UT-GOM2-1 Hydrate Pressure Coring Expedition

Chapter 4. Hole GC 955 H005

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Chapter 4. Hole GC 955 H005

Abstract

This chapter describes the operations, sample collection and handling, initial analyses, and preliminary interpretations developed by the UT-GOM2-1 Science Party for Hole GC 955 H005 (H005). This chapter describes H005 pressure coring, physical property analysis, quantitative degassing, lithostratigraphic analysis, geochemical analysis, and wireline logging. All methods are described in Chapter 2 Expedition Methods.

4.1 Background and objectives

H005 is located at 27° 0.004665' N, -90° 25.59125' W in Green Canyon Block 955 (Figure 1.3.2 of the UT-GOM2-1 Expedition Summary). H005 is 49.9 feet (15.2 m) WSW of the originally drilled Hole GC 955 H001 (H001). The water depth is 6666 ft (2031.8 m).

The objectives of the work carried out at this site follow the general objectives of the UT-GOM2-1 expedition. Our goal was to:

- Test the DOE pressure-coring tool with ball valve in the face bit configuration (PCTB-FB)
- Recover pressure core samples throughout the main hydrate reservoir, including the top and base of hydrate contacts
- Recover gas samples for geochemical and analysis
- Characterize the lithology and interpret the depositional environment of the hydrate reservoir
- Characterize hydrate saturation within the reservoir
- Characterize the pore water geochemistry and microbiology of the reservoir

Based on the depth of the seafloor observed by ROV at H005 and our mapping of seismic surfaces away from H001, we predicted the depths of events mapped at H005 (Table 4.1.1). After correlating the seismic reflectors associated with the seafloor and the top of the coarse-grained hydrate-bearing interval, we predicted that the top of the hydrate bearing interval would be the same depth relative to the rig floor and the same depth relative to the seafloor as encountered in H001.

Our goal was to sample in and near the sand-rich hydrate-bearing interval found by the JIP II logging while drilling (LWD) expedition (Boswell et al., 2012; Collett et al., 2010) and compare these results back to the previously acquired H001 LWD data.

Our initial coring plan, attempted in Hole GC 955 H002 (H002), assumed the stratigraphy encountered at H005 would be similar to that encountered at H001 and that cores would be taken in the same locations as H002. However, based on the core recovery and PCTB analysis from H002, the coring plan for H005 was modified on the rig before spudding (Figure 4.1.1 and Figure 4.1.2). In this new plan, the target location for Core H005-01FB was designed to test the PCTB well before entering the sand-rich hydrate bearing interval. Core H005-02FB was targeted 5 feet below the top of the hydrate-bearing interval based on the experience at H002. This was because the non-hydrate-bearing interval above was difficult

to core in H002 due to its unconsolidated nature. In addition, we dropped all plans to wash portions of this hole between coring runs because it was determined to be more efficient to core continuously.

Event	Depth below Rig Floor	Depth below Sea Level	Depth Below Seafloor	Seismic Reference Depth	Lithostratigraphic Unit
unit	fbrf	fbsl	fbsf	ft	
Sea floor	6,718	6,666	-	6,672	
Top Fracture Filling Hydrates	7,348	7,296	630	7,302	
Fault	7,396	7,344	678	7,350	**I**
5' thick Sand	7,467	7,415	749	7,421	
Base Fracture Filling Hydrates	7,694	7,642	976	7,648	
Top Sand - rich section	7,981	7,929	1,263	7,935	
Top Hydrate - Predicted	8,076	8,024	1,358	8,030	
Top Hydrate - Seismic Peak	8,080	8,028	1,362	8,034	**II**
Base of Main Hydrate Reservoir - Predicted	8,162	8,110	1,444	8,116	
Base of Sand Unit	8,335	8,283	1,617	8,289	
Base of Channel System	8,459	8,407	1,741	8,413	**III**

Table 4.1.1 Mapped horizons at H005. More information about the events and Lithostratigraphic Units can be found in Chapter 1. Expedition Summary Section 1.2.2 GC 955 Site Characterization and Selection and Section 1.4.1 Lithostratigraphy and Physical Properties. More information about the reference depths can be found in Chapter 2 Methods, Section the UT-GOM2-1 Methods Section 2.1.3. Depth References.

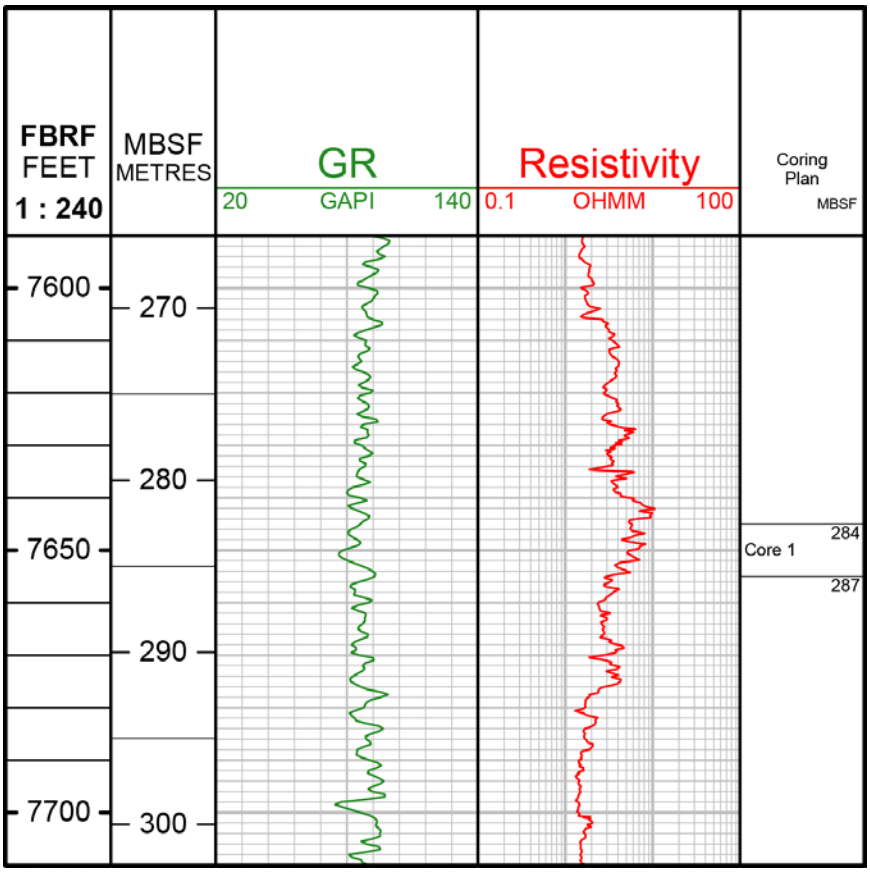


Figure 4.1.1 Plot 1 of H005 pre-spud coring plan modified after H002 versus H001 LWD data.Core 1 is found within the fractured hydrate unit higher up in section than the other proposed cores.

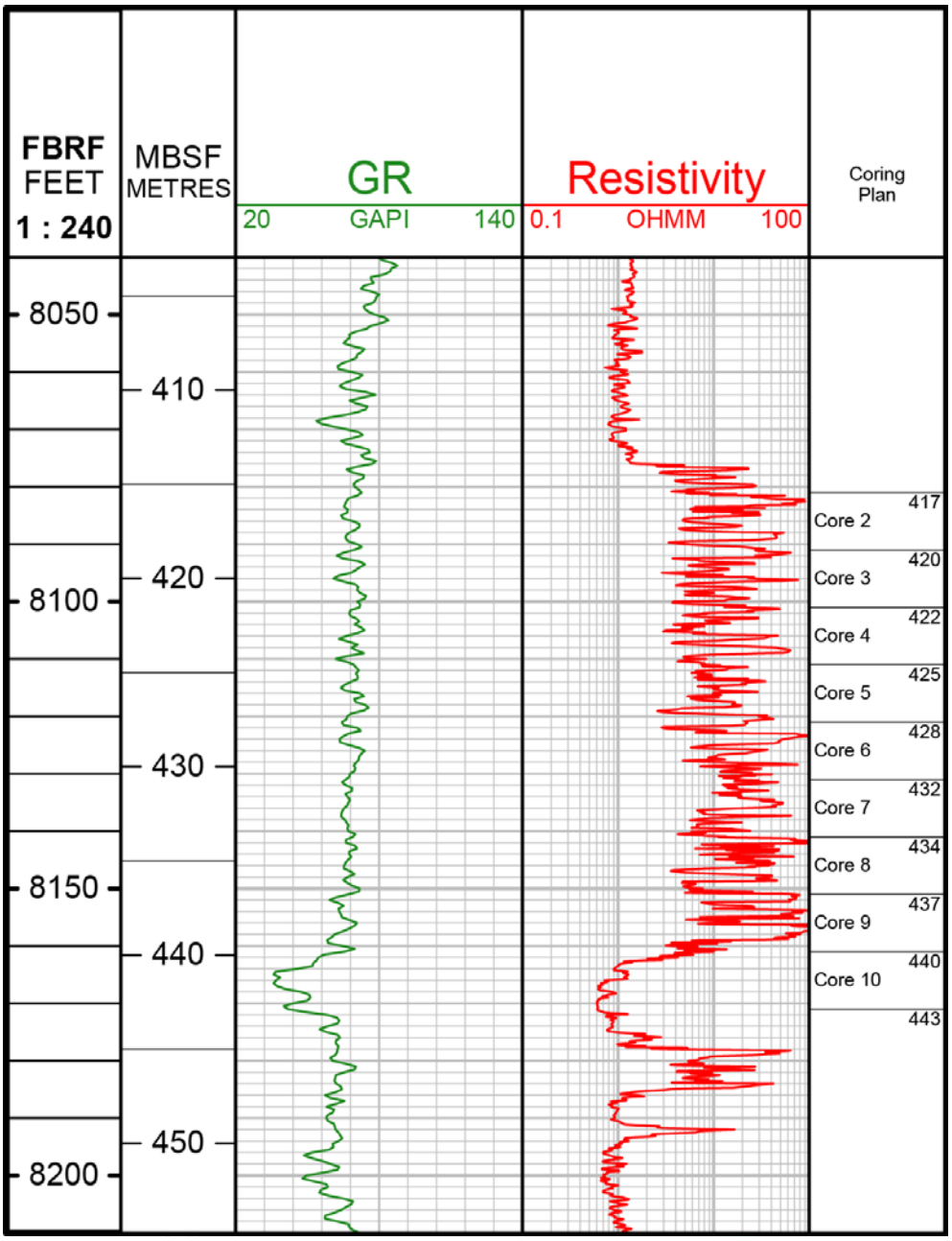


Figure 4.1.2 Plot 2 of H005 pre-spud coring plan versus H001 LWD data.

Following the completion of the coring program, the plan was to record hole deviation using a gyroscopic survey before plug and abandonment.

4.2 Operations

This section covers the operations associated with H005. Schedule and operational details for this drill and core hole can be found in Appendix A: UT-GOM2 Pre-Drill Operations Plan (activities, time estimates and forecast), and Appendix B: UT-GOM2 Post-Drill Operation Report and Daily Log (executed activities, drilling and coring statistics, and an event drilling-log) of Chapter 1 Expedition Summary.

In preparation for drilling and coring of H005 PCTB-FB and the BHA were prepared for deployment. To further test the engineering capability of the PCTB-FB, it was decided to test the tool in three successive Full Function Tests in which the configuration of the tool was not changed. In each case, the internal flow diverter in the pressure core barrel was sealed with an O-ring. (In H002 the sealing of the internal flow diverter was thought to be the cause of failure during coring operations and had been removed. When it was shown to not be the cause of failure before drilling H005, it was put back.) For these tests, the drill pipe and BHA was lowered to approximately at 1500 fbrf. The PCTB-FB core barrel was lowered into the BHA and the standard retrieval tool was used to release, activate the internal sealing mechanism, and recover the core barrel to the vessel. PCTB-FB Full Function Test 1 failed to hold pressure. However, the remaining Full Function Tests 2 and 3 both held pressure and the internal autoclave pressure boost achieved the expected amounts. Based on this result, it was decided to move forward with spudding of H005.

After pulling the PCTB-FB BHA from H002, the *D/V Q4000* was moved over the proposed H005 location, approximately 49.86 ft (15.2 m) WSW of H001 as shown in Figure 1.3.2 of the Expedition Summary. H005 was spud at 6666.0 fbrf (6718.0 fbrf) at 0230 hr on 17-May-2017 and advanced to the first core point at 7645 fbrf at 1330 hr on 17-May-2017. The first core (UT-GOM2-1-H005-1FB) was taken at a relatively shallow depth (7645-7655 fbrf; 282.3-285.4 mbsf) within an interval of elevated resistivity that had been previously interpreted to record fracture filled gas hydrate in mostly fine-grained sediments (Boswell et al., 2012; Cook et al., 2014; Lee and Collett, 2012). The target depth for Core UT-GOM2-1-H005-01 was specifically selected to test the impact of mud-rich sediments on the PCTB-FB core system. The hole was drilled to the first core point while pumping mostly seawater with gel sweeps every fourth stand (double pipe-length stands).

Core UT-GOM2-1-H005-01FB was cut while drilling with seawater (no drilling mud or gel) and recovered to the vessel at 2330 hr on 17-May-2017. On recovery, the ball valve was closed and the autoclave pressure was measured at 4115 psi. A total of 7.1 ft (217 cm) of sediment was recovered in Core UT-GOM2-1-H005-1FB. For more details on the autoclave pressure and other coring parameters for this and all recovered cores, see 4.3.3 Pressure core acquisition.

H005 was advanced from 7655 fbrf to 8081 fbrf, which was the depth of the next core point in the hole. The core point for Core UT-GOM2-1-H005-02FB was set 5 ft beneath the top of the hydrate-bearing section at this site (8081-8091 fbrf). It was decided to begin coring in the hydrate-bearing section because there was poor recovery during H002 in the material above the hydrate.

Cores UT-GOM2-1-H005-02FB through UT-GOM2-1-H005-07FB were cut with seawater (no drilling mud or gel). Cores UT-GOM2-1-H005-08FB and UT-GOM2-1-H005-09FB were cut while pumping 9.5 ppg water-based mud (WBM). Cores UT-GOM2-1-H005-10FB through UT-GOM2-1-H005-13FB were cut with

10.5 ppg WBM. The decision to drill with water was based on a desire to compare tool performance with and without weighted mud.

Core UT-GOM2-1-H005-02FB was cut and recovered to the vessel at 1240 hr on 18-May-2017. When recovered on deck, the ball valve was closed and the internal autoclave pressure was measured at 2834 psi (recovered 4.9 ft; 150 cm of core). Upon inspection on the rig floor, a small leak was detected around the ball valve and the autoclave pressure was increased to 4000 psi before being transferred to Geotek's pressure core analysis and transfer system (PCATS).

Core UT-GOM2-1-H005-03FB (8091-8101 fbrf) was cut and recovered to the vessel at 2120 hr on 18-May-2017. When recovered on deck, the ball valve was closed and the internal autoclave pressure was measured at 1780 psi (recovered 10.0 ft; 304 cm of core). The autoclave was transferred to PCATS where pressure was increased to 4000 psi before core handling and processing.

On 19-May-2017, H005 was advanced from 8101 fbrf to 8151 fbrf with the acquisition of five pressure cores. Core UT-GOM2-1-H005-04FB was cut and recovered to the vessel at 0330 hr on 19-May-2017. When recovered on deck, the ball valve was closed and the internal autoclave pressure was measured at 3477 psi, indicating that the autoclave had sealed at near in situ pressures (recovered 10.5 ft; 321 cm of core).

Core UT-GOM2-1-H005-05FB was cut and recovered to the vessel at 0800 hr on 19-May-2017. When recovered on deck, the ball valve was closed and the internal autoclave pressure was measured at 3242 psi, indicating that the autoclave had sealed at near in situ pressures (recovered 9.7 ft; 296 cm of core).

Core UT-GOM2-1-H005-06FB was cut and recovered to the vessel at 1230 hr on 19-May-2017. When recovered on deck, the ball valve was closed and the internal autoclave pressure was measured at 3250 psi, indicating that the autoclave had sealed at near in situ pressures (recovered 9.4 ft; 286 cm of core).

Core UT-GOM2-1-H005-07FB was cut and recovered to the vessel at 1700 hr on 19-May-2017. When recovered on deck, the ball valve was closed and the internal autoclave pressure was measured at 3000 psi. The boost set pressure for this deployment was at 3000 psi and consequently there was no boost (recovered 10.5 ft; 321 cm of core).

Core UT-GOM2-1-H005-08FB was cut while drilling with 9.5 ppg WBM and was recovered to the vessel at 2400 hr on 19-May-2017. When recovered on deck, the ball valve was closed and the internal autoclave pressure was measured at 3016 psi (recovered 8.2 ft; 250 cm of core).

On 20-May-2017 H005 was advanced from 8151 fbrf to 8185 fbrf with the acquisition of four pressure cores. Core UT-GOM2-1-H005-09FB was cut while drilling with 9.5 ppg WBM and was recovered to the vessel at 0630 hr on 20-May-2017. When recovered on deck, the ball valve was closed and the internal autoclave pressure was measured at 746 psi (recovered 8.9 ft; 270 cm of core). On this occasion the set pressure was 4015 psi indicating the boost did not function as expected and there was no accumulator function. The autoclave section was pumped up to 3250 psi before being transferred to PCATS. The DST recordings showed that autoclave did not seal until it was close to the sea surface; further indicating that some amount of the gas hydrate in this core had dissociated (i.e., the core pressure-temperature conditions had temporarily departed the methane hydrate stability zone).

While coring UT-GOM2-1-H005-10FB the cement pumps (mud pumps) stopped temporarily for about 30 seconds. At the same time, approximately 5 ft into the formation, very high torque occurred (as much as 30 klbs) and released, causing the drill string to spin in reverse momentarily. Coring was discontinued immediately at this point. On recovery, the ball valve was closed and the internal autoclave pressure was measured at 3225 psi (recovered 1.4 ft; 44 cm of core).

As a result of the difficulties experienced during the last coring run, the main objective of Core UT-GOM2-1-H005-11FB was to advance through what is interpreted on the logs as a water-bearing zone above another short gas hydrate interval. Consequently the pump rates were increased significantly at the expense of the core quality to ensure that a clean hole was developed for the next core (Core UT-GOM2-1-H005-12FB) which would be back in a gas hydrate interval. On recovery of Core UT-GOM2-1-H005-11FB, the ball valve was closed and the internal autoclave pressure was measured at 3002 psi (recovered 0.9 ft; 26 cm of core).

Core UT-GOM2-1-H005-12FB was cut while drilling with 10.5 ppg WBM and was recovered to the vessel at 2400 hr on 20-May-2017. Weight on bit and torque came on early during the core throw, hence the run was stopped after a 9 ft advance. On recovery, the ball valve was only half closed due to trapped sediment in the ball valve and hence maintaining no pressure. The core barrel was also over-filled, forcing the rabbit against the top plug and core material across the ball valve. Recovery was 5.4 ft (165 cm).

On 21-May-2017 H005 was advanced to the total depth of the hole at 8193 fbrf with the acquisition of Core UT-GOM2-1-H005-13FB. Core UT-GOM2-1-H005-13FB was cut while drilling with 10.5 ppg WBM and was recovered to the vessel at 0230 hr on 21-May-2017. When recovered on deck, the ball valve was closed and the internal autoclave pressure was measured at 2806 psi (recovered 5.8 ft; 175 cm of core).

Following regulatory requirements, H005 was logged from 8100 fbrf to the seafloor with two runs of a directional gyroscopic survey tool.

On 21-May-2017 and 22-May-2017 H005 was plugged for abandonment. The plan was to emplace a 500 ft cement plug beginning 178 ft above the hydrate zone at a depth of 7900 fbrf and extending to a depth of 7400 fbrf.

With the bit near total depth (TD) at 8189 fbrf, the bottom of the hole was displaced with 28 bbls of 11.5 Hi-Vis gel pad mud. Given the 9⅞ inch hole diameter, the top of the pad mud was at a depth of 7893 fbrf. The bit was then pulled to a depth of 7900 fbrf where 20 bbls of 10.5 ppg neat spacer was pumped, followed by 54.7 bbls of 16 ppg Class H cement, followed by 6.7 bbls of 10.5 ppg neat spacer. The cement slurry was then pumped into place within the hole with 180.7 bbls of seawater.

Note that 47.4 bbls of cement are required to create a 500 ft column in a 9⅞ in borehole assuming the borehole is to gauge over its entire length. Since H005 is only ~40 ft from H002 and H002 remained near gauge over its entire length (based on the cementing results) the decision was made to reduce the mean annular excess to 25%. Thus the volume of cement to be pumped was determined to be 54.7 bbls.

H005 was re-entered on 21-May-2017. The bit was lowered in the hole to a depth of 7621 fbrf without encountering the cement. The bit was pulled clear of the seafloor and circulated clean while waiting on the cement to further set up.

H005 was re-entered on 22-May-2017. The bit was lowered in the hole to the top of the cement plug at a depth of 7691 fbrf. The cement was confirmed by applying 15,000 lbs to the top of the cement plug. Tagging the top of cement at a depth of 7691 fbrf indicates a cement column height of 209 ft. Given that 54.7 bbls of cement was pumped the theoretical hole diameter is 16.414 inches (Note: The bit diameter was 9⅞ inches). This indicates, a) the hole was severely washed out, or b) the formation may have been fractured.

Since only 209 ft of cement was emplaced, the decision was made to emplace and additional 300 ft of cement directly on top of the first plug. Based on the results of the first cementing attempt, the mean annular excess was increased to 175%.

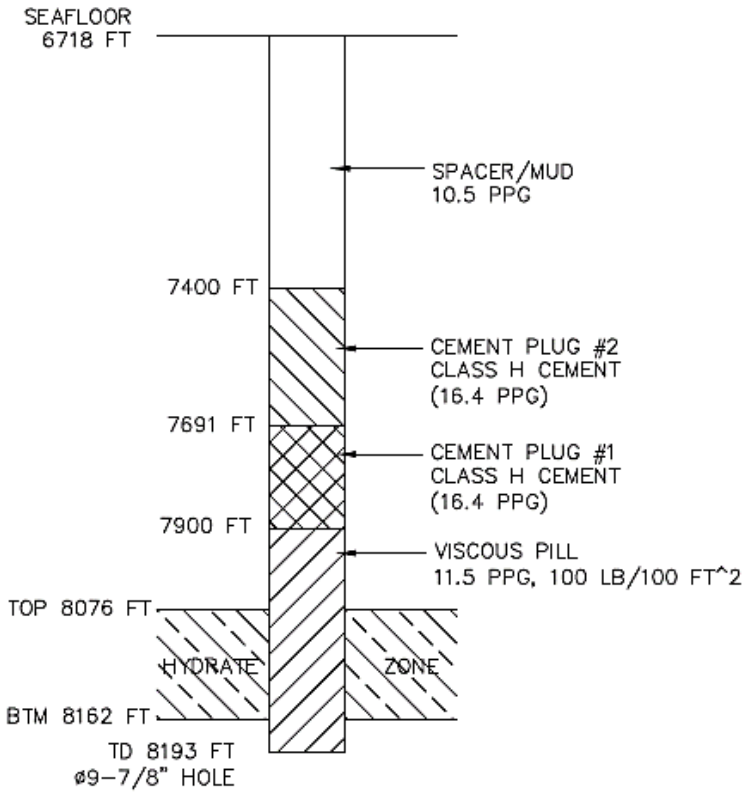
With the bit positioned at the top of the first cement plug at a depth of 7691 fbrf the

hole was circulated clean with 96 bbls of 10.5 ppg mud. 20 bbls of 10.5 ppg neat spacer was then pumped, followed by 58 bbls of 16 ppg Class H cement, followed by 17 bbls of 10.5 ppg neat spacer. The cement slurry was then pumped into place within the hole with 171.7 bbls of seawater. See Figure 4.2.1.

Since the first cement plug was confirmed by applying 15,000 lbs weight on bit to the top of the cement, permission was granted by BSEE not to have to re-enter H005 and tag the top of the second cement plug.

Demobilization from the *D/V Q4000* began on 22-May-2017 with the unloading of project equipment to the supply vessel *HOS Red Rock*. Demobilization operations continued until late on the night of 24-May-2017 with the transfer of equipment and extra drilling supplies to the supply vessel *HOS Red Rock*, which departed location at 2337 hr. The UT-GOM2-1 *D/V Q4000* demobilization operations ended with the arrival and offloading of the supply vessel *HOS Red Roc*k in the Port of Fourchon, LA at 1300 hr on 25-May-17. The pressure core storage van was offloaded by 1500 hr.

After demobilization from the D/V Q4000, PCATS and mub lab containers and equipment were remobilized at the InterMoor, Port Fourchon, LA dock. Operations continued at the dock until 6-June-17 with the start of the second demobilization.



HOLE H005 P&A SCHEMATIC

NOTES:
1. DEPTHS SHOWN ARE FROM RIG FLOOR.
2. AIR GAP = 52 FT.
3. LIQUID SPACERS NOT SHOWN.
4. MECHANICAL SPACERS (SPONGE BALLS) TO BE USED IN CONJUNCTION WITH THE LIQUID SPACERS.

Figure 4.2.1 Schematic displaying final cement plug emplacement. All H005 Operational data can be found in the expedition data directory under H005 / Operations.

4.3 Pressure Coring

This section describes the coring operations for H005 from the UT-GOM2-1 hydrate pressure coring expedition. This section covers Full Function Tests, pressure coring runs, and PCTB failure analysis. This section also contains a description of modifications to the PCTB after coring in H002.

4.3.1 Field Modifications to PCTB

After coring operations at H002 were completed, the science team conducted an assessment of the PCTB performance in H002 in an attempt to identify the failure modes encountered during drilling. After failure modes were identified, corresponding modifications were made to the PCTB in an attempt to increase pressure core recovery. The modifications that were made prior to commencing coring operations at H005 included replacing the ball valve seal in an attempt to achieve a tighter fit, grinding grooves into the diverter assembly that was binding and causing restrictions of high pressure fluid, not lubricating the ball to avoid trapping sediment, and welding small tabs on to the collet fingers which had been slipping and obstruction the ball valve from closing (Table 4.3.1).

PCTB Failure Mode	Corresponding Modification to PCTB
Ball valve seal dislodging as ball valve closes	Fitted a tighter ball valve seal
Hydraulic locking	Grinded grooves into diverter assembly
Sediment becoming trapped in ball valve	Not lubricating the ball to avoid attracting sediment
Ball valve release sleeve failure	Welded buttons onto each collet finger

Table 4.3.1: Summary of PCTB failure modes identified in H002 and corresponding modifications that were made prior to initiation coring at H005.

Procedural modifications were also made between UT-GOM2-1-H005-5FB and UT-GOM2-1-H005-06FB, when it was decided to change the applied boost pressure to just below in situ pressure, and to pause core retrieval near the seafloor for approximately 15 minutes. This change in the pressure boost procedure was implemented in hopes that the boost mechanism would act as an accumulator and that moveable components would be allowed time to actuate. This pause at the seafloor was implemented on all subsequent core runs with the exception of UT-GOM2-1-H005-09FB (see Pressure core acquisition below).

A final modification to the PCTB was made prior to coring UT-GOM2-1-H005-13FB, in which a 3/8 inch hole was drilled into the middle barrel in hopes of eliminating or reducing flow restriction. See section 4.3.4 PCTB Performance Review for a discussion of the results of the PCTB tool and procedural modifications.

4.3.2 Full-Function Tests

Three full-function tests (Table 4.3.2) were conducted prior to initiating coring operations at GC 955 H005 (see Pressure core acquisition). These tests were conducted to test the ability of the tool to successfully collect and maintain a pressurized sample.

Full Function Tests	Operational Depth (fbrf)	Outcome
PCTB-FB Full-Function Test 1	1038	Boost pressure not registered. Tool sealed at ~75 psi during wireline trip. Pressure lost when tool took a hit against the rig.
PCTB-FB Full-Function Test 2	1038	Ball valve closed, pressure boost recorded
PCTB-FB Full-Function Test 3	1035	Ball Valve closed, pressure boost recorded

Table 4.3.2: Summary of full function tests.

PCTB-FB Full-Function Test 1

Depth: 1038 fbrf

Recovery pressure: 75 psi (0.51 MPa)

PCTB-FB Full-Function Test 1 failed to record a pressure boost and maintain pressure back to the surface (Figure 4.3.1 and Figure 4.3.2). However, the PCTB did seal at approximately 75 psi further up as the PCTB was brought to the sea surface. (Pt. 6, Figure 4.3.2).

