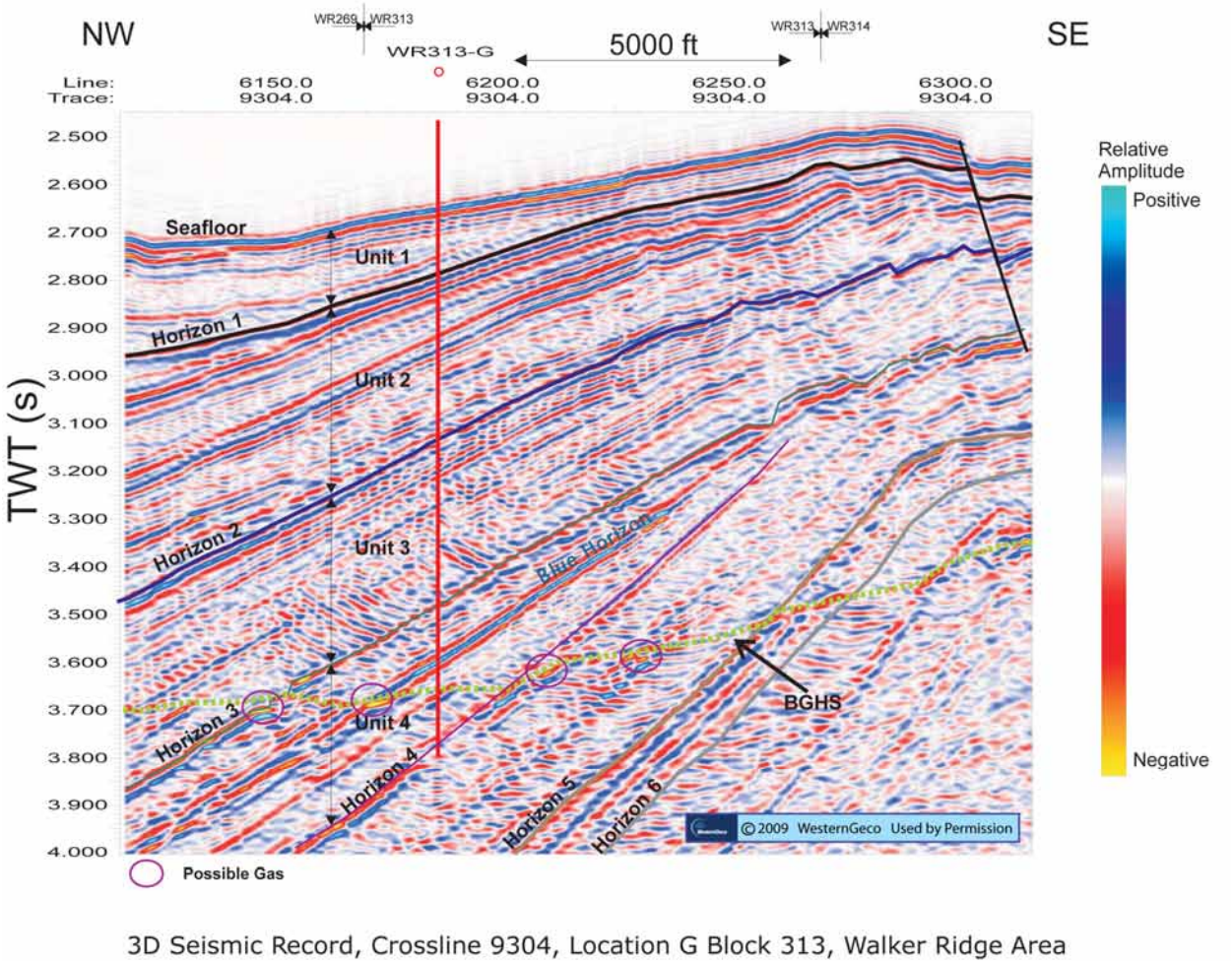
Appendix F1: *Stratigraphic interpretation, from AOA Geophysics; Seismic image provided by WesternGeco.*



Appendix F2: *Map showing location of proposed site WR313-G.*



Appendix F3: *Inline seismic profile across WR313-G. Seismic image courtesy of WesternGeco.*



3D Seismic Record, Crossline 9304, Location G Block 313, Walker Ridge Area

Appendix F4: *Crossline seismic profile across WR313-G. Seismic image courtesy of WesternGeco.*

Target WR313-H (JIP M4)
Drilling Target Documentation

Table 1: Background Information

General Site Objective	*Sand prone channel and overbank channel deposits;*
Drilling target and Specific Hole Objective	*"blue" at 2272' BML/ 8785' BSS (above TGHO)* *"orange" at 2696' BML/ 9209' BSS (within gas hydrate zone)* *BGHS at 2893' BML; 9406' BSS* *"green" 3426' BML/ 9939' BSS (below BGHS)*
Other Drilling in Vicinity	WR313#1 (0.85 mi to the NE),

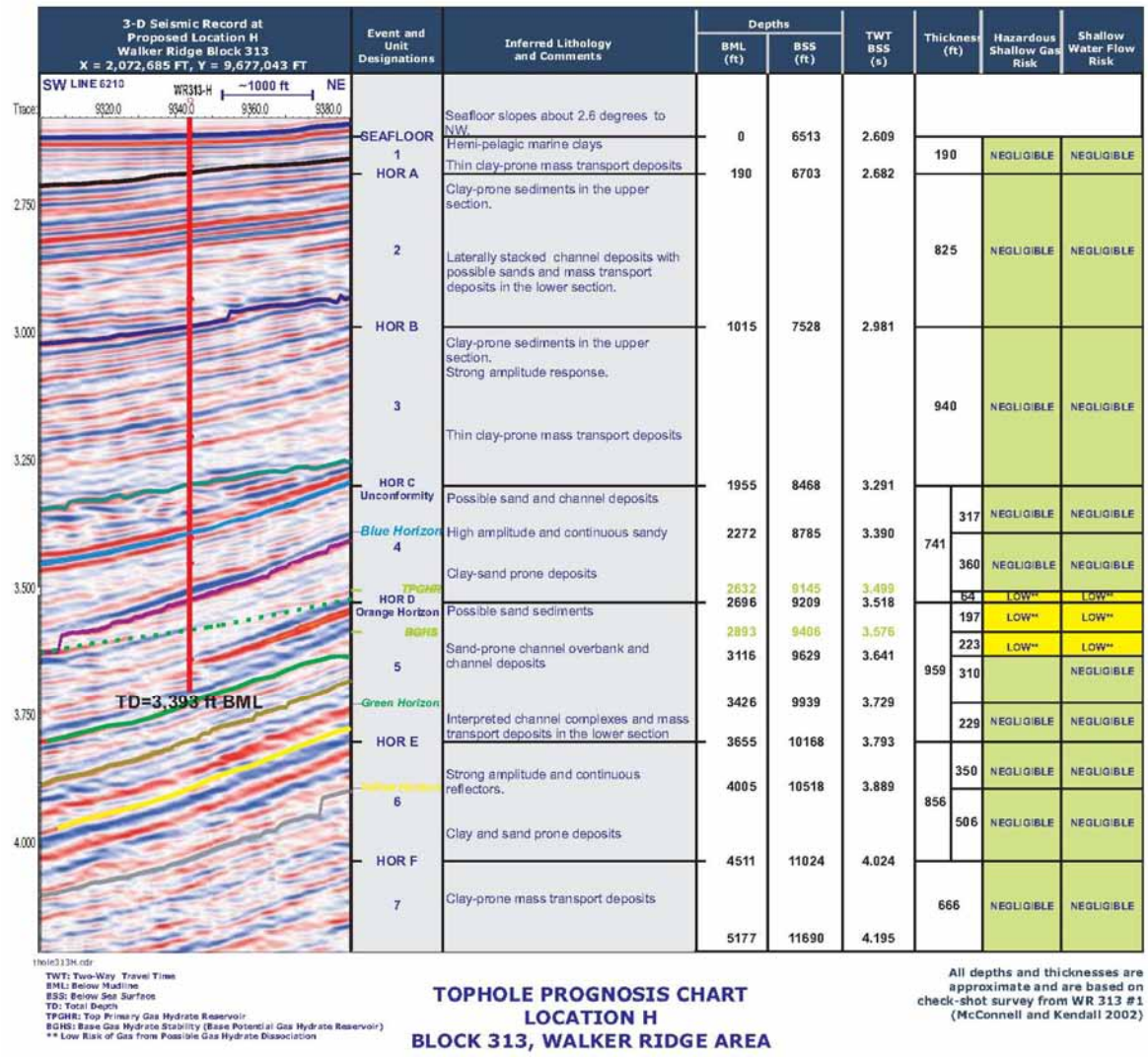
Table 2: Proposed Hole General Information

