Gulf of Mexico Gas Hydrate Joint Industry Project Leg II: Operational Summary

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Abstract

The Gulf of Mexico Gas Hydrate Joint Industry Project Leg II (JIP Leg II) began on April 16, 2009, with the mobilization of the semi-submersible drilling vessel Helix *Q4000* at sea in the Gulf of Mexico and drilling was conducted in the Walker Ridge, Green Canyon and the Alaminos Canyon lease blocks. The primary objective of the Gulf of Mexico JIP Leg II program was the collection of a comprehensive suite of logging-while-drilling (LWD) data within gas hydrate-bearing sand reservoirs. The LWD sensors just above the drill bit provided important new information on the nature of the sediments and the occurrence of gas hydrate. The two holes drilled at Walker Ridge yielded evidence of a laterally continuous thick fracture-filling gas hydrate section, but more importantly both wells also encountered sand reservoirs, between 40 to 50-ft-thick, highly saturated with gas hydrate. Gas hydrate-bearing sands were also drilled in two of the three Green Canyon wells, with one occurrence roughly 100-ft-thick. Initial interpretation of the Alaminos Canyon drilling results matches pre-drill expectations of sands with uniformly low to moderate gas hydrate saturation over a large area. The discovery of gas hydrate-bearing sands in close accordance with predictions in six of seven wells drilled validates the integrated geological and geophysical approach used in the pre-drill site selection process in order to predict hydrate accumulations before drilling, and provides increased confidence in assessment of gas hydrate volumes in the Gulf of Mexico and other marine sedimentary basins.

Drilling operations within the Gulf of Mexico JIP Leg II were marked by the constant challenge of optimizing data quality by maintaining borehole stability, which is difficult to achieve within shallow unconsolidated sediments. In addition, several of the targets were exceptionally deep: the two wells drilled in Walker Ridge 313 (at more than 3000 feet below the seafloor) exceeded by more than 1000 ft the previous record for the deepest gas hydrate research wells (NGHP Expedition 01, Site 17, Andaman Islands). The process of drilling the Gulf of Mexico JIP Leg II wells provided new insights into the optimal drilling strategies for marine "open-hole" drilling programs without surface conductors or drilling fluid returns. Most notably, original plans to drill these deep holes with minimal drilling fluid use were revised due to difficulties with borehole stability observed in the first well drilled (WR 313-G). In fact, despite the large volumes of gas hydrate that the expedition encountered, it is apparent that many of the primary drilling hazards that needed to be managed during the drilling program were not gas hydrate related, but were instead the common problems that face all drilling programs: borehole stability, drill cutting removal, gas releases into the borehole, and water flows. Additional experience was also gained relative to the expected response of thick gas hydrate bearing units to drilling, providing further opportunities to improve future gas hydrate drilling protocols.

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Introduction

The Gulf of Mexico Gas Hydrate Joint Industry Project (JIP) is a cooperative research program between the U.S. Department of Energy and a consortium of U.S. and international energy companies under the management of Chevron. Other JIP members include ConocoPhillips, Total, Schlumberger, Halliburton Energy Services, Japan Oil Gas and Metals National Corporation, India's Reliance Industries, the Korean National Oil Company, StatoilHydro, and the U.S. Minerals Management Service (MMS). The project was initiated in 2001 to investigate the occurrence, nature, and implications of gas hydrate in the Gulf of Mexico. The JIP has contributed significantly to the development of gas hydrate science and technology including the development of remote sensing and field sampling tools, wellbore stability models and gas hydrate drilling hazard assessments, the development of gas hydrate related physical/geomechanical properties databases and experimental data on the impact of gas hydrate on the physical properties of sediments of various grain sizes (Ruppel *et al.*, 2008). In 2005, the JIP completed Leg I drilling, logging, and coring operations designed primarily to assess gas hydrate-related hazards associated with drilling through the clay-dominated sediments that typify the shallow sub-seafloor in the deepwater Gulf of Mexico (Ruppel *et al.*, 2008).

Upon analysis of Leg I results, the JIP membership decided to expand the project's goals to assess issues related to the occurrence of gas hydrate within coarser-grained sediments. The 2009 drilling project, named the Gulf of Mexico Gas Hydrate Joint Industry Project Leg II (GoM JIP Leg II), featured the collection of a comprehensive set of logging-while-drilling (LWD) data through expected gas hydrate-bearing sand reservoirs in seven wells at three locations in the Gulf of Mexico. This was an important goal because other studies in northern Alaska and offshore Japan (Collett *et al.*, 2009), have shown that gas hydrates in sand reservoirs are likely the closest to potential production as a commercial energy resource.

For the Gulf of Mexico JIP Leg II, the semi-submersible drilling vessel Helix *Q4000* was mobilized at sea in the Gulf of Mexico and drilling was conducted in the Walker Ridge (WR), Green Canyon (GC) and the Alaminos Canyon (AC) lease blocks. The full research-level LWD data set on formation lithology, electrical resistivity, acoustic velocity, and sediment porosity enabled the greatly improved evaluation of gas hydrate in both sand and fracture dominated reservoirs. The technical and scientific contributions of Gulf of Mexico JIP Leg II are dealt with in considerable detail by Boswell *et al.*, (2009); Cook *et al.*, (2009); Frye *et al.*, (2009); Guerin *et al.* (2009a, 2009b), McConnell *et al.*, (2009a, 2009b), and Mrozewski *et al.*, (2009).

As noted, the primary objectives of the Gulf of Mexico JIP Leg II drilling program was to further examine the occurrence of gas hydrate within sand reservoirs in the Gulf of Mexico, to assess current approaches for interpreting gas hydrate occurrence from geologic and geophysical data, and to determine the most suitable sites for additional drilling and coring in future phases of the JIP program. This report provides an overview of the operational aspects of the Gulf of Mexico JIP Leg II, including: (1) pre-drill site selection survey, (2) pre-drill operational planning, and (3) a hole-by-hole synopsis of the drilling and LWD operations, including information on transits between sites and general activities during the expedition mobilization and demobilization phases. The report concludes with (4) an assessment of the more significant drilling problems encountered during the drilling leg and recommendations for improvement to drilling protocols.

Pre-Drill Site Survey Selection Process

In 2006, a research team lead by the U.S. Geological Survey (USGS) and with participants from the MMS, AOA Geophysics, WesternGeco, DOE, Naval Research Lab, Rice University and Chevron began detailed geologic and geophysical evaluations of numerous potential sites, seeking evidence for active petroleum systems (gas sources and migration pathways) co-located with sand-prone lithofacies (reservoir). An initial primary target was provided by Chevron through public release of well and seismic data around the "Tigershark" well in AC 818. Subsequently, a review of gas hydrate indicators within existing industry well log and seismic data by Boswell *et al.*, (2008) revealed compelling evidence for the occurrence of gas hydrate in AC 818.

In 2007, the JIP conducted an open workshop to solicit additional drilling opportunities, in which locations in WR 313 and GC 955 were brought forward by Dan McConnell of AOA Geophysics. In the case of WR 313, the primary attributes that was prospective for gas hydrate in sands were related to anomalous seismic responses that aligned with the inferred base of gas hydrate stability zone (McConnell and Kendall, 2002). These anomalies were interpreted to mark the systematic transition from water, to gas, and to gas hydrate within individual beds as traced up-dip and into the gas hydrate stability zone. Several such anomalies were noted in the area, providing numerous potential drilling opportunities. At GC 955, the primary evidence was the confluence of strong, anomalous-terminated seismic amplitudes indicative of gas sourcing within a closed, complexly-faulted structural high coincident within a long-lived sand delivery fairway. In both areas, seismic amplitudes with polarity in phase with that of the sea-floor (suggesting horizons across which acoustic impedance substantially increased) were observed. These anomalies provided additional support to the interpretation of gas hydrate at elevated saturations in units of appreciable (seismically resolvable) thickness (McConnell *et al.*, 2009a, 2009b).

By 2008, the JIP and its collaborators had developed the following technical data sets and review reports for sites in AC 818, GC 955, and WR 313: (1) geologic interpretations and prioritized drilling targets from the site selection group; (2) pre-stack, full-waveform 3-D inversions for gas hydrate saturation from WesternGeco; (3) drilling hazards assessments from AOA Geophysics; and (4) borehole stability models and operational recommendations from Schlumberger Geomechanics. Gulf of Mexico JIP Leg II operations were originally planned for the spring of 2008, but the JIP elected to postpone operations when delivery of the drill rig was delayed until after the start of the hurricane season. Plans were then made to conduct Leg II in the spring of 2009. In addition, further analysis of the drilling opportunity in AC 818 revealed the likelihood of reservoir overpressure, and the site was dropped from further consideration for the (riserless) Leg II drilling program.

The JIP used the additional time to continue site evaluation activities through the rest of 2008 and early 2009. The JIP effort continued to benefit greatly from ongoing gas hydrate assessment efforts in the MMS (Frye, 2008), which revealed additional opportunities to target gas hydrates in coarse-grained sediments in East Breaks (EB) 922, GC 781/825, and AC 21/65. The GC 781/825 provided another example of the setting similar to that at WR 313 (i.e., phase reversals coincident with the base of gas hydrate stability). The EB 922 and AC 21/65 sites provided a different model. In EB 992, the occurrence of resistive sand bounded by shales, well above the base of gas hydrate stability, was confirmed by existing well data (the EB 992 #001 Rockefeller well). Although the nature of the pore-filling material was not clear, previous analysis of seismic data and limited downhole log data from the EB 992 #001 well are consistent with moderate-to-low (20-30%) saturations of gas hydrate (Boswell *et al.*, 2009; Frye *et al.*, 2009).

Throughout early 2009, the JIP pursued permitting and hazards analysis for five sites (AC 21/65, EB 955, GC 955; WR 313; and GC 781/825; Figure F1, Table T1). Due to ongoing industry activity in the “Mad Dog” development area, the JIP was unable to obtain the necessary permission to drill in the GC 781/825 sites. In total, the JIP, with the support of AOA Geophysics, conducted hazard analyses and obtained permits for a total of 20 potential drill holes amongst the remaining four sites (Table T1). The site selection team also prepared detailed site summary reports to help guide drilling operations and shipboard decisions (Hutchinson *et al.*, 2009a, 2009b, 2009c; Shedd *et al.*, 2009). The pre-drill site review reports included extensive data tables, seismic and well log images developed during the site review process. The operational science team on the *Q4000* also had access to seismic workstations and 3-D seismic data volumes from each of the drill sites to help guide drilling operations and project decisions. In many respects the success of this expedition can be directly linked to the critical contributions of the site selection team.

Pre-Drill Operational Planning

The downhole logging program implemented during the Gulf of Mexico JIP Leg II was developed under the guidance of the Borehole Research Group from the Lamont-Doherty Earth Observatory of Columbia University (LDEO). The main goal of the downhole logging program was to assess the distribution and concentration of gas hydrates below the seafloor in the Gulf of Mexico. Six logging-while-drilling (LWD) and measurements-while-drilling (MWD) tools, provided by Schlumberger Drilling & Measurements, were deployed in each hole. The LWD tools used during the JIP expedition (Figure F2) were the MP3 (multipole acoustic — recently commercialized under the name SonicScope), geoVISION (electrical imaging), EcoScope (propagation resistivity, density and neutron), TeleScope (MWD), PeriScope (directional propagation resistivity), and sonicVISION (monopole acoustic). Because of its slimmer 4 ¾ inch collar, the MP3 was located behind the 6 ¾ inch bit and below an 8 ½ inch hole-opening reamer, above which

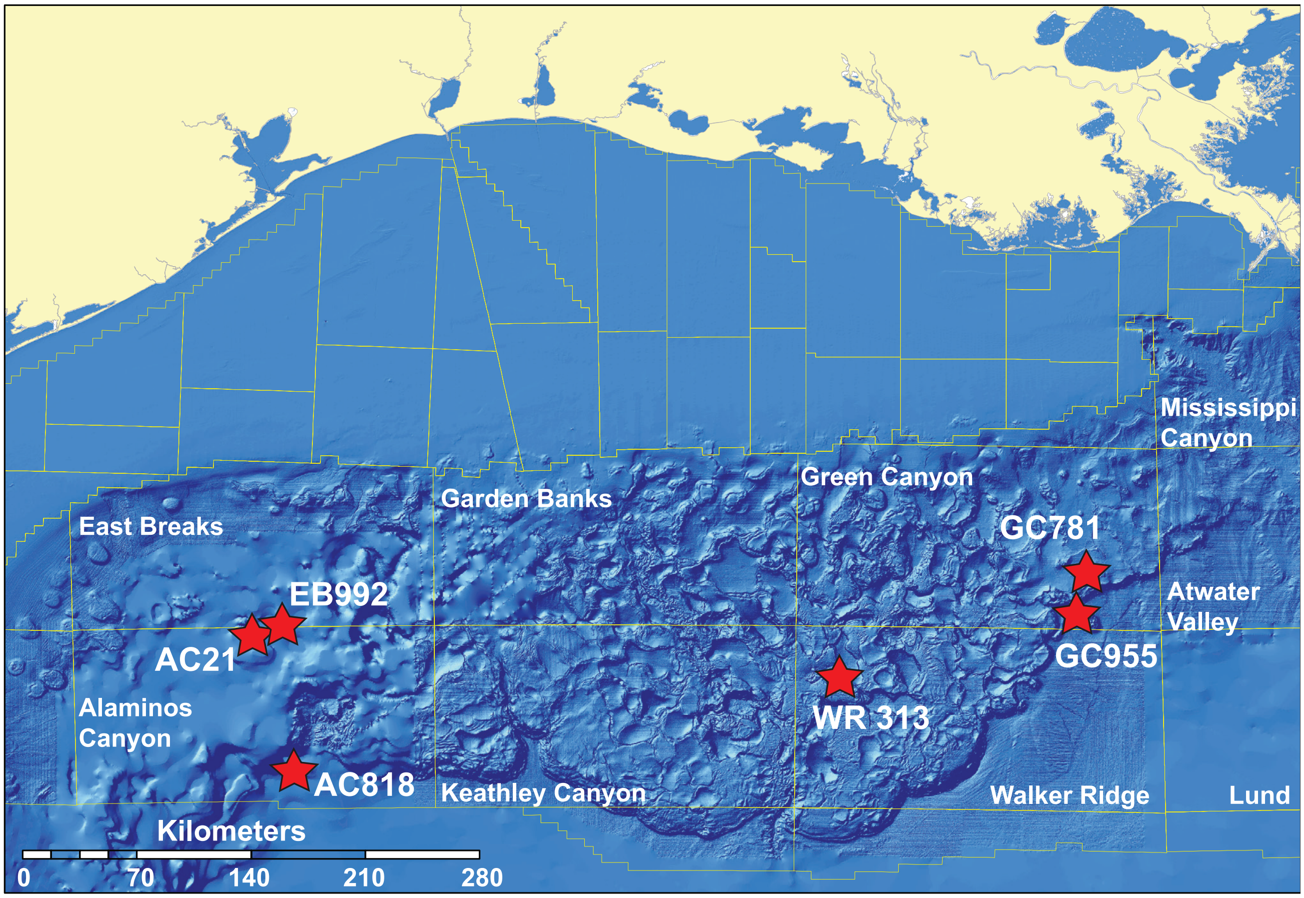
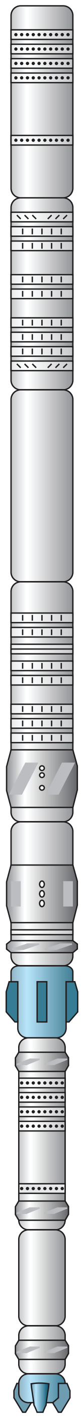