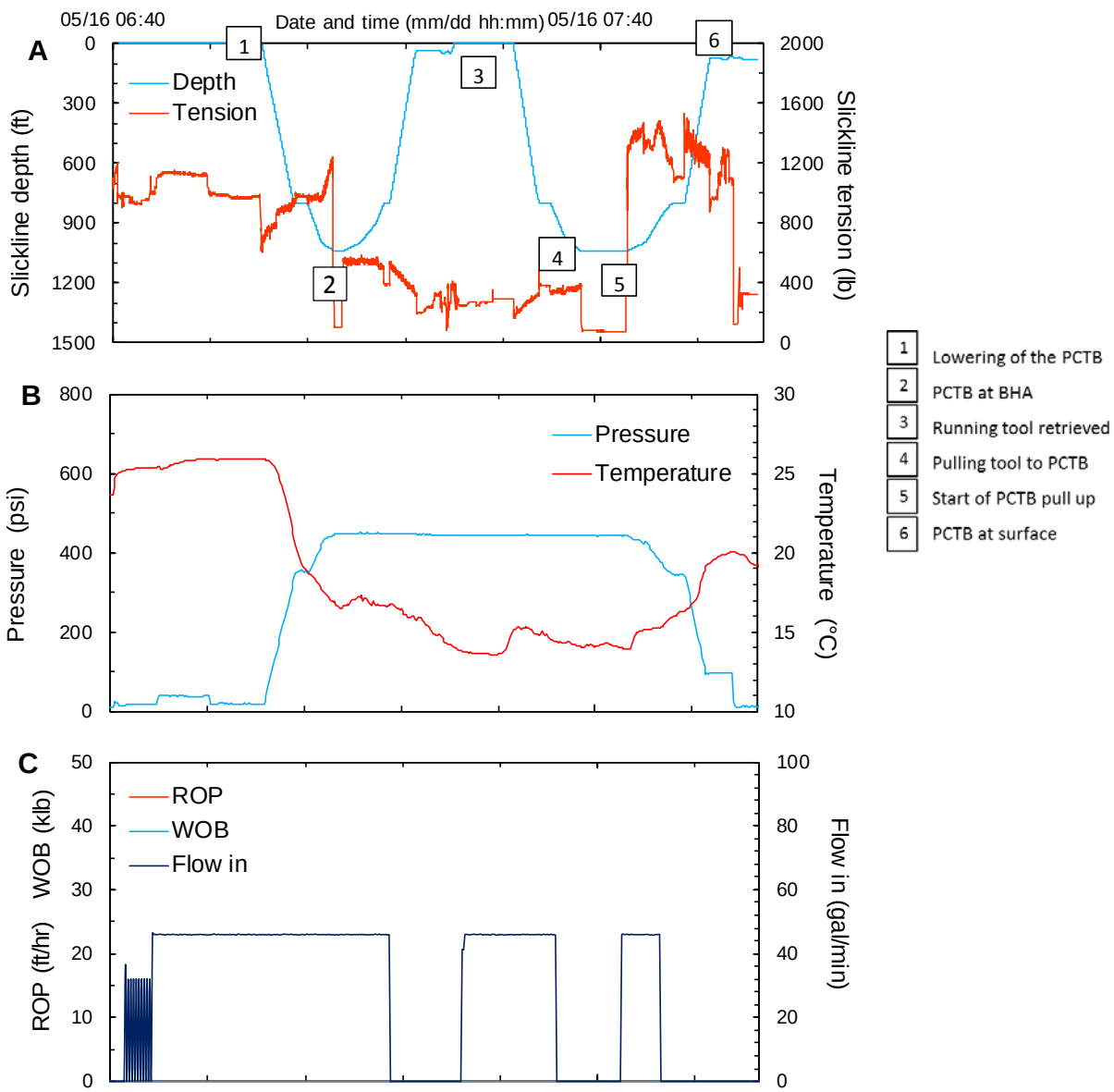


Figure 4.3.1 Deployment of PCTB-FB Full-Function Test 1. A) slickline tension and depth, B) pressure and temperature as measured by the rabbit DST, and C) WOB, ROP, and pump flow rate (Flow in). Flow in is the sum of all pump flows. WOB and ROP were zero as BHA was suspended in the water column. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

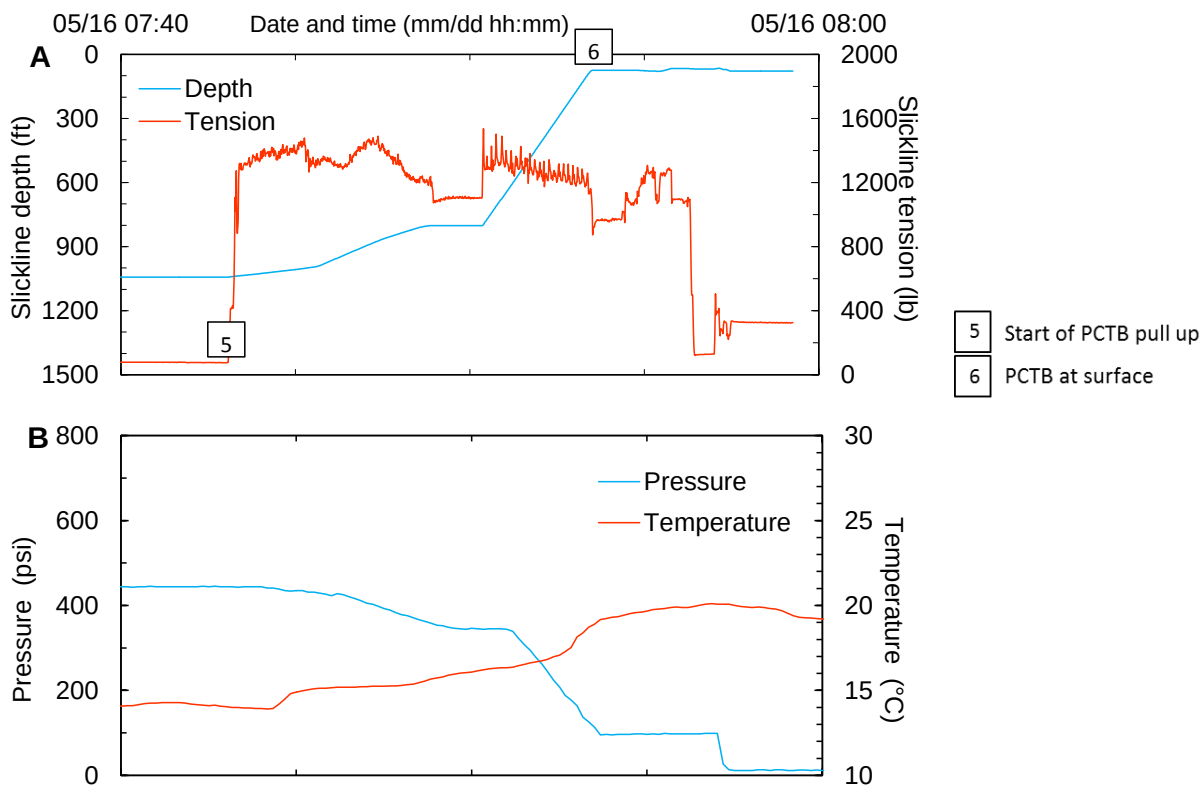


Figure 4.3.2 Expanded view of retrieval of PCTB-FB Full-Function Test 1. A) slickline tension and depth, B) pressure and temperature as measured by the rabbit DST.

PCTB-FB Full-Function Test 2

Depth: 1038 fbrf

Recovery pressure: 1015 psi (6.99 MPa)

During Full Function Test 2 (Figure 4.3.3 and Figure 4.3.4), the pressure boost fired immediately and boosted the pressure from an in situ value of 428 psi to 900 psi. The pressure further rose during recovery and was measured in the service van at 1015 psi.

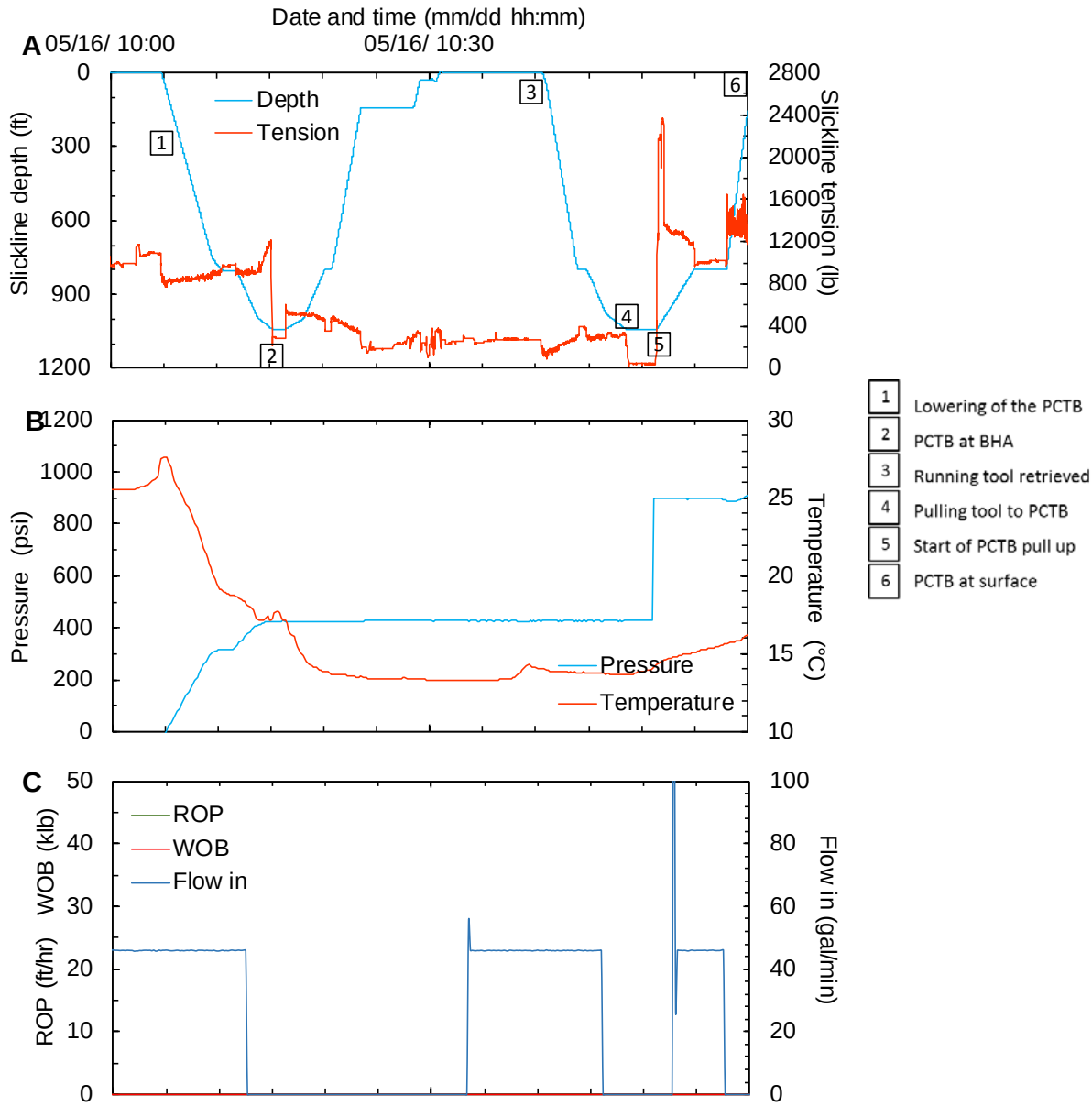


Figure 4.3.3 Deployment of PCTB-FB Full-Function Test 2. A) slickline tension and depth, B) pressure and temperature as measured by the rabbit DST, and C) WOB, ROP, and pump flow rate (Flow in). Flow in is the sum of all pump flows. as BHA was suspended in the water column. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

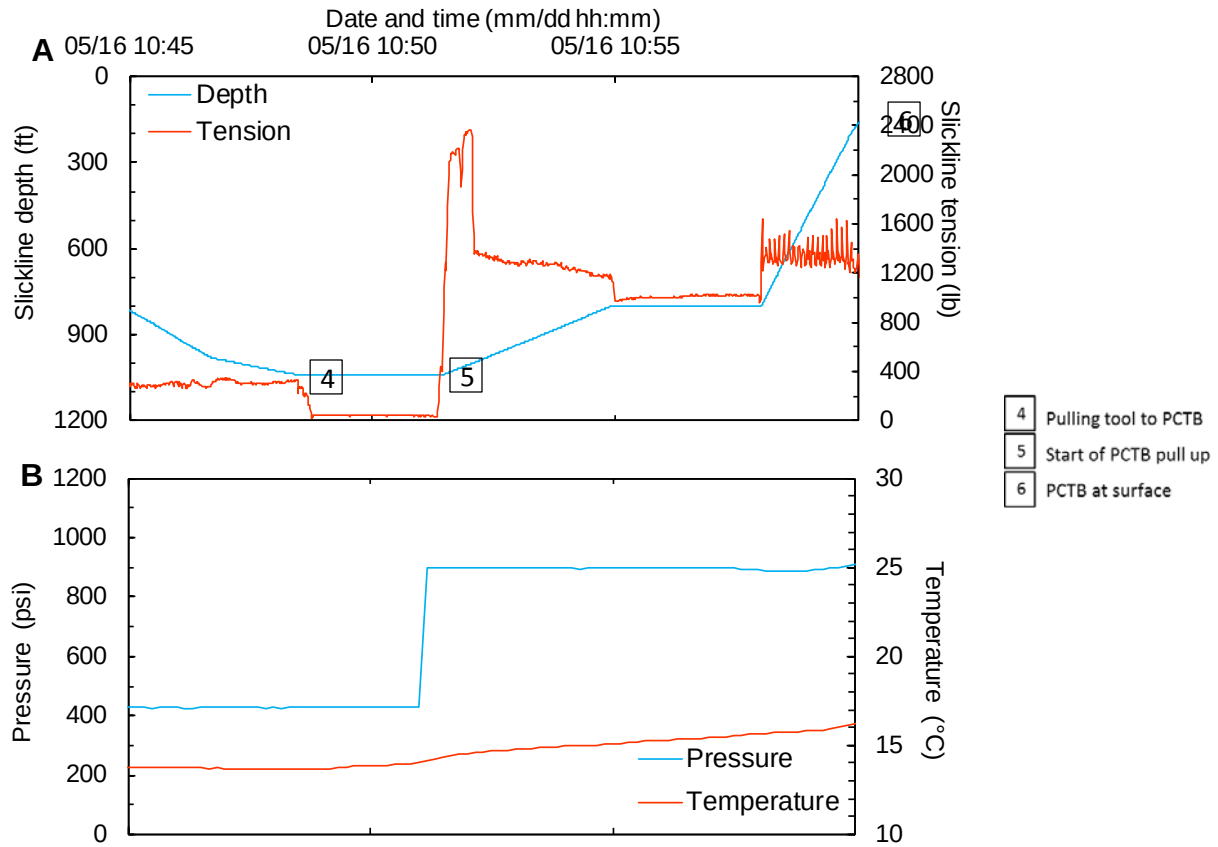


Figure 4.3.4 Expanded view of retrieval of PCTB-FB Full-Function Test 2. A) slickline tension and depth, B) pressure and temperature as measured by the rabbit DST.

PCTB-FB Full-Function Test 3

Depth: 1038 fbrf

Recovery Pressure: 1013 psi (6.99 MPa)

During Full Function Test 3 (Figure 4.3.5 and Figure 4.3.6), the pressure boost fired immediately and boosted the pressure from an in situ value of 430 psi to 943 psi. The pressure further rose during recovery and was measured in the service van at 1013 psi.

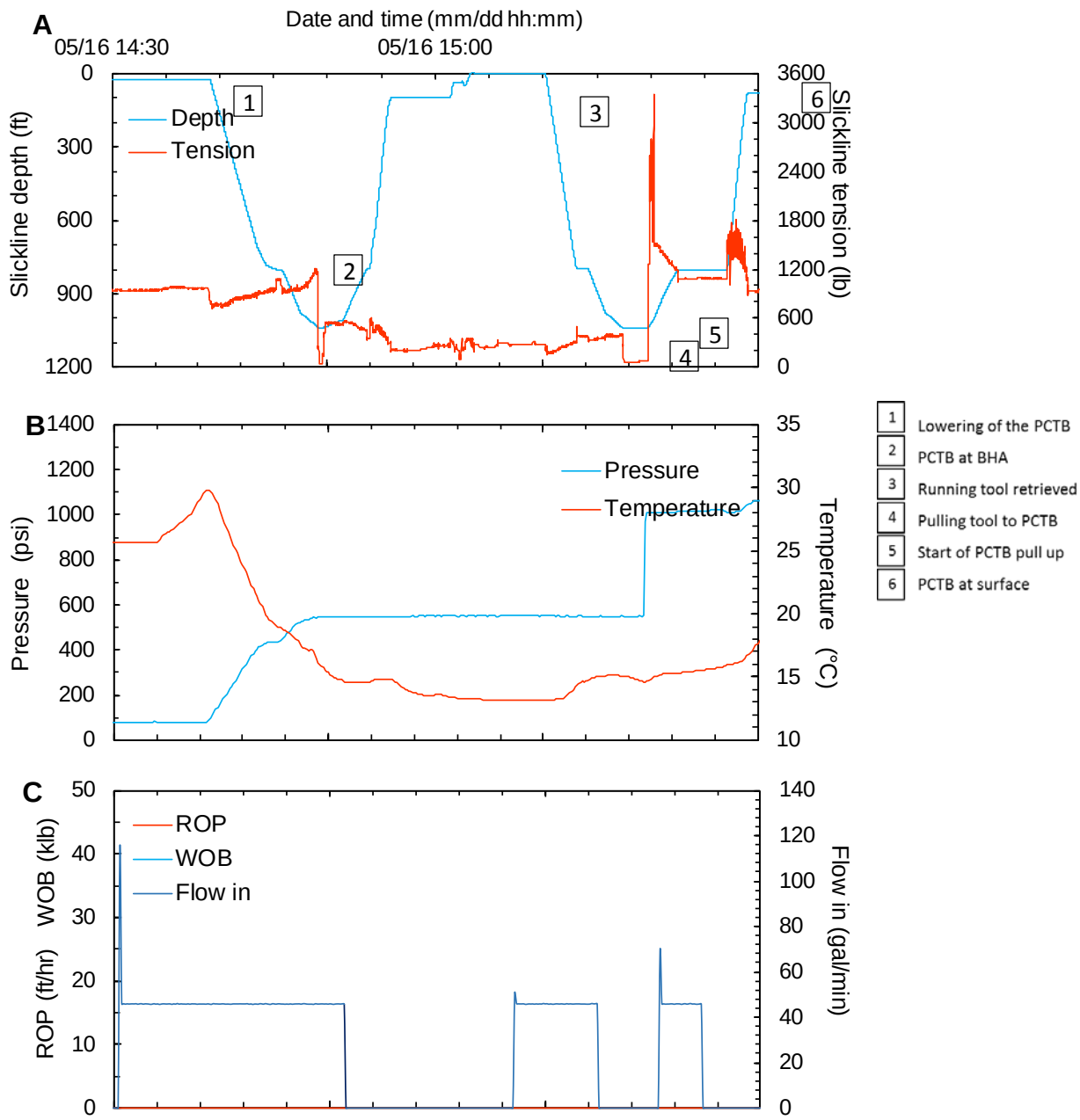


Figure 4.3.5 Deployment of PCTB-FB Full-Function Test 3. A) slickline tension and depth, B) pressure and temperature as measured by the rabbit DST, and C) WOB, ROP, and pump flow rate (Flow in). Flow in is the sum of all pump flows. WOB and ROP were zero as BHA was suspended in the water column. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

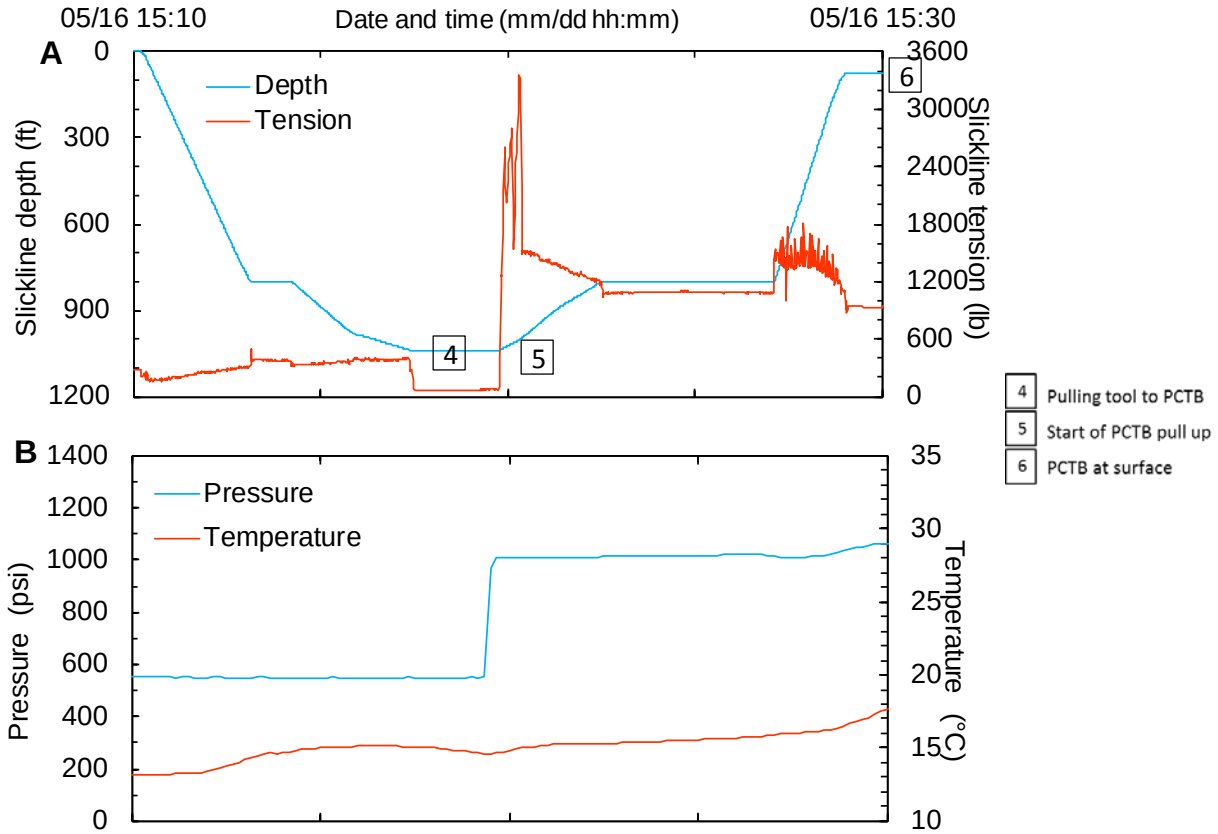


Figure 4.3.6 Expanded view of retrieval of PCTB-FB Full-Function Test 3. A) slickline tension and depth, B) pressure and temperature as measured by the rabbit DST.

4.3.3 Pressure core acquisition

The PCTB was deployed 13 times with the face bit configuration at H005. All but one deployment (UT-GOM2-1-H005-12FB) returned with core at pressure, though core UT-GOM2-1-H005-09FB likely incurred partial dissociation because the corer did not seal until the PCTB had almost reached the sea surface (Table 4.3.3). In this section, the first deployment in H005, UT-GOM2-1-H005-01FB, is described in detail with an example summary at the end, and the rest of the deployments only summarized.

Core	Top (fbrf)	Bottom (fbrf)	Cored Interval (m)	Core Recovery (m)	Set/Boost Pressure (psi)	Recovery Pressure (psi)	Mud Weight (ppg)	Comment
UT-GOM2-1-H005-01FB	7645	7655	3.05	2.17	4063	4115	seawater	Boost occurred when tool was pulled.
UT-GOM2-1-H005-02FB	8081	8091	3.05	1.5	4107	2834	seawater	No boost. PCTB sealed at 1792 fbrf. Core exited the methane hydrate stability zone
UT-GOM2-1-H005-03FB	8091	8101	3.05	3.04	4050	1780	seawater	No boost. Lost pressure to 1300 fbrf where the pressure was ~1800 psi. Core briefly exited the methane hydrate stability zone during recovery
UT-GOM2-1-H005-04FB	8101	8111	3.05	3.21	4060	3477	seawater	No boost pressure was recorded. Core may have sealed near total depth. Pressure stabilizes at 3250 psi at 1500 fbrf; far above hydrostatic.
UT-GOM2-1-H005-05FB	8111	8121	3.05	2.96	4015	3241	seawater	No pressure boost was recorded. Pressure declined from ~3400 to ~3100 during recovery. Core conditions briefly exited the methane hydrate stability zone.
UT-GOM2-1-H005-06FB	8121	8131	3.05	2.86	4010	3250	seawater	No pressure boost was recorded. Preserved pressure at approximately the hydrostatic pressure. Small fluctuations in pressure are probably due to temperature effects. There was high core recovery.

Core	Top (fbrf)	Bottom (fbrf)	Cored Interval (m)	Core Recovery (m)	Set/Boost Pressure (psi)	Recovery Pressure (psi)	Mud Weight (ppg)	Comment
UT-GOM2-1-H005-07FB	8131	8141	3.05	3.21	3000	3164	seawater	No pressure boost was recorded. Pressure declines as tool is picked up (~3600 to 3068 psi) and then it holds constant. In this run the boost pressure system was set at 3000 psi and used as an accumulator.
UT-GOM2-1-H005-08FB	8141	8151	3.05	2.5	3007	3015	9.5	No pressure boost recorded. Pressure declined from hydrostatic (~3700) to ~3,000 psi and then held constant. 250 cm of core was recovered. The core remained within the methane hydrate stability zone during the entire recovery process.
UT-GOM2-1-H005-09FB	8151	8161	3.05	2.7	4015	746	9.5	No pressure boost. Ball valve did not close until the PCTB was raised most of the way through the water column. (~1200 fbrf). Core clearly left the methane hydrate stability zone and began to dissociate.
UT-GOM2-1-H005-10FB	8161	8166	1.52	0.72	3204	3225	10.5	No pressure boost (accumulator pressure was set to 3,000 psi.) Core sealed when tool was raised to the point the accumulator was released. Sample remained in the methane hydrate stability zone: 72 cm recovery.
UT-GOM2-1-H005-11FB	8166	8176	3.05	0.27	3206	3001	10.5	Recovered with the ball valve closed and 3002 psi pressure. A total of 27 cm of sediment was recovered as determined by PCATS X-ray scans.
UT-GOM2-1-H005-12FB	8176	8186	3.05	1.65	3253	0	10.5	Failure; ball valve plugged with sediment, did not close
UT-GOM2-1-H005-13FB	8185	8193	2.44	1.76	4071	2806	10.5	Pressurized fell to 2900 psi and then sealed. Accumulator was set to high pressure.

Table 4.3.3 Summary of pressure coring runs from H005.

Core UT-GOM2-1-H005-01FB

Depth: 7645 – 7655 fbrf (282.5 – 285.6 mbsf)
Recovery: 7.12 ft (2.17 m), 71%
Pressure status: 4115 psi (28.45 MPa)

The deployment of UT-GOM2-1-H005-01FB is described in detail while remaining deployments are just summarized.

Deployment and recovery data for PCTB UT-GOM2-1-H005-01FB are shown in Figure 4.3.7, Figure 4.3.8, and Figure 4.3.9. The tool was initially lowered on the running tool and latched into the BHA (event 1, Figure 4.3.7A). The lowering of PCTB was indicated by the increase in slickline depth (Figure 4.3.7A) and the increase in pressure measured in the PCTB (Figure 4.3.7B). Temperature dropped as the tool was lowered through the water column to below the thermocline and into deeper water (Figure 4.3.7B). The temperature increase slightly as the PCTB was lowered below the seafloor and into the borehole. Pumping of drilling fluid occurred continuously at ~73 gal/min in this interval (Figure 4.3.7C). After lowering the PCTB, the running tool was retrieved (between event 1 and 2) and the pulling tool lowered to just above the BHA (beginning at event 2). Lowering of the pulling tool is indicated by the increase in slickline depth (Figure 4.3.7A) and increase in pressure recorded at pulling tool (Figure 4.3.7B). The beginning of coring is highlighted as event 3 (Figure 4.3.7A) marked by high positive value of rate of penetration (ROP) and weight on bit (WOB) shown in Figure 3.7 C. The pump rate increased to ~ 120 gal/min just before coring began, but during coring, a nearly constant pump rate of ~90 gal/min was maintained (Figure 4.3.7C). When the full coring stroke was achieved, the bit was lifted and the weight on bit (WOB) decreased to zero (Figure 4.3.7C) bringing the coring to an end (event 4). The pulling tool was then latched on to the inner barrel (event 5) and the inner barrel was pulled out of the BHA (Figure 4.3.7A). The upward pull on the inner barrel, as indicated by increase in slickline tension (event 6, Figure 4.3.7), activated the ball valve, sealing the core barrel with a pressure boost of ~450 psi (Figure 4.3.7B). The closure of ball valve is indicated by a clear divergence of core pressure from the pulling tool pressure (Figure 4.3.7B) and the pressure boost is indicated by a near instantaneous increase in core pressure by ~450 psi (Figure 4.3.7B). The PCTB was pulled back to the surface (event 6, Figure 4.3.7A) while the core pressure was maintained above reservoir pressure. An expanded view of the pullout and retrieval is shown in Figure 4.3.8. Figure 4.3.9 tracks the pressure and temperature measured at the top of the core, with a comparison to the methane hydrate stability boundary at seawater salinity. As the inner barrel was lowered, it passed into the methane hydrate stability zone (event 1 to event 5 in Figure 4.3.9). Because the PCTB sealed (event 6), the core remained within hydrate stability zone, as the inner barrel was pulled to the surface (event 7).

Coring was completed in 10 minutes. Core UT-GOM2-1-H005-01FB properly boosted and sealed. 2.17 m was recovered. Initial scans revealed that a large part of the recovered core (~1.6 m) is low density (1.75 g/cc), low velocity (1550 m/s) sediment (see 4.4 Physical Properties), without clear hydrate occurrences. The remaining 0.5 m had slightly higher velocity and density, as well as some wispy vein features in the X-ray images that may be gas hydrate. The interpretation is that the upper 1.6 m of material was washed into the base of the borehole. The bottom 0.5 m represents in situ material.