Site Name	Permitted WR313-H; JIP M4
General Area	*Southwest arm of the Terrebonne minibasin*
Location	Latitude: *26^o 39' 44.874" N* Longitude: *-91^o 40' 33.773" W*
Coordinate Datum	*NAD27*
Water Depth	*6513 ft BSS*
OPD/Lease Block	*WR313*
Seismic lines at hole	*6210 inline , 9344 crossline*

Table 3: Proposed Hole Drilling Information

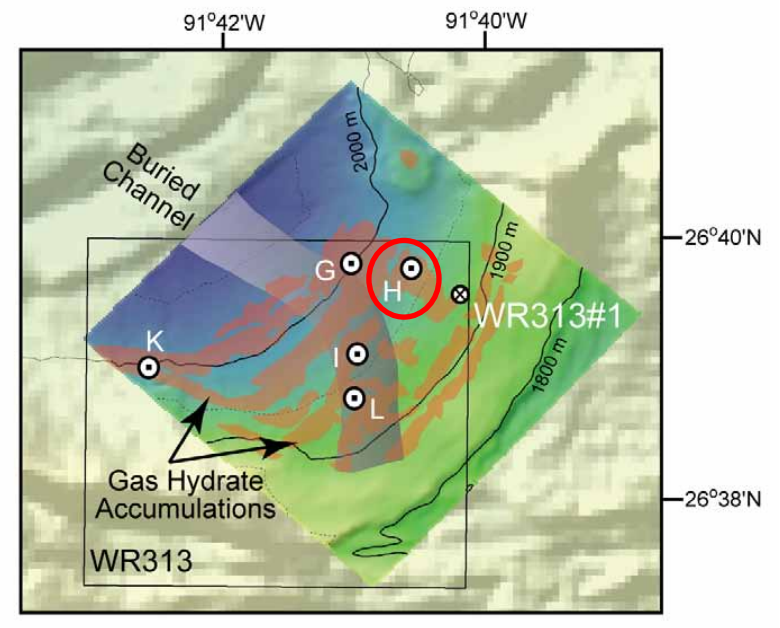
Proposed penetration	*3393 ft BML 9906 ft BSS*
Seafloor slope	*<2.6 ^{o} to the NW*
Expected lithologies and thicknesses	*190' Unit 1 – mud rich recent sediments* *825' Unit 2 – clay prone-upper, laterally stacked channel deposits, possible sand and mass transport in lower part.* *940' Unit 3 – well defined, continuous reflectors, clay prone* *741' Unit 4 – possible sand; blue in middle (lower part has clay-sand deposits)* *959' Unit 5 – possible sand in upper part (has BSR), below BSR = sand prone channel and overbank (bottom of hole is in this unit)*
Expected ages/section	*PlioPleistocene*
Estimated depth to TGHO	*2632 ft BML 9145 ft BSS*
Estimated depth to BGHS	*2893 ft BML 9406 ft BSS*
Estimated GH interval	*261 ft thick*
Estimated GH saturation	*%*
Anomalous conditions?	
Other relevant information	*Not near any obvious sea floor features*
Source of Information	*AOA Hazards Summary No. 4021-JIP-GOM-WR313H, 30 April 2008*

BML: Below Mud Line
BSS: Below Sea Surface
TGHO: Top of Gas Hydrate Occurrence
BGHS: Base of Gas Hydrate Stability

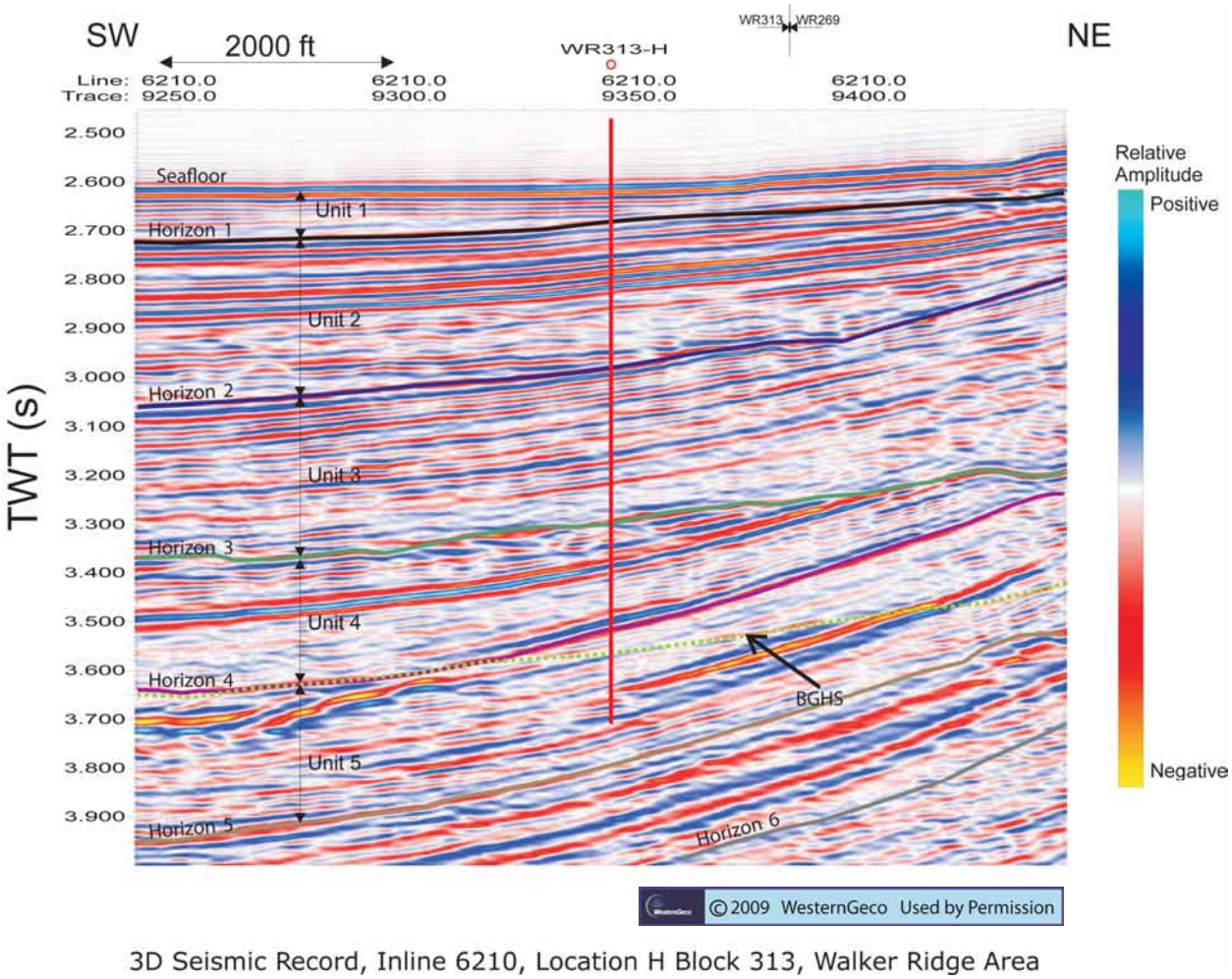


Event and Unit Designations	Inferred Lithology and Comments	Depths BML (ft)	Depths BSS (ft)	TWT BSS (s)	Thickness (ft)	Hazardous Shallow Gas Risk	Shallow Water Flow Risk
	Seafloor slopes about 2.6 degrees to NW.						
SEAFLOOR	Hemi-pelagic marine clays	0	6513	2.609			
1	Thin clay-prone mass transport deposits				190	NEGLIGIBLE	NEGLIGIBLE
HOR A		190	6703	2.682			
2	Clay-prone sediments in the upper section. Laterally stacked channel deposits with possible sands and mass transport deposits in the lower section.				825	NEGLIGIBLE	NEGLIGIBLE
HOR B		1015	7528	2.981			
3	Clay-prone sediments in the upper section. Strong amplitude response. Thin clay-prone mass transport deposits				940	NEGLIGIBLE	NEGLIGIBLE
HOR C Unconformity		1955	8468	3.291			
	Possible sand and channel deposits				317	NEGLIGIBLE	NEGLIGIBLE
Blue Horizon 4	High amplitude and continuous sandy	2272	8785	3.390	741		
	Clay-sand prone deposits				360	NEGLIGIBLE	NEGLIGIBLE
TPGHR		2632	9145	3.499			
HOR D Orange Horizon	Possible sand sediments	2696	9209	3.518	64	LOW**	LOW**
BGHS		2893	9406	3.576	197	LOW**	LOW**
5	Sand-prone channel overbank and channel deposits	3116	9629	3.641	223	LOW**	LOW**
					959 310		NEGLIGIBLE
Green Horizon		3426	9939	3.729			
	Interpreted channel complexes and mass transport deposits in the lower section				229	NEGLIGIBLE	NEGLIGIBLE
HOR E		3655	10168	3.793			
	Strong amplitude and continuous reflectors.				350	NEGLIGIBLE	NEGLIGIBLE
6		4005	10518	3.889	856		
	Clay and sand prone deposits				506	NEGLIGIBLE	NEGLIGIBLE
HOR F		4511	11024	4.024			
7	Clay-prone mass transport deposits				666	NEGLIGIBLE	NEGLIGIBLE
		5177	11690	4.195			