Figure F1: *Map of various proposed and drilled Gulf of Mexico JIP Leg II drill sites.*

OCS Block	JIP Designation	Well Designation	Latitude	Longitude
WR 313	M1	G	26.663732N	91.683855W
WR 313	M4	H	26.662465N	91.676048W
WR 313	M7	I	26.651676N	91.682921W
WR 313	M11	K	26.649845N	91.709404W
WR 313	M12	L	26.645935N	91.683342W
GC 955	AA	H	27.001063N	90.427064W
GC 955	KK	I	27.016536N	90.421357W
GC 955	NN	J	27.025533N	90.417464W
GC 955	QQ (HH &II)	K	27.006254N	90.423807W
GC 955	RR	L	27.037619N	90.428776W
GC 955	VV	O	26.999708N	90.430249W
GC 955	WW	P	27.003606N	90.435420W
GC 955	XX	Q	27.002386N	90.437299W
AC 21	A	A	26.92299N	94.89878W
AC 65	A	A	26.91078N	94.90252W
AC 21	B	B	26.94368N	94.89316W
EB 992	A	A	26.96947N	94.77536W
EB 992	B	B	26.97696N	94.76240W
EB 992	C	C	26.97653N	94.75293W
EB 992	D	D	26.97407N	94.77060W

Table T1: *List of all permitted well locations.*



	Collar OD (in)	Max OD (in)	Cumulative Length (ft)	Cumulative Length (m)
sonicVISION 675 w/ 8-3/8" stabilizer	6.750	8.375	172.60	52.61
PeriScope 675	6.906	7.500	144.70	44.10
TeleScope 675	6.890	6.890	123.58	37.67
EcoScope 675 w/ 8-1/4" stabilizer	6.890	8.250	93.51	28.50
geoVISION 675 w/ 8-1/4" stabilizer	6.750	8.250	66.85	20.37
6-3/4" x 8-1/2" hole opener	6.500	8.500	56.81	17.32
SonicScope 475 (MP3) w/ 2 x 6-1/2" stabilizers	4.750	6.500	51.03	15.55
Pony drill collar	4.750	4.750	18.37	5.60
Near-bit stabilizer	4.750	6.500	6.34	1.93
6-3/4" PDC bit	6.000	6.750	0.86	0.26

Figure F2: *Schematic diagram of the bottom-hole assembly (BHA) used for LWD operations during the Gulf of Mexico JIP Leg II. Collar lengths can be slightly different between versions of individual tools.*

were the rest of the 6 ¾ inch LWD collars. Some tools had stabilizers to centralize the collars in the borehole. Figure F2 shows the configuration of the LWD bottom hole assembly (BHA). For additional information about the measurements recorded by each tool on the LWD bottom hole assembly (BHA) see the following Gulf of Mexico JIP Leg II operations and results reports: Cook *et al.*, (2009); Guerin *et al.*, (2009a and 2009b); and Mrozewski *et al.*, (2009).

The detailed drill plan for the Gulf of Mexico JIP Leg II was developed by Chevron with support from JIP members, contractors, and several project science contributors. Considerable effort was committed to the development of a drill plan that would deliver both a safe and environmentally responsible program. It was decided early in the project that the hydrate research wells to be drilled under this effort would be drilled "open hole" without the use of a riser, which follows a long history of similar gas hydrate research expeditions operated under the Ocean Drilling Program (ODP) and the Integrated Ocean Drilling Program (IODP). All of the wells drilled under the Gulf of Mexico JIP Leg I were also drilled without a riser or a drilling fluid return system.

Results of previous gas hydrate drilling programs, such as ODP Legs 146 (Westbrook *et al.*, 1994), 164 (Paull *et al.*, 1996), and 204 (Tréhu *et al.*, 2004), and more recently the Chevron lead Gulf of Mexico JIP Leg I (Ruppel *et al.*, 2008), IODP Expedition 311 (Riedel *et al.*, 2006) and NGHP Expedition 01 (Collett *et al.*, 2008), have shown that gas hydrate-bearing sections do not represent a significant threat to drilling operations and that as long as the hole is advanced at relatively "normal" drilling rates with drilling fluid temperatures near that of the deeper water column there are no significant gas flows from gas hydrate-bearing formations. LWD measurements sensitive to the presence of free gas and/or gas hydrate include the borehole fluid pressure (decreased because of less dense fluids in the borehole), the compressional velocity in the borehole fluid and the formation, the coherence of measured sonic waveforms (strong decrease with free gas), the electrical resistivity (increase with free gas or gas hydrate), and the neutron and density logs (decrease of density and of neutron porosity, e.g. neutron/density crossover) (Riedel *et al.*, 2006; Collett *et al.*, 2008). In addition, the gamma ray log can help to indicate whether changes in the logs are due to changes in the lithology rather than in the pore fluid and the caliper can be used to assess the reliability of the measurements and the possible influence of material falling in the borehole. All of the above log measurements were monitored throughout the program to identify and respond to any gas hydrate or free gas induced drilling problems. It is important to highlight that the primary measurement used to monitor for gas in the borehole was the "annular pressure while drilling" (APWD) measured by the EcoScope tool in the borehole annulus (the space between the drill string and the borehole wall).

The Gulf of Mexico JIP Leg II drill plan assumed that the *Q4000* would be mobilized at sea somewhere in the central Gulf of Mexico. The 21-day pre-drill plan called for drilling at least three wells at Site GC 955 and Site WR 313; and three wells to be shared between Site AC 21/65 and Site EB 992. The drill plan also proposed drilling up to three wells at each site on one LWD-BHA deployment, which would require careful monitoring of downhole LWD tool batteries and computer chip memory. It was further assumed that the LWD-BHA would be tripped back to the ship after the completion of the last well at each site and tool memory would be downloaded and required batteries replaced.

The pre-drill plan indicated that at the start of operations at each site the self propelled *Q4000* would be positioned over the first drill location using GPS positioning devices and confirmed with a series of beacons deployed by the ship's remotely operated vehicle (ROV). The drill plan called for a constant supply of at least 2500 bbls of 16 pound per gallon (ppg) "dynamic kill drilling" (DKD) fluid on the drill ship. The LWD BHA would be deployed from the ship on 5 inch, 19.5#, Z-140 XT50 drill pipe. At the mud line the depth and location of the drill pipe was to be confirmed with the ROV. Each well was to be spud with minimal pump rate to avoid excessive disturbance. After most of the LWD BHA had been buried beneath the surface, each hole would be drilled to the permitted depth with seawater and drilling fluid sweeps as needed. At about 500 ft below the mud line (BML), the drill plan called for pumping 40 bbl gel sweeps (8.8 ppg) as needed to clean the hole. At TD, the hole was to be swept clean with a 8.8 ppg gel sweep, at which point the well would be monitored for any flow, and upon being confirmed static, the BHA would be pulled to 100 ft above the mud line. The well would then be monitored by the ROV for 30 minutes before moving to the next well or pulling BHA all the way to the ship.

In the pre-drill plan it was also decided that if a gas or shallow water flow zone was encountered, the well would be displaced with up to 16 ppg drilling fluid. If the flow did not stop with use of a heavy kill drilling fluid, the bit would be pulled above the zone and cement pumped through the BHA and the well abandoned. However, if the flow was controlled with DKD fluid, the bit would still be pulled above the hydrate zone and cement should be pumped through the BHA. Also if the well flow was determined to be severe or if hole collapse is suspected with the possibility of losing the LWD BHA in the hole, the BHA would be pulled out of the hole. In that case, the plan called for the well to be reentered with an open ended BHA to pump cement. Apart from monitoring flow by ROV, the APWD log was also to be monitored closely to detect any significant (100 psi or greater) drop in pressure. Additional pre-drill recommendations included the following:

- Monitor the APWD measured borehole pressures to detect hole cleaning, fluid influxes, and wellbore stability problems.
- Maintain optimal circulation of 340 gallons per minute (GPM) if moderate to low risk of gas hydrate dissociation is expected. In zones with a high risk of gas hydrate dissociation consider reducing circulation rate to 300 GPM.
- Maintain the recommended circulation rate as long as hole and bit cleaning are not unduly compromised.
- To minimize bit cleaning problems, consider reducing ROP.
- Use sweeps only when absolutely necessary as these may increase downhole temperatures.
- Monitor temperature of drilling fluids on rig floor, ocean temperatures, ocean current velocities, and temperatures at mouth of borehole (using ROV).
- To reduce the downhole temperature lower the flow rate, without jeopardizing cleaning.
- Be prepared for possible gas influx in locations where there is a high risk of hydrate dissociation.
- Monitor ROV for evidence of gas, shallow water flow etc.

In general, the above guidelines were followed throughout the drilling leg. However, the plan to use limited drilling fluid was changed to address several borehole stability issues as described later in this report.

Drilling and LWD Operations

The initial project mobilization was completed at sea (without a port call) and was supported by the supply boat M/V *Mia* out of Fourchon, Louisiana and several helicopter transfers from the Chevron heliport in Leeville, Louisiana. The logging tools, drill pipe, and other drilling equipment were mobilized from Fourchon via the M/V *Mia* on April 12, 2009. The Chevron shipboard supervisors and the Schlumberger logging engineers traveled to the *Q4000* by helicopter on April 14, 2009. The first three members of the science party, from the MMS, arrived on the *Q4000* via a MMS contracted helicopter on April 16, 2009. The remaining members of the science party, from the DOE, USGS, LDEO, AOA Geophysics arrived via helicopter on April 17, 2009.

In support of the drilling operations there were numerous supply boat transfers; the M/V *Mia* worked in direct support of the *Q4000* for almost the entire duration of the project. Most of the crew transfers where completed by helicopter flying out of the Chevron heliport in Leeville, Louisiana or later in the program out of Texas. While the initial project mobilization was staged from Louisiana, most of the post-leg demobilization was handled through Texas staging areas due to their proximity to the holes drilled at the end of the project in AC 21.

On board science operations were managed by scientists from the USGS, DOE, MMS, AOA Geophysics, and LDEO. Baker-Hughes drilling fluid engineering also provided critical project support. The LWD operations were conducted by Schlumberger. The science team, in daily consultation with Chevron drill site managers, as well as Chevron project managers and Schlumberger Geomechanics engineers onshore, recommended the course of day-to-day operations and data acquisition. The selection and sequence of drill locations were determined during the course of the expedition based on the results of the previously drilled and logged holes, as were drilling depth and drilling/logging parameters. Selected drill locations were modified up to 500 ft from permitted locations per MMS regulations based on insights from previous drilling.

Daily reporting during the Gulf of Mexico JIP Leg II consisted of (1) Chevron drilling reports, (2) science reports, (3) *Q4000* drilling reports, (4) drilling fluid reports, and (5) preliminary site summaries prepared after completing operations at each of the three sites. Most of these reports were posted

Hole	API Number	Latitude (N)	Longitude (W)	Water Depth (fbsl)	Hole Depth (fbrf)	Hole Depth (fbsf)
AC 21A	608054007000	26 55 23.8503	94 54 00.0702	4889	6700	1760
AC 21B	608054007100	26 56 39.1900	94 53 35.6216	4883	6050	1116
GC 955H	608114053700	27 00 02.0707	90 25 35.1142	6670	8654	1933
GC 955 I	608114054400	27 00 59.5305	90 25 16.8928	6770	9027	2205
GC 955Q	608114054300	27 00 07.3484	90 26 11.7156	6516	8078	1511
WR 313G	608124003900	26 39 47.4841	91 41 01.9404	6562	10200	3586
WR 313H	608124004000	26 39 44.8482	91 40 33.7467	6450	9770	3269

Table T2: *List of wells drilled during the Gulf of Mexico JIP Leg II, with final surveyed locations, water depths in feet below sea level (fbsl), total hole depth in feet below rig floor (fbrf) and feet below sea floor (fbsf).*

on the following project web sites as the drilling program progressed: http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/2009GOMJIP/index.html and http://gomhydratejip.ucsd.edu/.

Gulf of Mexico JIP Leg II began at 15h30 (Central Time) on April 16, 2009, with the transfer of authority to Chevron representatives on the *Q4000* located in block GC 195. The *Q4000* provided the Gulf of Mexico JIP Leg II with a stable drilling platform and a dynamic derrick with a maximum lift capacity of 600 MT. The vessel has full drilling and pipe handling capability. The *Q4000* also has 150 hp built-in heavy work class ROV, which was used to monitor the well head at the seafloor during drilling and to position the drill string for precise spuds.

Ultimately three sites were occupied with seven LWD holes being drilled, a total of 15,380 ft formation were drilled and logged during this research leg (Table T2, Figure F1). Penetration depths varied from 1116 to 3586 feet below seafloor (ftbsf). All of the holes were abandoned with heavy drilling fluid as prescribed in the drill plan. Two of the holes in Green Canyon were plugged with cement. During the Gulf of Mexico JIP Leg II there were 4.8 days spent in transit or mobilizing equipment, another 15.1 days were spent on-site conducting drilling operations. Gulf of Mexico JIP Leg II officially ended at about noon (Central Time) on May 6, 2009 with the release of the rig in AC 21. Schedule details, statistics, and an event drilling log record for the Gulf of Mexico JIP Leg II can be found in Table T3.