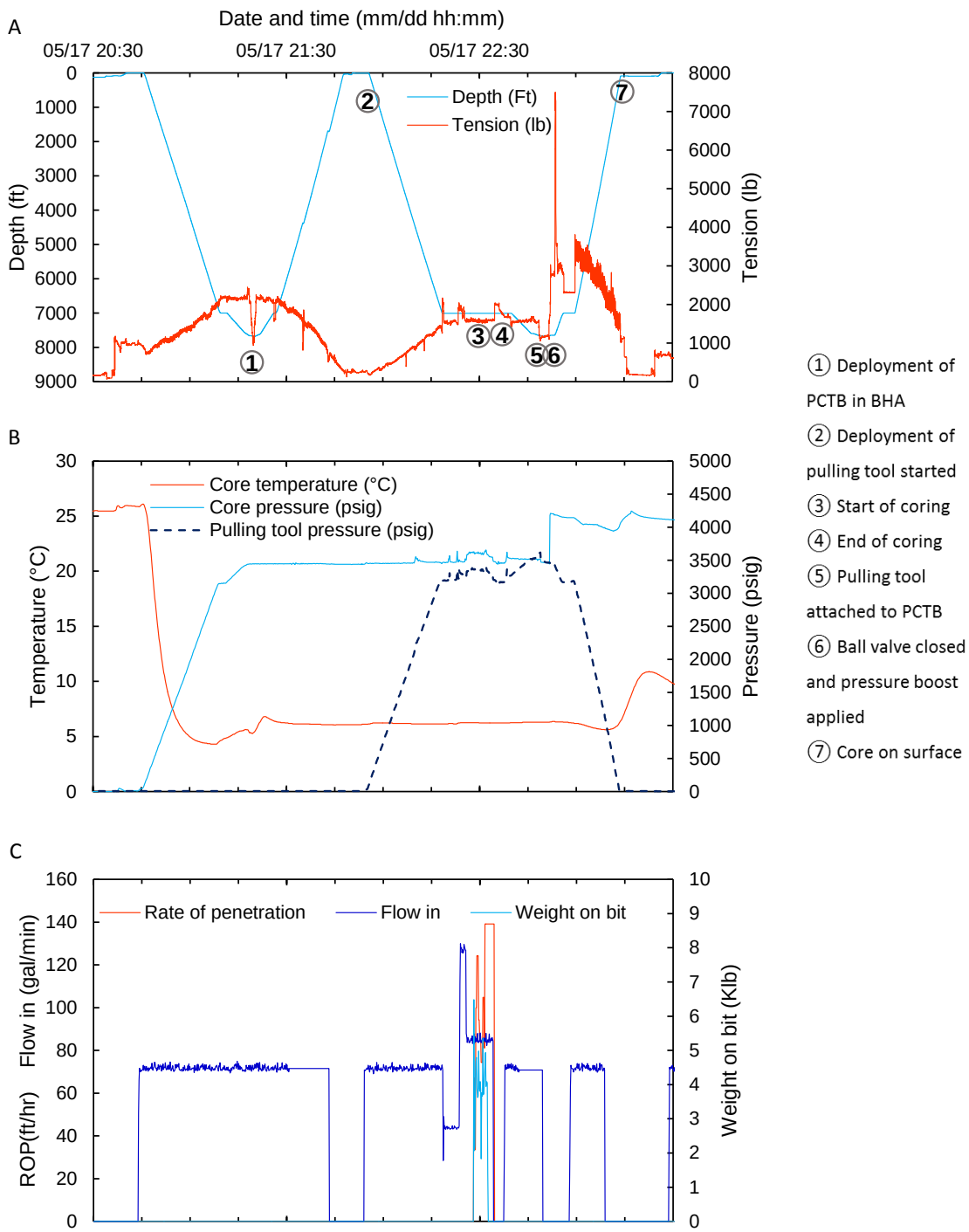


Figure 4.3.7 UT-GOM2-1-H005-01FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit, the cap that contacts the top of the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

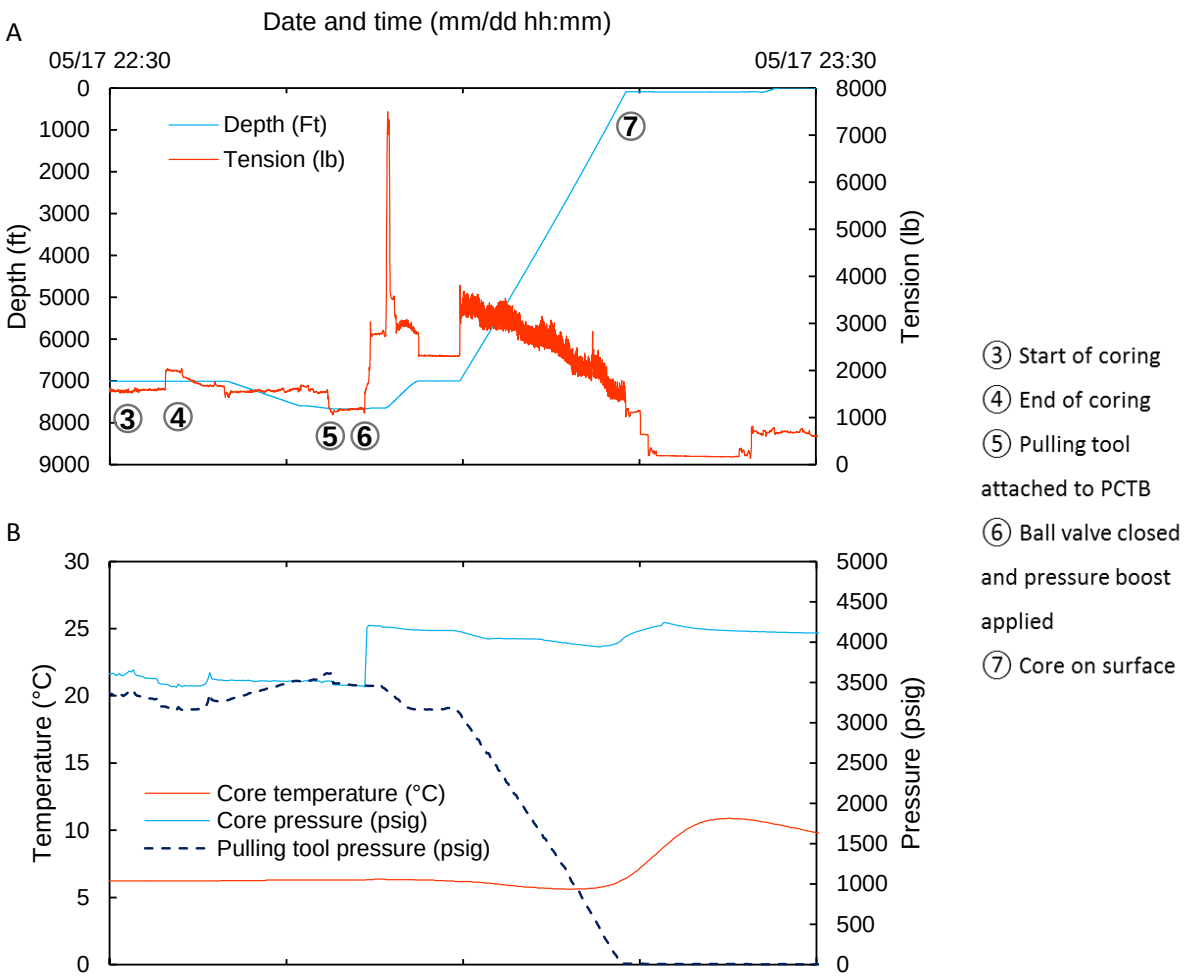


Figure 4.3.8 UT-GOM2-1-H005-01FB core retrieval details. A zoomed in section of Figure 4.3.7 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

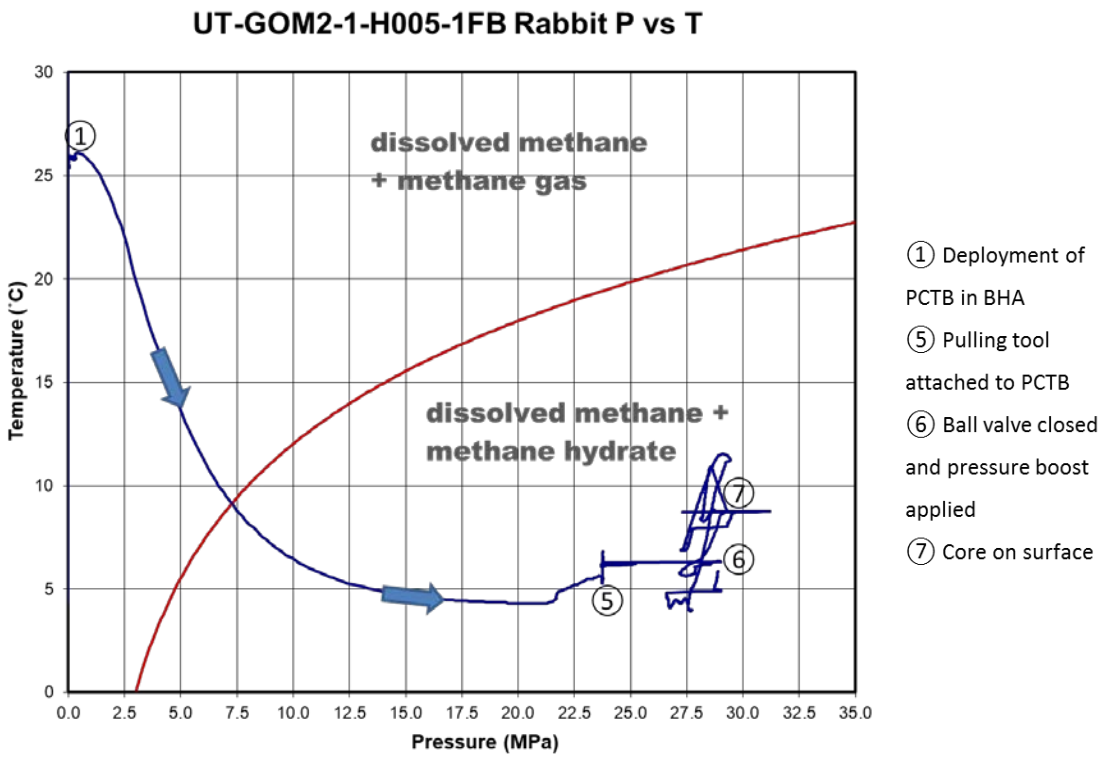


Figure 4.3.9 UT-GOM2-1-H005-01FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-02FB

Depth: 8081 – 8091 fbrf (415.4 – 418.5 mbsf)
Recovery: 4.92 ft (1.5 m), 49%
Pressure status: 2834 psi (19.63 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-02FB are shown in Figure 4.3.10, Figure 4.3.11, and Figure 4.3.12. After coring, the PCTB remained at the bottom of the hole for 18 minutes until retrieval began. A boost pressure was not recorded in Core UT-GOM2-1-H005-02FB. Ball valve closure was achieved at least 6000 ft above coring depth (event 6, Figure 4.3.10A), which caused the core to briefly exit the methane hydrate stability zone before it was brought back into the zone with a pressure boost at the surface (Figure 4.3.12). Pressure declined as the PCTB was raised. At 2059 fbrf, the barrel appeared to seal at approximately 856 psi, which is hydrostatic pressure. As the core was raised further, pressure continued to decline and the temperature decreased. At 1792 fbrf pressure started to increase reaching 1147 psi, potentially due to further dissociation of the hydrate. At the rig floor, a leak was observed at the ball valve seal. The core was immediately pressurized further and taken to PCATS. 150 cm of sediment was recovered with little disturbance and containing intervals of P-wave velocities >3000 m/s indicating a likely high hydrate saturation (see 4.4 Physical Properties). PCATS results suggest

that, although the tool may have left the methane hydrate stability zone, hydrate dissociation did not occur.

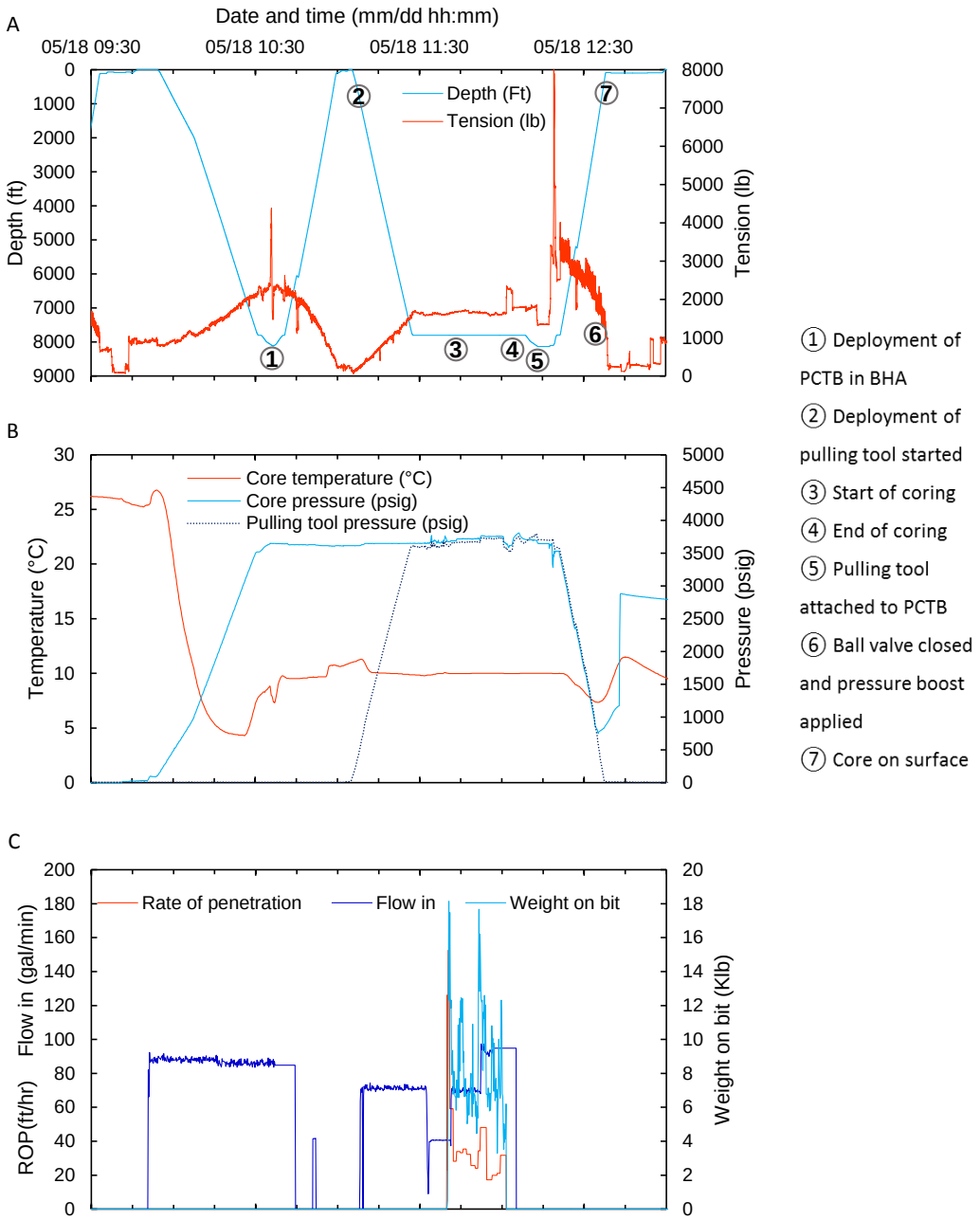


Figure 4.3.10 UT-GOM2-1-H005-02FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

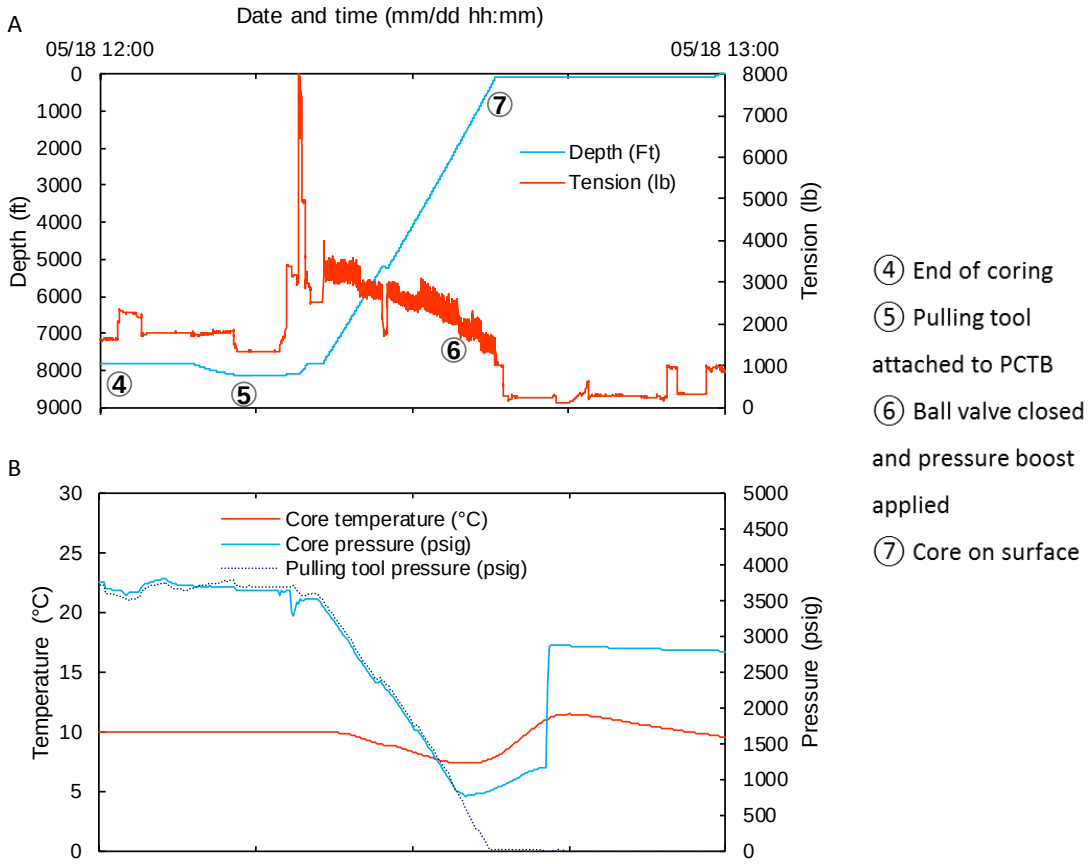


Figure 4.3.11 UT-GOM2-1-H005-02FB core retrieval details. A zoomed in section of Figure 4.3.10 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

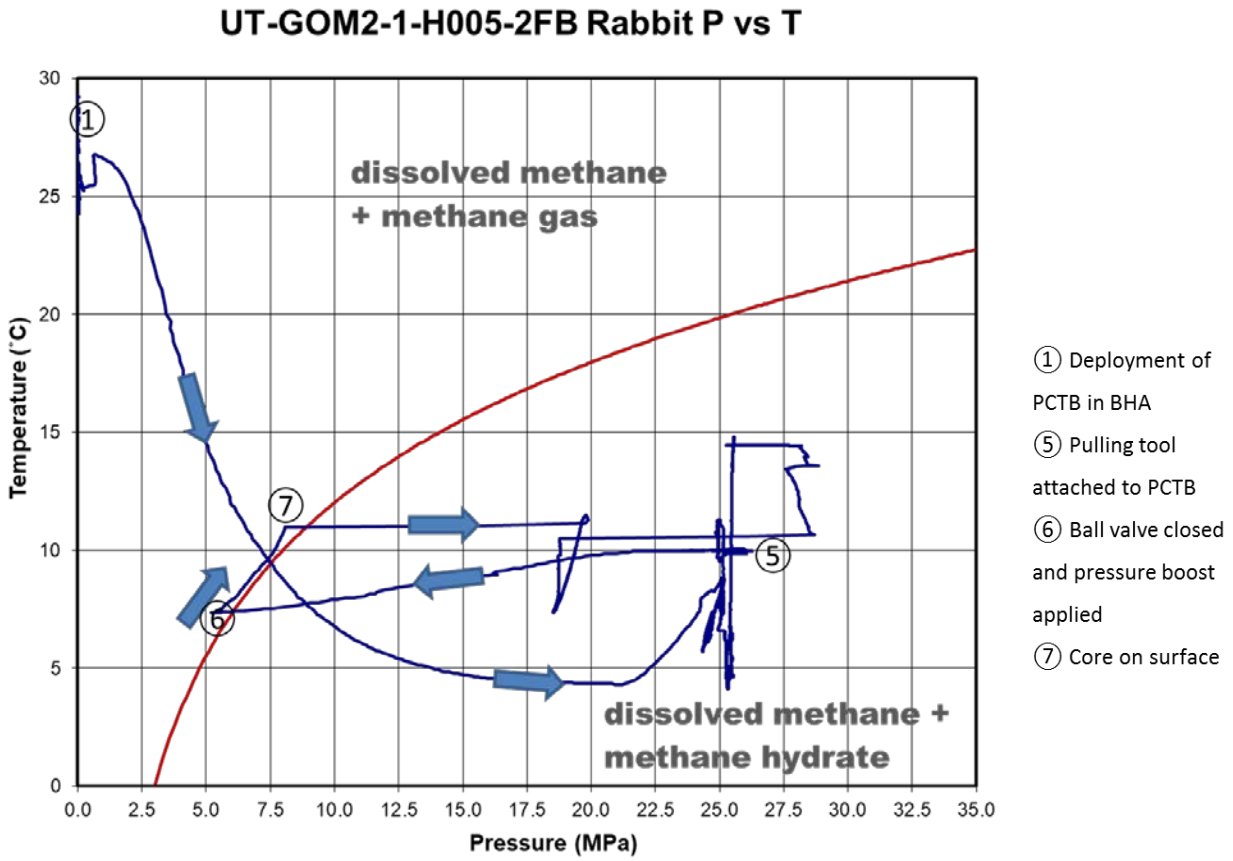


Figure 4.3.12 UT-GOM2-1-H005-02FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-03FB

Depth: 8091 – 8101 fbrf (418.5 – 421.5 mbsf)
Recovery: 9.97 ft (3.04 m), 100%
Pressure status: 1780 psi (12.37 MPa)

Deployment and recovery data for UT-GOM2-1-H005-03FB are shown in Figure 4.3.13, Figure 4.3.14, and Figure 4.3.15. UT-GOM2-1-H005-03FB did not record a pressure boost. Although the ball valve closed at ~6500 fbrf, it only partially sealed and the PCTB lost pressure until a depth of approximately 1300 fbrf, where the pressure was ~1800 psi.

Further pressure drop has been attributed to a pin hole leak in ball valve. The recovery pressure was significantly higher than hydrostatic pressure (~559 psi). Total sediment recovery was 304 cm. The core briefly exited the methane hydrate stability zone during recovery (Figure 4.3.15, point 7) probably after reaching the rig floor but no physical evidence of hydrate dissociation was found from PCATS data.

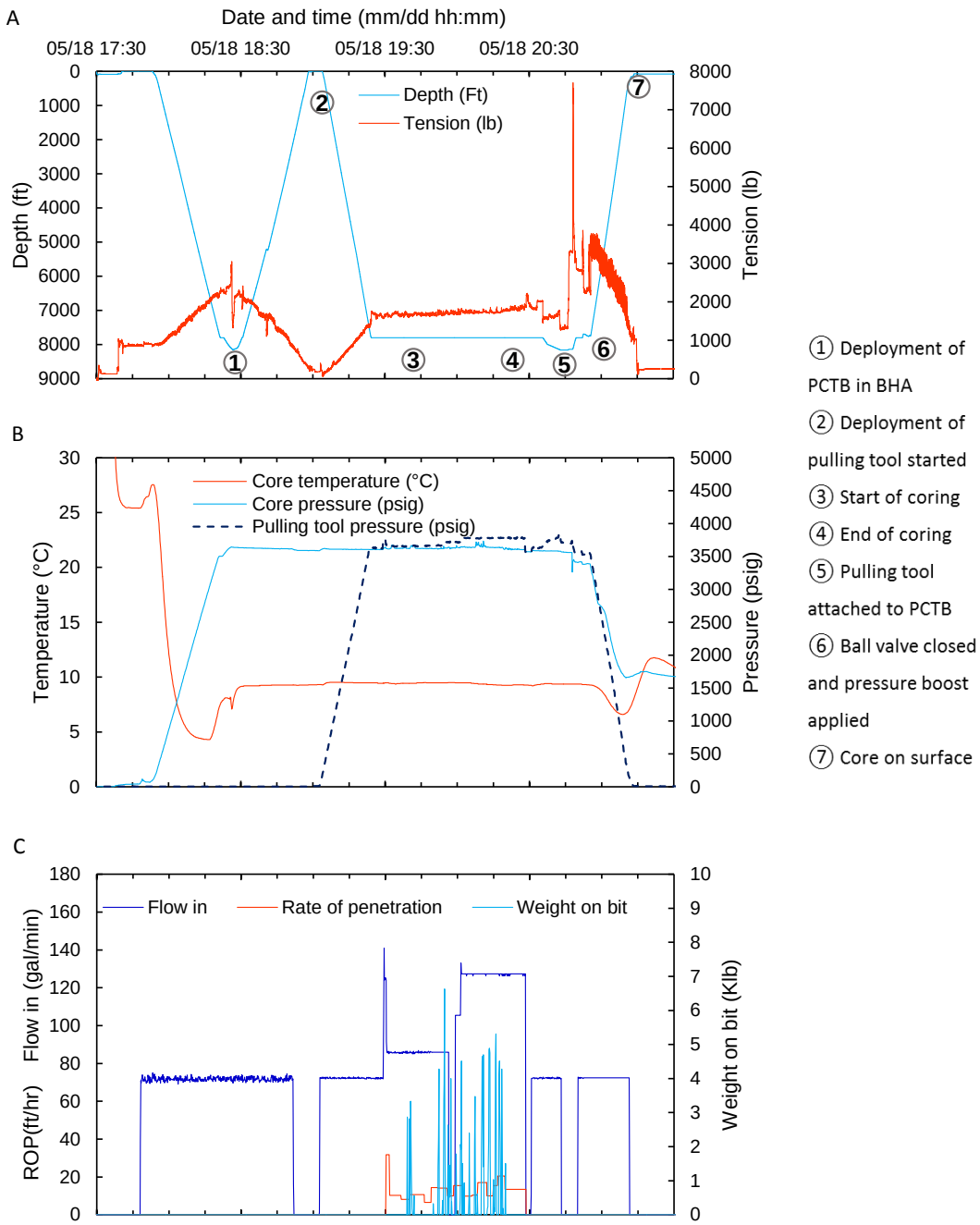


Figure 4.3.13 UT-GOM2-1-H005-03FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

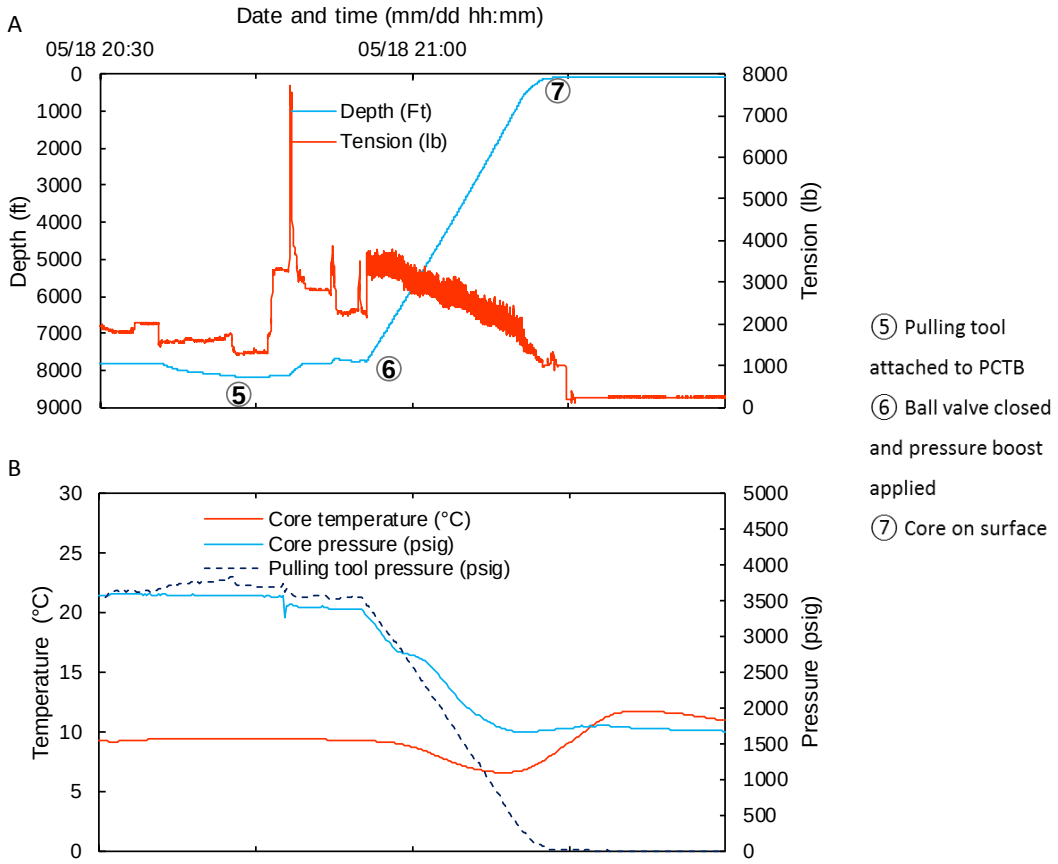


Figure 4.3.14 UT-GOM2-1-H005-03FB core retrieval details. A zoomed in section of Figure 4.3.13 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

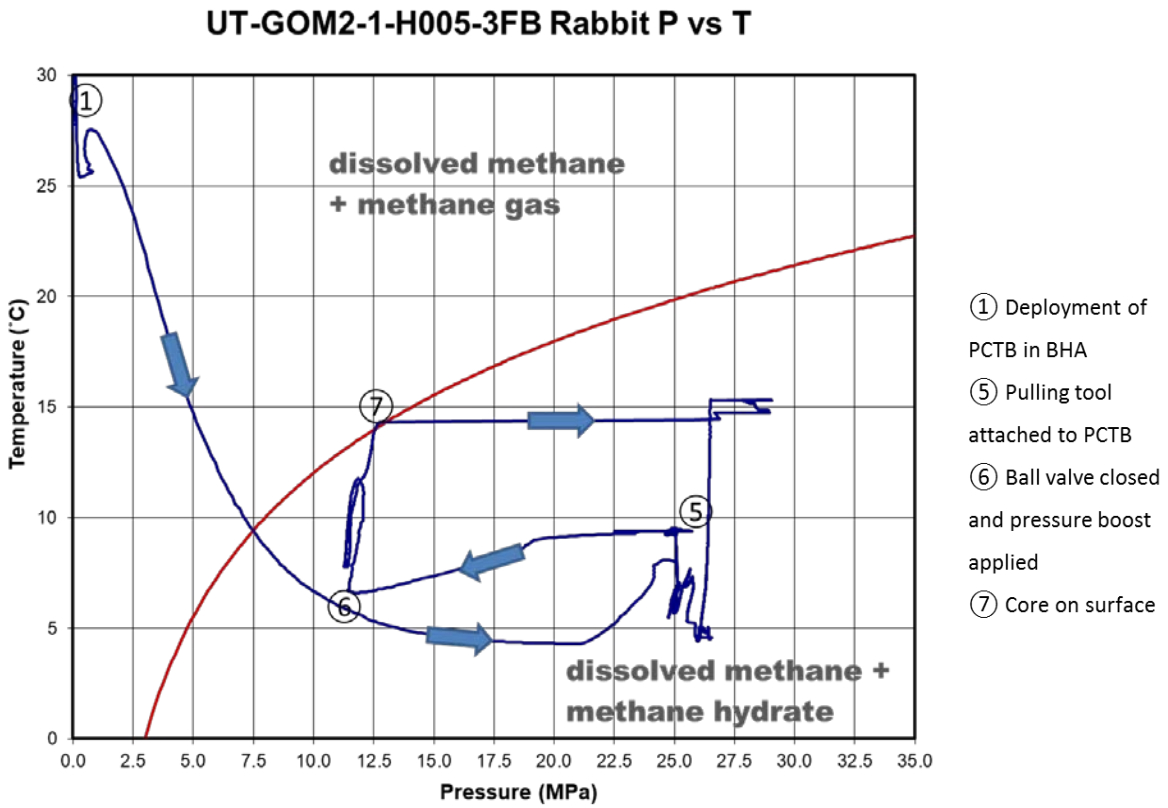


Figure 4.3.15 UT-GOM2-1-H005-03FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-04FB

Depth: 8101 – 8111 fbrf (421.5 – 424.6 mbsf)
Recovery: 10.5 ft (3.21 m), 105%
Pressure status: 3477 psi (24.06 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-04FB are shown in Figure 4.3.16, Figure 4.3.17, and Figure 4.3.18. UT-GOM2-1-H005-04FB was recovered under pressure. The PCTB sealed about 300 ft above core depth, without any recorded pressure boost. However, the rapid temperature rise during the later part of the ascent of the PCTB to the surface caused the core to briefly touch the methane hydrate stability boundary (Figure 4.3.18). No physical evidence of significant hydrate dissociation was found in the X-ray image of the core. The recovered core length was 3.21 m, which is slightly higher than the planned length.