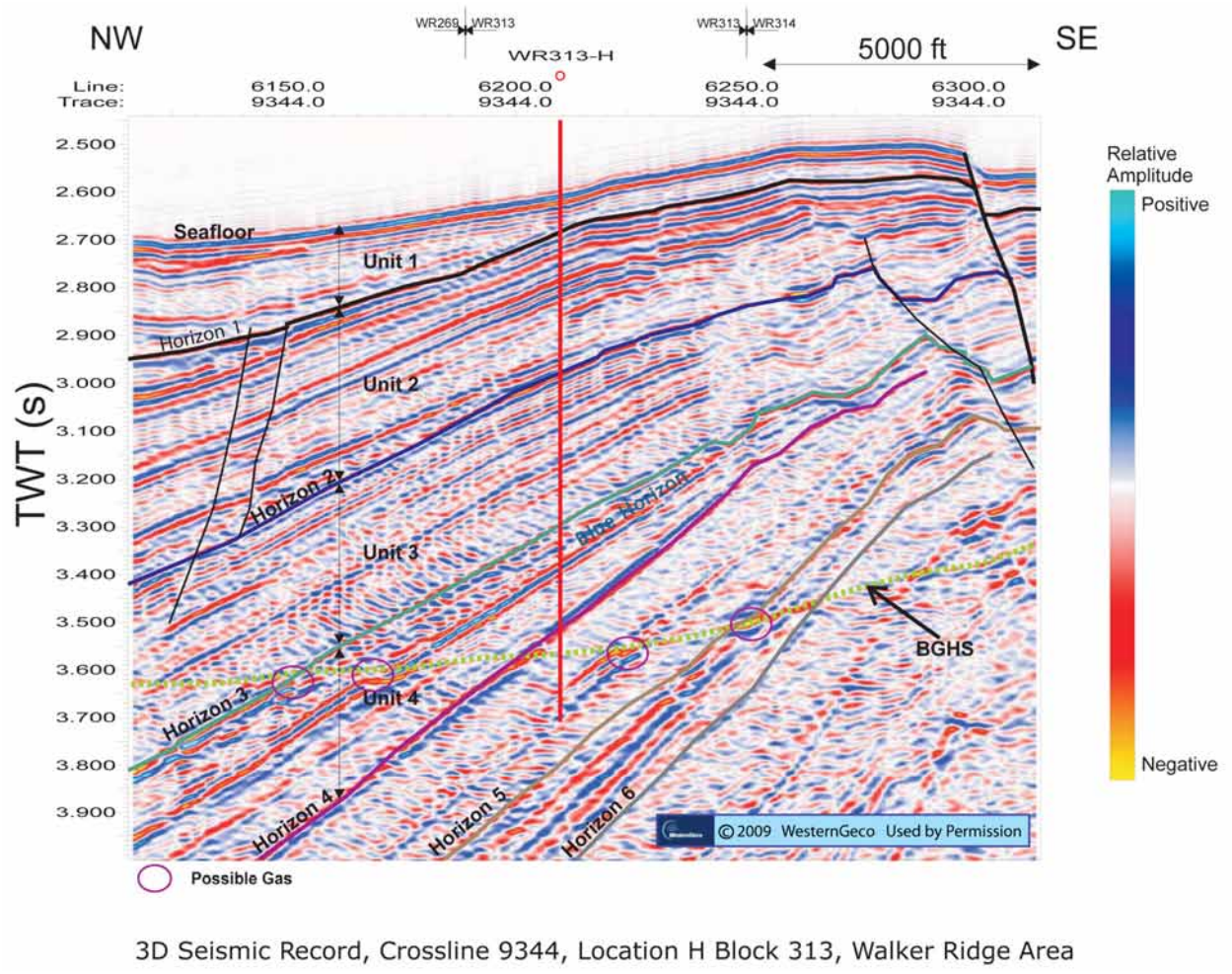
Appendix F5: *Stratigraphic interpretation, from AOA Geophysics; Seismic image provided by WesternGeco.*



Appendix F6: Map showing location of proposed site WR313-H.



Appendix F7: *Inline seismic profile across WR313-H. Seismic image courtesy of WesternGeco.*



3D Seismic Record, Crossline 9344, Location H Block 313, Walker Ridge Area

Appendix F8: *Crossline seismic profile across WR313-H. Seismic image courtesy of WesternGeco.*

Target WR313-I
Drilling Target Documentation

Table 1: Background Information

General Site Objective	*Channel fill at orange horizon that is both sand-prone and clay-prone*
Drilling target and Specific Hole Objective	*Orange is at BGHS.* *"blue" at 2380 ft BML; 8849 ft BSS (above TGHO)* *"orange" at 3144 ft BML; 9613 ft BSS (at BGHS)* *"green" at 3518 ft BML; 9987 ft BSS (below BGHS)*
Other Drilling in Vicinity	WR313#1 (1.2 mi to the SE),

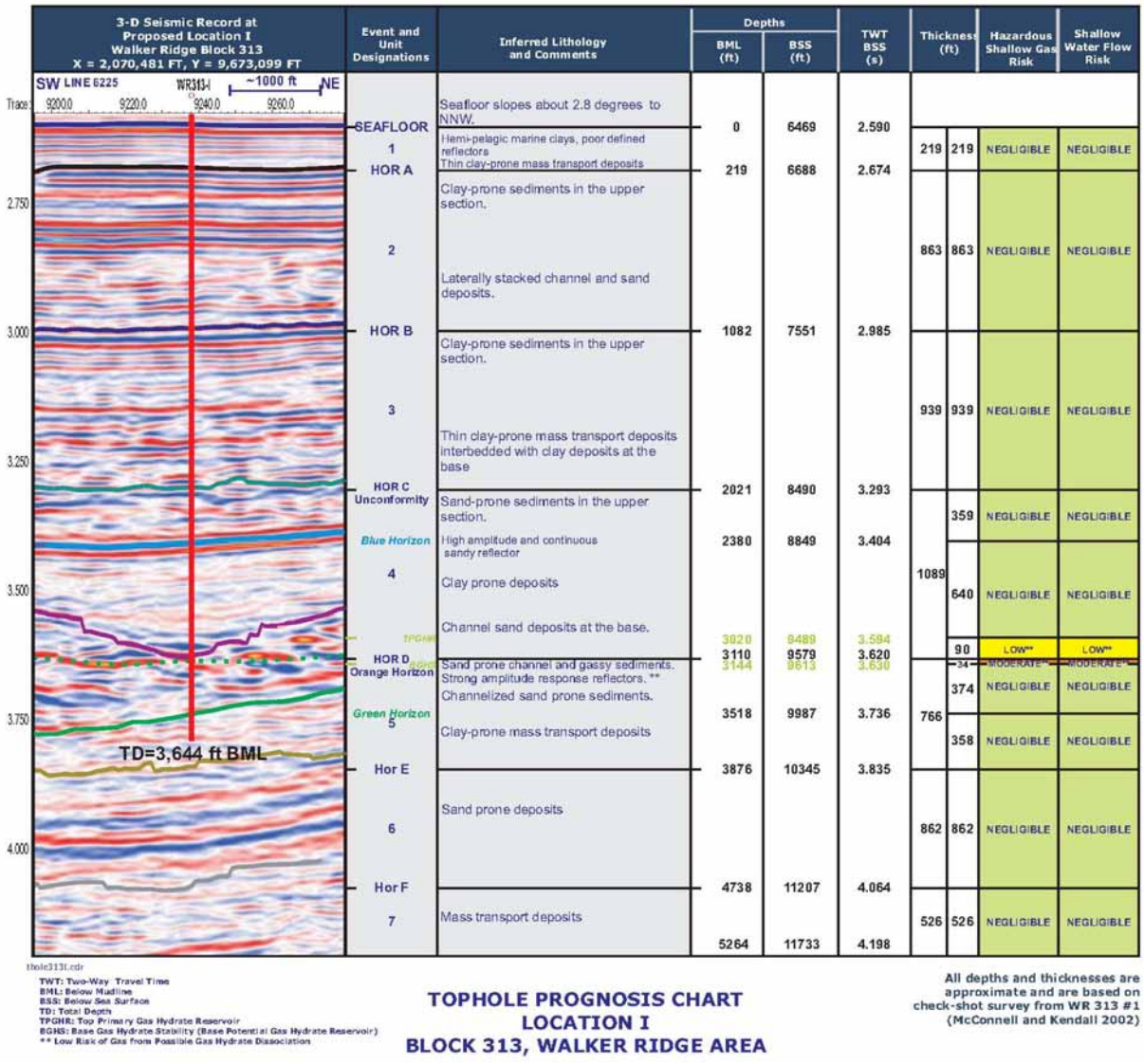
Table 2: Proposed Hole General Information