The following section of the report is dedicated to a hole-by-hole synopsis of the project drilling activities, including information on ship transits and mobilization of equipment and crew to and from the *Q4000*.

Walker Ridge 313-G

Gulf of Mexico JIP Leg II began at 15h30 (Central Time) on April 16, 2009, with the mobilization of the *Q4000* in GC 195 and a 77 nmi transit to the first drill site at WR 313-G, which was completed in less than 20.5 hr at an average speed of 3.8 nmi/hr. During the transit, initial attempts to transfer drilling equipment from the M/V *Mia* to the *Q4000* was aborted due to bad weather, it was decided to continue the transit to WR 313-G. On the afternoon of April 17, 2009, the *Q4000* arrived at the WR 313-G location and the ship was ballasted down, the ROV was used to set two compacts, which are transponders used to position the drillship over the borehole. The rig crew began to pickup and run to the seafloor the bottom hole assembly (BHA) at 02h30 on April 17, 2009. The seafloor was tagged at a depth of 6614 feet below rig floor (fbrf) as confirmed by ROV (most of the depths used in this report were measured from the height of the rotary on the drilling rig floor, which in most cases was 52 ft above sea surface). The WR 313-G well was officially spudded at 17h00 on April 18, 2009, at a depth of 6614 fbrf. The duel diameter BHA, with a 6 ¾" drill bit followed by an 8 ½" hole opener was advanced from the seafloor to a depth of 7116 fbrf by 021h30 on April 18, 2009. Drilling continued relatively smoothly, pumping between 380 and 410 gpm of seawater with sweeps of 10.5 ppg drilling fluid as needed. At roughly 7754 fbrf the ROP was reduced temporarily to ~100 ft/hr in order to capture higher-resolution log images over a zone of interest. While drilling the muddy sediments above the primary target at the WR 313-G well, a zone of elevated resistivity (from 4 to 10 Ω-m) was encountered through a thick interval from 7458 fbrf to 7850 fbrf. Initial interpretation was that this zone marks a strata-bound interval of clay-dominated sediments having fracture-filling gas hydrate. At 8264 fbrf, it became necessary to backream each stand and drilling became very difficult despite the increase in drilling fluid sweeps. Rotary speed was increased to 120 rpm in response to torque, and the drill string would occasionally pack off despite multiple backreams per stand. It is critical to highlight that the backreaming employed in WR 313-G was not done for precautionary reasons, it was done in response to the observed increases in torque and was conducted to protect the LWD BHA and to advance the hole. A major packoff at 9244 fbrf (stalling the rotary and requiring 140,000 lb of overpull) prompted a switch to continuously drilling with 10 ppg drilling fluid. The main target in the WR 313-G well was encountered at an expected depth of 9412 fbrf and included a net of ~30 ft of sand containing gas hydrate at high saturations within a total 70-ft-thick interval (McConnell *et al.*, 2009a). After further weighting up the drilling fluid to 10.5 ppg at 9599 fbrf, the rest of the hole was drilled incident-free. The total depth of 10,200 fbrf was reached at 18h45 on April 20, 2009 and the hole was displaced with 12 ppg drilling fluid. The LWD tools were brought back to the surface at 08h00 on April 21, 2009 and rig down was completed by 10h30 while preparing for transit to GC 955.

It was originally planned that after completing the first well in WR 313 the rig would be moved in "dynamic positioning (DP) mode" (a short intra-site move taken between locations with the drill string lifted approximately 500 ft above the sea-floor) to a second Walker Ridge site. This plan was changed in order to assess the condition of the LWD string and to address several potential tool data quality issues (Cook *et al.*, 2009; Mrozewski *et al.*, 2009). In part because of the technical success of discovering hydrate-bearing sands in the WR 313-G well (Boswell *et al.*, 2009; McConnell *et al.*, 2009a) and because of the unexpected requirement to recover the LWD BHA to the ship, it was decided to sail the *Q4000* on to GC 955 with a plan to return to the WR 313 site later in the drilling leg.

Green Canyon 955-I

The 90 nmi transit from WR 313-G to GC 955-I was completed in less than 14.5 hr at an average speed of 6.2 nmi/hr. Ultimately three wells were drilled in GC 955 from April 22, 2009 to April 28, 2009. The first well (GC 955-I) was drilled very close to a late-stage channel axis (to maximize the occurrence of sand reservoirs) in a location with muted geophysical indications of gas hydrate (McConnell *et al.*, 2009b). The rig crew began to pickup and run to the seafloor the bottom hole assemblage at about midnight on April 21, 2009. After tagging the seafloor at a driller's depth of 6822 fbrf, Hole GC 955-I was spudded at 11h15 on April 22, 2009. Drilling continued smoothly with drilling fluid sweeps every couple of stands until 8097 fbrf when ROP was reduced to 180 ft/hr for the target zone of interest. As prescribed in the new drilling plan, developed after the drilling problems encountered in WR 313-G, drilling fluid was also automatically switched to 10.5 ppg water-based drilling fluid at a depth of 8097 fbrf to facilitate cuttings removal and borehole stability. At 8132 fbrf, the rotary speed was increased to 140 rpm, and at 8697 fbrf, ROP was restored to 250 ft/hr for the remainder of the well. The GC 955-I reached a total depth of 9027 fbrf at 05h45 on April 23, 2009. The hole was not displaced with heavy drilling fluid since the deepest part of the hole had been drilled with a 10.5 gpm drilling fluid, but an LWD downlink was performed to slow the tools' record rates before the bottom hole assembly (BHA) was pulled out of hole and suspended in open water for the rig move to the next drill location.

Subsequent visual monitoring of the GC 955-I wellhead with the *Q4000* ROV revealed that the well was flowing water (no evidence of gas). To stop the observed water flow it was decided to place a cement plug in the well. The LWD BHA was brought to surface by 23h30 and laid down shortly after. A simple BHA, without the LWD tools, was run back into the hole to place the cement plug. The cement BHA was recovered to the ship at 17h00 on April 24, 2009; thus marking about a day of effort to control the water flow from the GC 955-I hole.

Green Canyon 955-H

After completing the cementing operations in the GC 955-I well, the *Q4000* was moved, about 1.0 nmi to the southwest to the GC 955-H location. The GC 955-H well targeted high amplitude seismic anomalies with features suggestive of gas hydrate at a projected depth of 8025 fbrf. Operations at the GC 955-H location started at 21h30 on April 24, 2009, with rigup and running the drill pipe and the LWD BHA to the seafloor. After tagging the seafloor at a driller's depth of 6721 fbrf, Hole GC 955-H was spudded at 06h30 on April 25, 2009. Drilling continued smoothly with drilling fluid sweeps every few stands until 7821 fbrf when ROP was reduced to 180 ft/hr for the target zone of interest. At the same time, drilling fluid was changed to a 10.5 ppg water-based drilling fluid in anticipation of more difficult drilling. One hundred feet deeper, rotary speed was increased to 135 rpm in response to a developing problem with torque on the drill string. At 8241 fbrf, ROP and rotary speed were increased again to 300 ft/hr and 120 rpm, respectively. A total depth of 8657 fbsf was reached at 23h20 on April 25, 2009. The hole was displaced with 13.0 ppg drilling fluid before the BHA was pulled out of hole and suspended in open water in preparation for the rig move. The BHA cleared the seafloor at 03h00, April 26, 2009, after a camera survey had ensured that the hole was not flowing, and the rig was moved to the next location.

The GC 955-H was drilled and completed without any significant problems and without any special measures other than the standard use of drilling fluid; which is important to note, since the well penetrated a thick gas-hydrate-filled fracture section within the depth interval of 7250-7670 mbrf and at a depth of 7795 fbrf the well encountered a gas hydrate-bearing sand section more than 100 ft thick (McConnell *et al.*, 2009b).

Green Canyon 955-Q

Based on the highly successful technical and operational results of the GC 955-H well, the science team and the JIP elected to drill the GC 955-Q well in a separate fault block in a structurally higher position, potentially placing the sand reservoirs encountered in GC 955-H higher in the gas hydrate stability zone. On seismic data, this location exhibited a thick sequence of high-amplitude geophysical responses that had been assessed a “high” risk of free gas in pre-expedition hazards analysis; however, the science team determined that this risk had been sufficiently mitigated by the lack of significant free gas observed below hydrate in the GC 955-H well and the drilling fluid handling capabilities of the *Q4000*.

After completing the short move to the GC 995-Q location, operations started with the tagging of the seafloor at a driller’s depth of 6567 fbrf, and spudding Hole GC 955-Q at 14h15 on April 26, 2009. For the first 190 fbsf the rate of penetration was highly variable and averaging roughly 600 ft/hr, but it was later stabilized at about 400 ft/hr. Drilling continued smoothly with drilling fluid sweeps every couple of stands until 7497 fbrf when rotary speed was increased to 135 rpm in response to drilling conditions. At 7805 fbrf, the ROP was reduced to 180 ft/hr for the target zone of interest. At the same time, drilling fluid was changed from seawater to a 10.5 ppg water-based drilling fluid. At 7921 fbrf, the well encountered gas hydrate-bearing sand, which continued to a depth of at least 7974 fbrf (the deepest data point measured by the MP-3 acoustic tool, which was located 35 ft above the bit, see Figure F2) (McConnell *et al.*, 2009b). At a depth of 8014 ft below rig floor, drilling was halted when a gas release from the well was visually observed by the *Q4000*’s ROV. The LWD assembly was eventually recovered to the ship, and the well re-entered and cemented. The gas release and eventual flow from the GC 955-Q well is further discussed and reviewed later in the report in a section that deals with the assessment and the response to the more significant drilling problems encountered during this drilling leg.

Walker Ridge 313-H

After completing operations at GC 955-Q and transiting back to WR 313, operations resumed with the rigup of the BHA at 12h00 on April 29, 2009. The seafloor was tagged at a driller’s depth of 6501 fbrf and Hole WR 313-H was spudded at 19h43. The WR 313-H well is located ~1.0 nmi to the east of the WR 313-G well drilled at the start of the program.

At 6841 fbrf, following a spud protocol designed to maintain good conditions at the top of the hole, the pump rate was increased to 385 gpm to facilitate MWD directional surveys. Drilling continued relatively smoothly with drilling fluid sweeps every few stands (a stand in this case was approximately 60 feet or two pipe lengths). The drill bit rotary speed was gradually increased to 133 rpm in response to drilling conditions. The shallow, fracture-filling gas hydrate occurrence was again observed at about 7050 to 7400 fbrf. As in the WR 313-G well, the underlying sediments contained interbedded muds and thin sands, and virtually every unit indicated gas-hydrate fill (McConnell *et al.*, 2009a). The top of the primary target in the WR 313-H was logged at 9096 fbrf, which consisted of two (~15 ft-thick and ~21 ft-thick) hydrate-bearing sand lobes. At 8501 fbrf, ROP was reduced to 160 ft/hr for the target zone of interest. At the same time, drilling fluid was changed to 10.5 ppg water-based drilling fluid. The well reached a total depth of 9886 fbrf at 20h45 on April 30, 2009. The hole was displaced with 10.5 ppg drilling fluid, followed by a 320-barrel “pill” of 12.0 ppg drilling fluid before the BHA was slowly pulled out of the hole to surface. The BHA cleared the rig floor at 11h30 on May 1, 2009 and the rig was made ready for transit to AC 21.

The effectiveness of the drilling procedures used to complete the WR 313-G and WR 313-H wells are also reviewed later in the report in the section that deals with the assessment of the more significant drilling problems encountered during the expedition.

Alaminos Canyon 21-A

Proposed Gulf of Mexico JIP Leg II drilling sites (Table T1) in AC 21/65 lie within the Diana sub-basin and target anomalous seismic reflections that occur approximately 600 ft below the seafloor and 800 ft above the inferred base of gas hydrate stability. Two wells were drilled through the prospective shallow sand facies in AC 21. A third permitted well in AC65 was not drilled, and none of the permitted wells in the EB 992 site were drilled.

After offloading drilling fluids to improve the *Q4000*'s transit speed, the ship made the 175 nmi transit from WR 313-H to AC 21-A in 28 hr, at an average speed on 6.3 nmi/hr. After arriving on site, deploying the BHA, and tagging the seafloor at a driller's depth of 4940 fbrf, Hole AC 21-A was spud at 05h00 on May 3, 2009. Drilling continued smoothly with weighted gel sweeps every couple of stands until 5440 fbrf when ROP was reduced to 170 ft/hr and rotation was increased to ~110 rpm for the target zone of interest. At 5840 fbrf, ROP was returned to 330 ft/hr and remained constant until the total depth of 6700 fbrf was reached at 17h00 on May 3, 2009. The hole was not displaced with heavy drilling fluid because the bottom of the hole had been drilled with a 10.5 gpm drilling fluid. The LWD BHA was pulled from the hole and suspended in open water at 21h00 ahead of the rig move to the next drill location. As expected, the well encountered two sands (at 5429 and 5459 fbrf) separated by a 15-ft-thick shale. The resistivity in these sands was consistently ~2 Ω-m, which at this site is believed to indicate the occurrence of sand with low gas hydrate saturations (<20-30%) (Frye *et al.*, 2009). The AC 21-A borehole was in very good condition over most of the section drilled, except for the two main targeted sands, where calipers indicated an extremely enlarged hole and suggested that some of the data recorded in these intervals, particularly density and porosity, are unreliable.

Alaminos Canyon 21-B

After a ~1.5 nmi transit to the north, operations resumed with tagging the seafloor at a driller's depth of 4934 fbrf and spudding Hole AC 21-B at 08h00 on May 4, 2009. The AC 21-B well was also spud following a protocol designed to maintain good conditions. At a depth of ~5104 fbrf, the drilling fluid pump flow rate was increased to 350 gpm to activate all the LWD tools, rotation rate was increased to ~90 rpm, and the ROP to ~310 ft/hr. Bit rotation was further increased to ~108 rpm at 5154 fbrf. Drilling continued smoothly with sweeps every couple of stands until 5219 fbrf when ROP was reduced to ~180 ft/hr. Through the primary target zone, the flow rate was set to the minimum necessary for the LWD tools to run, in order to reduce washouts in the sand-rich sections. This well logged a single sand body 125 ft thick at 5403 fbrf. As with the AC 21-A well, the resistivity of the sand was remarkably consistent at 1.8 to 2.5 Ω-m (Frye *et al.*, 2009). All drilling parameters remained generally constant until the total depth of the well was reached at 6050 fbrf at 18h15 on May 4, 2009. The attempted controlled drilling through the main sand targets in the AC 21-B well failed to yield significantly improved borehole conditions or downhole log data quality. By 23h30 on May 4, 2009, the decision was made to conclude the project with the AC 21-B hole, and pipe was pulled from the hole and broken down into doubles for offloading.