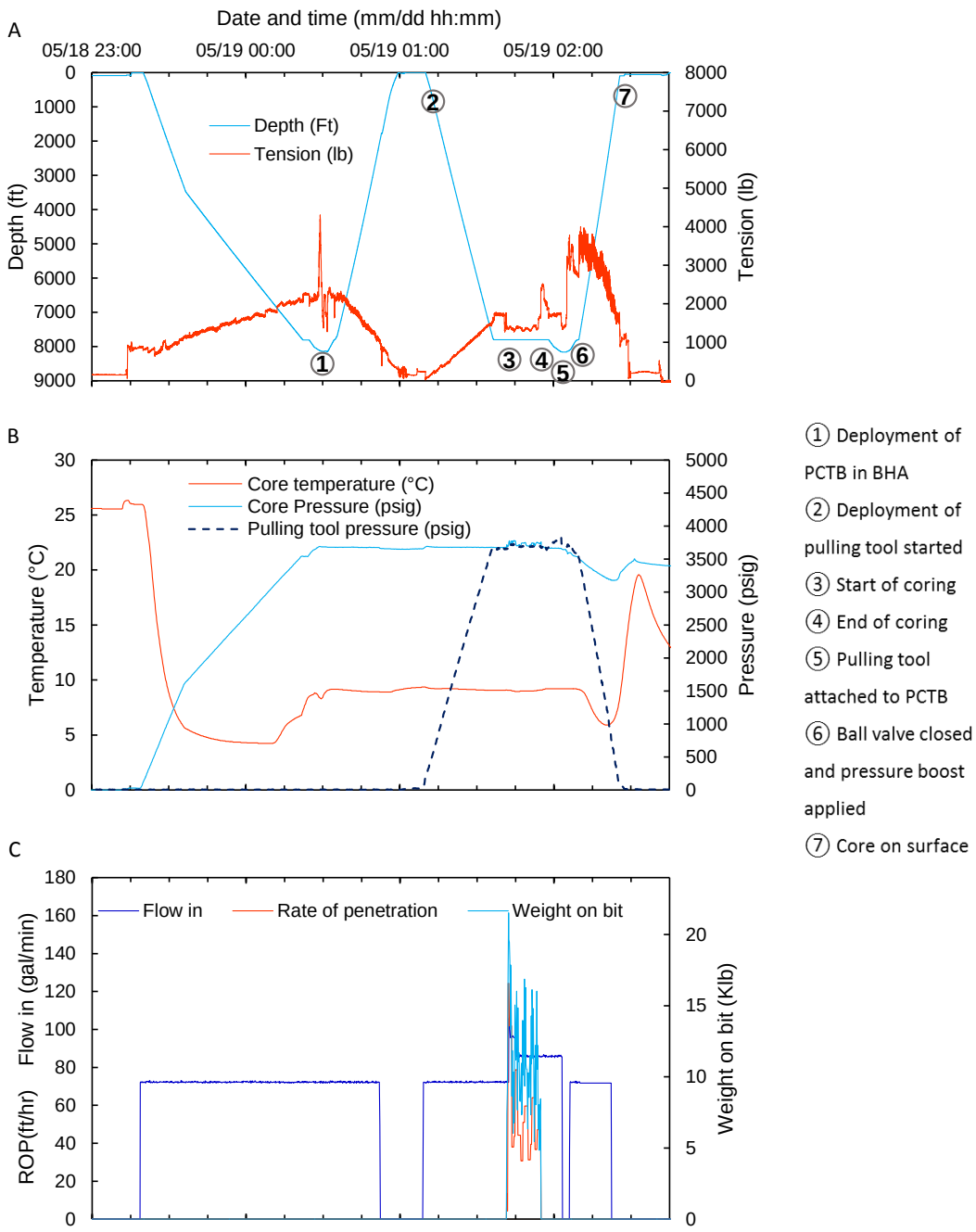


Figure 4.3.16 UT-GOM2-1-H005-04FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

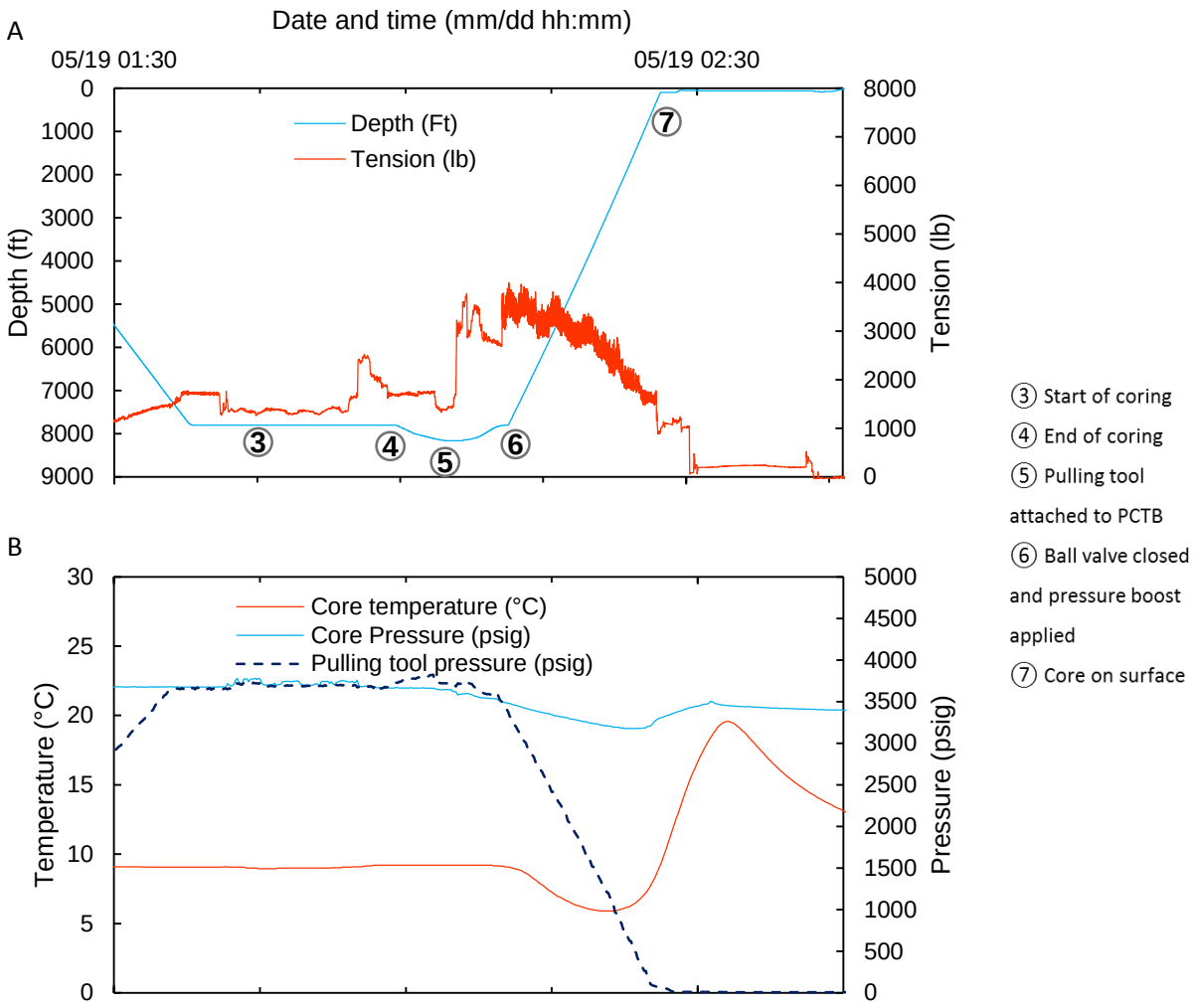


Figure 4.3.17 UT-GOM2-1-H005-04FB core retrieval details. A zoomed in section of Figure 4.3.16 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

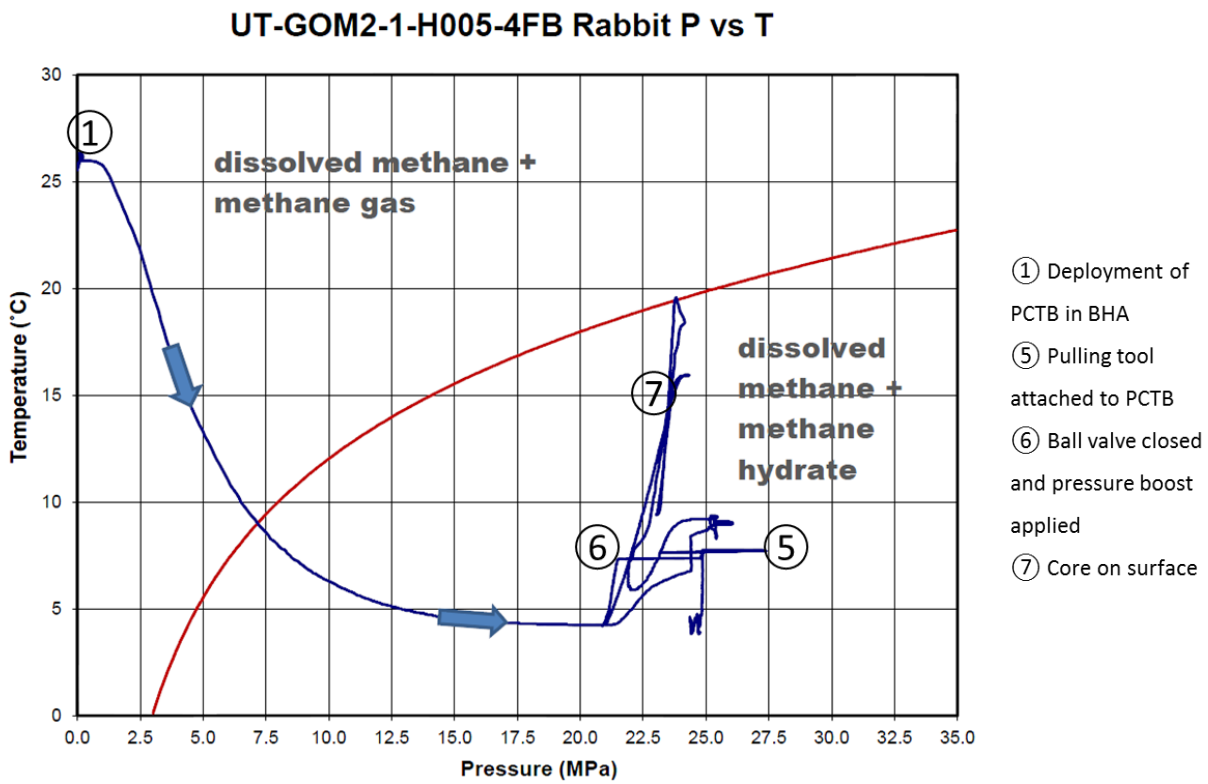


Figure 4.3.18 UT-GOM2-1-H005-04FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-05FB

Depth: 8111 – 8121 fbrf (424.6 – 427.6 mbsf)
Recovery: 9.97 ft (2.96 m), 97%
Pressure status: 3164 psi (21.90 MPa)

Deployment and retrieval data of UT-GOM2-1-H005-05FB are shown in Figure 4.3.19, Figure 4.3.20, and Figure 4.3.21. As the PCTB was retrieved using the pulling tool, the ball valve sealed at approximately 365 ft above core depth. No pressure boost was observed. Pressure declined from ~3400 to ~3100 psi during recovery. The core was retrieved without leaving the methane hydrate stability zone (Figure 4.3.21). 2.96m of core was retrieved at a pressure slightly below in situ pressure at core depth.

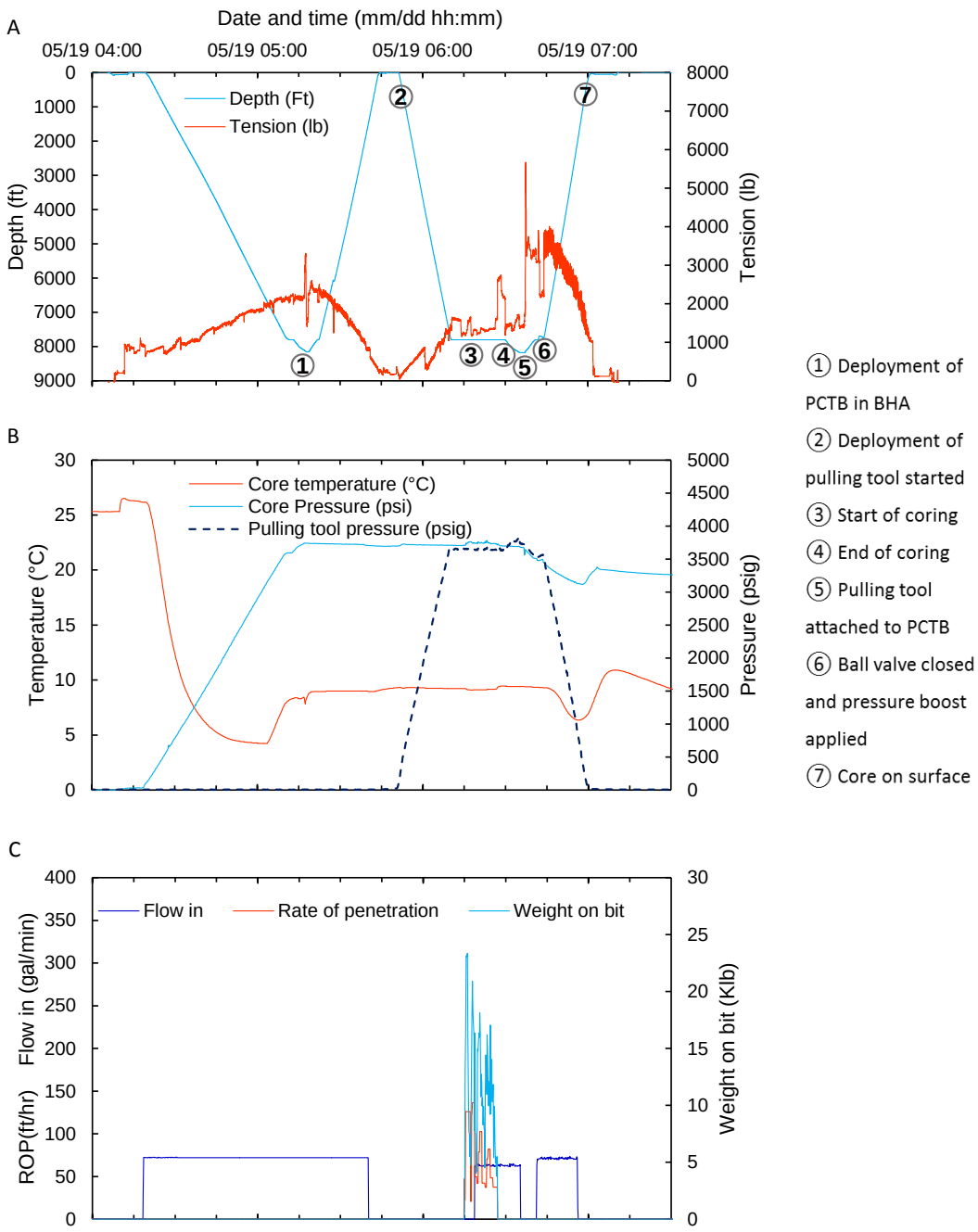


Figure 4.3.19 UT-GOM2-1-H005-05FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

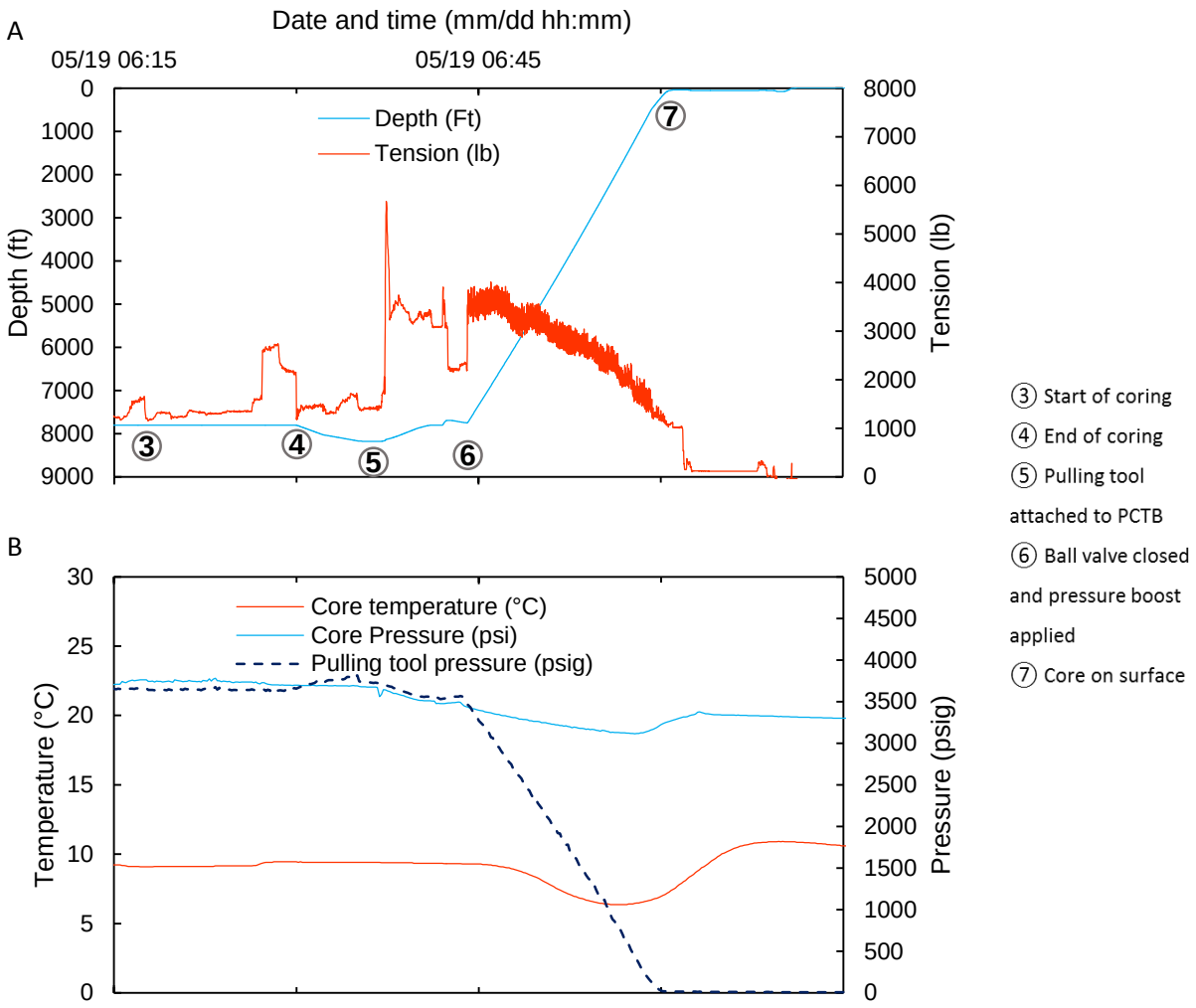


Figure 4.3.20 UT-GOM2-1-H005-05FB core retrieval details. A zoomed in section of Figure 4.3.19 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

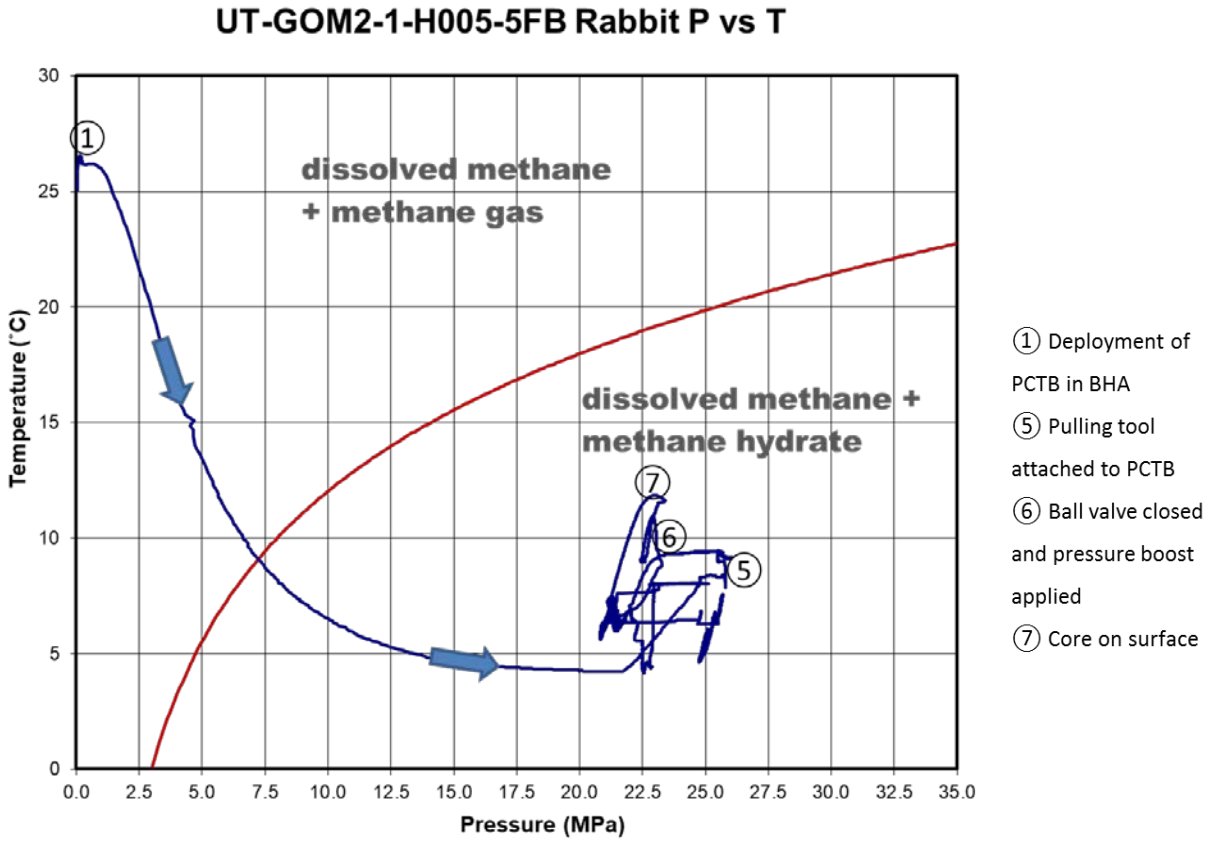


Figure 4.3.21 UT-GOM2-1-H005-05FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-06FB

Depth: 8121 – 8131 fbrf (427.6 – 430.7 mbsf)
Recovery: 9.38 ft (2.86 m), 94%
Pressure status: 3250 psi (22.49 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-06FB are shown in Figure 4.3.22, Figure 4.3.23, and Figure 4.3.24. While the core was retrieved using the pulling tool, the ball valve sealed at core depth (Figure 4.3.22, event 6). No pressure boost was recorded. The recovery of the PCTB was paused near the seafloor for ~ 15 minutes, before it was brought to the surface. The core remained within the methane hydrate stability zone (Figure 4.3.24). 2.86 m of core was retrieved.

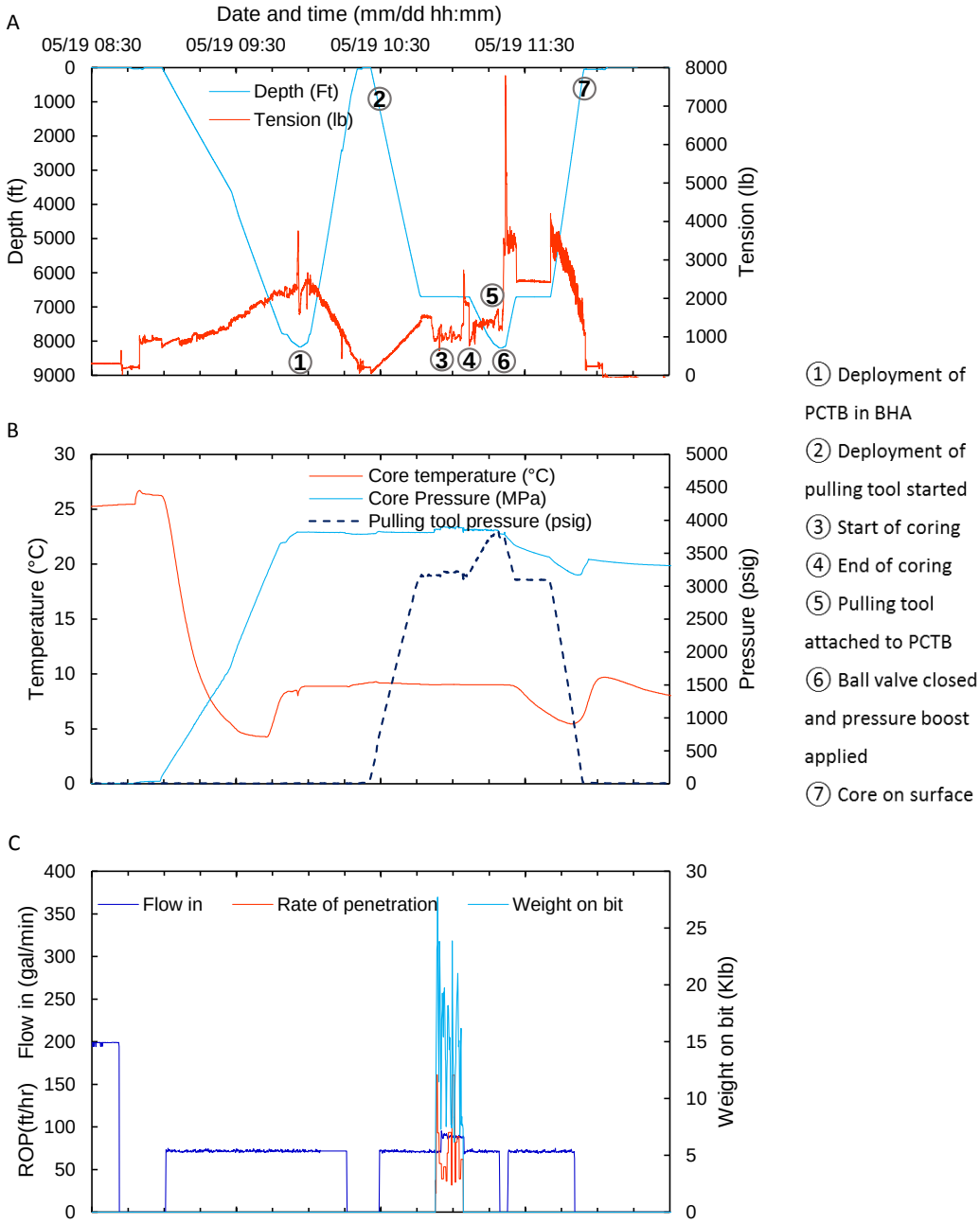


Figure 4.3.22 UT-GOM2-1-H005-06FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