Site Name	WR313-I Permitted; JIP M7
General Area	*Semi-enclosed southwest arm of the Terrebonne basin*
Location	Latitude: *26^{o} 03' 06.034" N* Longitude: *-91^{o} 40' 58.516" W*
Coordinate Datum	*NAD27*
Water Depth	*6469 ft BSS)*
OPD/Lease Block	*WR313*
Seismic lines at hole	*6225 Inline, 9238 crossline*

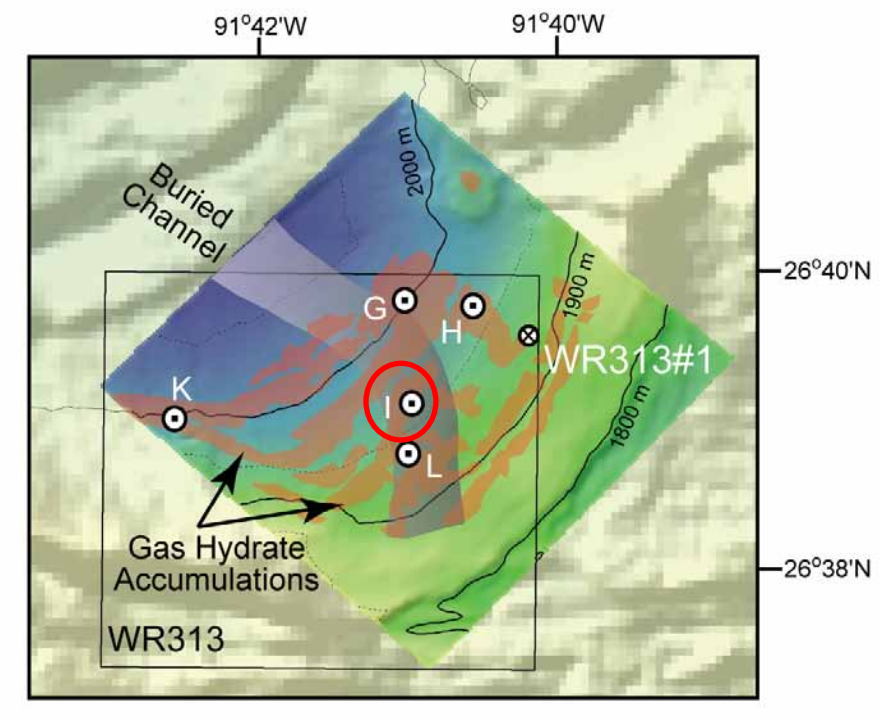
Table 3: Proposed Hole Drilling Information

Proposed penetration	*3644 ft BML 10113 ft BSS*
Seafloor slope	*2.8 ^{o} to the northwest*
Expected lithologies and thicknesses	*219' Unit 1 – normal marine clays over submarine landslide deposits* *863' Unit 2 – upper part: parallel stratigraphy, marine clays, lower part: laterally stacked channel and sand deposits* *939' Unit 3 – upper part: clay prone; lower part: thin clay prone mass transport/ Major unconformity* *1089' Unit 4 – upper part: sand prone; blue in the middle of this unit, lower part: clay prone and channel fill* *766' Unit 5 – sand prone channel, contains BGHS, TD in this unit*
Expected ages/section	*PlioPleistocene*
Estimated depth to TGHO	*3020 ft BML 9489 ft BSS*
Estimated depth to BGHS	*3144 ft BML 9613 ft BSS*
Estimated GH interval	*124 ft thick*
Estimated GH saturation	*%*
Anomalous conditions?	
Other relevant information	*No fault planes cross the well bore*
Source of Information	*AOA Hazards Summary No. 4021-JIP-GOM-WR313H, 30 April 2008*

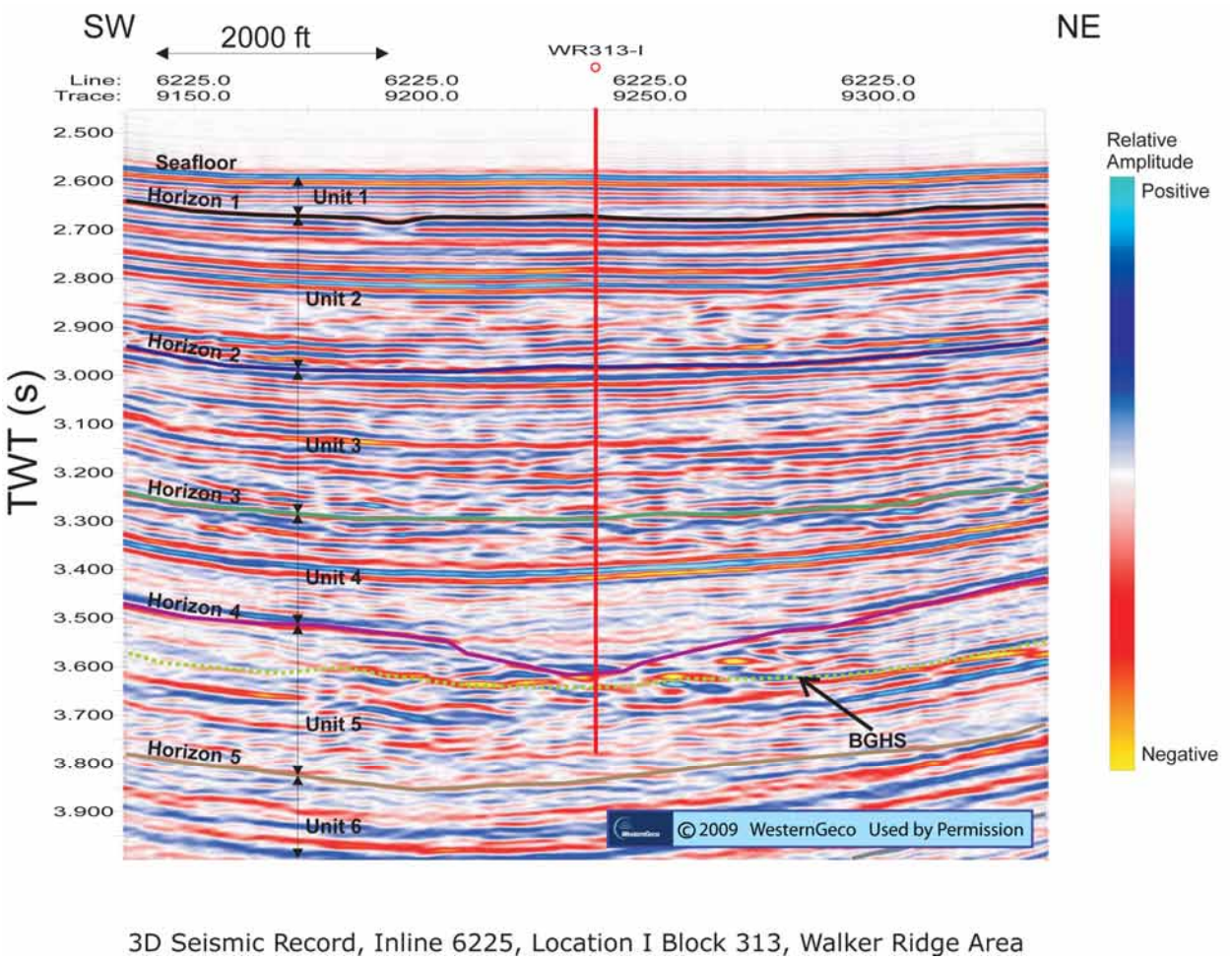
BML: Below Mud Line
BSS: Below Sea Surface
TGHO: Top of Gas Hydrate Occurrence
BGHS: Base of Gas Hydrate Stability