Planned operations at the EB 992 site, where the JIP had permitted four locations, were complicated by the arrival of the rig *Ocean Valiant* in northeastern AC 24 on May 2, 2009 to conduct development operations on behalf of ExxonMobil. ExxonMobil representatives were extremely supportive of the JIP project, and gave permission for two locations (EB 992-A and EB 992-C) to be drilled. However, based on drilling results from AC 21-A and AC 21-B, the science team determined that further drilling was not cost-effective. The *Q4000* was demobilized at sea with the assistance of the M/V *Mia*, and the Gulf of Mexico JIP Leg II ended at approximately noon on May 6, 2009.

Drilling Problems and Responses

Going into the project one of the most significant concerns dealt with possible borehole stability problems caused by gas hydrate dissociation. Pre-drilling borehole stability modeling by Schlumberger Geomechanics and drilling experience from Gulf of Mexico JIP Leg I (Birchwood *et al.*, 2007) had shown that the thermal and mechanical disturbance of highly concentrated gas hydrate occurrences could adversely affect borehole stability conditions leading to severe washouts and borehole cavings if drilling protocols and fluid temperatures are not properly managed. But upon the completion of the Gulf of Mexico JIP Leg II drilling and the examination of the LWD tool measured downhole drilling fluid temperatures (Figure F3), it was determined

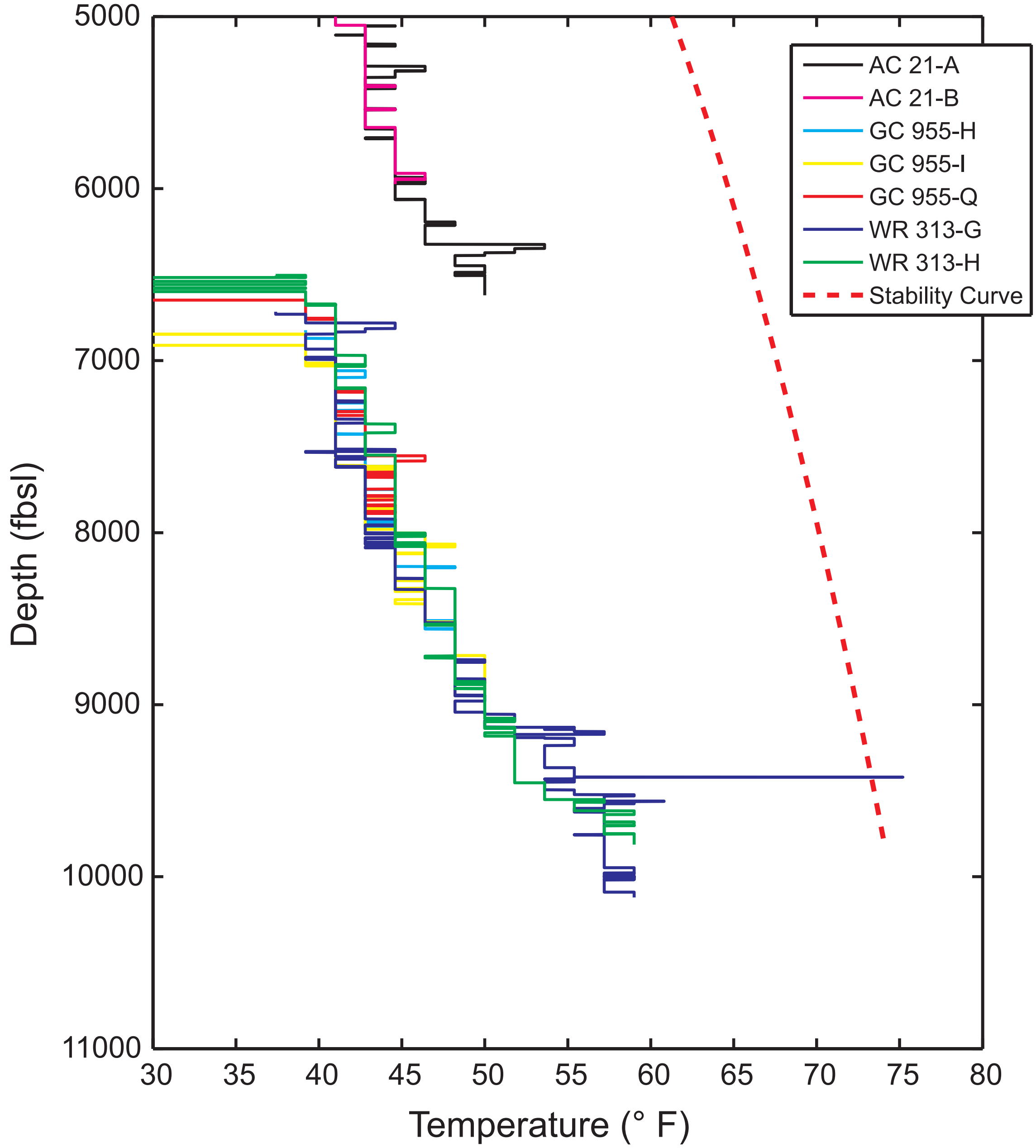


Figure F3: *Methane hydrate stability diagram along with the LWD tool measured downhole drilling fluid temperatures recorded during the Gulf of Mexico JIP Leg II.*

that drilling fluid temperatures in all seven wells drilled during Leg II was never great enough to cross the gas hydrate stability phase boundary (other than one limited event in the WR 313-G well). In fact, it appears that the occurrence of gas hydrate provided some resistance to mechanical erosion with most of the hydrate-bearing sand sections exhibiting near in gauge borehole calipers with no significant washouts. Despite the large volumes of gas hydrate drilled during Leg II, most of the borehole drilling problems encountered were attributed to common drilling problems, including drill cuttings removal, gas releases into the borehole, and water flows as discussed in greater detail in this section of the report.

One of the more significant drilling problems encountered during the Gulf of Mexico JIP Leg II was documented in the WR 313-G well (the first well drilled during the expedition), which was also one of the deepest gas hydrate wells ever drilled in the world. It was assumed in the pre-leg drill plan that these deep holes could be drilled with minimal drilling fluid, but drilling difficulties in WR 313 and GC 955 required the pre-leg drill plan to be significantly modified. From spud in the WR 313-G well (Figure F4), drilling continued relatively smoothly, pumping the drill plan prescribed 380 and 410 gpm of seawater with intermittent sweeps of 10.5 ppg drilling fluid and suffering occasional pipe stalls. Below 1650 fbsf, it became increasingly more difficult to maintain hole stability and remove drill cuttings from the hole. Despite increasing the number of drilling fluid sweeps and the rotary speed to above 120 rpm in response to torque, the drill string would occasionally pack off despite multiple backreams per stand. It is again important to highlight that backreaming was used in the WR 313-G well as a response to the observed increases in torque and threats to the LWD BHA. After making the decision to continuously pump a 10.5 ppg weighted drilling fluid below 2985 fbsf, the rest of the hole was drilled incident-free.

Cook *et al.*, (2009) also showed that excessive backreaming, required to remove drill cuttings, adversely affected the quality of the acquired downhole log data. Ultrasonic and density borehole calipers from the WR 313-G well reveal the typically enlarged nature of the near-seafloor borehole (Figure F4). In addition, notable washouts, where density and porosity data are unreliable, occur below 1645 fbsf within the interval that exhibited numerous pack offs and required multiple backreams. Another example of drilling induced washouts can be seen in the GC 955-H well (Figure F5), in which ultrasonic and density calipers, as well as the resistivity images, reveal significant washouts in apparent water-bearing sand sections (~1280 to 1600 fbsf) that straddle an in gauge gas hydrate-bearing sand section. It is interesting to note that the possible under-saturated gas hydrate-bearing sands encountered in the two AC 21 wells (Frye *et al.*, 2009; Guerin *et al.*, 2009b) exhibited very large washouts, suggesting again that the occurrence of gas hydrate affects borehole stability conditions.

As the Gulf of Mexico JIP Leg II advanced through the drilling program, the drill plan was modified to address experience gained from the previous wells drilled in the program. The modified drilling program featured a relatively complex set of well spud protocols designed to yield a higher quality near-surface hole. In addition, it was decided after experiencing the deeper drilling problems WR 313-G well, that the remaining wells would be drilled with a 10.5 ppg weighted drilling fluid below about 1600 fbsf or shallower if needed.

The following well spud protocol was designed to maintain good borehole conditions at the top of the hole: the first ~60 fbsf of each hole was drilled while circulating between 200-250 gpm of seawater and a rate of bit-rotation of about 10-50 rpm. Between about 60 and 170 fbsf, the pump flow rate was slowly increased to ~250 gpm and the bit-rotation was increased to 50 rpm, after which point they were increased to 350 gpm and 80 rpm, respectively.

For the main section of the hole below ~170 fbsf, the rate of penetration was usually targeted at ~350 ft/hr and the wells were advanced by pumping seawater and (8.8 ppg) gel sweeps as needed. At a pre-determined depth, usually near 1600 fbsf, the rate of penetration was slowed to an instantaneous target rate of ~180 ft/hr and weighted drilling fluid (10.5 ppg) was continuously pumped to the bottom of the hole. Particular attention was paid to reduce washout problems in sand-rich sections: in such cases, the drilling protocol was modified to (1) minimize stationary circulation during connections, (2) reduce and/or eliminate the time required for deviation surveys during which the drill pipe is stationary, and (3) reduce flow rate to the minimum required to keep the LWD tools running. The comparison of the drilling performance logs (including caliper logs) from WR 313-G (Figure F4) and WR 313-H (Figure F6) directly document the effectiveness of the

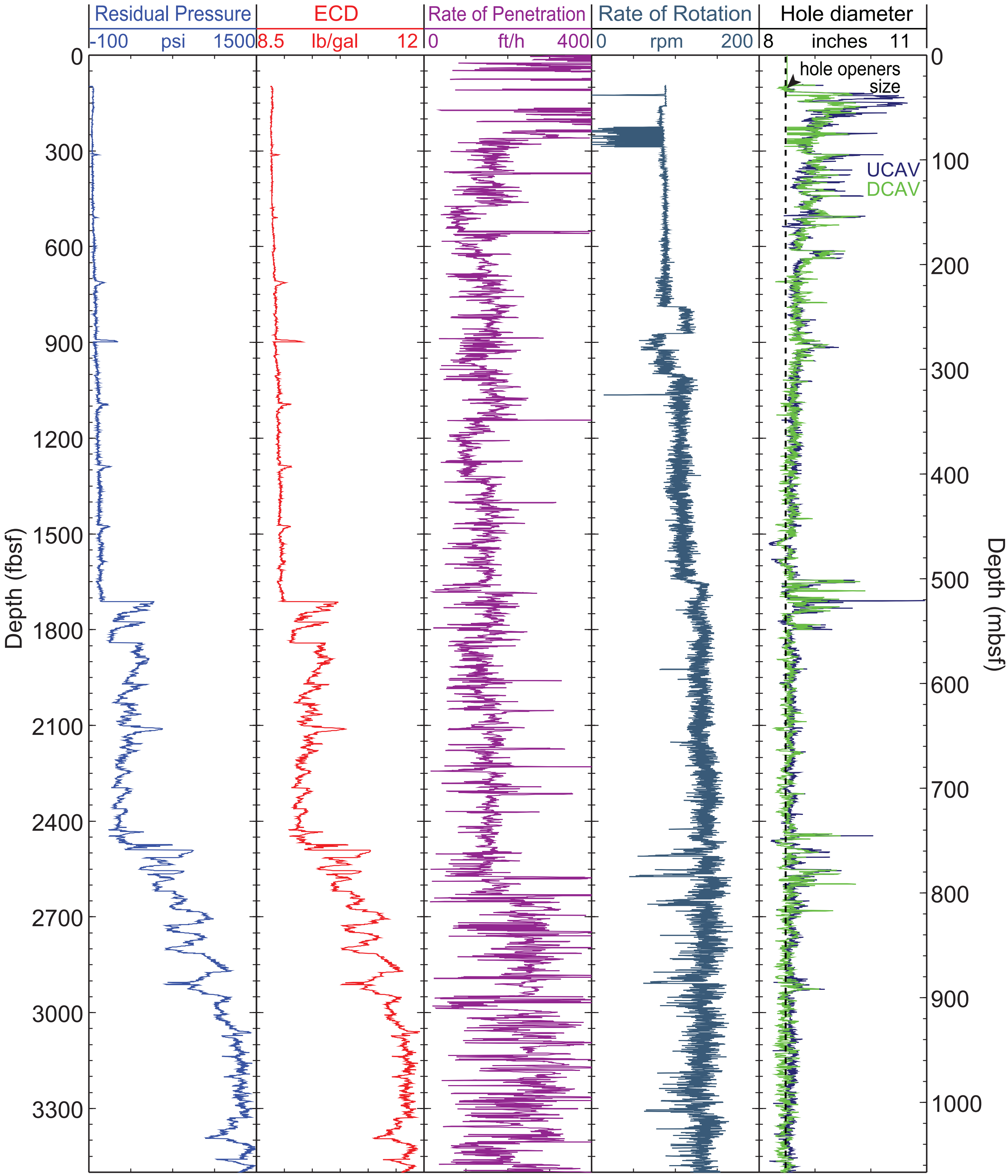


Figure F4: *Monitoring and quality control LWD/MWD logs from Hole WR 313-G. Residual Pressure = Pressure in the annulus after subtraction of the hydrostatic pressure; ECD = Equivalent Circulating Density = effective density of the fluid exerting pressure against the borehole formation; UCAV = Ultrasonic caliper, DCAV = Density caliper.*