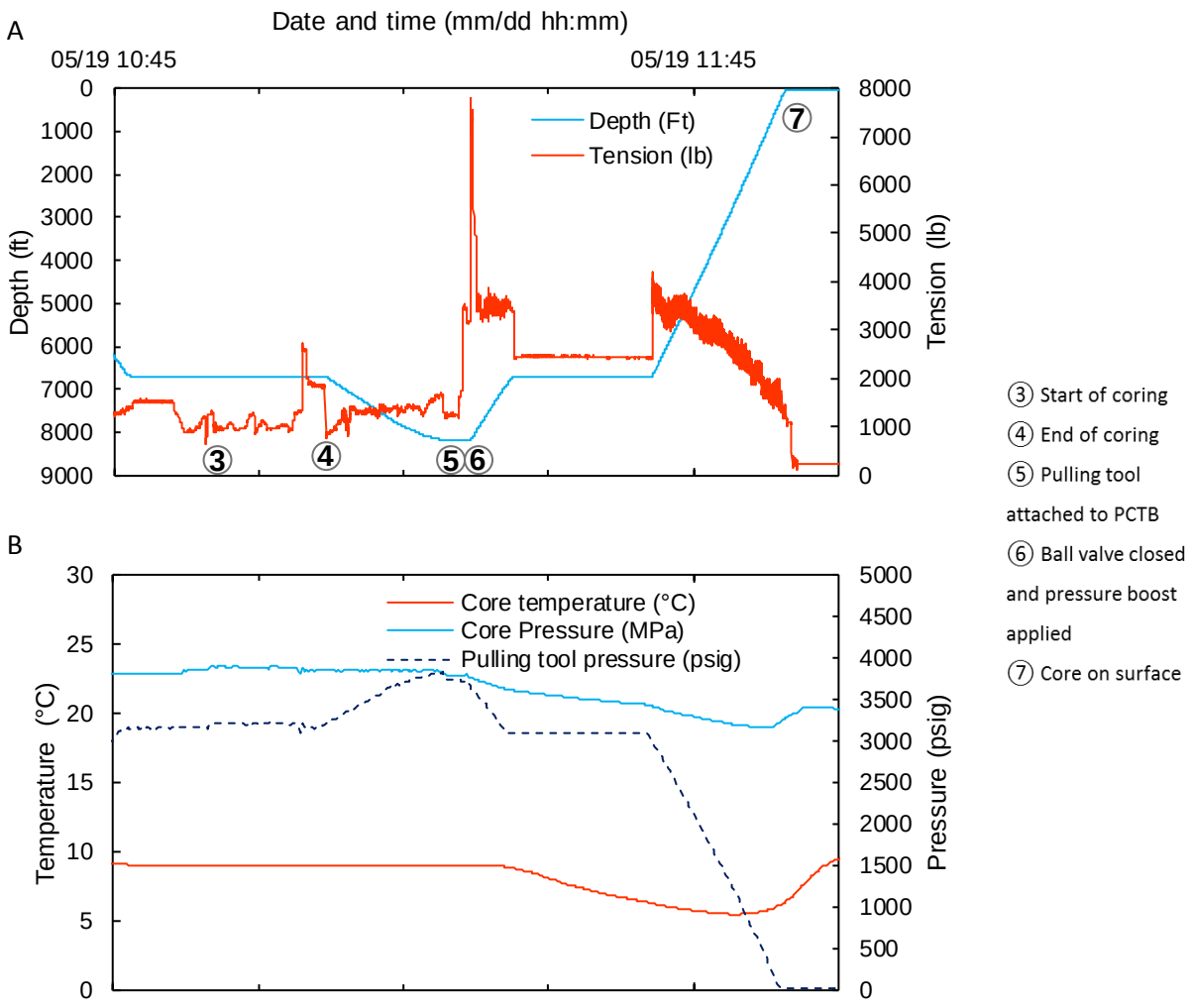


Figure 4.3.23 UT-GOM2-1-H005-06FB core retrieval details. A zoomed in section of Figure 4.3.22 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

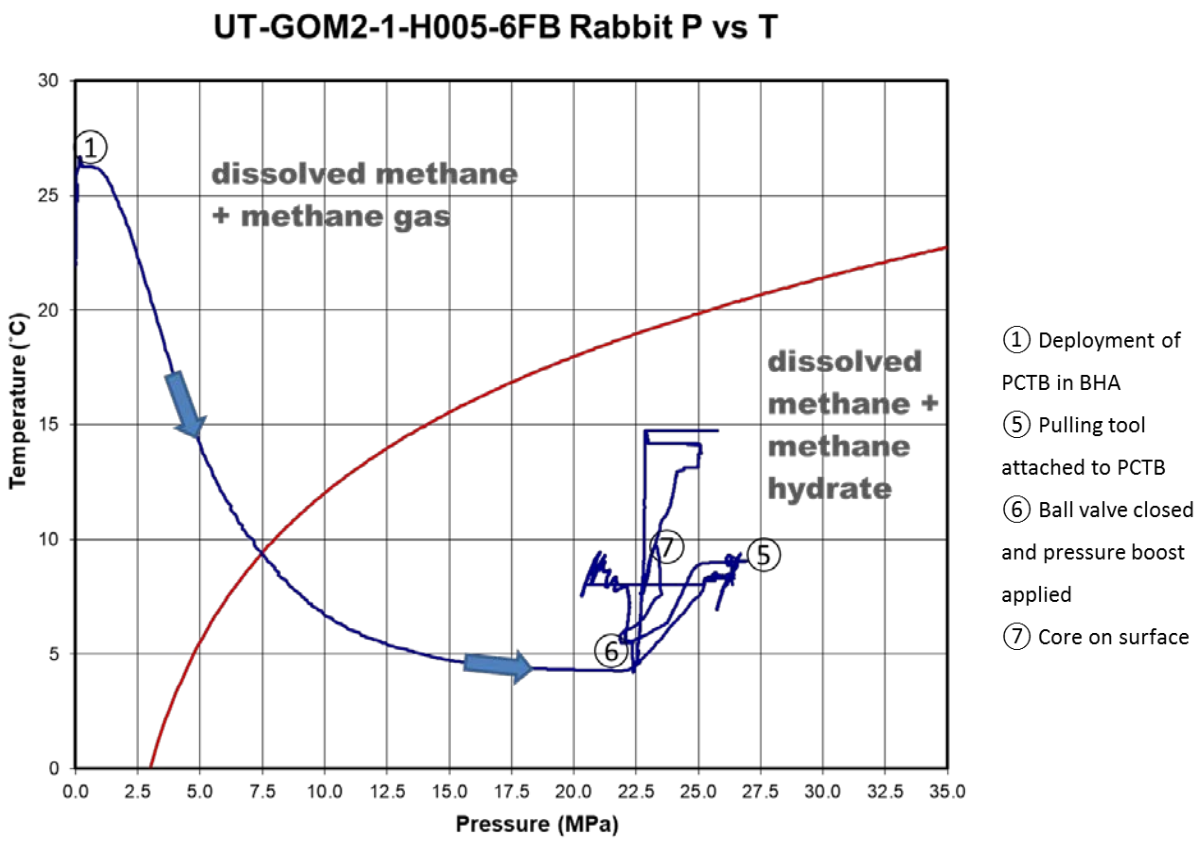


Figure 4.3.24 UT-GOM2-1-H005-06FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-07FB

Depth: 8131 – 8141 fbrf (430.7 – 433.7 mbsf)
Recovery: 10.5 ft (3.21 m), 105%
Pressure status: 3164 psi (21.90 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-07FB are shown in Figure 4.3.25, Figure 4.3.26, and Figure 4.3.27. While the core was retrieved using the pulling tool it was paused near the seafloor for ~20 minutes. Once the PCTB continued to be raised from the seafloor, the ball valve closed sealed at ~6587 fbrf (Figure 4.3.25, event 6). No pressure boost was recorded. The core was retrieved under pressure and it remained within the methane hydrate stability zone (Figure 4.3.27). 3.21 m of core was retrieved.

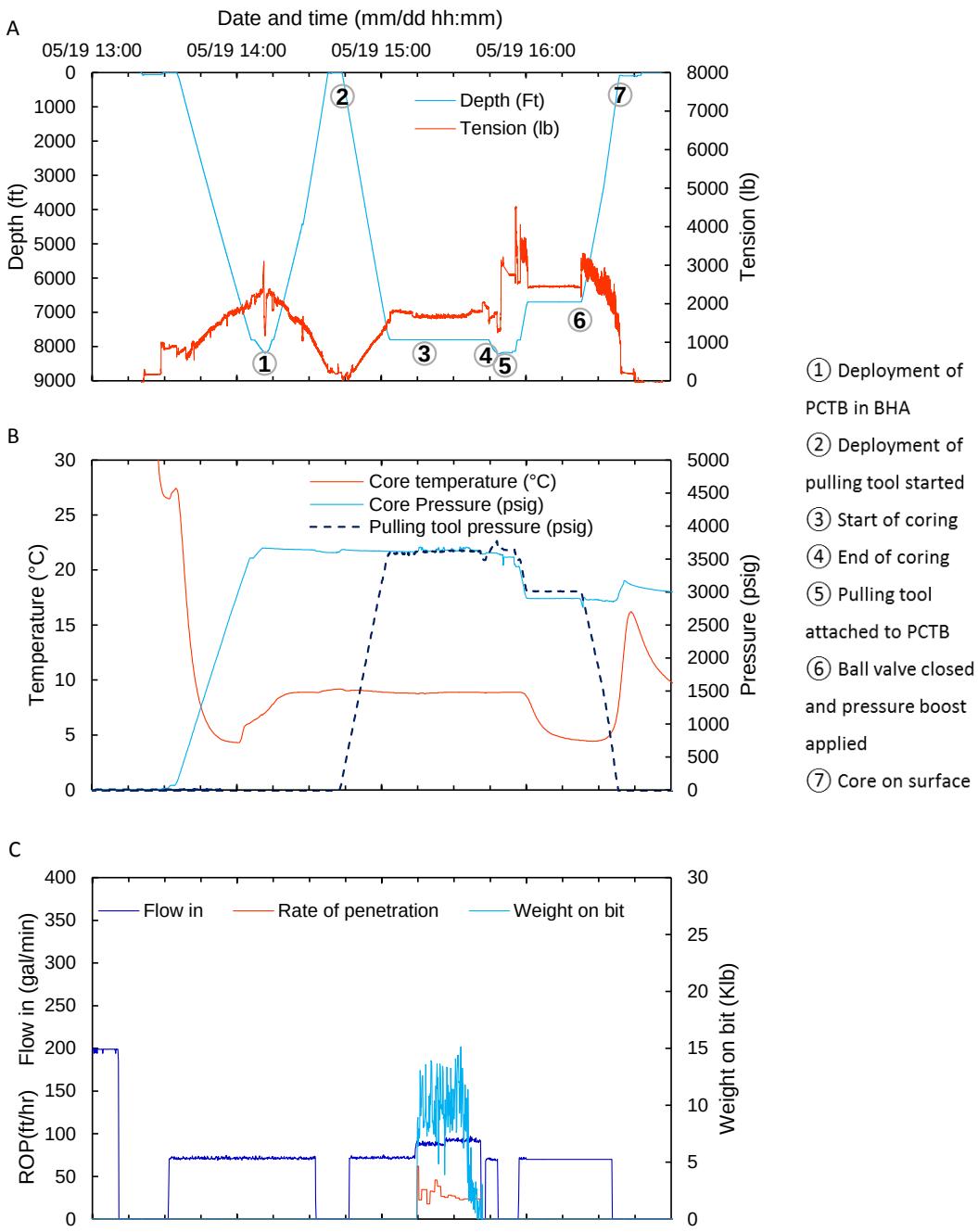


Figure 4.3.25 UT-GOM2-1-H005-07FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

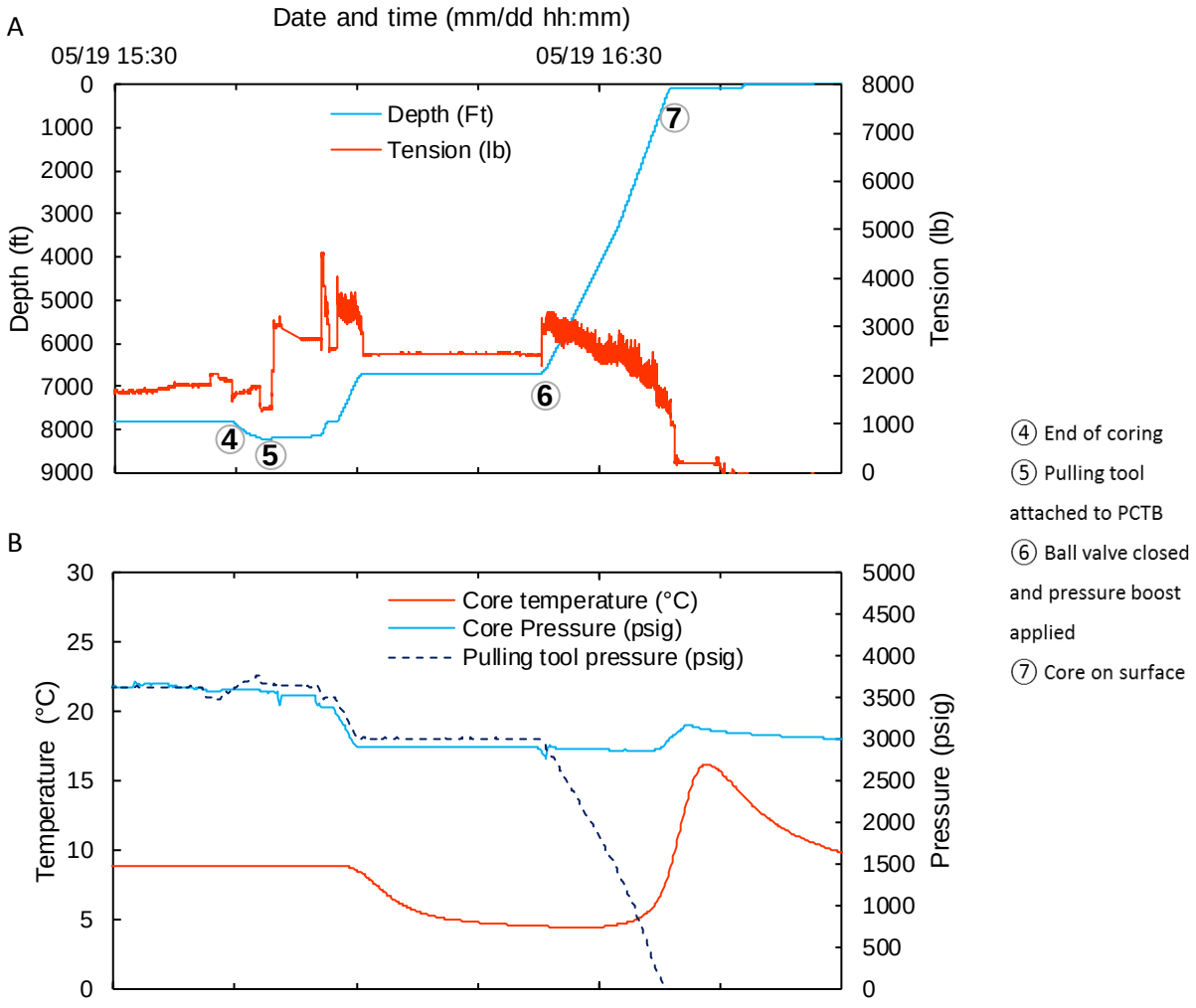


Figure 4.3.26 UT-GOM2-1-H005-07FB core retrieval details. A zoomed in section of Figure 4.3.25 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

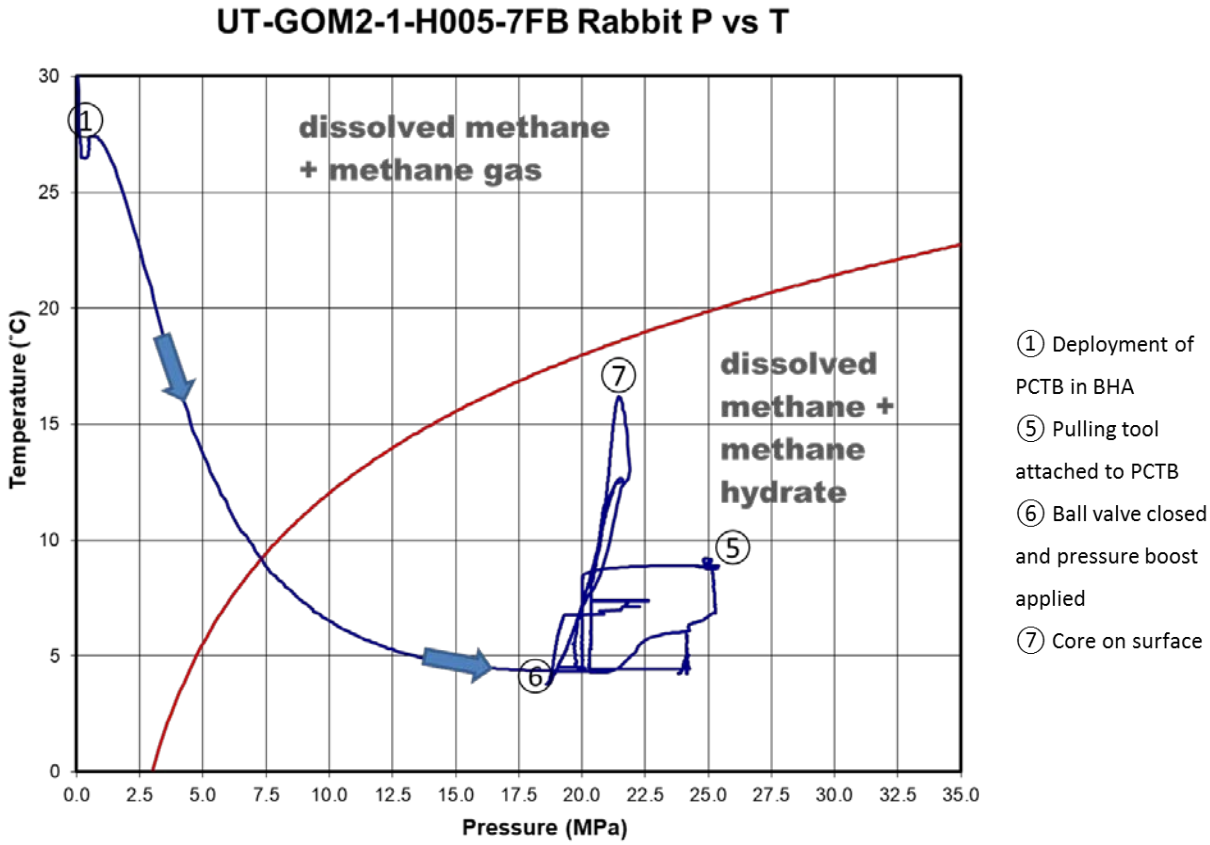


Figure 4.3.27 UT-GOM2-1-H005-07FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-08FB

Depth: 8141 – 8151 fbrf (433.7 – 436.8 mbsf)
Recovery: 8.20 ft (2.50 m), 82%
Pressure status: 3016 psi (20.88 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-08FB are shown in Figure 4.3.28, Figure 4.3.29, and Figure 4.3.30. While the core was retrieved using the pulling tool it was kept near the seafloor for ~20 minutes. As the core was raised from seafloor, the ball valve sealed at ~6700 fbrf (Figure 4.3.28, event 6). No pressure boost was recorded. The core was retrieved under pressure and it remained within the methane hydrate stability zone (Figure 4.3.30). 2.50 m of core was retrieved.

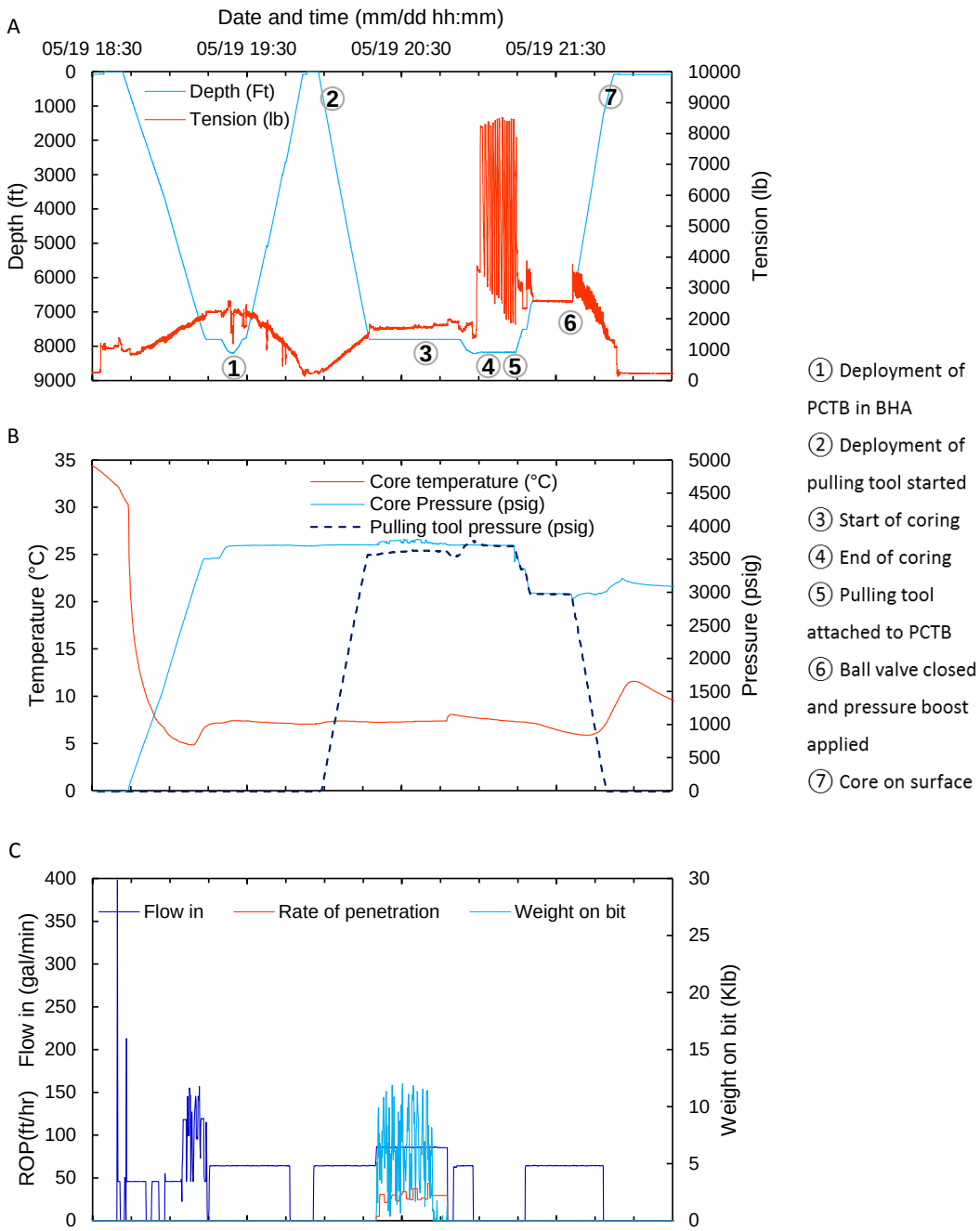


Figure 4.3.28 UT-GOM2-1-H005-08FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

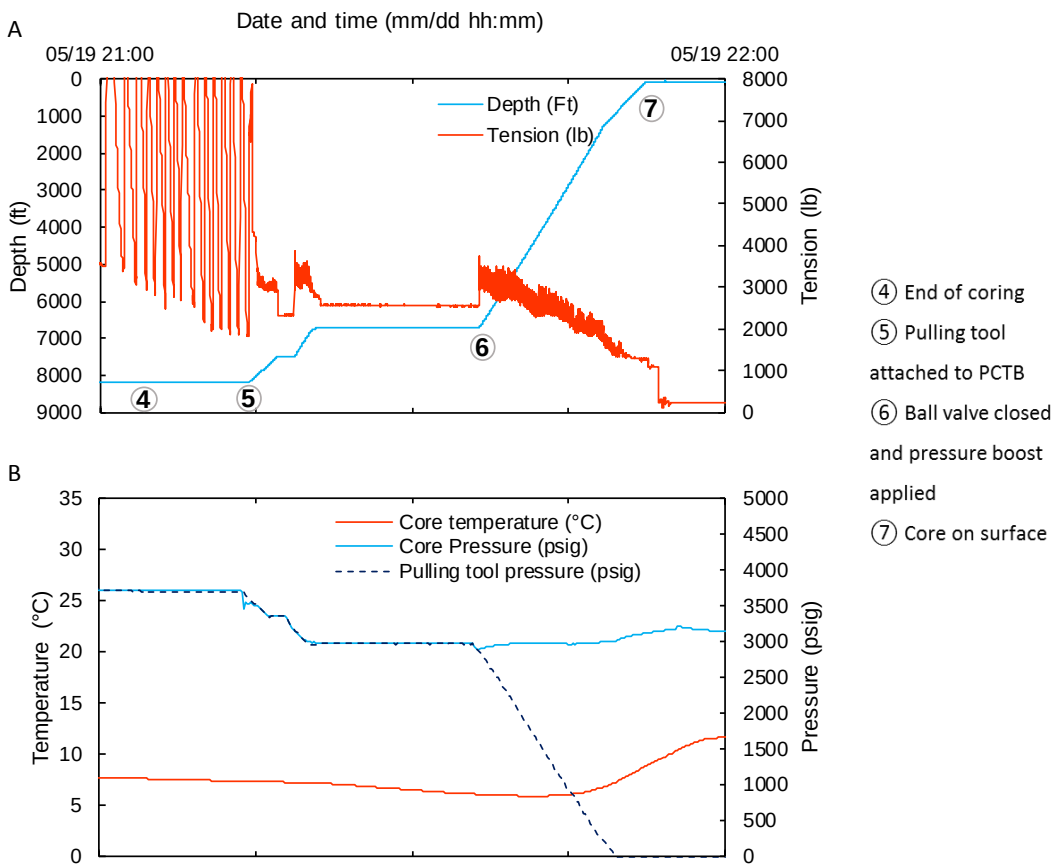


Figure 4.3.29 UT-GOM2-1-H005-08FB core retrieval details. A zoomed in section of Figure 4.3.28 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

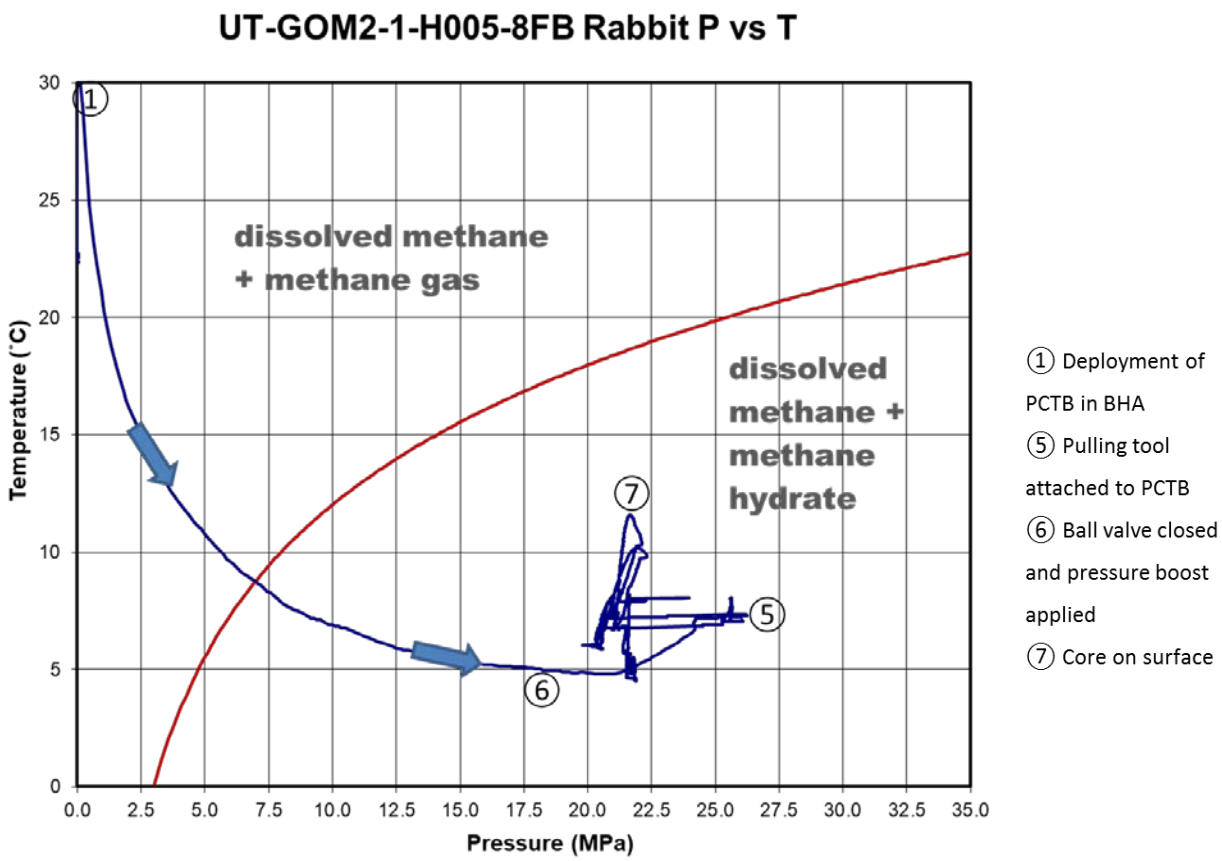


Figure 4.3.30 UT-GOM2-1-H005-08FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-09FB

Depth: 8151 – 8161 fbrf (436.8 – 439.8 mbsf)
Recovery: 8.86 ft (2.70 m), 89%
Pressure status: 746 psi (5.24 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-09FB are shown in Figure 4.3.31 and Figure 4.3.32. While the core was retrieved using the pulling tool, it was kept near the seafloor for ~20 minutes. Once the PCTB retrieval was restarted, the core was raised without sealing until the ball valve closed at ~1215 fbrf (Figure 4.3.31, event 6). No pressure boost was recorded. Since the ball valve closed at a very shallow depth, the core did not remain within the methane hydrate stability zone (Figure 4.3.33). 2.70 m of core was recovered under pressurized condition, but the core pressure and temperature conditions left the methane hydrate stability zone. The core X-ray images showed evidence of hydrate dissociation (see 4.4 Physical Properties and Core Transfer).