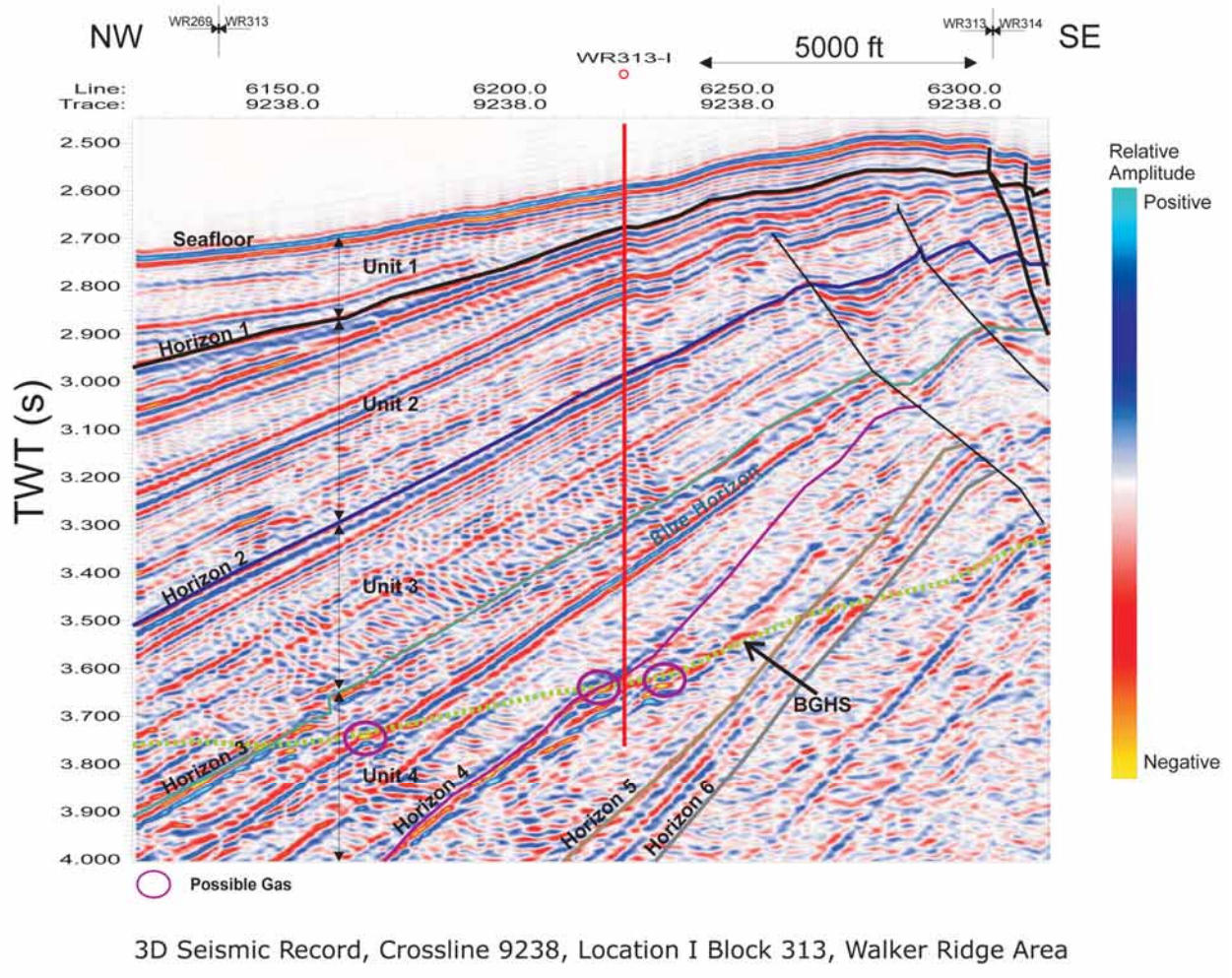
Appendix F9: *Stratigraphic interpretation, from AOA Geophysics; Seismic image provided by WesternGeco.*



Appendix F10: *Map showing location of proposed site WR313-I.*



Appendix F11: *Inline seismic profile across WR313-I. Seismic image courtesy of WesternGeco.*



Appendix F12: *Crossline seismic profile across WR313-I. Seismic image courtesy of WesternGeco.*

Target WR313-K (JIP M11)
Drilling Target Documentation

Table 1: Background Information

General Site Objective	*Sand prone sediments in a minibasin with gas charge below BGHS*
Drilling target and Specific Hole Objective	*Large amplitude anomaly (green monster) in wastern edge of cube* *"blue" at 2858 ft BML; 9460 ft BSS (at top of GH occurrence)* *BGHS at 3183 ft BML; 9785 ft BSS* *"orange" at 3483 ft BML; 10085 ft BSS*
Other Drilling in Vicinity	WR313#1 (1.2 mi to the SE),

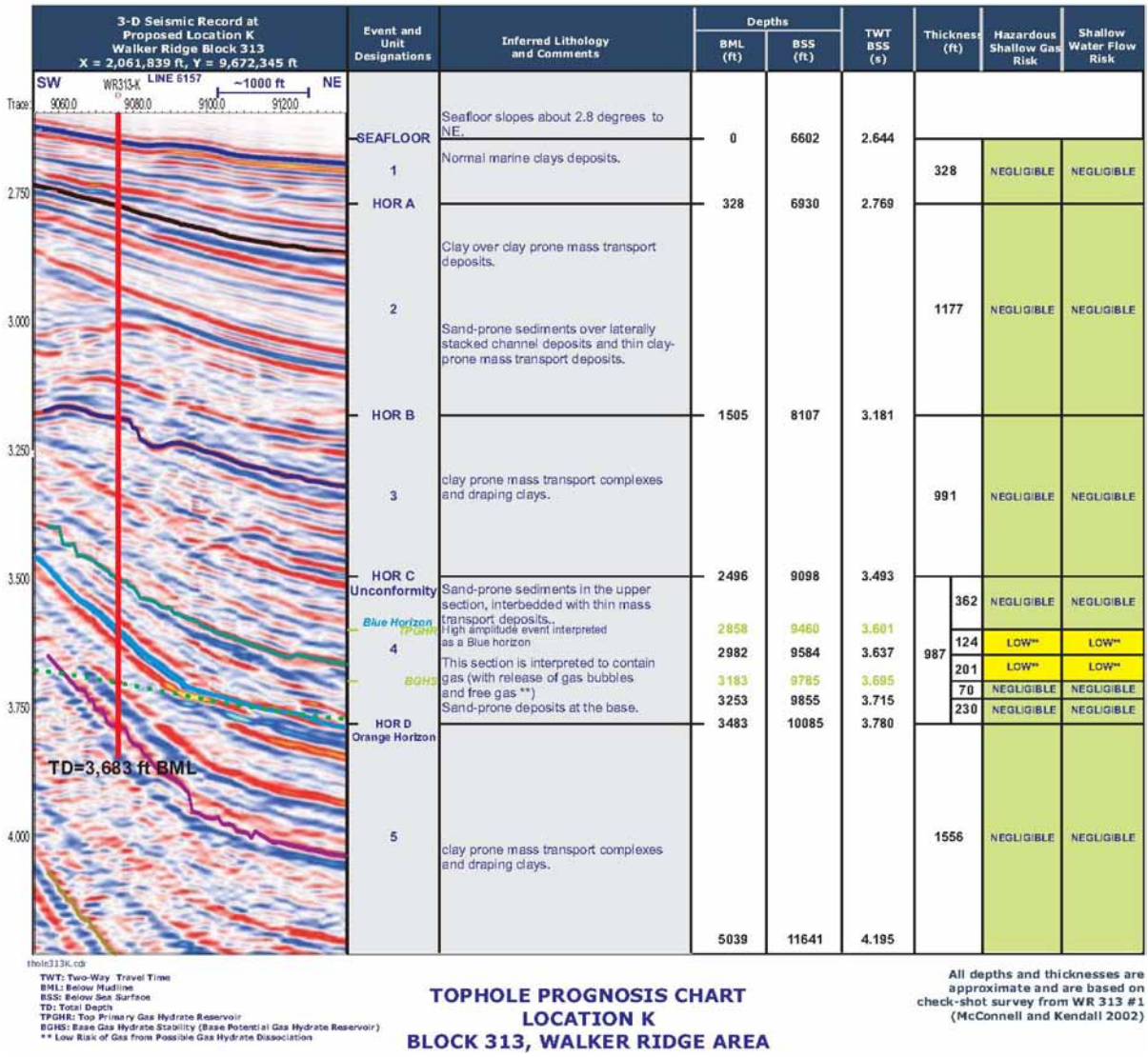
Table 2: Proposed Hole General Information

Site Name	Permitted WR313-K; JIP M11
General Area	*Southwest arm of the Terrebonne minibasin*
Location	Latitude: *26^o 38' 59.442" N* Longitude: *91^o 42' 33.854" W*
Coordinate Datum	*NAD27*
Water Depth	*6602 ft BSS*
OPD/Lease Block	*WR 313*
Seismic lines at hole	*6157 Inline, 9076 crossline*

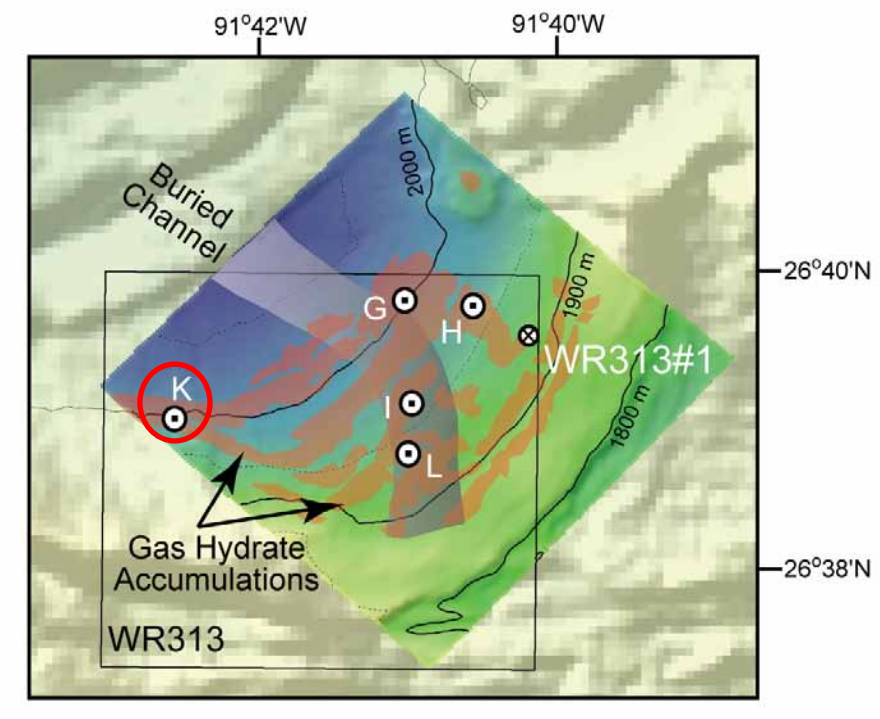
Table 3: Proposed Hole Drilling Information