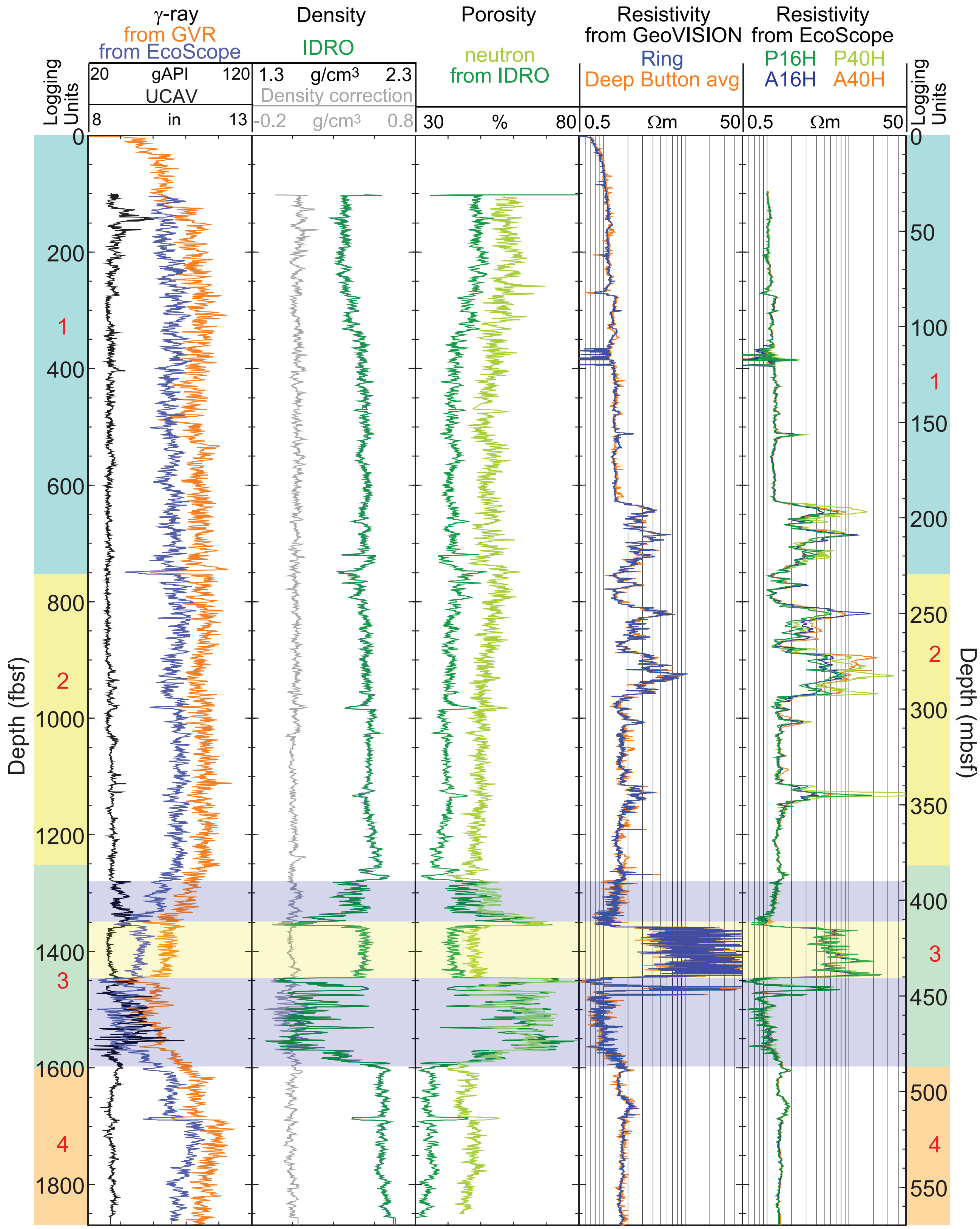


Figure F5: *Summary of LWD log data from Hole GC 955-H. Water-bearing sand sections are highlighted in blue and the gas hydrate-bearing sand section is highlighted in yellow. gAPI = American Petroleum Institute gamma ray units, UCAV = Ultrasonic caliper, IDRO = Image-derived density (EcoScope); neutron = "Best neutron porosity" (EcoScope); Ring = Ring resistivity (geoVISION); PXXH = Phase-shift resistivity at 2 MHZ and a transmitter-receiver spacing of XX inches (EcoScope); AXXH = Attenuation resistivity measured at 2 MHz and a transmitter-receiver spacing of XX inches (EcoScope). Logging units as described in Guerin et al., (2009a).*

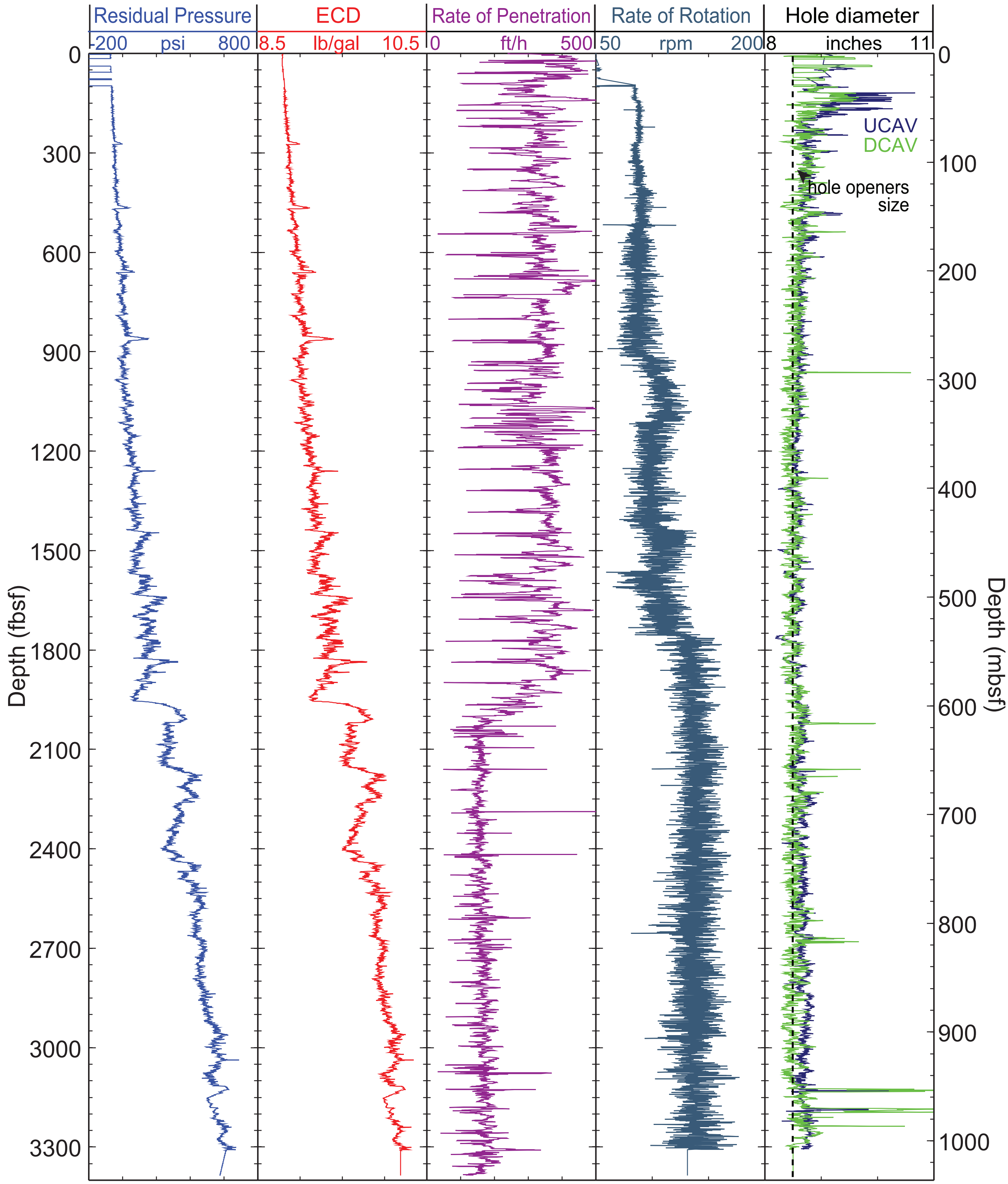


Figure F6: *Monitoring and quality control LWD/MWD logs from Hole WR 313-H. Residual Pressure = Pressure in the annulus after subtraction of the hydrostatic pressure; ECD = Equivalent Circulating Density = effective density of the fluid exerting pressure against the borehole formation; UCAV = Ultrasonic caliper, DCAV = Density caliper.*

modified drill plan with more consistent drilling parameters and improved borehole conditions in WR 313-H.

The most notable drilling problem encountered during the drilling leg was the gas release and eventual flow from the GC 955-Q well. When making a connection at 1516 fbsf at 00h04 on April 27, 2009 in the GC 955-Q well, shortly after real-time LWD measurements had indicated the bit had reached a hydrate-bearing formation, the *Q4000* ROV observed both visually and on sonar a "gas bubble" release from the wellhead (lasting no more than a minute). However, the LWD pressure sensor (APWD) showed no evidence of gas entering the borehole, which would usually be expressed as a significant drop in the apparent borehole pressures. The apparent contradiction is explained as follows: as the well was advanced into the gas hydrate-bearing sand section, the combined borehole volume of sand and gas hydrate was being normally lifted to the surface and expelled from the hole. Since gas hydrate has a density almost the same as water, the LWD APWD pressure sensor did not see any evidence of gas in the borehole. This was seen in all the wells in which gas hydrate-bearing sands were drilled. However, in the case of the GC 955-Q well, a delay incurred while making a standard connection (the addition of 60 ft of drill pipe to the drill string), which provided the gas hydrate residing in the borehole enough time to dissociate into water and gas forming a bubble in the annular space of the borehole very near the surface. After making the connection and bringing the pumps back online, the gas bubble was expelled from the hole. There was no evidence or observation of a continuous supported gas flow from the borehole at this time. Nevertheless, the drilling protocols established prior to the expedition required that the well to be cemented and abandoned in response to any observed gas release. Future gas hydrate drilling projects will need to consider that when drilling highly concentrated gas hydrate sections they will by nature release a significant amount of hydrate and gas either with or without drilling fluids. The size and intensity of the gas release from a hydrate-bearing section can be controlled to some extent by reducing the rate of penetration, but gas should be expected as a consequence of drilling thick concentrated gas hydrate sections.

After observing the gas bubble at the sea floor in GC 955-Q, the well was initially filled with a 13.0 ppg drilling fluid. After observing no flow from the well for over an hour, the LWD BHA was slowly pulled back toward the seafloor in anticipation of running a cementing BHA to plug and abandon the well. While pulling the drill pipe at 156 fbsf, the ROV observed a new gas release from the well; however, this gas release appeared to be a small sustained flow. After running back into the hole and tagging an apparent bridge at 743 fbsf, the well was displaced with two borehole volumes of 16.0 ppg drilling fluid. The well continued to flow intermittently and after two more displacements of 16.0 ppg drilling fluid, the LWD BHA was pulled to surface and laid down by 18h45 on April 27, 2009, before running in with the cementing BHA. It is possible that borehole swabbing as the BHA was being pulled from the hole may have contributed to the development of the gas flow from the GC 955-Q well. The use of the heavy drilling fluid may have also fractured the sediments at the bottom of the hole that could have extended into an as yet unidentified free-gas zone beneath the gas hydrate-bearing section. A 500-ft-thick cement plug was run over the interval from 833 fbsf to 333 fbsf at 04h30 on April 28, 2009. The cement BHA was recovered to the ship at 13h00 on April 28, 2009.

Summary

From an operational standpoint, the Gulf of Mexico Gas Hydrate Joint Industry Project Leg II (Gulf of Mexico JIP Leg II) was extremely successful; being completed on time and under budget, with zero injuries. The performance of the LWD tools was outstanding, without a single incidence of operational time loss due to tool failure. Scientifically, the expedition was a clear success, yielding extremely valuable and advanced datasets on gas hydrate occurrences ranging from low to high saturation in sands as well as thick sections of fracture-filling gas hydrate in muds. It is expected that further evaluation of the complex geology of these sites, including both conventional and pressure coring, will add significantly to the understanding of the nature and occurrence of gas hydrate-bearing sands in marine environments.

The expedition provided significant new information on the optimal drilling and well control protocols for deep water gas hydrate research projects. JIP Leg II drilled some of the thickest and most concentrated gas hydrate accumulations yet encountered. Consistent with the results of previous gas hydrate drilling programs, our experience confirmed that gas hydrate-bearing strata pose no unique or significant drilling hazards that cannot be managed through normal drilling protocols. The drilling problems encountered during the program where primarily those that face any shallow drilling program, maintaining borehole stability, removal of drill cuttings while maintaining hole quality, and controlling water flows. The expedition did confirm that maintaining sufficient borehole conditions in shallow unconsolidated sands to enable valuable log data acquisition will be a great challenge. However, where those sands were gas hydrate-bearing, they were very stable, providing excellent hole quality. The expedition also showed that gas hydrate drilling can, by its very nature, result in gas releases that differ in character (and in the way they manifest themselves in MWD data) from free gas flows. In particular, short-duration, single event releases are to be expected, and can be assigned as a by-product of gas hydrate dissociation in the well bore, particularly when the MWD pressure data show no pressure responses at the bit. In such cases, drilling response protocols should be modified to reduce the chances of damaging the well bore through unnecessary application of heavy kill drilling fluids.

In summary, the most important operational findings and accomplishments of the Gulf of Mexico JIP Leg II are the following:

- Acquisition of critical operational experience and drilling performance data from deepwater settings, which will be used by the JIP to further refine drilling parameters for future drilling and coring efforts.
- Future drilling operations at such considerable depths will need to consider advanced drilling fluid handling programs, which have not been previously required for gas hydrate research drilling.
- This drilling expedition further documented that with appropriate monitoring and controlled drilling, gas hydrate does not represent a significant threat to drilling operations.
- Highly concentrated gas hydrate accumulations are likely to be characterized by significant gas returns to the seafloor during drilling in open-hole configurations (no riser). But the volume of gas expelled from a drilled hydrate section will be limited to the volume of the sediments disaggregated by the bit as long as the drilling fluid temperature is not elevated.
- Drill plans and response protocols to drilling problems need to be modified to distinguish between gas releases from gas hydrates and sustained gas flows from free-gas occurrences. While the flow of gas from a free-gas occurrence can be controlled by pumping a heavy kill drilling fluid, a gas release from a hydrate-bearing section will often not be controlled by the use of heavy drilling fluid. In fact a heavy drilling fluid could compound the problem by artificially fracturing into an underlying free-gas accumulation.
- Monitoring and characterizing the response and nature of gas and/or water "flows" from drilling wells in a open-hole configuration (no riser) requires a complete analysis of all of the available LWD data (APWD pressure measurements, well log formation responses, acoustic borehole monitoring, etc.), drilling performance data, and ROV monitoring of the well head at the seafloor along with a detailed pre-drill hazard assessment and drilling plan that recognizes the distinct differences between gas hydrate and free-gas related hazards.