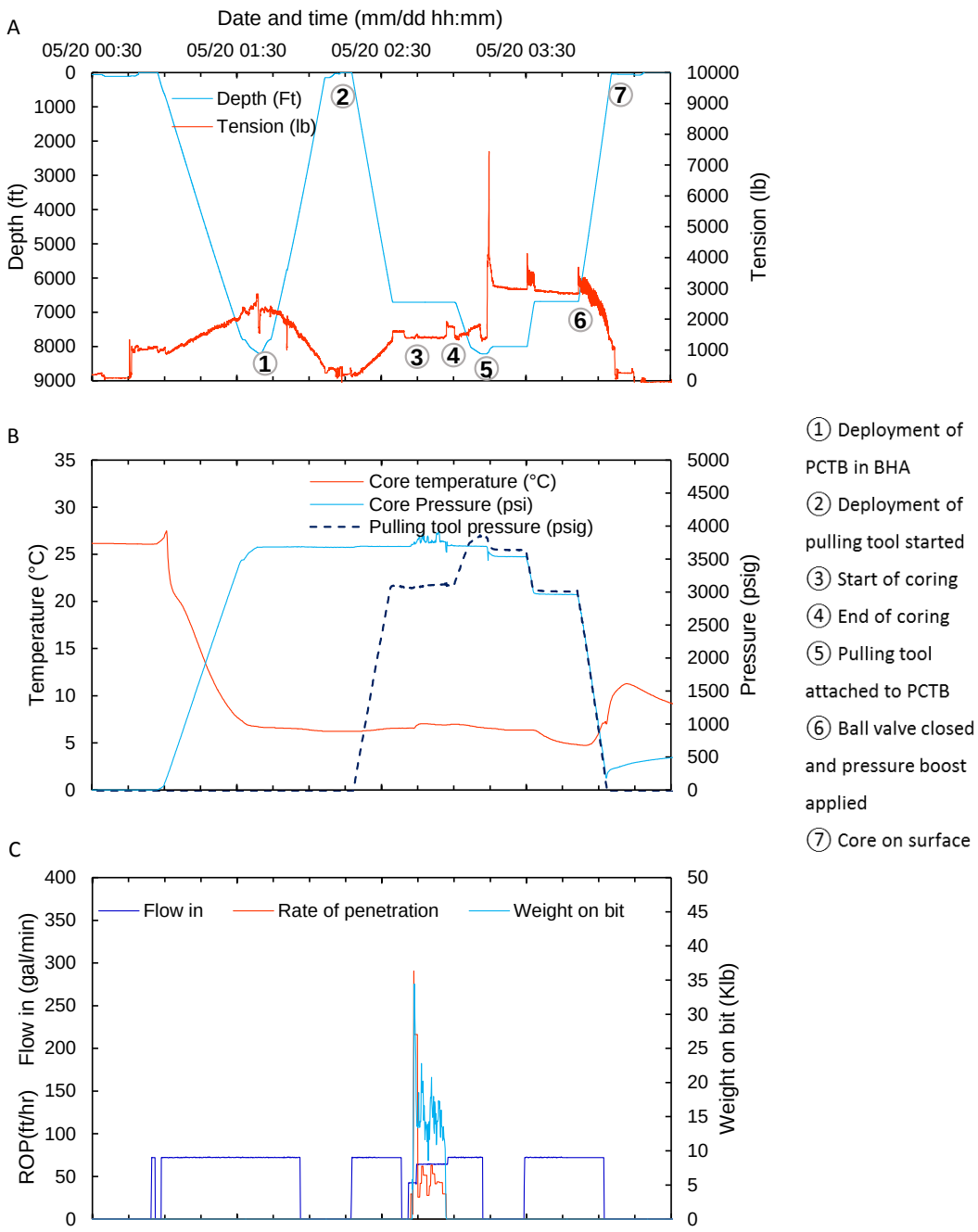


Figure 4.3.31 UT-GOM2-1-H005-09FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

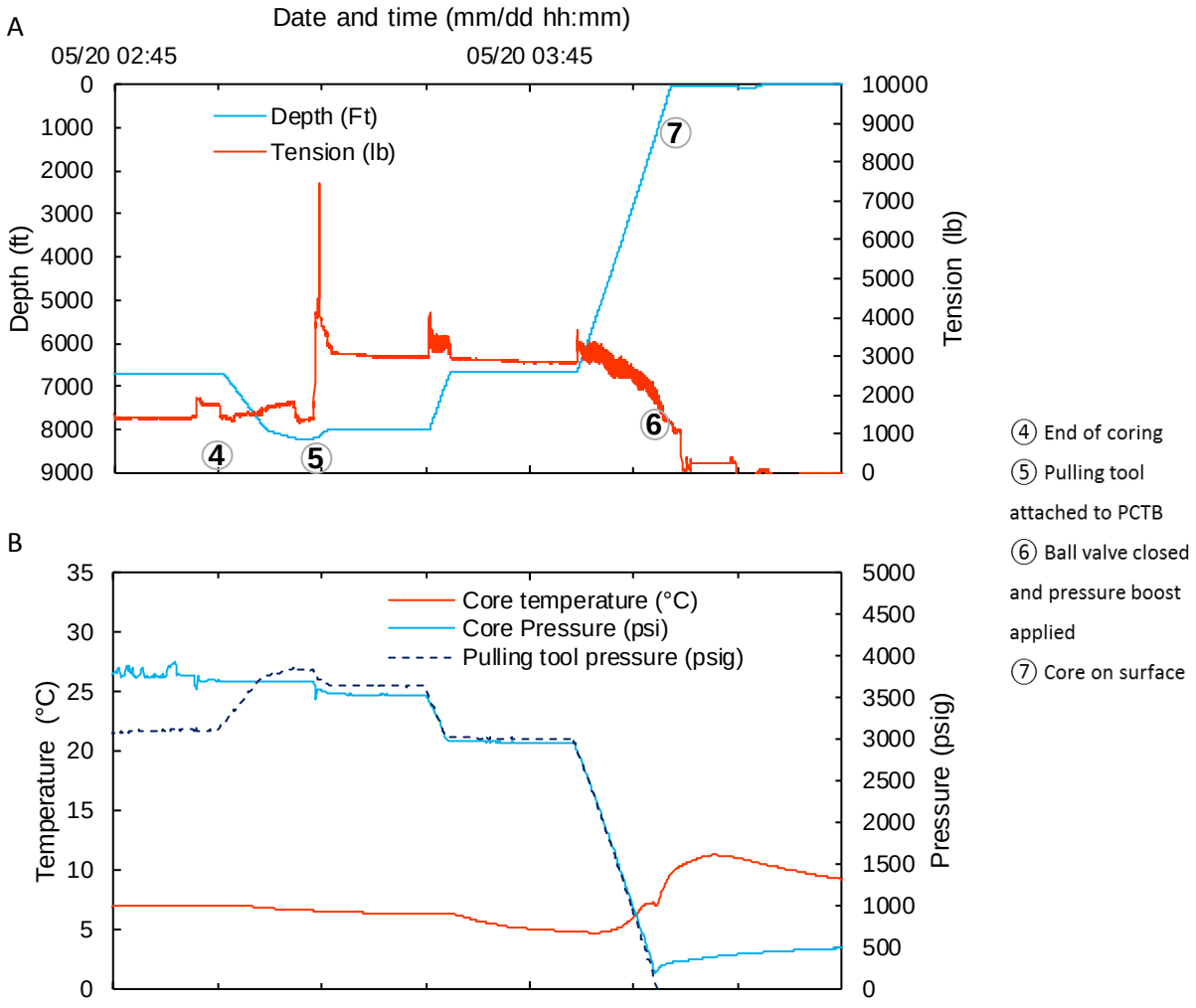


Figure 4.3.32 UT-GOM2-1-H005-09FB core retrieval details. A zoomed in section of Figure 4.3.31 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

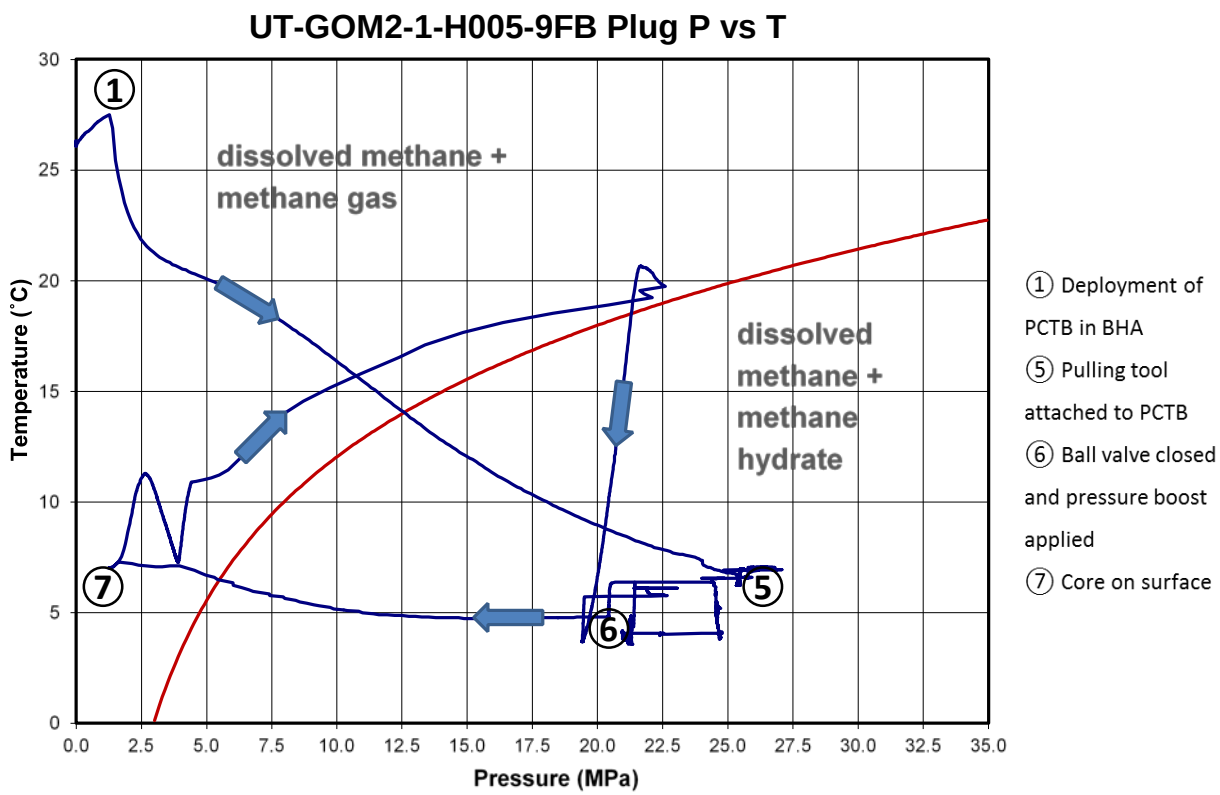


Figure 4.3.33 UT-GOM2-1-H005-09FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time and are sourced from DST attached to IT plug, since "rabbit" data were not available. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-10FB

Depth: 8161 – 8166 fbrf (439.8 – 441.4 mbsf)
Recovery: 2.36 ft (0.72 m), 47%
Pressure status: 3255 psi (22.53 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-10FB are shown in Figure 4.3.34, Figure 4.3.35, and Figure 4.3.36. The cement pumps stopped temporarily 5 ft into the core throw, increasing the torque on the drill bit and causing the drill string to begin to spin in reverse. At this point, the coring run was terminated early. While the core was retrieved using the pulling tool, the ball valve sealed at ~7683 fbrf (Figure 4.3.34, event 6). No pressure boost was recorded. The boost pressure was set to 3,000 psi for this deployment, with the boost functioning as an accumulator. The core was retrieved under pressure and it remained within the methane hydrate stability zone (Figure 4.3.36). 0.72 m of core was retrieved.

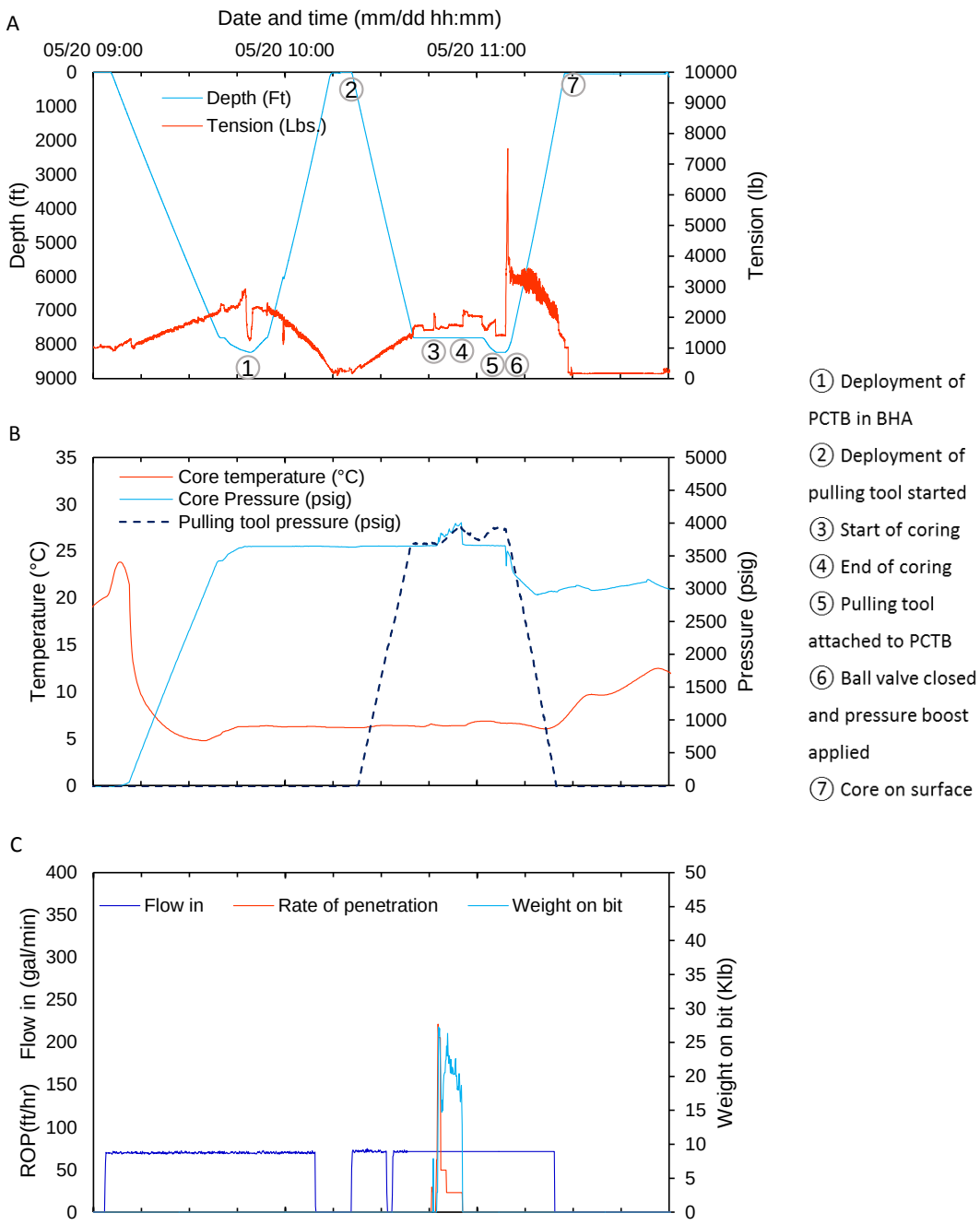


Figure 4.3.34 UT-GOM2-1-H005-10FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB and pressure measured from DST attached to pulling tool, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

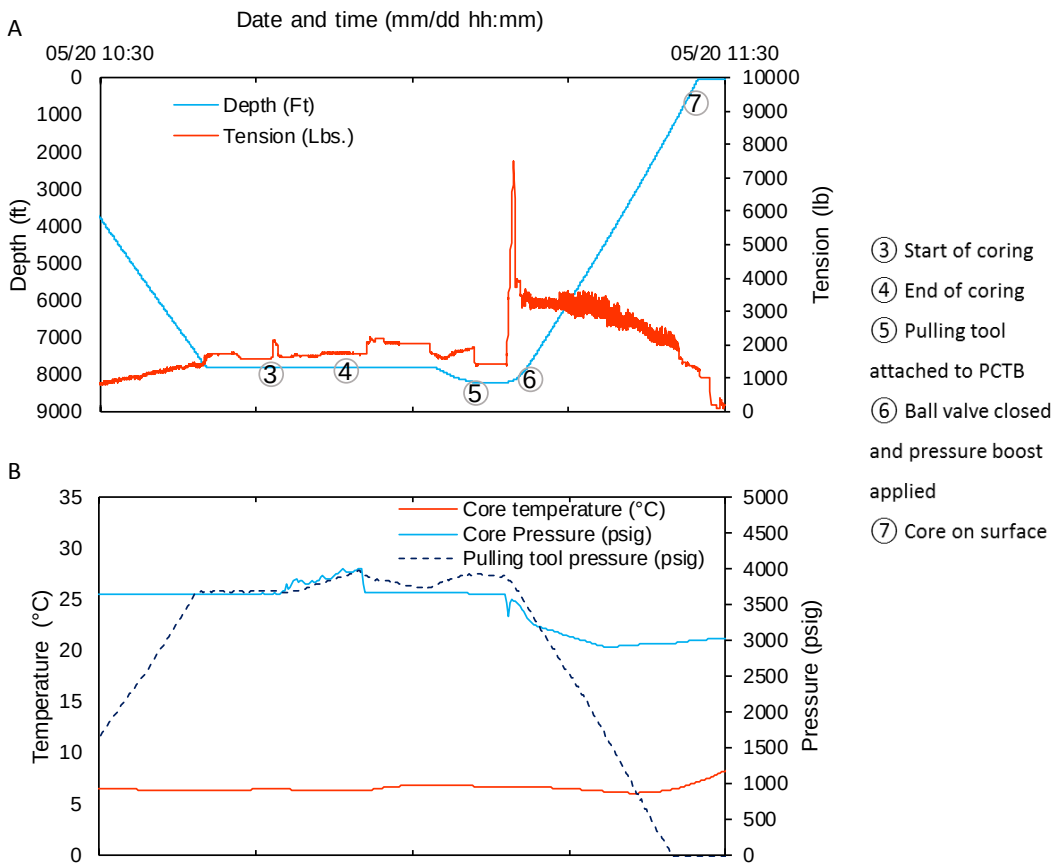


Figure 4.3.35 UT-GOM2-1-H005-10FB core retrieval details. A zoomed in section of Figure 4.3.34 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

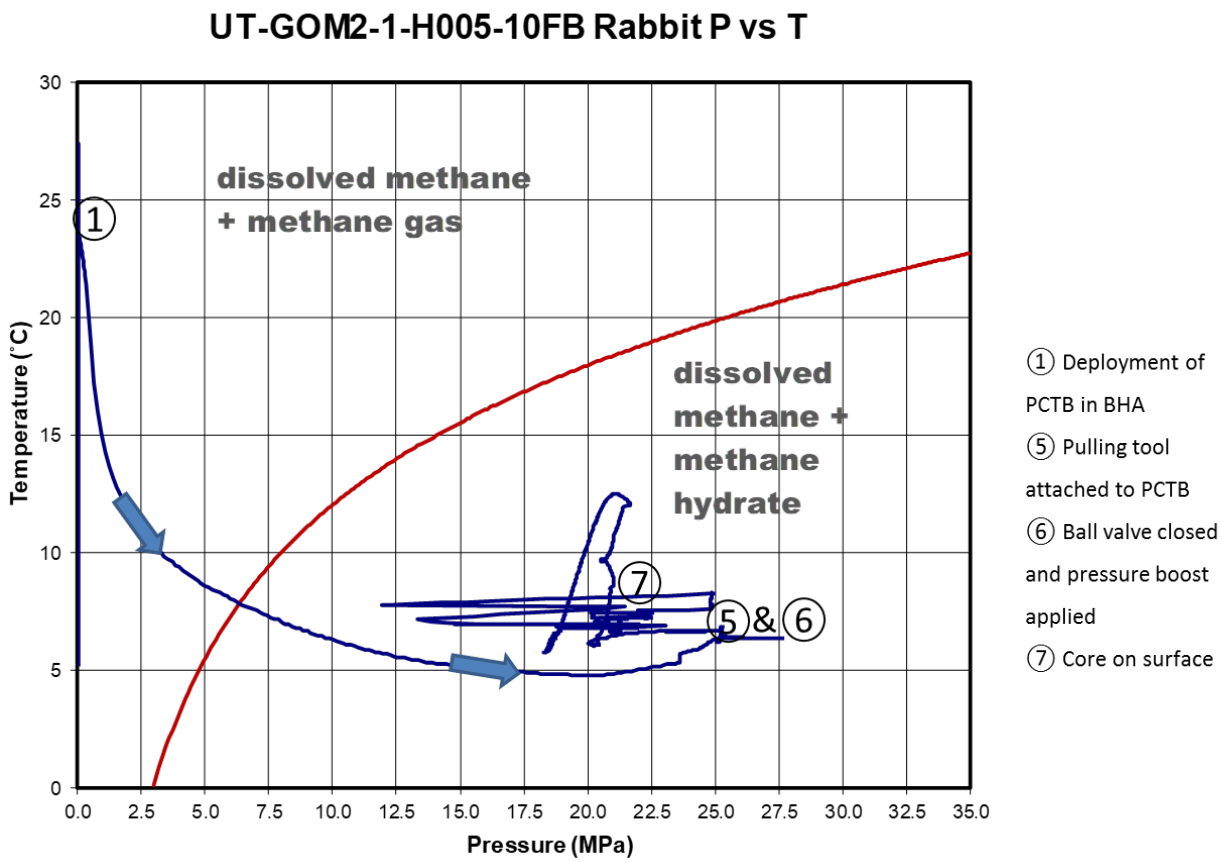


Figure 4.3.36 UT-GOM2-1-H005-10FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-11FB

Depth: 8166 – 8176 fbrf (441.1 – 444.4 mbsf)
Recovery: 0.88 ft (0.27 m), 9%
Pressure status: 3002 psi (20.79 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-11FB are shown in Figure 4.3.37, Figure 4.3.38, and Figure 4.3.39. Due to the expected water-bearing sands in this interval, the pump was run at a relatively higher flow rate during coring to try and maintain a clean hole for the next hydrate-bearing interval (Core UT-GOM2-1-H005-12FB). While the core was retrieved using the pulling tool, the ball valve sealed at ~7006 ft fbrf (Figure 4.3.37, event 6). No pressure boost was recorded. The boost pressure was set to 3000 psi for this deployment. The PCTB was held at the seafloor for ~ 15 minutes before it was brought to the surface. The core was retrieved at 3002 psi and it remained within the methane hydrate stability zone (Figure 4.3.39). A total of 27 cm was recovered.

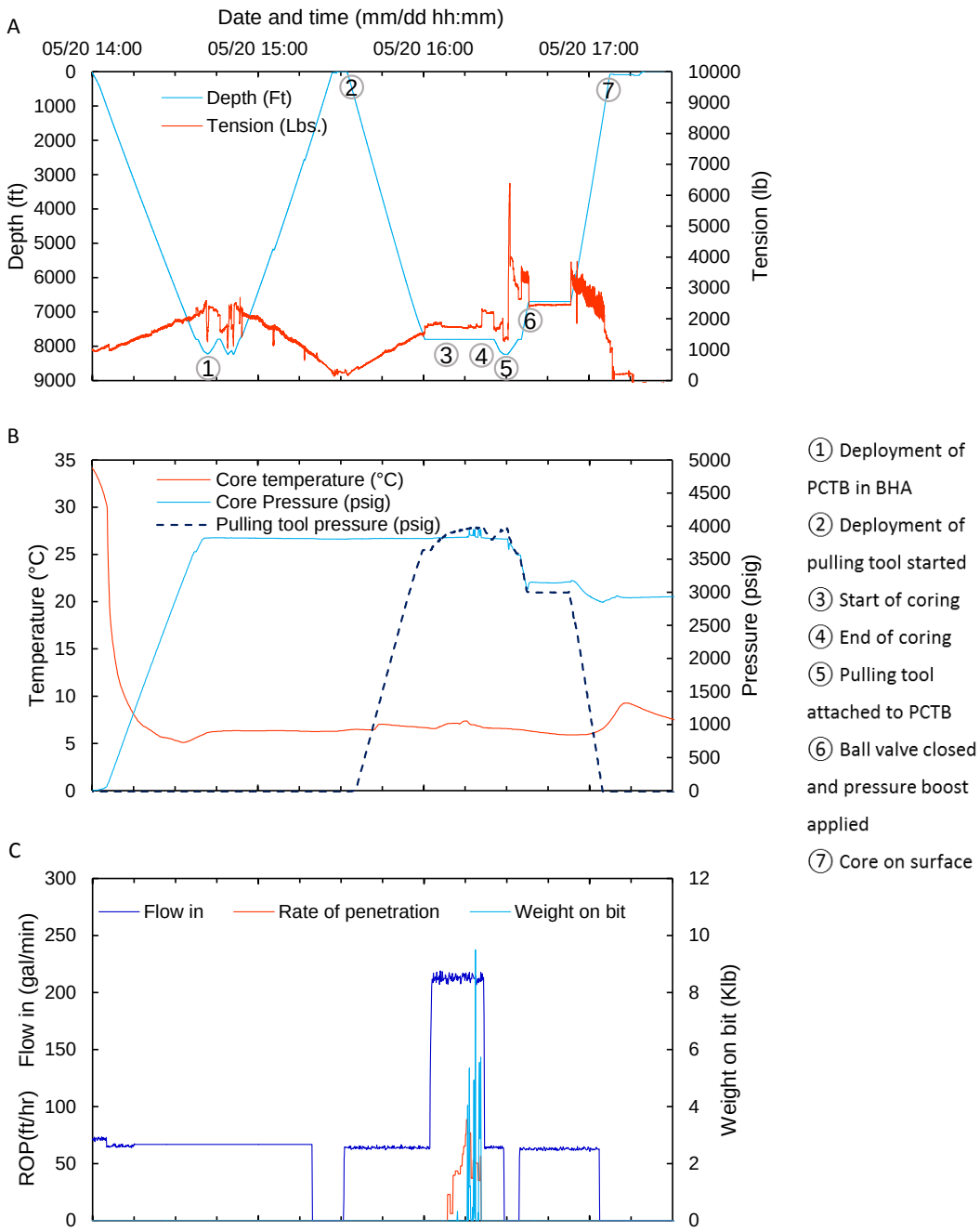


Figure 4.3.37 UT-GOM2-1-H005-11FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

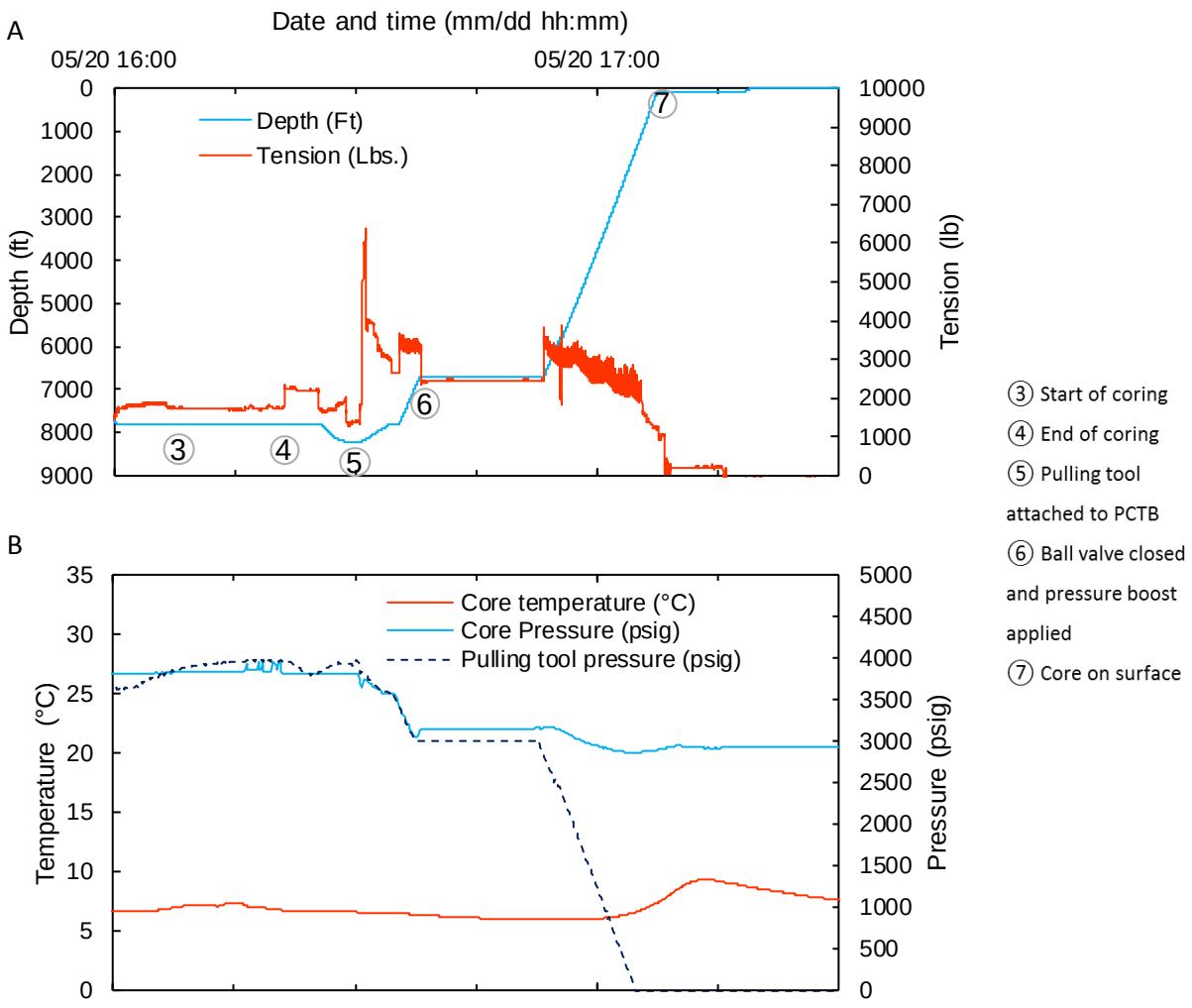


Figure 4.3.38 UT-GOM2-1-H005-11FB core retrieval details. A zoomed in section of Figure 4.3.37 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

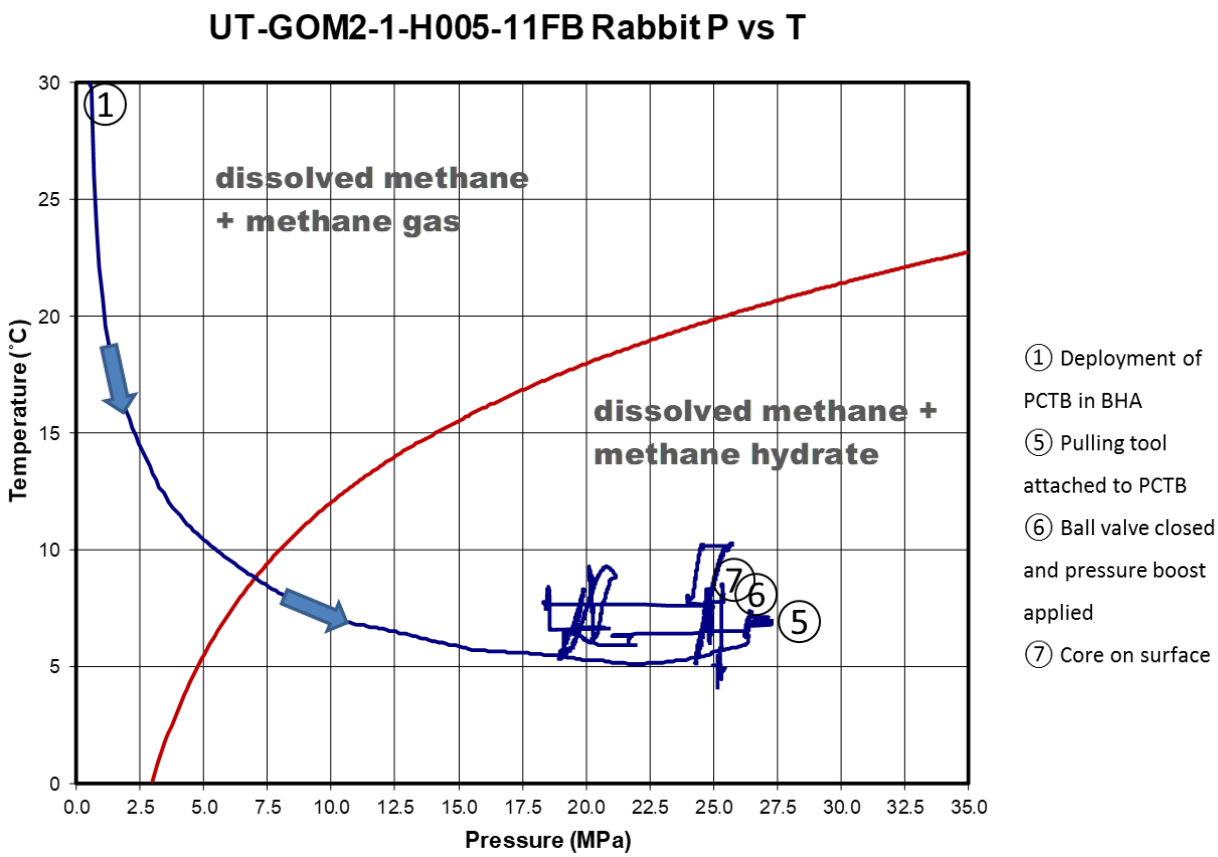


Figure 4.3.39 UT-GOM2-1-H005-11FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-12FB

Depth: 8176 – 8185 fbrf (444.4 – 447.1 mbsf)
Recovery: 5.74 ft (1.75 m), 57%
Pressure status: 0 psi (0.10 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-12FB are shown in Figure 4.3.40, Figure 4.3.41, and Figure 4.3.42. While retrieving the core using the pulling tool the PCTB was held near the mud line for 15 minutes for cooling. Core UT-GOM2-1-H005-12FB failed to seal due to partial ball valve closure and sediment accumulation in the ball follower. 1.75 m of depressurized sediment was recovered.