Proposed penetration	*3683 ft BML 10285 ft BSS*
Seafloor slope	*2.8 ^{o} to the northeast*
Expected lithologies and thicknesses	*328' Unit 1 – recent mud rich sediments* *1177' Unit 2 – upper: clay over clay-prone mass transport; middle: sand-prone; lower: laterally stacked channel deposits* *991' Unit 3 – clay-prone mass transport and draping clays* *Major unconformity* *987' Unit 4 – upper: sand-prone sediments with thin mass transport deposits; lower: sand-prone deposits* *1556' Unit 5 – clay-prone mass transport complexes and draping clays (TD in unit 5)*
Expected ages/section	*PlioPleistocene*
Estimated depth to TGHO	*2858 ft BML 9460 ft BSS*
Estimated depth to BGHS	*3183 ft BML 9785 ft BSS*
Estimated GH interval	*325 ft thick*
Estimated GH saturation	*%*
Anomalous conditions?	*~45 ft from a fault scarp to the east* *Sea floor scars ~600 ft to SE; ~1000 ft to NW; and ~1070 ft to SW*
Other relevant information	*No faults cross the wellbore*
Source of Information	*AOA Hazards Summary No. 4021-JIP-GOM-WR313H, 30 April 2008*

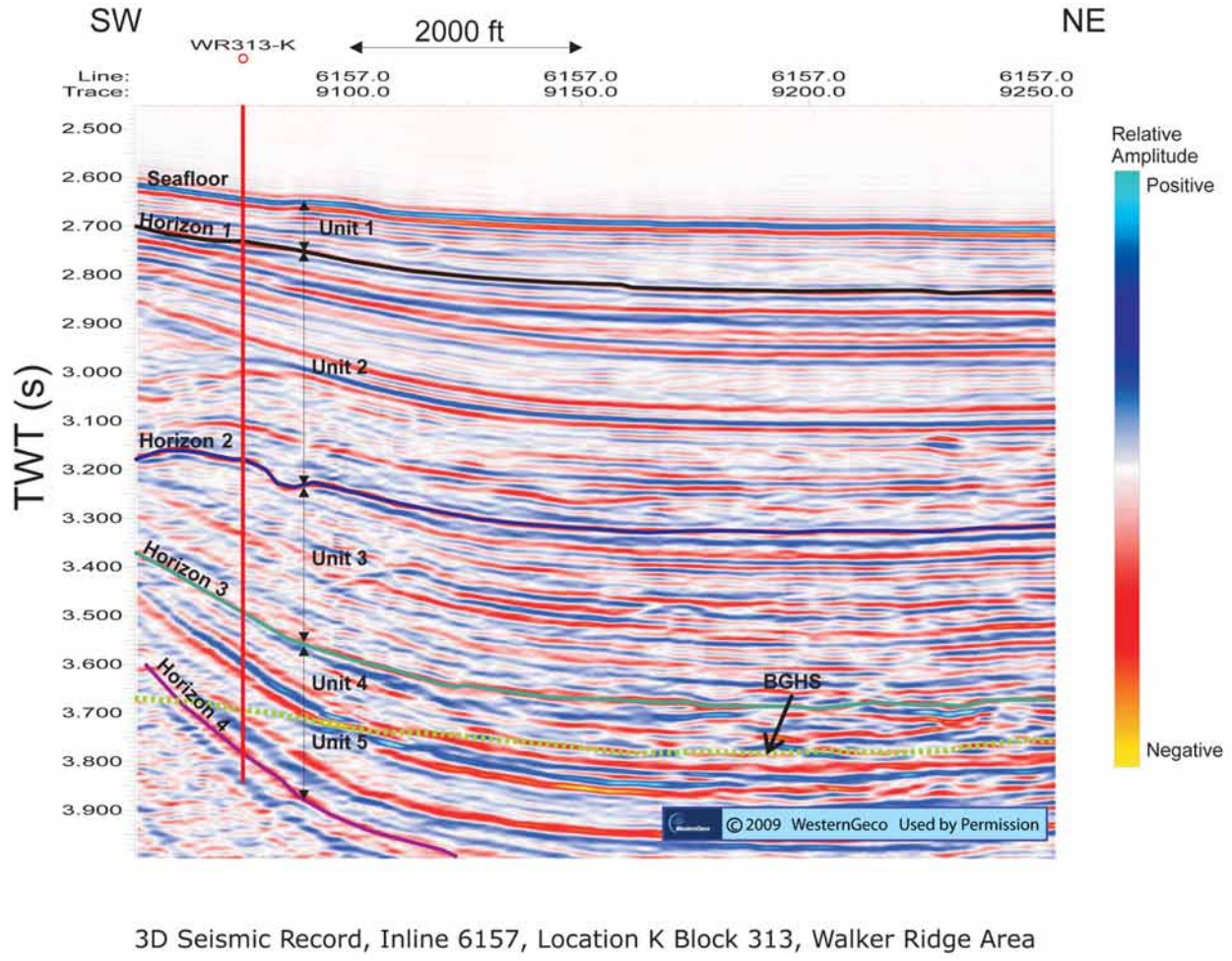
BML: Below Mud Line
BSS: Below Sea Surface
TGHO: Top of Gas Hydrate Occurrence
BGHS: Base of Gas Hydrate Stability



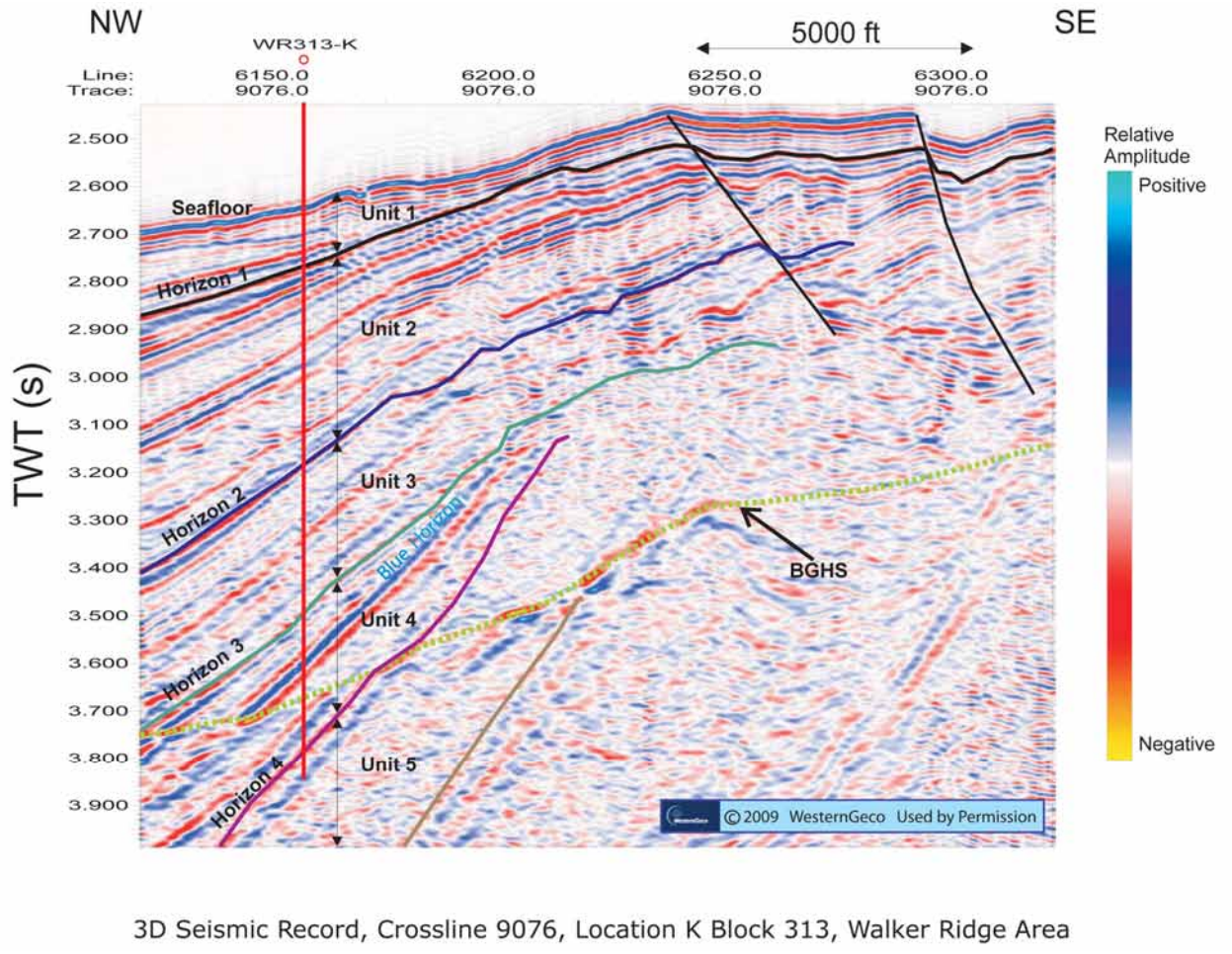
Appendix F13: *Stratigraphic interpretation, from AOA Geophysics; Seismic image provided by WesternGeco.*