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Date	Time log		Duration	Operations	Operations and remarks
	From	To	(hr)	code	
April 16, 2009	15:30	16:45	1.25	21	**PROJECT START -** Q4000 underway moving 1 nm from the "Deep Gulf" site (GC-195) to mobilize for the Chevron GOM JIP Leg II. Consumables on the vessel as of 1500 hrs (project start): Fuel 703 cubic meters, Lube oil 5.5 cubic meters, Potable water 349 cubic meters, Industrial water 251 cubic meters.
	16:45	19:15	2.50	21	Arrived at mobilization location. Supply boat unable to offload due to bad weather. Decision was made by Chevron to abort mobilization and continue transit to WR313-G. Began ballasting vessel to transit draft. Offline activities included changing of saver sub to XT50 connection. Torqued same to 52700 ft lbs. Installed sensor spool onto kelly hose/stand pipe and pressure tested same to 4000 psi.
	19:15	24:00	4.75	21	Vessel in transit to WR313-G. Continue with general housekeeping and rig maintenance. Serviced block and top drive system (TDS). Added 5 gallons of gear oil to TDS. Installed geolograph to block and calibrated same with Schlumberger. Mechanics performing maintenance on lower draw works. Held spud meeting with crews. Consumables: Fuel = 4421 bbls, Potable water = 2195 bbls, Drill water = 1578 bbls.
					Consumables: Fuel = 4421 bbls, Potable water = 2195 bbls, Drill water = 1578 bbls.
April 17, 2009	0:00	12:00	12.00	23	Vessel in transit to WR313-G. Continue with general housekeeping and rig maintenance. Assisting Schlumberger with calibration on geolograph line. Mechanic continued with maintenance of lower draw works.
					0530 hrs - Weather conditions - winds 40+ Knots SE, 8-9 ft sea state. Advisory no personnel on lower walk or underhual area.
	12:00	15:00	3.00	24	Vessel arrived on location WR313-G. Start ballasting down to work draft. Performing dynamic positioning (DP) status checks.
					ROV off deck at 1400 hrs setting compact.
	15:00	24:00	9.00	21	Move vessel to well center. Offloading vessel "Mia". Preparing rig for handling of BHA. Assisting Schlumberger and Directional Driller with handling of BHA components. Lowered mud hose and received 2505 bbls of 16 ppg WBM while offloading tubular. Began taking on gel product at 2330 hrs.
					Consumables: Fuel = 4170 bbls, Potable water = 1968 bbls, Drill water = 1031 bbls.
April 18, 2009	0:00	2:30	2.50	20	Schlumberger continue programming and testing tools and continue offloading supply vessel "Mia". Preparing rig for handling BHA. Assisting Schlumberger and Directional Driller with handling of BHA components. Began taking on gel product to Barite tanks 2,3, and 4.
	2:30	5:00	2.50	6	Start picking up drilling BHA and RIH and plug in and upload MWD tools.
	5:00	8:00	3.00	6	Schlumberger loading radioactive source into MWD tool, continue P/U & M/U Drilling BHA.
	8:00	9:00	1.00	20	Completed P/U of the BHA, M/U TD & Schlumberger MWD performing Shallow Test on MWD Drilling BHA 971 ft.
	9:00	11:00	2.00	6	Tool test completed, check good, continue RIH w/ BHA on 5" DP. ROV off deck to confirm water depth, etc.
	11:00	11:30	0.50	48	Roughneck observed bolt strike rig floor, called "all stop" and investigated & found that bolt dropped approx 12' from Top Drive Dolly roller guard. Inspected remaining hardware and found all secured. EHS was notified and resumed operations.
	11:30	12:00	0.50	6	Continued RIH w/ Drilling BHA on 5" DP T/ 3175.89' depth on 5" double DP #35 & filled pipe w/ SW = 38 bbls / 330 stks.
	12:00	17:00	5.00	6	Continue RIH with 6 3/4" x 8 1/2" drilling BHA on 5" drill pipe F/3175' T/6614'. Filling pipe every 35 doubles RIH. Drifting with 3" o.d., Torq=46k ft lbs.
	17:00	17:30	0.50	2	Moved vessel to well center as per survey. Held JSA with drill crew on drilling operations and proper well control. Established circulation and synchronizing of MWD tools as per Schlumberger. Tagged mud line at 6614' RKB. Hook load 273k. **Spud WR313-G**
	17:30	21:30	4.00	2	Drilling 6 3/4" x 8 1/2" hole from mud line at 6614' T/6678' @ 48 gpm=100 psi, TDS=15 RPM, Torq=2-3k. Maintaining ROP of 70 FPH. Continue drilling as per directional driller F/6678' T/7116'. TDS=80 RPM, Drilling Torq=3-4k, Rot Torq=2-3k, Pump rate 385 gpm=800 psi. Off bottom pressure=908 psi with seawater. Maintaining ROP of 160 FPH with no WOB. P/U 280k S/O 273k. Rot wt 280k. Pumping gel sweeps as directed. ROV monitoring drilling operations at mud line.
	21:30	22:30	1.00	2	Decreased ROP to 70 FPH F/7116' T/7169' as directed. P/U 273k S/O 280k Rot Wt 280k. TDS=80 rpm, Torq=3-4k, Rot Torq=2-3k. 0 WOB. Pump rate 385 gpm=800 psi. Off bottom pressure=908 psi with seawater.
	22:30	24:00	1.50	2	Increased ROP to 160 FPH F/7169' T/7242' as directed. P/U 273k S/O 280k Rot Wt 280k. TDS=80 rpm, Torq=3-4k, Rot Torq=2-3k. 0 WOB. Pump rate 385 gpm=800 psi. Off bottom pressure=908 psi with seawater. Back reaming and pumping 15 bbl gel sweeps as directed. No drag noted during connections or back reaming.
					Consumables: Fuel = 4044 bbls, Potable water = 1987 bbls, Drill water = 987 bbls.
April 19, 2009	0:00	0:30	0.50	2	Continue Drilling 6 3/4" x 8 1/2" hole as per Directional Driller F/ 7242' T/ 7375' at 409 gpm=896 psi, TDS=105 RPM, Torq=3-5k. Maintaining ROP of 160 FPH. Pumping gel sweeps as directed. ROV monitoring drilling operations at mud line. Back ream double up every 450'.

Table T3: *Gulf of Mexico JIP Leg II operational schedule with drilling statistics and event drilling log. Also included is a list of standard or commonly used IADC well operational codes. These codes are used in the timeline event drilling log record to assign the listed events to a given class of activities. An index of the commonly used IADC well operational codes are listed at the end of Table T3. The times listed in the event drilling log are "approximate times" for any given event and are rounded to the nearest quarter hour for accounting purposes.*

Date	Time log		Duration	Operations	Operations and remarks
	From	To	(hr)	code	
	0:30	1:00	0.50	20	Stopped as per Directional Driller to perform MWD Roll Test.
	1:00	5:00	4.00	2	Continue Drilling as per directional driller F/7375' T/ 7601'.
	5:00	6:00	1.00	20	Drill 966' with out establishing a survey. Stop drilling operation. Continue to cycle pumps to establish a survey with no success. Rana Roy with Chevron contacted Ms Amy Wilson with MMS Houma district to inform them that we could not get a survey. Ms Wilson gave approval that we could drill ahead without an official survey every 1000'.
	6:00	7:30	1.50	2	Resume drilling operation after MWD survey off line correction.
					0615 hrs at 7618' pipe stalled, pulled off bottom & all readings returned to normal @ 409 gpm=896 psi, TDS=81 RPM, Torq=3-5k. Maintaining ROP of 160 FPH. Went to bottom & had high torque from 10.4 - 11.3K, torque dropped to normal of 3-6K.
	7:30	8:30	1.00	2	Decreased ROP T/ 100' FPH F/7762' as directed. P/U 281k S/O 288k Rot Wt 288k. TDS=79 rpm, Torq=3-4k, Rot Torq=4-6k. 0 WOB. Pump rate 385 gpm=941 psi. Off bottom pressure=908 psi with seawater.
	8:30	9:00	0.50	43	Held safety shut down w/ crew & supervisors about two incidents on vessel.
	9:00	12:00	3.00	2	Drilling operation continued from F/ 7826 T/ 8085', P/U 288k S/O 295k Rot Wt 295k. TDS=100 rpm, Torq=3-4k, Rot Torq=3-8k. 0 WOB. Pump rate 405 gpm= 981 psi. Off bottom pressure=923 psi with seawater. Back reaming and pumping 15 bbl gel sweeps as directed. No drag noted during connections or back reaming.
	12:00	15:00	3.00	2	Drill 6 3/4" x 8 1/2" hole section F/8085' T/8340' with seawater at 405 gpm=1039 psi. TDS=100 rpm, Torq=3-7k, 0 WOB. Rot wt 295k, P/U 294K S/O 301k. Back reaming and pumping sweeps as directed.
	15:00	15:30	0.50	43	Held safety stand down on fallen object from from TDS Dolly and valve misalignment of drilling mud gel transfer with drill and crane crew.
	15:30	16:00	0.50	5	Noted pressure increase of 500 psi at 146 gpm after making connection at 8340'. Noted no excess drag. Had minor torq of 8-9k when starting rotary. P/U 295k S/O 301k. Pumped 30 bbl gel sweep and circulated out of hole while rotating and reciprocating drill string. TDS=120 rpm, Torq=4-6k, 405 gpm=992 psi.
	16:00	21:30	5.50	2	Continue drilling 6 3/4" x 8 1/2" hole section F/8340' T/8735 ' with increased rotary of 120 rpm, Torq=3-8k, WOB=0-5k. Noted max of 9k drag on last connection made. Normal P/U 315 S/O 301k. Pumping 25 bbls sweeps and other connection and back reaming every connection.
	21:30	23:00	1.50	2	Continue drilling 6 3/4" x 8 1/2" hole section F/8735' T/8857' with 405 gpm=1335 psi, TDS=120 rpm, Torq=5-8k, WOB=0k, Rot wt=301k. P/U 315 S/O 301k. Pumping 25 bbls sweeps and back reaming every connection drilled.
	23:00	24:00	1.00	5	Prior to performing connection pump pressure did not fall below 150 psi with pumps off. Worked string in order to bleed down pressure. Pumped 40 bbls of gel sweep while rotating and reciprocating string. Pumping at 405 gpm=1230 psi, TDS=120 rpm, Torq=6-9k, Rot wt=301k, P/U 315k S/O 301k.
					Consumables: Fuel = 5063 bbls, Received 1188 bbls of fuel, Potable water = 2113 bbls Received 320 bbls, Drill water = 1119 bbls, Received 597 bbls.
April 20, 2009	0:00	5:00	5.00	2	Continue drilling 6 3/4" x 8 1/2" hole section F/8857' T/ with 405 gpm=1335 psi, TDS=120 rpm, Torq=5-8k, WOB=0k, Rot wt=301k, P/U 315k S/O 301k. Pumping 25 bbl gel sweeps and back reaming each connection. TD torque limit set at 10K.
	5:00	7:30	2.50	2	Depth 9180', while back reaming on stand #128 the string pacoff w/ torq up to 14K & standpipe press up to 1870 psi, working up & down to free w/405 gpm, TDS=125 rpm, Rot wt=308k. P/U 315k S/O 308k.
	7:30	8:00	0.50	2	Depth 9244' string packed off w/ 16 K torque & unable to gain rotation pulled to 440k with 139 k over pull pipe broke free, 125 rpm.
	8:00	9:00	1.00	2	When attempting to making connection at 9246', still had 380 psi on standpipe, bled S/P & when closed S/P pressure returned to 350 psi. made up connection & returned to circulating & moving string awaiting on building mud.405 gpm=1544 psi, TDS=125 rpm, Torq=5-9k.
	9:00	9:30	0.50	2	Start pumping 10 ppg mud down drill string, & continue circulating & reciprocating string.
	9:30	12:00	2.50	2	10 ppg mud in annulus, M/U connection & continue drilling F/ 9247' T/ 9580' w/ 405 gpm=1460 psi, TDS=120 rpm, Torq=5-9k,ROT 301.
	12:00	19:00	7.00	2	Drill from 9580' to 10200' w/ spm - 83 = 405 gpm. = 1620 psi, rpm = 120, torq. = 10 - 17K, rot. wt. - 322K, WOB = 7 - 15K, built mud wt. up to 10.5 ppg at 9600' due to torq.
	19:00	19:30	0.50	48	Schlumberger taking survey at 10154'.
	19:30	20:00	0.50	5	Pump and spot 230 bbls of 12ppg mud in annulus and leave 30 bbls of 12 ppg mud in drill pipe.