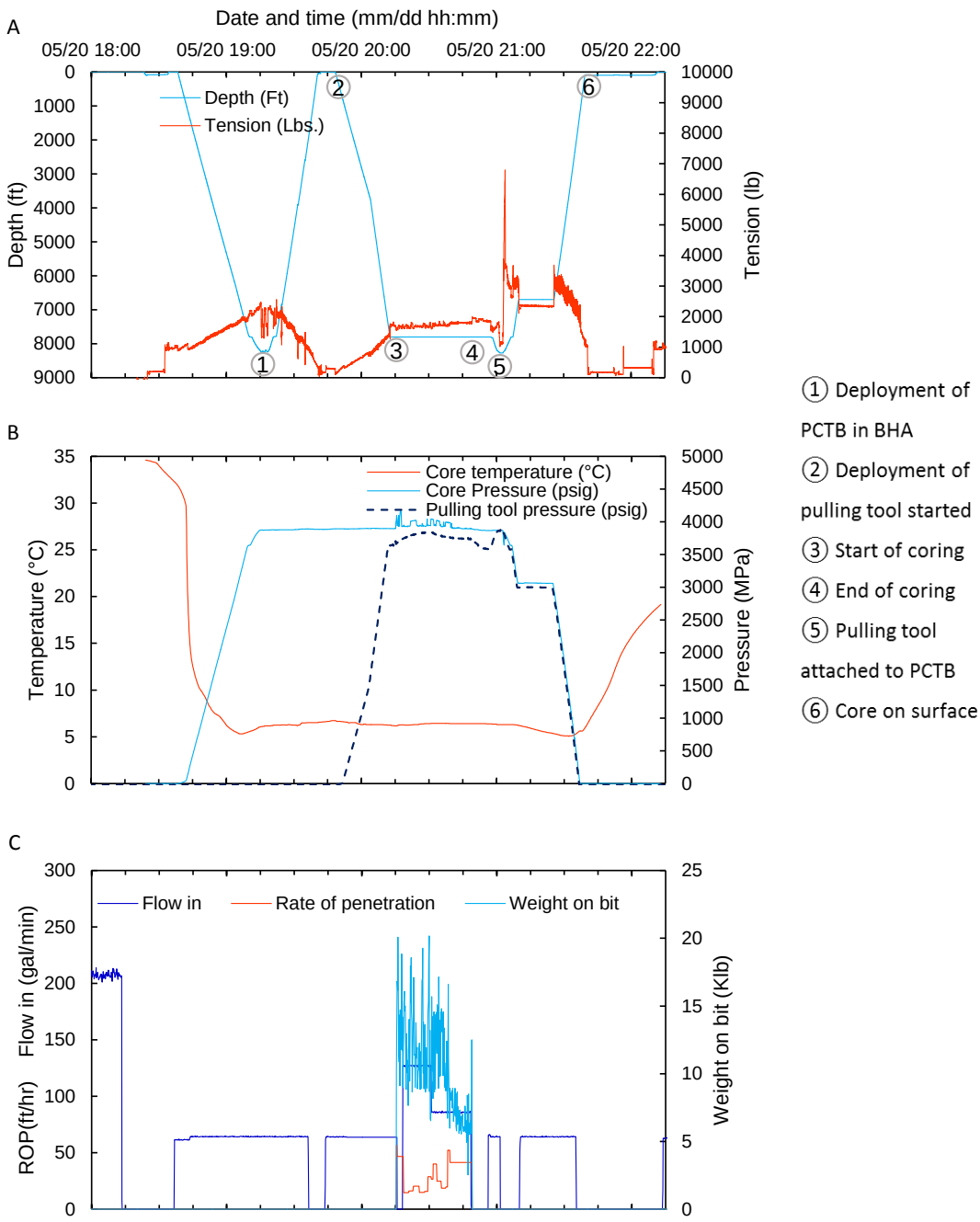


Figure 4.3.40 UT-GOM2-1-H005-12FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

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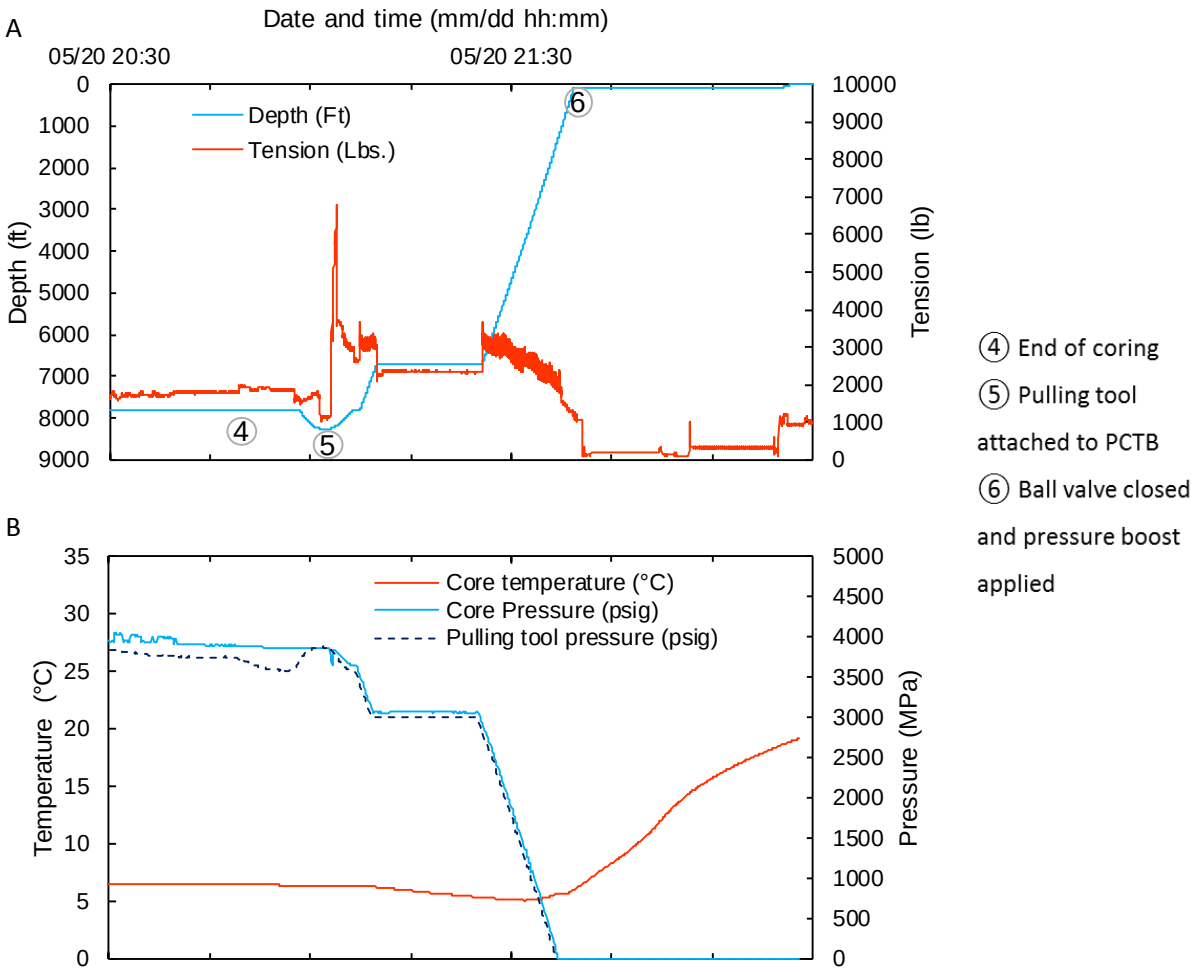

Figure 4.3.41 UT-GOM2-1-H005-12FB core retrieval details. A zoomed in section of Figure 4.3.40 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

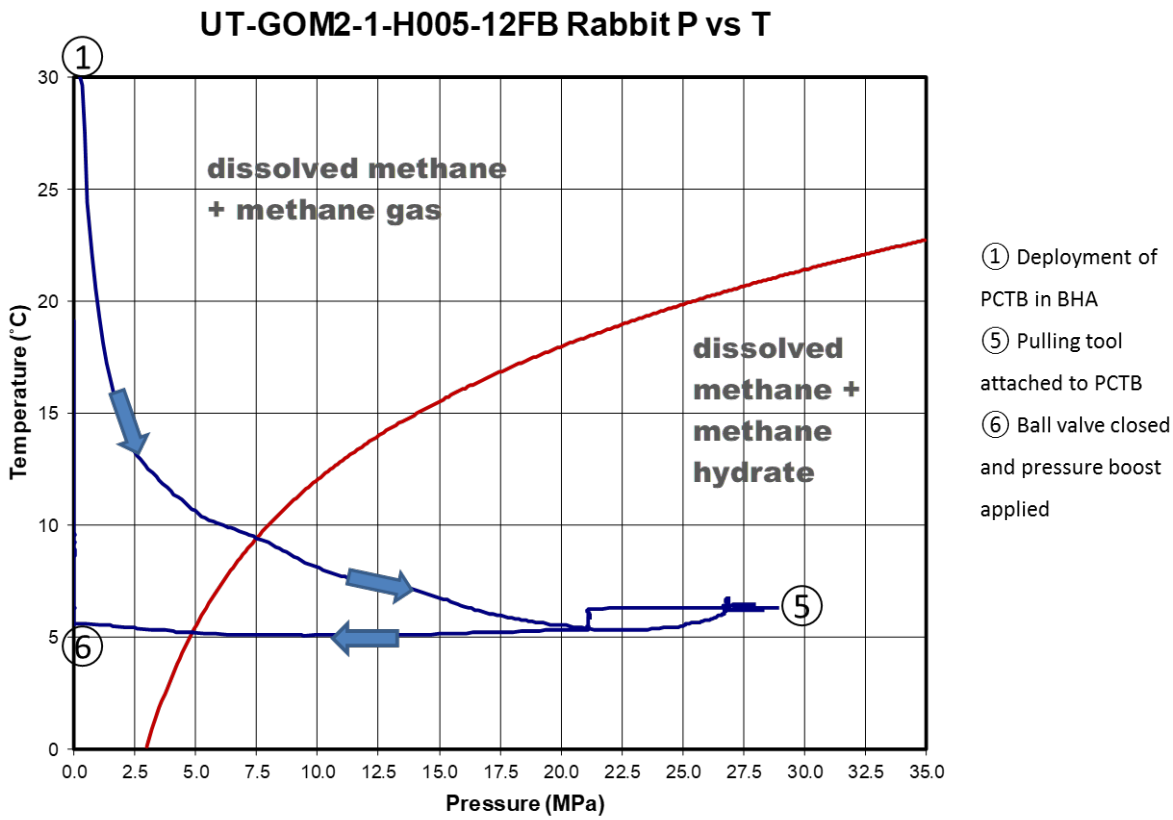

Figure 4.3.42 UT-GOM2-1-H005-12FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

Core UT-GOM2-1-H005-13FB

Depth: 8185 – 8193 fbrf (447.1 – 449.6 mbsf)
Recovery: 5.77 ft (1.76 m), 58%
Pressure status: 2806 psi (19.43 MPa)

Deployment and retrieval data for UT-GOM2-1-H005-13FB are shown in Figure 4.3.43, Figure 4.3.44, and Figure 4.3.45. While the core was retrieved using the pulling tool it was kept at the seafloor for ~20 minutes. As the core was raised from the seafloor, the ball valve sealed at ~6515 fbrf (Figure 4.3.43, event 6). No pressure boost was recorded. The core remained within the methane hydrate stability zone (Figure 4.3.45). A total of 1.76 m of core was retrieved.

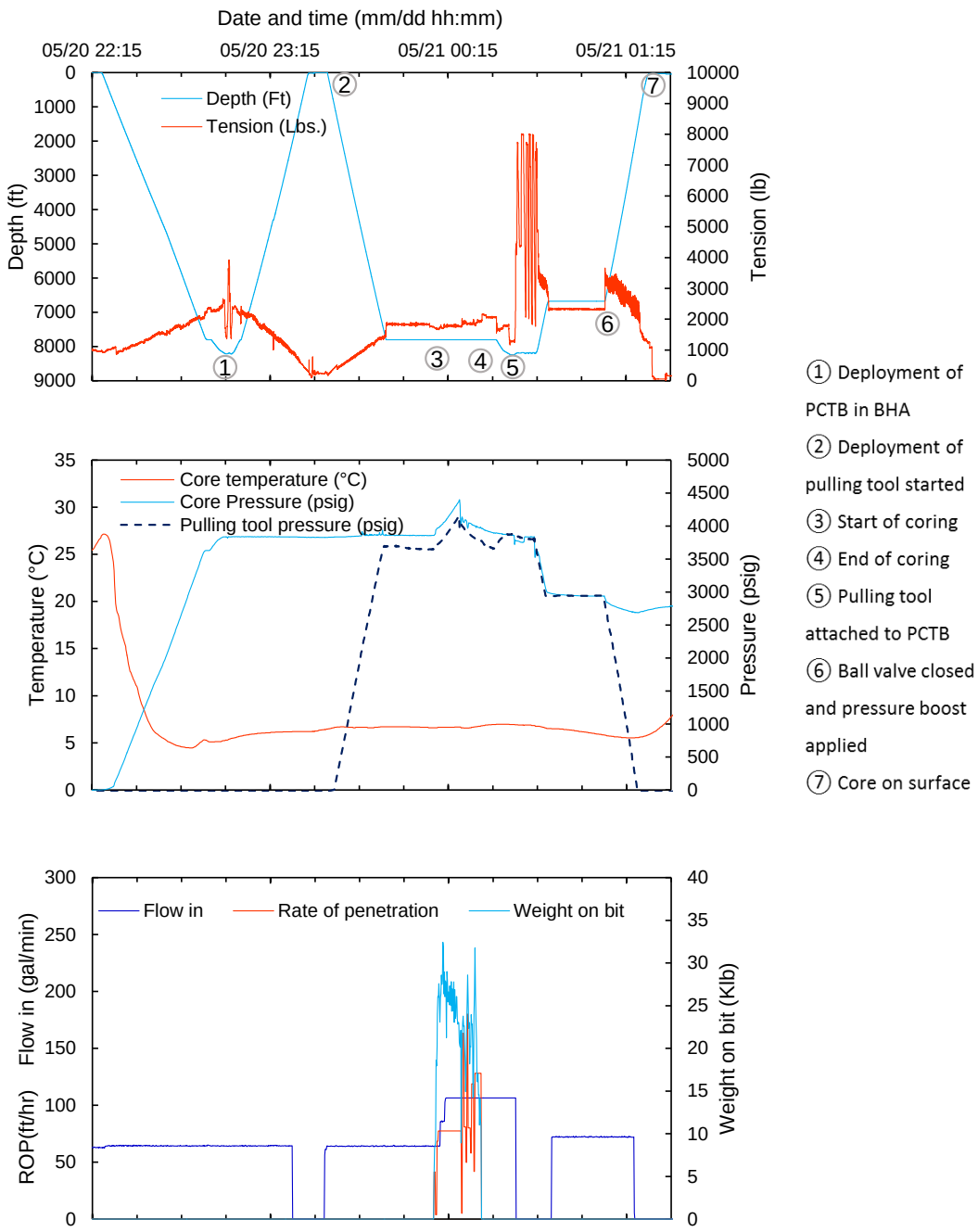

Figure 4.3.43 UT-GOM2-1-H005-13FB coring data. A) slickline tension and depth, B) pressure and temperature as measured in gauge pressure by the Data Storage Tag (DST) inside the rabbit atop the core in the PCTB, and C) WOB, ROP, and pump flow rate. WOB = weight on bit. ROP = rate of penetration. Flow in is the sum of all pump flows. All H005 pressure coring combined Weatherford, Schlumberger, and DST data can be found in the expedition data directory under H005 / Pressure Coring / Combined Datasets. See the readme file located there for more direction.

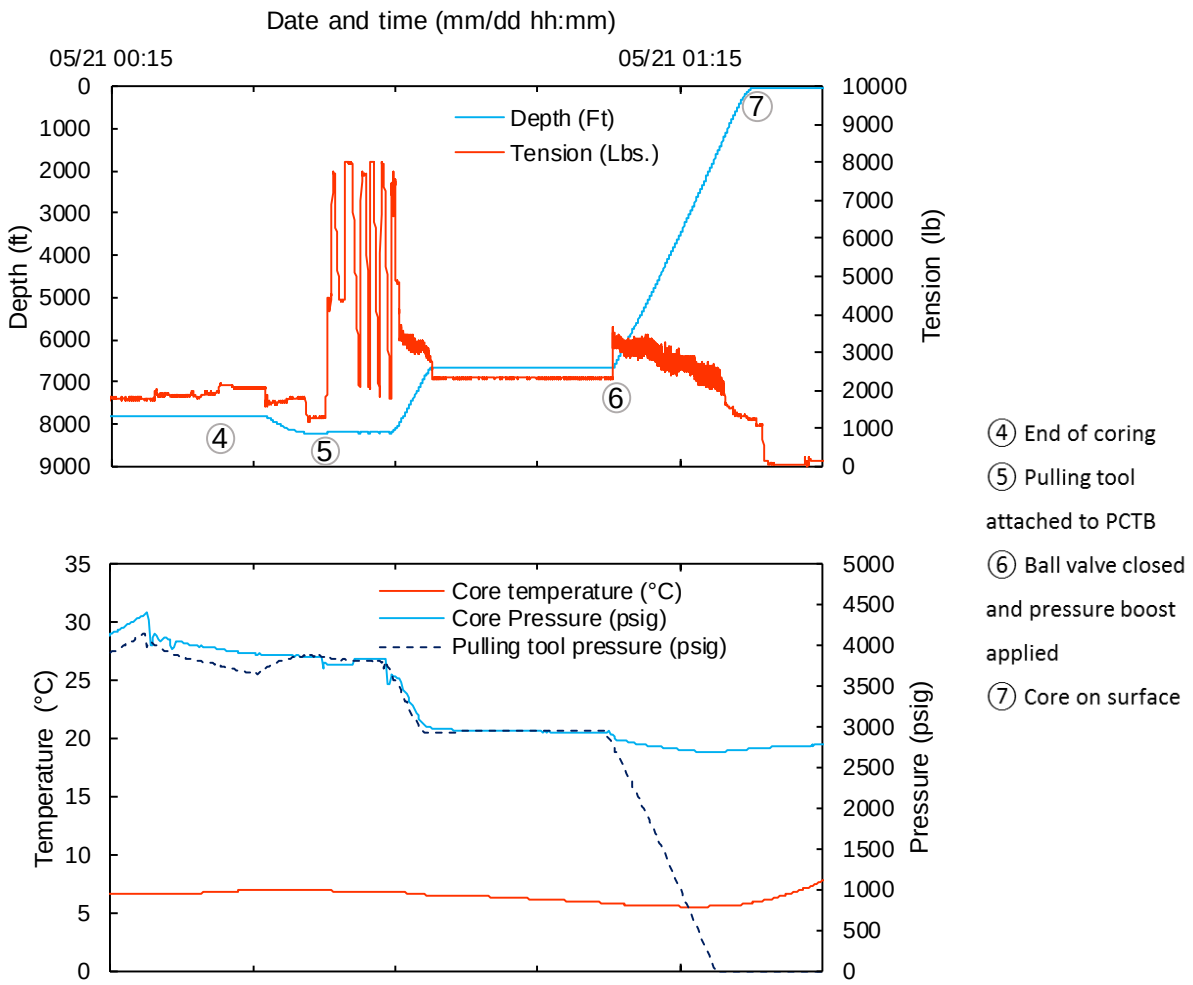

Figure 4.3.44 UT-GOM2-1-H005-13FB core retrieval details. A zoomed in section of Figure 4.3.43 showing the completion of coring and the pressure temperature conditions as the PCTB tool was pulled to the surface.

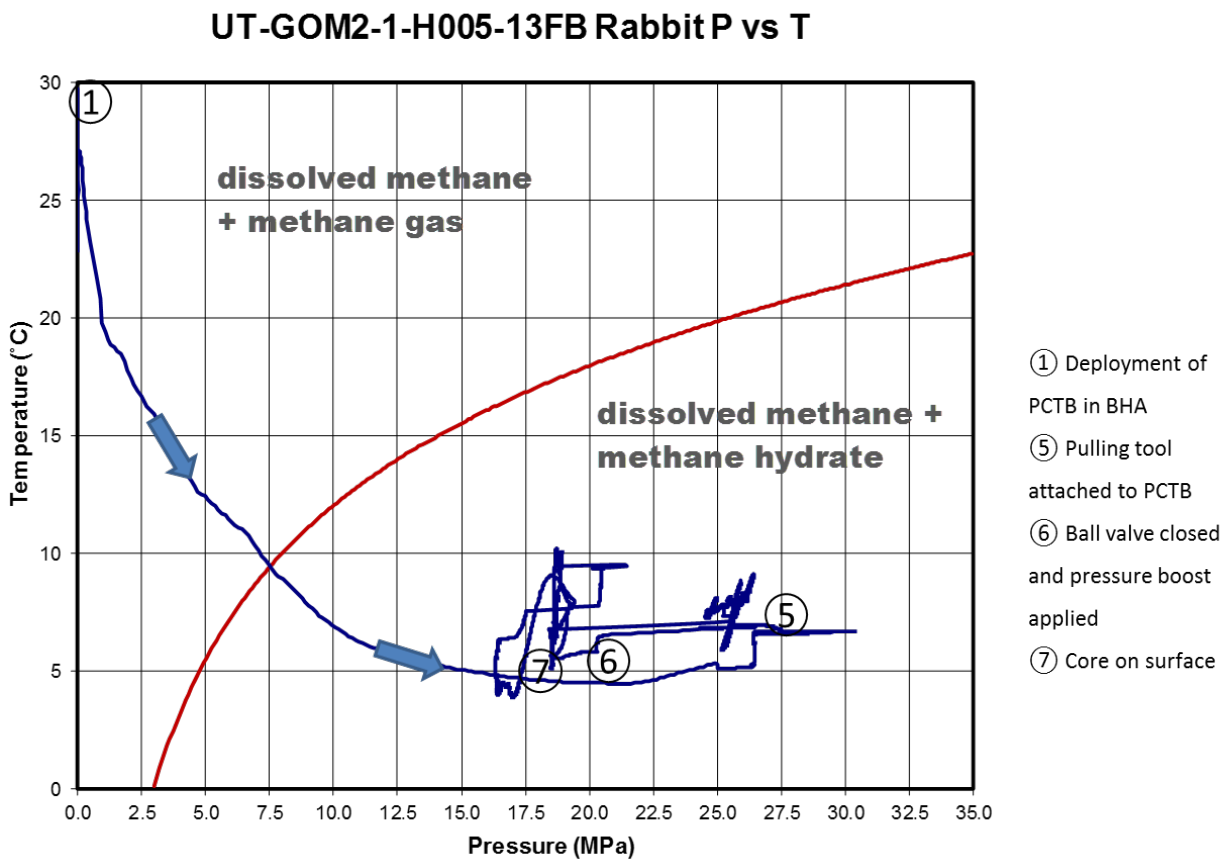

Figure 4.3.45 UT-GOM2-1-H005-13FB pressure and temperature versus calculated hydrate stability. Arrows on the P-T DST data, in blue, indicate the direction of increasing time. The hydrate stability boundary, in red, assumes methane in the presence of brine at seawater salinity.

4.3.4 PCTB Performance Review

At H005, 12 pressurized cores were acquired out of 13 PCTB deployments. Core UT-GOM2-1-H005-12FB was the only core that was not pressurized (Figure 4.3.46). Out of the 12 pressurized cores, one core (Core UT-GOM2-1-H005-09FB) moved out of the methane hydrate stability zone during retrieval due to late ball valve closure. The X-ray image as well as the P-wave velocity log of this core indicated that there was considerable gas hydrate dissociation. Three other cores (UT-GOM2-1-H005-02FB, UT-GOM2-1-H005-03FB and, UT-GOM2-1-H005-04FB) might have briefly touched the methane hydrate stability boundary during core retrieval. The PCTB sealed at a fairly shallow depth for Core UT-GOM2-1-H005-02FB (Figure 4.3.46, Table 4.3.4). A pin-hole leak in the ball valve allowed pressure drop during retrieval of core UT-GOM2-1-H005-03FB. Temperature rose at an unexpectedly rapid rate during retrieval of core UT-GOM2-1-H005-04FB (Figure 4.3.46). However, none of these three cores show physical evidence of significant gas hydrate dissociation from linear X-ray or 3D CT data.

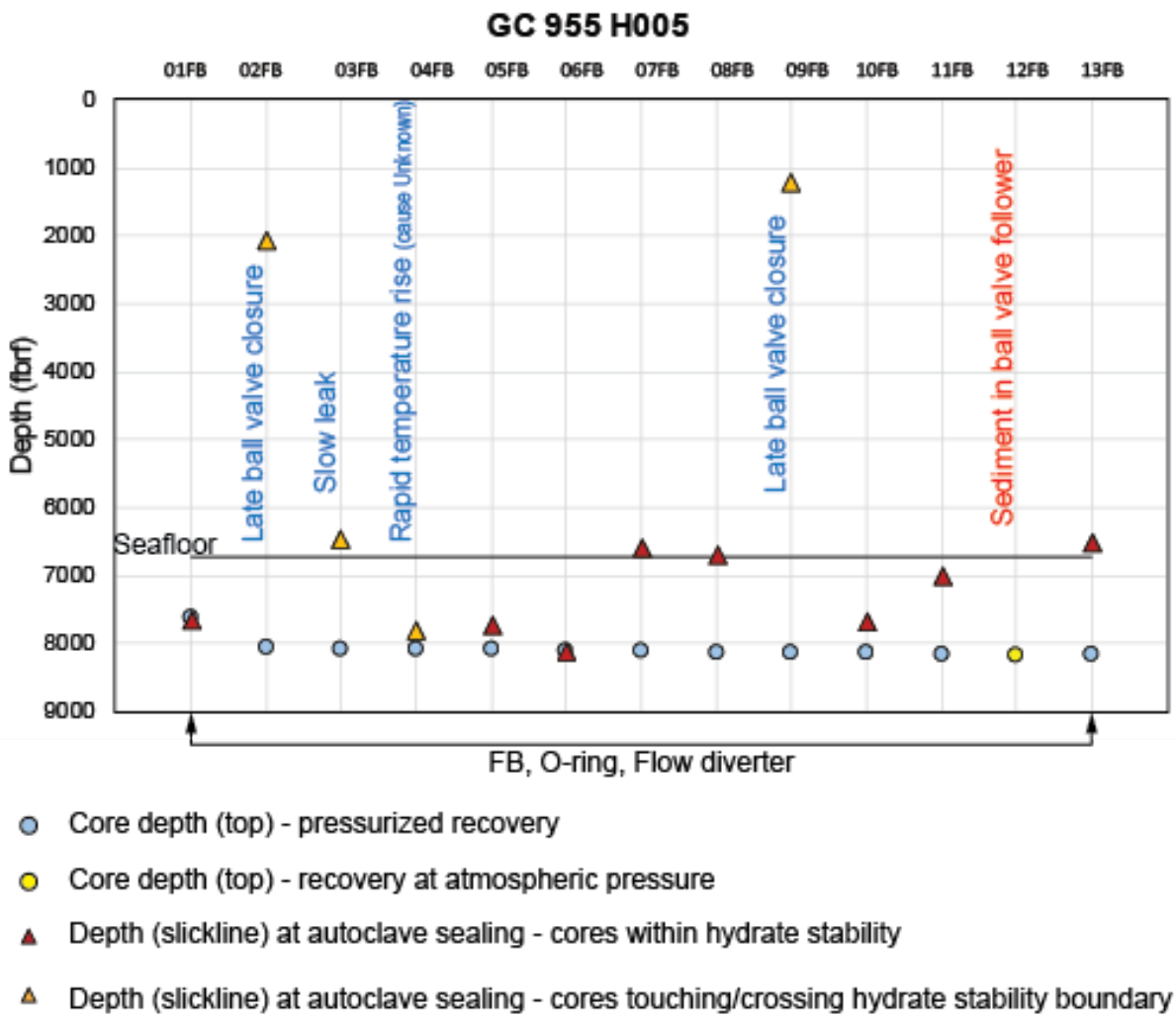

Figure 4.3.46 Depth of autoclave sealing for each of the 13 coring runs. Circled ball valve closure depths indicate that the ball valve did not close before the core touched the methane hydrate stability boundary or left the methane hydrate stability zone. All coring runs used the PCTB with the flow diverter and O-ring seal in place. Three cores (2FB, 3FB and 4FB) touched the methane hydrate stability boundary (for different reasons) but showed no indication of hydrate dissociation. One core cross out of the methane hydrate stability zone (9FB) before the ball valve closed and in one coring run (12FB) the ball valve failed to close.