Appendix F14: *Map showing location of proposed site WR313-K.*



Appendix F15: *Inline seismic profile across WR313-K. Seismic image courtesy of WesternGeco.*



Appendix F16: *Crossline seismic profile across WR313-K. Seismic image courtesy of WesternGeco.*

Target WR313-L (JIP M12)
Drilling Target Documentation

Table 1: Background Information

General Site Objective	*Sand prone sediments in a minibasin with gas charge below BGHS*
Drilling target and Specific Hole Objective	*Within channel at "orange" horizon* *"blue" at 2117 ft BML; 8514 ft BSS (above TGHO)* *"orange"at 2672 ft BML; 9060 ft BSS (above BGHS)* *BGHS at 3089 ft BML; 9486 ft BSS*
Other Drilling in Vicinity	WR313 ~1.2 mi to the SE

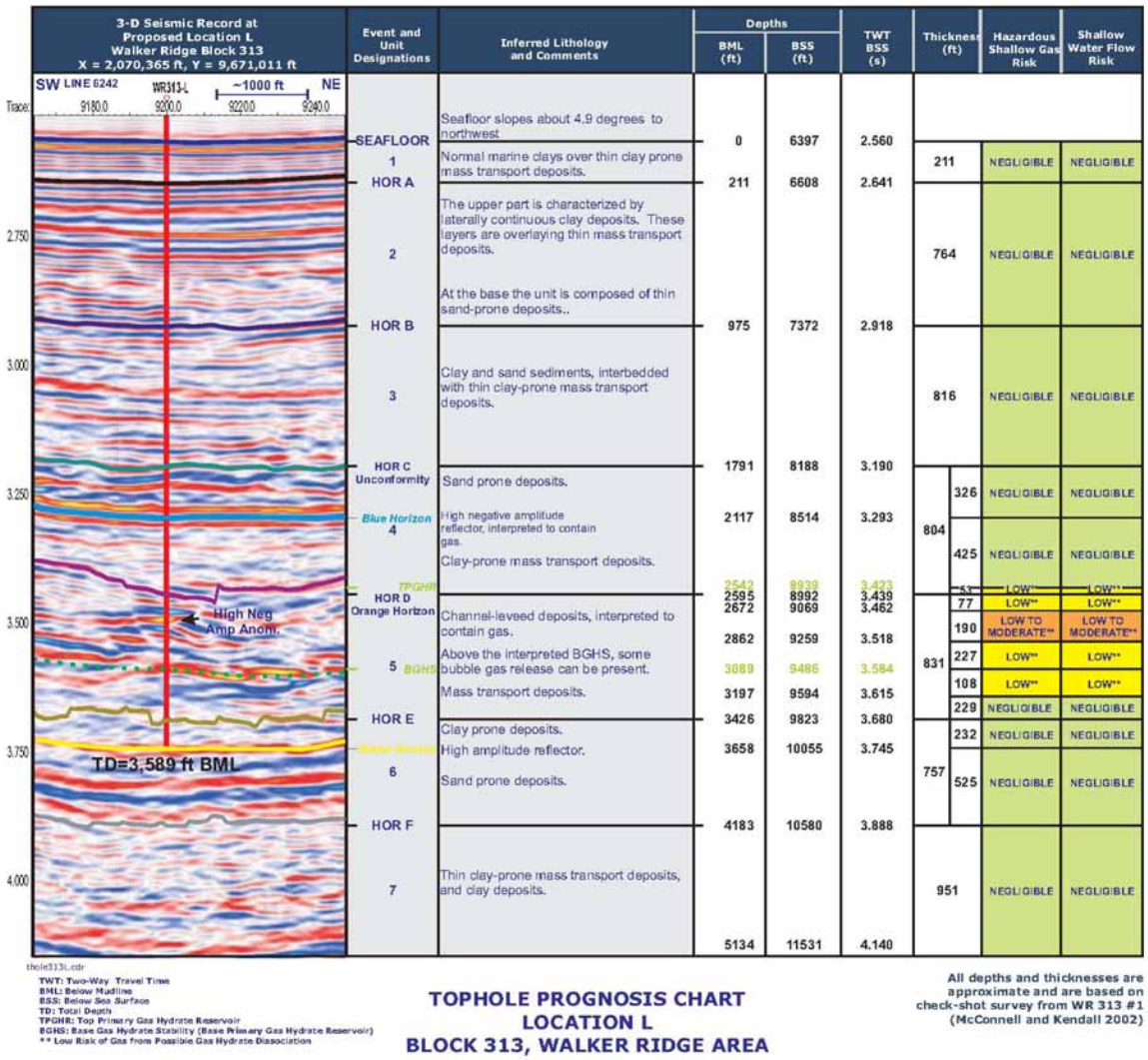
Table 2: Proposed Hole General Information

Site Name	Permitted WR313-L; JIP M12
General Area	*southwest arm of the Terrebonne Basin*
Location	Latitude: *26^{o} 38' 45.366" N* Longitude: *-91^{o} 40' 00.031" W*
Coordinate Datum	*NAD27*
Water Depth	*6397 ft BSS)*
OPD/Lease Block	*WR313*
Seismic lines at hole	*6242 Inline , 9200 crossline*

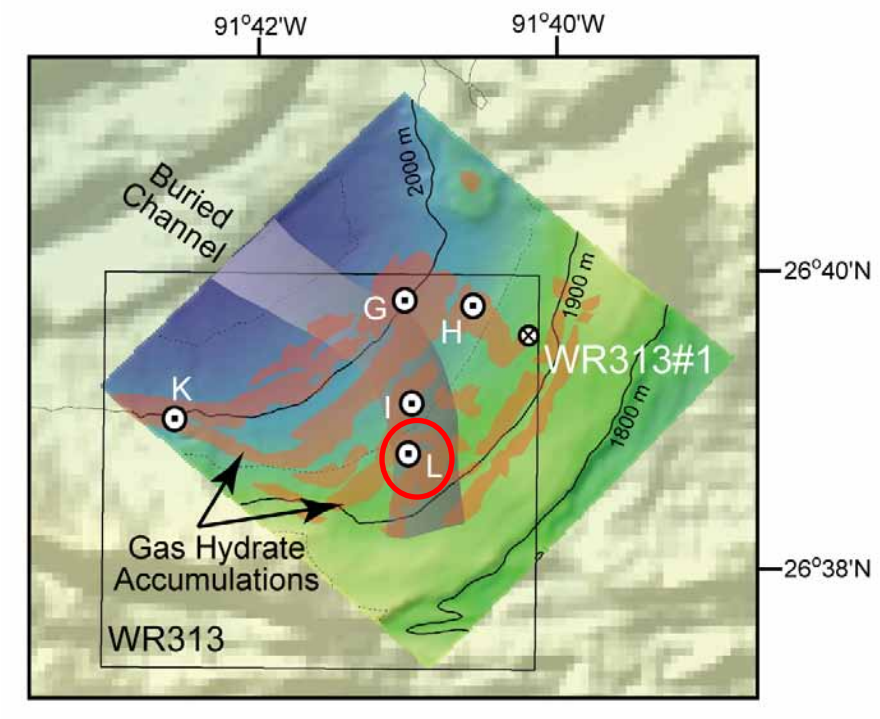
Table 3: Proposed Hole Drilling Information