Table T3 (cont.): *Gulf of Mexico JIP Leg II operational schedule with drilling statistics and event drilling log. Also included is a list of standard or commonly used IADC well operational codes. These codes are used in the timeline event drilling log record to assign the listed events to a given class of activities. An index of the commonly used IADC well operational codes are listed at the end of Table T3. The times listed in the event drilling log are "approximate times" for any given event and are rounded to the nearest quarter hour for accounting purposes.*

Date	Time log From	To	Duration (hr)	Operations code	Operations and remarks
	20:00	24:00	4.00	6	Pooh slowly watching for over pull and swabbing MAX over pull 90 K 7890' and continue POOH.
					Consumables: Fuel = 4943 bbls, Potable water = 2214 bbls, Drill water = 603 bbls.
April 21, 2009	0:00	1:00	1.00	6	POOH slowly watch over pull till clear sea bed, F/ 7890' to 6562'.
	1:00	6:00	5.00	6	ROV observed BHA clear mud line, continue pooh F/ 6562' to BHA.
	6:00	9:30	3.50	6	Breakdown and lay out BHA. 0625 hrs held JSA & TBT on removing radio active source. 0810 hrs removed radio active source.
					At 09:30 hrs complete WR313-G
					Ballast up and transit to 1 mile from WR313-G. At 0100 hrs moving vessel to first Compact location. At 02:00 hrs ROV recoveries compact.
	9:30	12:00	2.50	23	Vessel in transit to GC 955-I. Making up Schlumberger tools in preparations for next well. Move compacts to main deck for ETO.
	12:00	24:00	12.00	23	Vessel in transit to GC 955-I. Making up tools for next well. Move compacts to main deck for ET. Rolling Mud through gun lines in Brine Tanks 2, 3, & 4. Vessel performing DP trials & checks. Move compacts down to ROV area.
					Consumables: Fuel = 4786 bbls, Potable water = 2232 bbls, Drill water = 535 bbls.
April 22, 2009	0:00	0:30	0.50	24	Held JSA & TBT. On picking up BHA & DP. Pick up & make up BHA.
	0:30	4:00	3.50	6	0200 hrs held JSA & TBT on loading radioactive source. 0210 hrs load radio active source. Pick up first stand of DP, break circ. & test MWD @ 1008'.
	4:00	5:00	1.00	6	Continue to RIH from 1008' to 6530', breaking circulation every 30 stands.
	5:00	10:00	5.00	6	Held a pre-spud safety meeting. ROV found bit and continue to run into the hole from 6530' to 6788' picking up doubles. 0915 hrs taking on mud from supply boat - 529 bbls - 16 ppg.
	10:00	10:30	0.50	6	1015 hrs disconnected mud line from work boat. Vessel moved 90 mtr @ 257 degree to location.
	10:30	11:00	0.50	48	Make up TD, slack off to mud line - 6822 RKB, 6772 W/D.
	11:00	11:30	0.50	48	Bring pump on line to let MWD get in sink.
					Spud GC995-I - Spud bit in sea bed, string wt - 267K, 41 spm w/ 221 psi - 200 gpm. Drilled from 6822' to 6854'.
	11:30	12:00	0.50	2	1130 hrs commence taking on 16 ppg mud from supply boat. Continue drilling 6 3/4" x 8 1/2" hole F/6852' T/ 6,900 with 225 gpm=300psi psi, TDS=40 rpm, Torq=2-4k, WOB=0k, Rot wt=274k. P/U 281k S/O 281k.
	12:00	13:00	1.00	2	Pumping 25 bbl gel sweeps every other connection. TD torque limit set @ 12K. Increased ROP to 250 FPH F/6900' T/ 8100' as directed. P/U 281k S/O 274k Rot Wt 281k. TDS=80 rpm, Torq=3-4k, Rot Torq=3-4k. 0 WOB.
	13:00	20:30	7.50	2	Increased ROP to 250 FPH F/6900' T/ 8100' as directed. P/U 281k S/O 274k Rot Wt 281k. TDS=80 rpm, Torq=3-4k, Rot Torq=3-4k. 0 WOB. Pump rate 351 gpm=600 psi. Off bottom pressure=649 psi with seawater.
	20:30	22:00	1.50	2	Decreased ROP to 180 FPH F/8100' T/ 8268' as directed. P/U 280k S/O 295k Rot Wt 295k. TDS=80 rpm, Torq=3-4k, Rot Torq=3-4k. 0 WOB. Pump rate 351 gpm=551 psi. Swapped over to 10.5 ppg mud.
	22:00	24:00	2.00	2	Increased RPM 125, continue drilling ahead F/ 8268' T/ 8424' as directed. P/U 295k S/O 308k Rot Wt 308k. TDS=125 rpm, Torq=4-5k, Rot Torq=5-6k. 0 WOB. Pump rate 351 gpm= psi. Continue to drill 6 3/4" X 8 1/2" F/ 8,424' to 9,027' w/ 366 gpm = 750 psi, 125 rpm Tq + 5-8KL. Mud wt of 10.5 ppg.
					Consumables: Fuel = 4667 bbls, Potable water = 2151 bbls, Drill water = 2579 bbls. Received 2000 bbls of drill water.
April 23, 2009	0:00	5:00	5.00	2	POOH F/ 9027' to 8851'.
	5:00	5:30	0.50	6	Down linked Schlumberger MWD tools.
	5:30	6:00	0.50	48	POOH F/ 8851' to 6770', Bit clear ML at 6770'.
	6:00	10:00	4.00	6	Continue POOH F/ 6770' to 5948'.
	10:00	11:00	1.00	6	ROV monitor well for 45 mins - no flow observed.
	11:00	12:00	1.00	9	Moving vessel for ROV to retrieve compact's & perform on bottom survey at 1600 hrs during survey noticed the water was cloudily ROV could not get a clear view of well, ROV return to surface to change batteries, When ROV return to bottom noticed that well was flowing.
	12:00	18:00	6.00	9	Due to well flowing POOH F/ 5948' to 910'. B/D Drilling BHA at surface.
	18:00	24:00	6.00	6	Supply Boat Operations: MSV "John G McCall" on location with two conex to off load. The MSV "MIA" also on location for crew change and back load of equipment. Took on 700 bbls 16 ppg mud from boat, store same in Brine & Modules Tanks.
					Consumables: Fuel = 4553 bbls, Potable water = 2151 bbls, Drill water = 2396 bbls.
April 24, 2009	0:00	0:30	0.50	6	POOH with BHA and laying down same.
	0:30	3:00	2.50	6	P/U and TIH with clean out BHA to 722'.

Table T3 (cont.): *Gulf of Mexico JIP Leg II operational schedule with drilling statistics and event drilling log. Also included is a list of standard or commonly used IADC well operational codes. These codes are used in the timeline event drilling log record to assign the listed events to a given class of activities. An index of the commonly used IADC well operational codes are listed at the end of Table T3. The times listed in the event drilling log are "approximate times" for any given event and are rounded to the nearest quarter hour for accounting purposes.*

Date	Time log From	Time log To	Duration (hr)	Operations code	Operations and remarks
	3:00	6:00	3.00	48	TIH F/ 722' T/ 6791'. Filling pipe every 30 stands.
	6:00	7:00	1.00	48	ROV found Drill String & moved vessel to well.
	7:00	7:30	0.50	6	TIH F/ 6791' T/ 6822' & ROV attempted to guide bit into old hole.
	7:30	8:30	1.00	6	TIH F/ 6822' T/ 6854', wash and ream F/ 6854' T/ 7049' tag up w/ 15K down attempted several times to enter old hole with no success.
	8:30	9:00	0.50	34	Pumped 50 bbls of 16.0 ppg and spot in open hole.
	9:00	10:30	1.50	6	POOH F/ 7049' T/ 6985' and ROV monitor well, well continue to flow.
	10:30	13:30	3.00	48	Working string F/ 6855' T/ 6920' while mixing spacer for CMT job.
	13:30	14:00	0.50	48	TIH F/ 6985' T/ 7049' & R/U Cement lines.
	14:00	15:00	1.00	35	Break circulation w/10 bbls of 13.5 ppg spacer. Test surface lines to 3000 psi. Pump 20 bbls 13.5 ppg spacer total of 30 bbls, mix and pump 60 bbls 16.4 ppg cement. Cement Slurry - 311 sks Class H cement + 0.02 GPS D47, + 0.6 GPS D500, + 0.02 GPS D185A, + 0.17 GPS D186 @ 16.4 PPG. 1.084 CU Ft YLD / 4.525 GPS, FLD / 4:18 Pump Time. Displace w/ 115 bbls of 8.6 ppg Seawater.
	15:00	16:00	1.00	34	Rig Down surface lines, POOH F/ 7049' T/ 6599'. Pump 1.5 drill string volume w/ sea water to clean cement from drill pipe w/ 488 gpm.
	16:00	17:00	1.00	6	Continue POOH F/ 6599', start moving vessel to GC955-H.
					At 1700 hrs complete GC955-I
	17:00	21:30	4.50	6	Continue POOH F/ 6599' T/ surface and lay down old BHA while moving vessel to next well location at GC955-H.
	21:30	22:00	0.50	48	Pick up cement stand brake out and lay down same.
	22:00	23:30	1.50	48	Pick up 6 3/4" x 8 1/2" drilling BHA, while vessel continue moving to GC955-H location.
	23:30	24:00	0.50	48	Held JSA & loaded Radioactive Source into MWD tool.
					Consumables: Fuel = 4402 bbls, Potable water = 2214 bbls, Drill water = 2333 bbls.
April 25, 2009	0:00	1:00	1.00	6	ROV setting compacts while TIH with BHA.
	1:00	1:30	0.50	6	Vessel moved 447 m at 240 degree to location while continued TIH with BHA and 1 std DP.
	1:30	2:00	0.50	48	Change out saver sub and conduct shallow water MWD test.
	2:00	6:30	4.50	6	TIH filling DP every 30 std to 6721' RKB, 6670' W/D.
	6:30	7:00	0.50	48	Stage up to 350 gpm to synchronize MWD.
	7:00	12:00	5.00	2	**Spud GC955-H -** First 10' drilled @ 10 RPM with 200 GPM, 60' - 50 RPM with 250 GPM, 170' - 80 RPM with 350 GPM. Drlg F/ 6721' to 7560', 80 to 110 RPM, 72 SPM w/ 350 GPM & 750 psi, torq - 2/12 K.
	12:00	13:30	1.50	2	Continue drilling 6 3/4" x 8 1/2" hole section F/7,560,' T/' 7800 with 351 gpm=1335 psi, TDS=100 rpm, Torq=2-7k, WOB=0 k, Rot wt=288k. P/U 281k S/O 288k ROP 300 FPH. Pumping 25 bbls sweeps every third double.
	13:30	19:30	6.00	2	Swapped over and pumping 10.5 ppg mud & decreased ROP to 180 FPH F/7800' T/'8270 as directed. P/U 288k S/O 295k Rot Wt 295k. TDS=120 rpm, Torq=3-4k, Rot Torq=3-7k. 0 WOB.
	19:30	20:00	0.50	48	Performed 30 min Flow Check at 8270', ROV observed NO Flow & Resume Drilling F/ 8270'.
	20:00	23:30	3.50	2	Drilled F/ 8270' To TD of 8654' and MWD down loading information on TD of hole. Pump 150 bbls 13.0 ppg KWM followed by 142 bbls 8.6 ppg Seawater.
	23:30	24:00	0.50	48	Work drill string while monitoring well for flow for 30 min. ROV observed No flow.
					Consumables: Fuel = 4270 bbls, Potable water = 2232 bbls, Drill water = 2232 bbls.
April 26, 2009	0:00	3:30	3.50	6	POOH at reduced speed from 8654' to 6721', no drag seen, bit clear of ML at 0250 hrs, continue pooh to 5950'.
					ROV monitored well for 30 min while pooh to 5950', well static.
	3:30	6:00	2.50	9	ROV recovered compacts.
					Made up TD and Schlumberger down linked MWD, continue pumping on tool for batteries while moving.
					At 18:00 hrs complete GC955-H.
	6:00	7:00	1.00	23	Vessel moved 1300 m west at 0.4 knots to GC955-Q well location.
	7:00	9:00	2.00	9	Vessel moving and ROV setting out compacts.
	9:00	12:00	3.00	48	Vessel moved 590 m at 318 degree at 0.2 knots to well site.
	12:00	12:30	0.50	48	Arrived on well location GC955-Q, ROV off deck at 1220 hrs, calibrate compacts.
	12:30	14:00	1.50	6	Moved vessel to well center as per survey. Established circulation and synchronizing of MWD tools as per Schlumberger. Tagged mud line at 6567' RKB to Mud line. Hook load 273k to Mud line. Hook load 273k. **Spud GC955-Q.**

Table T3 (cont.): *Gulf of Mexico JIP Leg II operational schedule with drilling statistics and event drilling log. Also included is a list of standard or commonly used IADC well operational codes. These codes are used in the timeline event drilling log record to assign the listed events to a given class of activities. An index of the commonly used IADC well operational codes are listed at the end of Table T3. The times listed in the event drilling log are "approximate times" for any given event and are rounded to the nearest quarter hour for accounting purposes.*

Date	Time log		Duration	Operations	Operations and remarks
	From	To	(hr)	code	
	14:00	15:00	1.00	2	Drilling 6 3/4" x 8 1/2" hole from mud line at F/6567' T/6627' @ 200 gpm=300 psi, TDS=15 RPM, Torq=1-3k. Maintaining ROP of 400+ FPH. Continue Drilling as directed F/6627' T/6737'. TDS=50 RPM, Drilling Torq=1-3k, Rot Torq=1-3k, Pump rate 250gpm=350 psi. Off bottom pressure= 450 psi with seawater. Maintaining ROP of 400 FPH with no WOB. P/U 278 k S/O 274k. Rot wt 274k.
	15:00	21:30	6.50	2	Drilling 6 3/4" x 8 1/2" hole F/6737' at 350 gpm=686 psi, TDS=100 RPM, Torq=3-4k. Maintaining ROP of 400+ FPH. Pump 25 bbl sweep HVS every other connection.
					Consumables: Fuel = 4151 bbls, Potable water = 2214 bbls, Drill water = 1868 bbls.
	21:30	24:00	2.50	2	Drilling 6 3/4" x 8 1/2" hole F/ 6,737'' T/ 7,800', swapped F/ 8.6ppg seawater T/ 10.5ppg Mud & pump down hole. Slow ROP to 180' FPH w/ 351 gpm=316 psi, TDS=125 RPM, Torq=3-4k, S/O 301K, P/U 295K, Rot wt 301k. Continue Drilling as per Company man F/7,800'' T/ 8,065'.
April 27, 2009	0:00	1:00	1.00	2	Drill 6 3/4" x 8 1/2" hole section F/8065' to 8,078' w/ 10.5ppg. At 0015 hrs drill into gas bubble causing the well to kick. Line up on 13.0 ppg kill mud and displace 10.5ppg w/ 120 bbls of 13.0 ppg kill mud leaving 15 bbls in pipe for displacement.
	1:00	2:00	1.00	9	ROV monitor well for 1 hour - well static.
	2:00	4:30	2.50	6	POOH at a reduced speed F/ 8078' to 6723' ROV noticed well start flowing. Note tight spots at 7,857', 7,678' w/ 10-12K over pull.
	4:30	6:00	1.50	34	Line up on 16.0 ppg and displaced drill pipe, installed bop and TIH F/ 6,723' to 7,305'. Tagged up w/15K.
	6:00	6:30	0.50	34	Displaced two annulus volumes at 7305' w/ 16.0ppg. No observed flow.
	6:30	7:30	1.00	6	POOH at a reduced speed F/ 7305' to 6660' bit 93' inside hole.
	7:30	8:30	1.00	34	ROV monitor well for 1 hour. Well started flowing, pump 50 bbls of 16.0 ppg at 6,660'- no flow detected.
	8:30	10:30	2.00	6	TIH F/ 6660' to 7563'. Tagged up w/15K.
	10:30	11:00	0.50	34	Pumped two annulus volumes at 7563' w/ 16.0ppg - no flow.
	11:00	12:00	1.00	6	POOH and reduced Speed F 7,653'.
	12:00	16:00	4.00	6	Continue POOH and reduced speed F/7563' T/mud line while monitoring well. Change lines and Continue POOH.
	16:00	19:00	3.00	6	BHA at surface. Service break and lay out same.
	19:00	24:00	5.00	6	P/U and M/U 6 3/4 bit and 3 DC, HWDP & TIH w/ same on 5" DP T/ 6407'.
					Consumables: Fuel = 3981 bbls, Potable water = 2251 bbls, Drill water = 1824 bbls.
April 28, 2009	0:00	3:00	3.00	6	Trip into the hole with the cement assembly, 0020 hrs ROV guided bit into well, tagged at 6860', made up TD and washed from 6860' to 6923', continued to 7400'.
	3:00	4:30	1.50	12	Held JSA and TBT, fill lines and test same to 3K, perform cmt job - pump 35 bbl, 16.0 ppg spacer followed by 47.5 bbl, 16.4 ppg cmt followed by 6 bbl, 16.0 ppg spacer and spot in place with 115 bbls of seawater - 500' cmt plug from 7400' to 6900', cmt in place at 0430 hrs. Cmt - 246 SKS H, 0.02 GPS D47, 0.6 GPS D500, 0.2 GPS D185A, 0.17 GPS D186 at 16.4 ppg,
	4:30	6:00	1.50	6	POOH from 7400' to 6343'.
	6:00	6:30	0.50	48	Make up TD and flush through drill string 2.5 pipe volumes.
	6:30	12:00	5.50	6	POOH from 6,343' to surface. ROV recovering compacts.
	12:00	13:00	1.00	6	Continue POOH, Lay down Cement BHA .
	13:00	17:00	4.00	40	Standby awaiting MMS approval for completion of well GC955-Q.
	17:00	19:00	2.00	9	ROV off deck to perform observation and inspection of GC955-Q well site.
	19:00	20:00	1.00	48	MMS has given approval of completion, recover ROV to surface. **At 20:00 hrs complete GC955-Q**
	20:00	24:00	4.00	23	Vessel start transit to WR313-H.
					Consumables as of 2000 hrs: Fuel 619 cubic meters, Lube oil 5.0 cubic meters, Industrial water 281 cubic meters
April 29, 2009	0:00	11:30	11.50	23	Vessel in transit to WR313-H. Vessel on location and all stop. 1030 hrs vessel four miles off location, commence picking up BHA.
	11:30	12:00	0.50	6	Vessel in position and making checks. Continue RIH and ROV setting compacts.
	12:00	14:30	2.50	6	Continue P/U & M/U 6 3/4" x 8 1/2" Drilling BHA .
	14:30	19:30	5.00	6	TIH w/ 5" DP F/ 846' T/ 6501' mud line. BHA total wt. 45K, Below Jars 31K & Above Jars.
	19:30	24:00	4.50	2	Moved vessel to well center as per Fugro. Established circulation and synchronizing MWD tools as per Schlumberger. Tagged mud line at 6501'.**Spud WR313-H**. Spud in 6 3/4" x 8 1/2" hole from mud continue drilling as directed F/6571' T/6631'. TDS=50 RPM, Drilling Torq=1-3k, Pump rate 250gpm=350 psi. Off bottom pressure 450 psi line at F/6,501'' T/6,571' at 200 gpm=300 psi, TDS=15 RPM, Torq=1-3k. Maintaining ROP of 350' FPH. Continue Drilling as directed F/6571' T/ 6631'. TDS=50 RPM, Drilling torq=1-3k, Pump rate 250gpm=350 psi. Off bottom pressure 450 psi with seawater. Maintaining ROP of 350 FPH with no WOB. Drilling 6 3/4" x 8 1/2" hole F/6671'' T/ 7,181' at 350 gpm=686 psi, TDS=80 RPM, Torq=3-4k. Maintaining ROP of 350 FPH. Pump 25 bbl HVS every third double connection. Increased pump rate to 385 GPM at 2200 hrs to assisting MWD tool taking surveys.

Table T3 (cont.): *Gulf of Mexico JIP Leg II operational schedule with drilling statistics and event drilling log. Also included is a list of standard or commonly used IADC well operational codes. These codes are used in the timeline event drilling log record to assign the listed events to a given class of activities. An index of the commonly used IADC well operational codes are listed at the end of Table T3. The times listed in the event drilling log are "approximate times" for any given event and are rounded to the nearest quarter hour for accounting purposes.*

Date	Time log From	Time log To	Duration (hr)	Operations code	Operations and remarks
April 30, 2009	0:00	12:00	12.00	2	Drlg from 7181' to 8500' with sea water, RPM - 80 - 90, SPM - 79 with 950 - 1000 psi at 385 gpm, torq - 2 - 12 K, string wt - 181K, slack off wt - 174K. 0745 hrs changed over from sea water to 10.5 ppg WBM. Drlg from 8500' to 8918', with 10.5 ppg mud, RPM - 125, SPM - 79 with 850 - 900 psi @ 385 gpm, torq - 4 - 13 K, RW - 301K, PW - 308 K, SW - 295 K.
	12:00	21:00	9.00	2	Continue Drill F/8918' T/9888', with 10.5 ppg mud, RPM - 125, SPM - 79 with 850 - 900 psi at 385 gpm, torq - 4 - 13 K, Rot - 329K, P/U - 329 K, S/O - 329K.
	21:00	22:00	1.00	34	Displace hole w/ 10.5ppg 1 1/2 time hole volume (235 bbls) & pump 12.0 ppg mud 320 bbls, then displace with 80 bbls SW.
	22:00	24:00	2.00	6	POOH F/9888' t/8730' at reduced rate, watch for overpull and preventing swabbing hole.
May 1, 2009	0:00	4:00	4.00	6	POOH reduced speed to 6593' - no drag, bit 92' in well. Trip drill - 33 seconds.
	4:00	4:30	0.50	48	ROV monitor well for flow - well static.
	4:30	11:30	7.00	6	Continue POOH from 6593' to surface and breakdown BHA, remove radioactive source and drill bit. While POOH ROV pick up compacts and preformed seabed survey.
					At 11:30 hrs complete WR313-H.
	11:30	0:00	12.50	23	Transit to the AC21-B location.
					Consumables: Fuel 1030 cubic meters, lube oil 6.8 cubic meters, potable water 371 cubic meters, industrial water 203 cubic meters.
May 2, 2009	0:00	20:00	20.00	23	Transit to the AC21-A location. 1530hrs started ballasting vessel towards 15.2 m working draft while continuing transit.
					1530 hrs - Started ballasting vessel towards 15.2 meter working draft while continuing transit.
					1800hrs - Completed ballasting to 15.2 meters working draft (51' RKB) and continue transit to AC21- A location.
	20:00	22:00	2.00	24	Arrived on location: AC21-A, performed DP trials.
					MWD installing batteries and plugging into MWD tools.
					2100 hrs - ROV off deck, deploying two compacts.
	22:00	24:00	2.00	6	P/U and M/U 6 3/4" x 8 1/2" Drilling BHA F/ RKB T/ 178'.
					22:30 hrs - DP Trials complete vessel moving to drilling location.
					23:30 hrs - MWD plugged into tools, then held JSA on radioactive source and MWD installed radioactive source.
May 3, 2009	0:00	1:30	1.50	6	Picking up BHA. Total wt. - 47K, Below jars - 33K, Above jars - 14K.
					Perform shallow hole test on MWD.
	1:30	4:00	2.50	6	Continue to RIH 4784' , breaking circ every 30 stands.
	4:00	4:30	0.50	48	Schlumberger performed static density reading, hooked up geolograph line.
	4:30	5:00	0.50	6	RIH from 4784' to 4940'. Mud line RKB - 4940', Water depth - 4890'.
	5:00	12:00	7.00	2	Spud bit in, 4940' to 4950' - rpm - 10, spm - 41 w/200 gpm. **Spud AC021-A.**
					Drill 4950' to 5000' increase in increments - rpm 10 to 50, spm from 41 - 51 w/250 gpm.
					Drill 5000' - 5110', rpm - 50, spm - 51 w/250 gpm.
					Drill 5110' to 5450', rpm -80, spm - 72, psi - 775 w/350 gpm, torq - 3 - 6 K rop - 300 - 350 ft/hr, RW - 237K, PW - 240K, SW - 233K.
					Drill 5450' to 5826', with 80 - 100 rpm, 79 spm with 800 psi at 385 gpm, rop 150 - 180 ft/hr.
					Drill 5826' to 5883', rpm 100, 79 spm w/ 775 - 825 psi at 385 gpm, torq - 4 - 7K, rop 300 - 350 ft/hr. RW - 246K, PW - 253K, SW - 240K.
	12:00	17:00	5.00	2	Continue drilling w/ 6 3/4" x 8 1/2" drilling BHA F/ 5883' T/ 6700', rpm 100, 79 spm w/ 775 - 825 psi @ 385 gpm, torq - 4 - 7K, rop 300-350 ft/hr. Rot - 246K, 246K, P/U - 253K, S/O - 240K.
	17:00	17:30	0.50	34	Displace hole w/ 8.7 ppg sweep (50 BBLS) and pump 12.0 ppg mud 200 bbls, then displace with 60 bbls 8.6 SW.
	17:30	20:30	3.00	6	POOH F/9888' T/5042 ' at reduced rate, watch for over pull and preventing swabbing hole.
	20:30	21:00	0.50	9	ROV monitor well for flow - well static.
	21:00	22:00	1.00	6	Continue POOH F/5042' T/4396' = 500' above ML. **At 21:00 hrs complete AC021-A.**
	22:00	24:00	2.00	44	ROV recovering compacts.
May 4, 2009	0:00	4:30	4.50	23	Vessel moved 2396 m at 016.9 degree to AC021-B at 0.4 Knots.
	4:30	6:00	1.50	9	ROV setting out compacts.
	6:00	7:00	1.00	6	RIH F/4396' to 4783', ROV found bit at 4475' and followed down to 4783'.
	7:00	7:30	0.50	48	Schlumberger down link tool to wake up MWD done static density reading at 4783'.
	7:30	8:00	0.50	6	RIH from 4783' to 4934' and tagged sea bed, RKB - 4934', WD - 4884'.

Table T3 (cont.): *Gulf of Mexico JIP Leg II operational schedule with drilling statistics and event drilling log. Also included is a list of standard or commonly used IADC well operational codes. These codes are used in the timeline event drilling log record to assign the listed events to a given class of activities. An index of the commonly used IADC well operational codes are listed at the end of Table T3. The times listed in the event drilling log are "approximate times" for any given event and are rounded to the nearest quarter hour for accounting purposes.*

Date	Time log		Duration	Operations	Operations and remarks
	From	To	(hr)	code	
	8:00	12:00	4.00	2	Spud bit. **Spud AC021-B.**
					Drill 4934' to 4944', rpm - 10, spm - 41, gpm - 200.
					Drill 4944' to 4994', increase parameters in increments - rpm - 10 / 50, spm - 41 / 51, gpm - 200 / 250.
					Drill 4994' to 5110', rpm - 50, spm - 51, gpm - 250.
					Drill 5110' to 5365', rpm - 80 / 100, spm - 72, gpm - 350, psi - 600 / 630, torq - 3 - 5K, RW - 240K, PW - 246K, SW - 233K, ROP - 200 / 350 ft/hr.
	12:00	18:00	6.00	2	Drill 6 3/4" X 8 1/2" hole F/ 5365' T/ 6050' with an instantaneous ROP of 180 - 200 fph. Pumping seawater at 340 - 385 gpm = 605 - 870 psi, torque = 3 7 K, rotary = 100 rpm, WOB = 0 K. weight at T/D = 260K, S/O = 246, rotating weight = 253.Pumping 25 bbl gel sweeps every other double drilled, taking MWD surveys 5' off bottom every double drilled.
	18:00	18:30	0.50	5	Pump 50 bbl gel sweep at 6050' and circulate out with 160 bbls seawater at 385 gpm = 1015 psi. rotating and reciprocating drill string while circulating at 100 rpm, torque 3-4 K.
	18:30	19:00	0.50	5	Displace well with 160 bbls 12.0 ppg WBM, followed by 60 bbls seawater at 385 gpm = 285 psi rotating and reciprocating drill string while circulating at 100 spm, torque 3-4 K.
	19:00	21:30	2.50	6	POOH with 6 3/4" X 8 1/2" drilling assy F/ 6050' T/ 5041'. Speed restricted due to pulling BHA through open hole. Bit 107' in well.
	21:30	22:00	0.50	48	ROV monitored well for 30 min for flow - well static.
	22:00	24:00	2.00	6	POOH from 5041' to 2750', bit clear mud line (4934') at 2215 hrs - no drag. **At 22:15 hrs complete AC021-B.**
May 5, 2009	0:00	24:00	24.0	21	Back-loading vessel "Mia".
May 6, 2009	0:00	12:00	12.0	21	Continue back-loading vessel "Mia", **PROJECT END 12:00 hrs** - GOM JIP Leg II officially ended with the release of the Q4000 in AC21.

Code Number	Operation	Code Number	Operation	Code Number	Operation	Code Number	Operation
1	Rig Up & Tear Down	13	Wait on Cement	25	WROV "As Found" Survey	37	Well Testing
2	Drill Actual	14	Nipple Up BOP	26	HP Cap Run/Pull	38	Wait on Weather Client
3	Reaming	15	Test BOP	27	HP Cap Test	39	Wait on Weather
4	Coring	16	Drill Stem Test	28	LWRP Run/Pull	40	Standby Client
5	Condition & Circulate Mud	17	Plug Back	29	LWRP Test	41	Standby
6	Trips	18	Squeeze Cement	30	Slickline	42	Marine
7	Lubricate Rig	19	Fishing	31	Electricline	43	Safety Stand Down
8	Repair Rig	20	Dir Work	32	Coil Tubing	44	WROV "As Left" Survey
9	ROV Operations	21	Mobilize	33	Stimulation	45	Transit to Port
10	Deviation Survey	22	Make Up/Breakdown DP	34	Fluid Pumping	46	Demobilize
11	Wireline Logs	23	Transit to Location	35	Cementing	47	Safety Meeting
12	Run Casing & Cement	24	DP Trials	36	Wait on Cement	48	Other

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