Proposed penetration	*3589 ft BML 9986 ft BSS*
Seafloor slope	*4.9 ^{o} to thenorthwest*
Expected lithologies	*211' Unit 1 – recent mud rich deposits* *764' Unit 2 – upper: clay; lower: thin mass transport deposits* *816' Unit 3 – clay + sand interbedded with thin mass transport deposits* *804' Unit 4 – Upper: sand-prone; middle: blue; lower: clay-prone mass transport deposits* *831' Unit 5 – upper: channel-levee deposits; lower: mass transport deposits (contains BGHS)* *757' Unit 6 – clay prone, but may be deeper sand-prone deposits, too (TD in Unit 6)*
Expected ages/section	*PlioPleistocene*
Estimated depth to TGHO	*2542 ft BML 8939 ft BSS*
Estimated depth to BGHS	*3089 ft BML 9486 ft BSS*
Estimated GH interval	*547 ft thick*
Estimated GH saturation	*%*
Anomalous conditions?	
Other relevant information	*No faults interpreted to cross the well bore*
Source of Information	*AOA Hazards Summary No. 4021-JIP-GOM-WR313H, 30 April 2008*

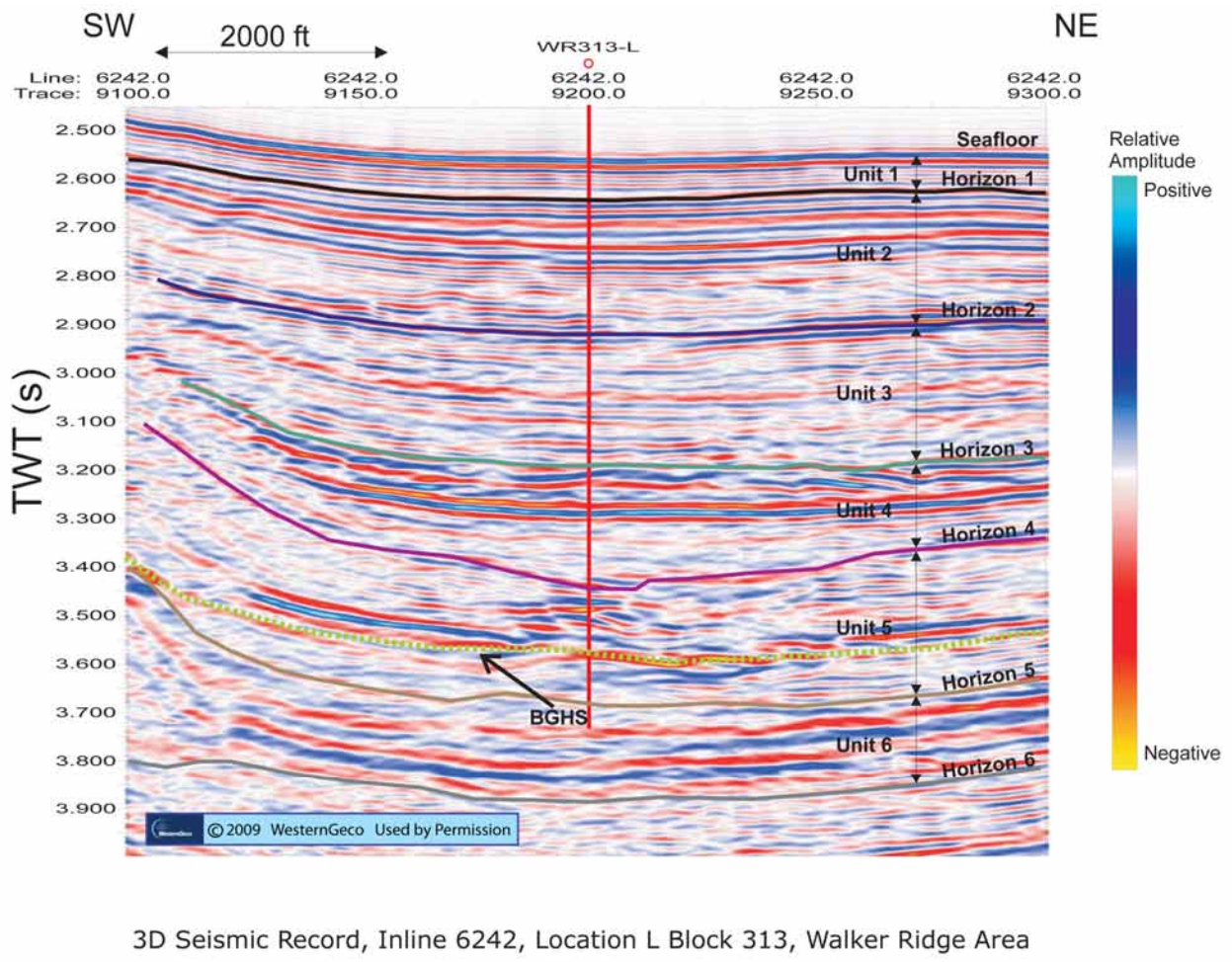
BML: Below Mud Line
BSS: Below Sea Surface
TGHO: Top of Gas Hydrate Occurrence
BGHS: Base of Gas Hydrate Stability



Appendix F17: *Stratigraphic interpretation, from AOA Geophysics; Seismic image provided by WesternGeco.*

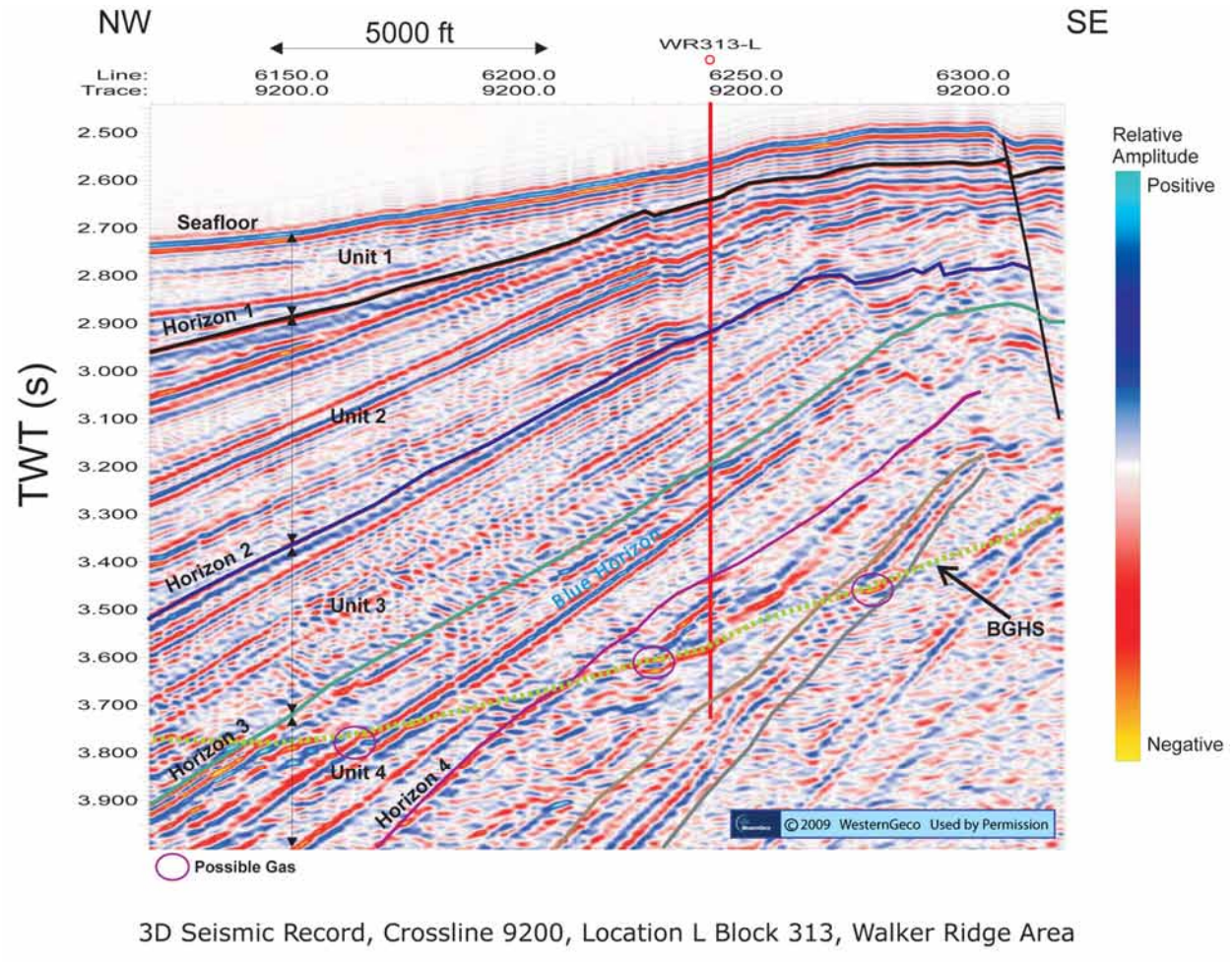


Appendix F18: *Map showing location of proposed site WR313-L.*



3D Seismic Record, Inline 6242, Location L Block 313, Walker Ridge Area

Appendix F19*: Inline seismic profile across WR313-L. Seismic image courtesy of WesternGeco.*



3D Seismic Record, Crossline 9200, Location L Block 313, Walker Ridge Area

Appendix F20: *Crossline seismic profile across WR313-L. Seismic image courtesy of WesternGeco.*