Core	Top of core depth (fbrf)	Slickline depth when the ball valve closed (fbrf)	DST measured pressure when the autoclave sealed (psi)
01FB	7645	7668	3443
02FB	8081	2059.5	856
03FB	8091	6472	2786
04FB	8101	7803	3518
05FB	8111	7746	3445
06FB	8121	8163.6	3819
07FB	8131	6587	2766.5
08FB	8141	6700	2872
09FB	8151	1216	180
10FB	8161	7683	3254
11FB	8166	7006	3060
12FB	8176	N.A.	N.A.
13FB	8185	6515	2837

Table 4.3.4 Slickline depth and DST pressure when the autoclave sealed.

PCTB Failure Analysis

In H005, out of 13 PCTB deployments, only UT-GOM2-1-H005-12FB failed to retrieve pressurized core. Despite the improved sealing performance of the PCTB-FB configuration of the tool in H005 relative to the performance of the cutting shoe configuration (PCTB-CS) in H002, we also observed that the tool did not seal at the depth that the core was acquired in every case except Cores 1FB and 6FB as described above. The reason for this failure appears to be incomplete closure of ball valve due to sediment accumulation on ball valve follower. After coring, the PCTB was retrieved by wireline. The tool was designed such that during retrieval, as the inner barrel of the PCTB is pulled upward, the autoclave (the pressure vessel) is immediately sealed/isolated. The process is mechanically complicated and is ultimately achieved because the ball valve at the bottom and a seal at the top of the autoclave are closed

The improved recovery of pressurized core in H005 reflect a combination of incremental improvements in design and process over the evolution of the expedition and, perhaps, differences between the cutting shoe configuration used in H002 and the face bit configuration used in H005. It is challenging to determine the relative role of these two factors. H002 was drilled first with the PCTB-CS and H005 was drilled second with the PCTB-FB. None of the failure modes encountered in either well are related specifically to the unique components of the separate tool designs. For example, the problem with the hydraulic lock discovered early in H002 in the CS configuration would have equally limited the face bit deployment; furthermore, all of the iterative changes made between H002 and H005 would have contributed to the performance at H005. In addition, the PCTB deployment team went through a learning curve over the duration of the expedition. Thus, the team was far more experienced when they began coring H005. While it is difficult to untangle the factors that contributed to the PCTB-FB and PCTB-CS performance, the very limited data suggest that the core quality is higher in the face bit than in the cutting shoe, primarily due to the reduced internal core deformation afforded by the FB design.

4.3.5 Core recovery

As described above, thirteen pressured cores were attempted at H005. The shallowest core (UT-GOM2-1-H005-01FB) was taken between 7645-7655 fbrf, from a stratigraphic section that was previously interpreted as mud with hydrate-filled fractures (Figure 4.3.47). The remaining 12 cores were taken from the sand-rich, main target interval at a depth of 8081–8193 fbrf (Figure 4.3.48). Recovery is generally very high, with some cores achieving more than 90% recovery (Figure 4.3.47, Figure 4.3.48, and Table 4.3.5).

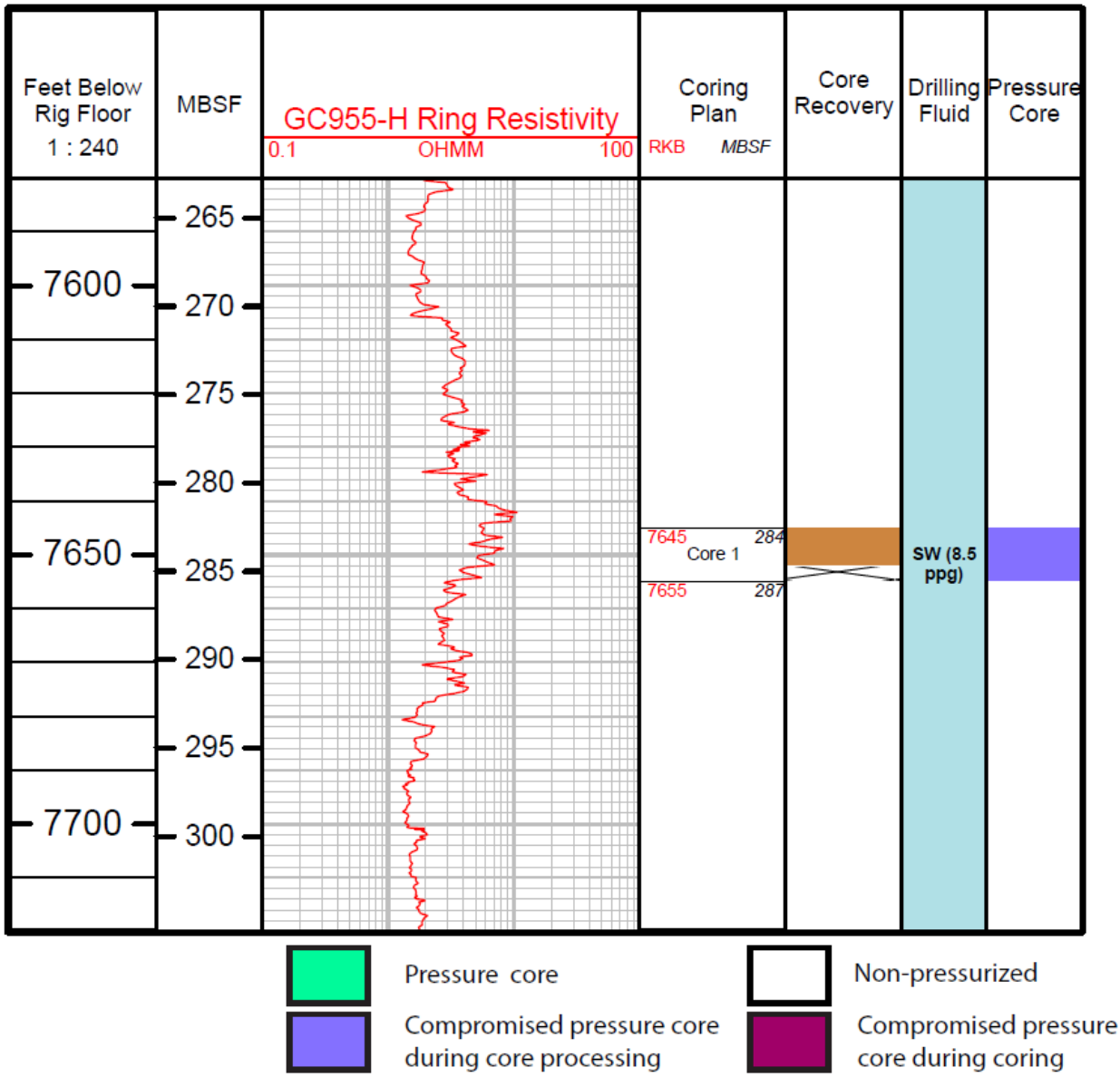

Figure 4.3.47 H005 Core recovery above the main target interval.

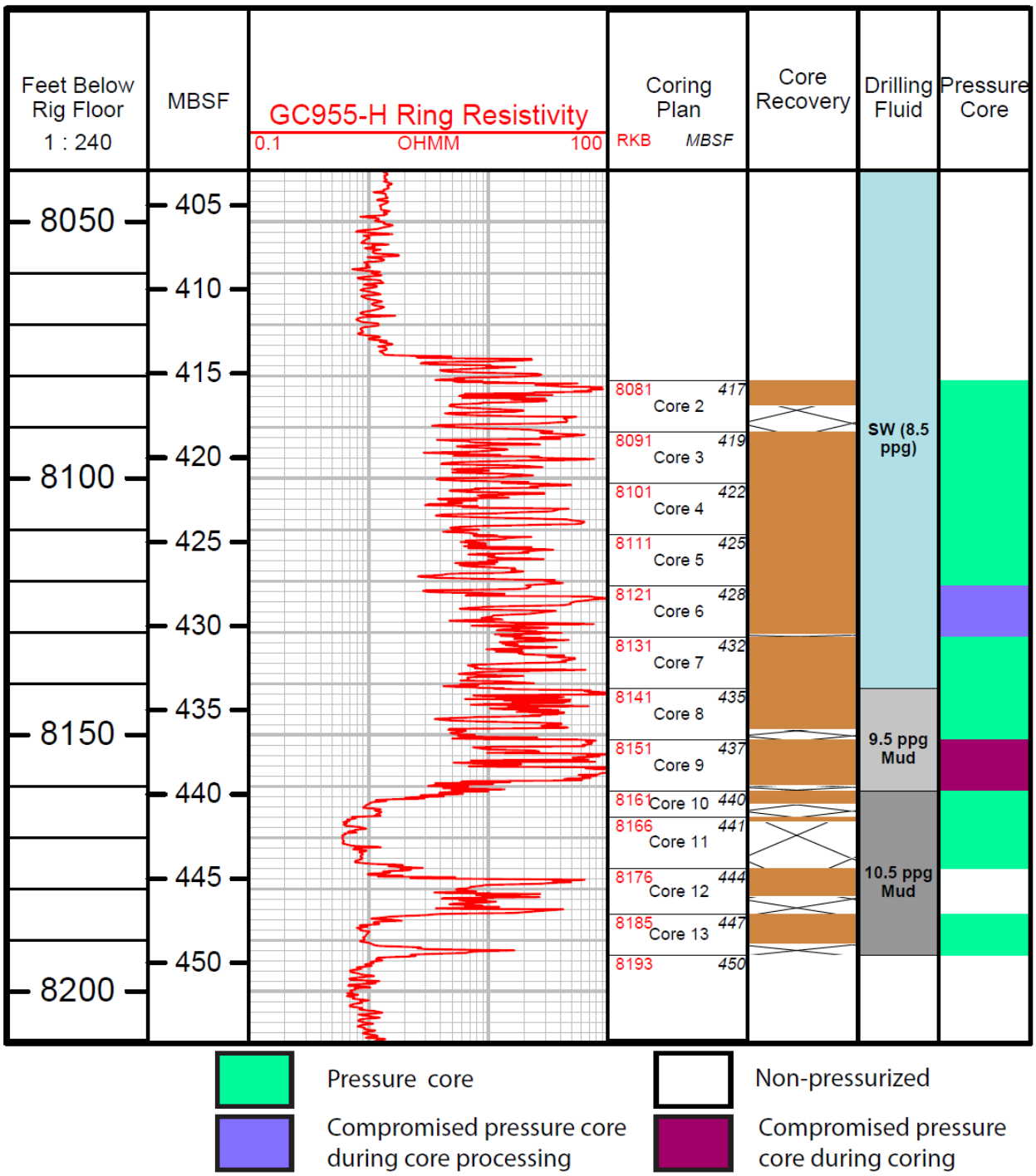

Figure 4.3.48 H005 Core recovery in the main target interval.

Core	Interval (fbrf)	Interval (mbsf)	Stroke (ft)	Stroke (m)	Recovery (ft)	Recovery (m)	Pressure (psi)	Recovery %	Core quality
UT-GOM2-1-H005-1FB	7645.0 - 7655.0	282.55 - 285.60	10.0	3.05	7.1	2.17	4115	71	Pressurized, but compromised during processing
UT-GOM2-1-H005-2FB	8081.0 - 8091.0	415.44 - 418.49	10.0	3.05	4.9	1.5	2834	49	Pressurized
UT-GOM2-1-H005-3FB	8091.0 - 8101.0	418.49 - 421.54	10.0	3.05	10	3.04	1780	100	Pressurized
UT-GOM2-1-H005-4FB	8101.0 - 8111.0	421.54 - 424.59	10.0	3.05	10.5	3.21	3477	105	Pressurized
UT-GOM2-1-H005-5FB	8111.0 - 8121.0	424.59 - 427.63	10.0	3.05	9.7	2.96	3241	97	Pressurized
UT-GOM2-1-H005-6FB	8121.0 - 8131.0	427.63 - 430.68	10.0	3.05	9.4	2.86	3250	94	Pressurized, but compromised during processing
UT-GOM2-1-H005-7FB	8131.0 - 8141.0	430.68 - 433.73	10.0	3.05	10.5	3.21	3164	105	Pressurized
UT-GOM2-1-H005-8FB	8141.0 – 8151.0	433.73 - 436.78	10.0	3.05	8.2	2.5	3015	82	Pressurized
UT-GOM2-1-H005-9FB	8151.0 - 8161.0	436.78 - 439.83	10.0	3.05	8.9	2.7	746	89	Pressurized, but compromised during core recovery
UT-GOM2-1-H005-10FB	8161.0 – 8166.0	439.83 - 441.35	5.0	1.52	2.4	0.72	3255	47	Pressurized
UT-GOM2-1-H005-11FB	8166.0 – 8176.0	441.35 - 444.4	10.0	3.05	0.9	0.27	3001	9	Pressurized
UT-GOM2-1-H005-12FB	8176.0 – 8185.0	444.4 - 447.14	9.0	2.74	5.7	1.75	0	64	Non-pressurized
UT-GOM2-1-H005-13FB	8185.0 - 8193.0	447.14 - 449.58	8.0	2.44	5.8	1.76	2806	72	Pressurized
		Totals	122	37.2	94	28.7			
							Average recovery	77	

Table 4.3.5 H005 Core recovery and quality.

4.4 Physical Properties and Core Transfer

This section of the expedition report will discuss the X-ray imaging, gamma density, P-wave velocity of pressure and depressurized core, and core cutting.

4.4.1 Pressurized Whole Core

Twelve cores at H005 (Figure 4.4.1 to Figure 4.4.12) were recovered at pressure and processed in PCATS (see 4.3 Pressure Coring). A total of 30.73 m were scanned in PCATS including X-ray (2D and 3D CT), gamma density, and P-wave velocity. These scans highlight the presence of three major lithofacies in H005: only lithofacies 1 was encountered in Core UT-GOM2-1-H005-01FB (282.55 to 284.54 mbsf); lithofacies 2 and 3 were interbedded within Cores UT-GOM2-1-H005-02FB to -10FB and -13FB (415.44 to 448.84 mbsf) (see 4.6 Lithostratigraphy).

PCATS density and velocity

Gamma density measurements for the twelve cores analyzed in PCATS were influenced by two primary factors: 1) the variation between lithofacies 2 and lithofacies 3 (as defined in 4.6 Lithostratigraphy), and 2) the diameter of the recovered core. As in H002, generally lithofacies 2 sediments had maximum apparent densities near 1.9 g/cm^3, and lithofacies 3 had densities near 2.0 g/cm^3. Lithofacies 2 sediments, as a rule, did not fill the core liner and the densities will require correction for this reduced core diameter.

Lithofacies 2 sediments of good quality had recorded velocities of ~2500-3300 m/s, consistent with the presence of pore-filling gas hydrate, while lithofacies 3 sediments had velocities that varied from 1550-2000 m/s. As with the density measurements, lithofacies 2 sediment velocity will require correction for diameter variations; the velocities will increase when corrected. The variation in lithofacies 3 velocities cannot be explained by variations in core diameter, as these sediments fill the liner. These sediments should be examined carefully for core disturbance to understand the origin of the variation in velocity, and whether such a variation might be related to the presence of gas hydrate. There are surely subtleties in the relationship between density and P-wave velocity in both lithofacies 2 and 3, but they will not be revealed until both data sets are corrected for core diameter and screened for core disturbance.

There are a few other notable variations in gamma density and velocity in the cores from H005. Core UT-GOM2-1-H005-1FB, containing lithofacies 1, had an average gamma density of 2.06 g/cm^3, slightly higher than lithofacies 3, and uniform velocities near 1700 m/s. Core UT-GOM2-1-H005-9FB, which spent 92 minutes outside the methane hydrate stability zone, had slightly decreased densities (0.05-0.1 g/cm^3)–except in a coherent interval composed of lithofacies 3 near 2.8 m core depth. The lack of change in density may indicate that this portion of the core had a very low hydrate saturation, which is consistent with degassing experiments (see 4.5 Quantitative Degassing).

PCATS 2D and 3D X-ray

X-ray 2D linear images and X-ray 3D CT data sets were collected for Cores UT-GOM2-1-H005-1FB-11FB & -13FB. The X-ray images show that the cores collected within the main hydrate-bearing target interval (Cores UT-GOM2-1-H005-2FB-10FB & -13FB) contained at least two basic lithologies, an X-ray-dark (dense) lithology (likely more clay-rich) and an X-ray-light lithology. These correspond to lithofacies 3 and 2, respectively, as described in 4.6 Lithostratigraphy. As at H002, interbedding of these two facies can be clearly seen, as well as subhorizontal density variations within lithofacies 2. A sedimentological description of the core from the X-rays can be found in 4.6 Lithostratigraphy; however, some notable features are discussed in this section.

<u>Gas hydrate veins in fine-grained sediment</u>

Core UT-GOM2-1-H005-1FB, collected above the main target interval in a zone predicted to contain fine-grained sediment hosting gas hydrate veins, had visible low-density veins within the sediment (Figure 4.4.13). The sediment core was broken into ~1-cm-thick pieces (or biscuits) as it was cored, and the pieces, with the veins, rotated with respect to each other.

<u>Core cracks and possible gas hydrate veins</u>

Low-density features were observed in a number of the cores. Most examples of these low-density features were obviously coring-induced cracking in the core, or, in the case of Cores UT-GOM2-1-H005-2FB, -3FB, -6FB (CT image only), and -9FB, possible depressurization-induced cracking. However, it is also possible that some of these features were gas hydrate veins (e.g., those shown in Figure 4.4.14 from Core UT-GOM2-1-H005-5FB). While no definitive determination of cracking versus hydrate vein can be made from the field data, a detailed examination of the CT data and comparison with known examples of core disturbance might suggest hypotheses to test in other apparatus to determine whether any of these features contain hydrate, or if hydrate may have existed in situ.

Potential faults

Occasional features present in a number of cores are suggestive of small faults (e.g. Core UT-GOM2-1-H005-4FB, 243-250 cm (Figure 4.4.15). While the first explanation for a crack in a core is generally coring disturbance, a crack with displacement may represent an in situ feature.

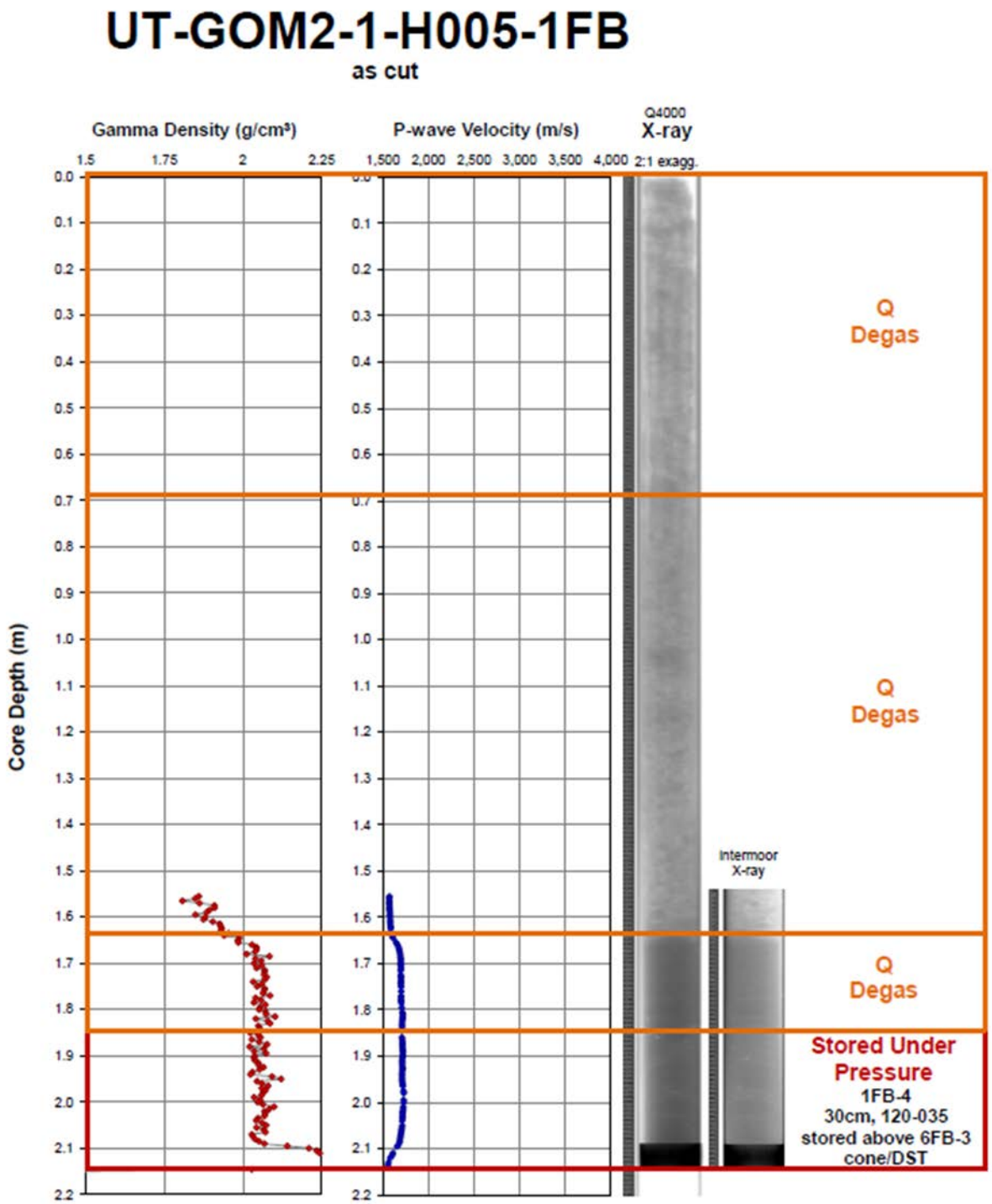

Figure 4.4.1 UT-GOM2-1-H005-01FB PCATS data and section cuts. Gamma density, P-wave velocity and the right X-ray image were acquired at Intermoor (Port Fourchon). The left X-ray image was acquired on-board. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

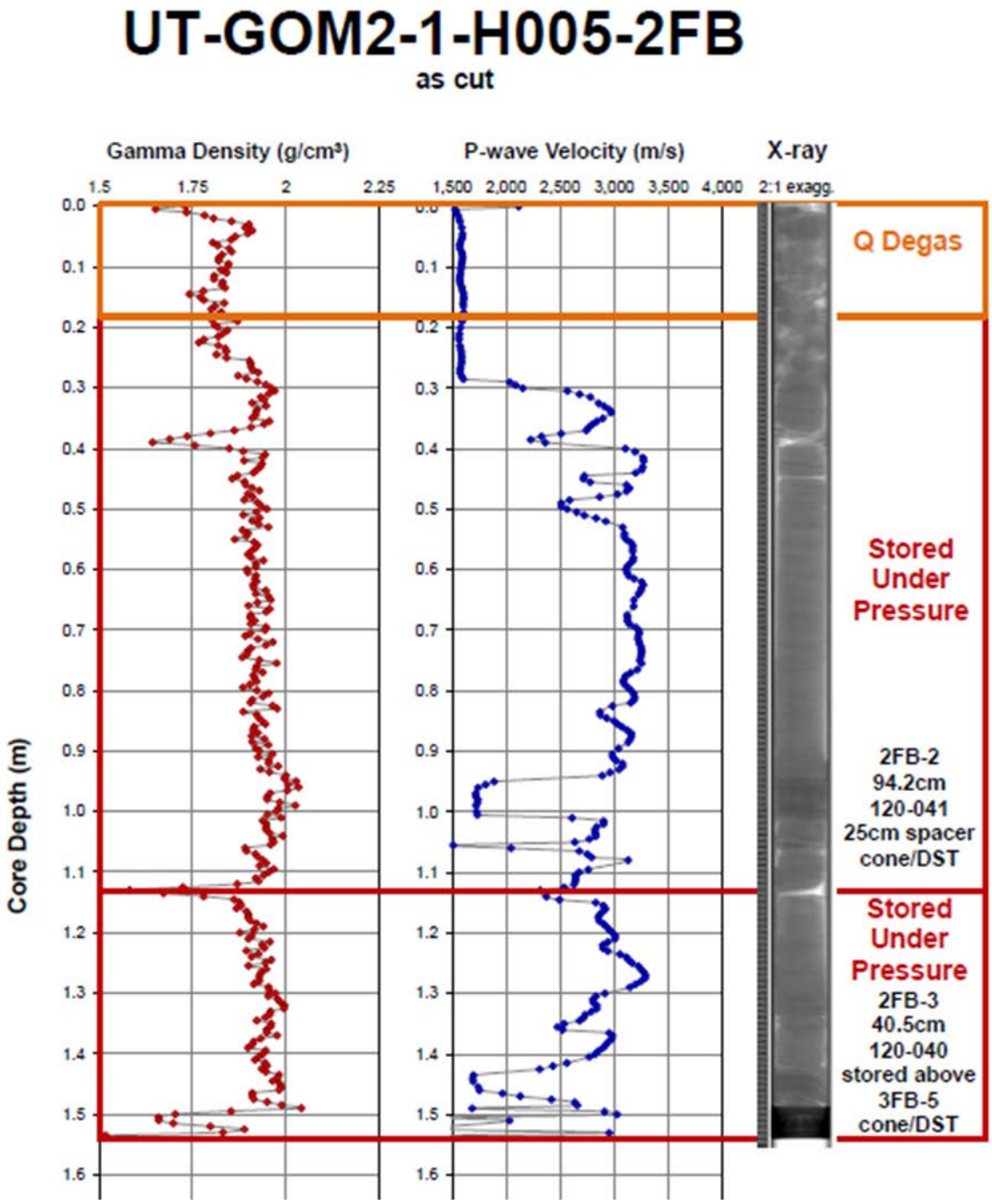

Figure 4.4.2 UT-GOM2-1-H005-02FB PCATS data and section cuts. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

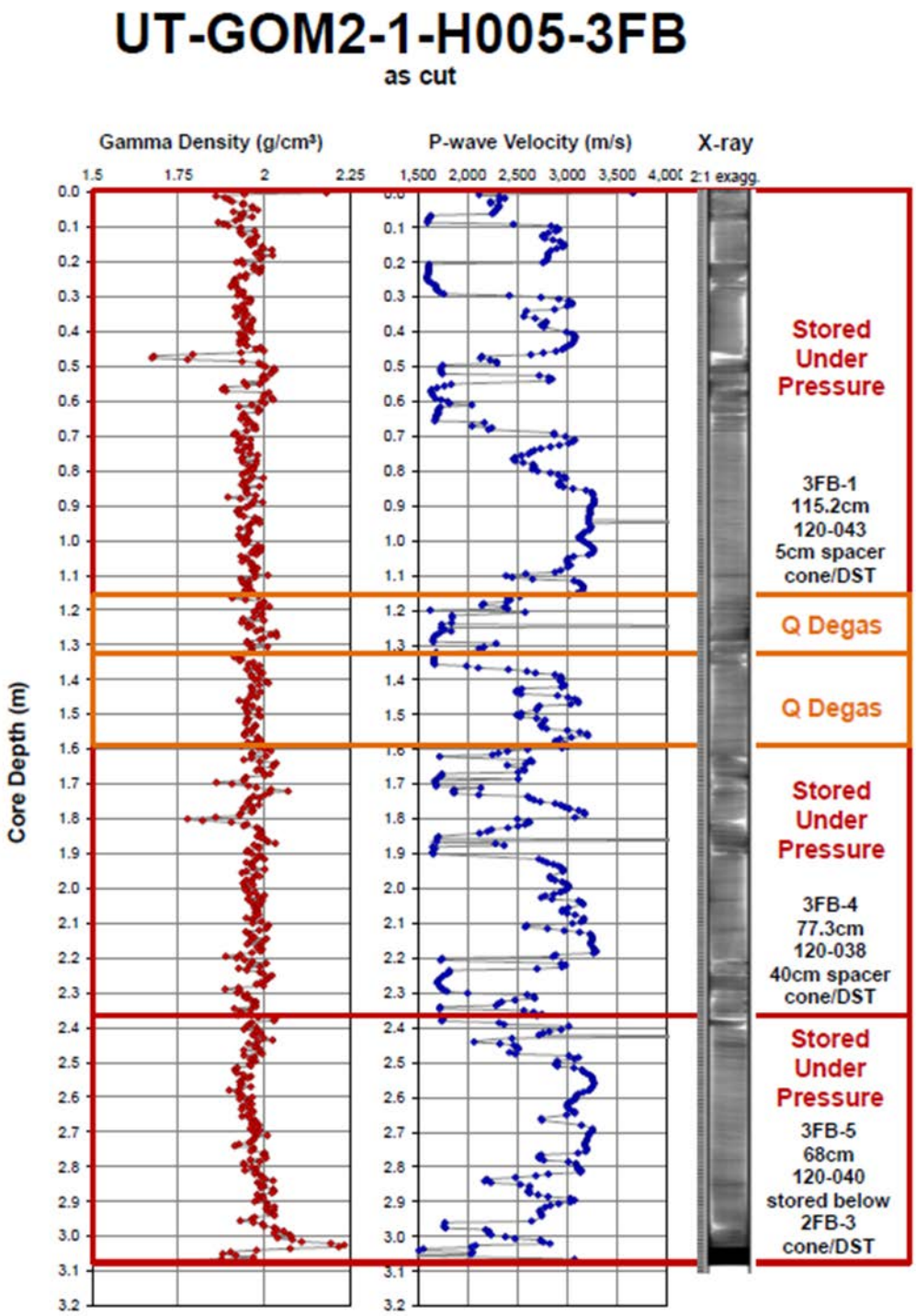

Figure 4.4.3 UT-GOM2-1-H005-03FB PCATS data and section cuts. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

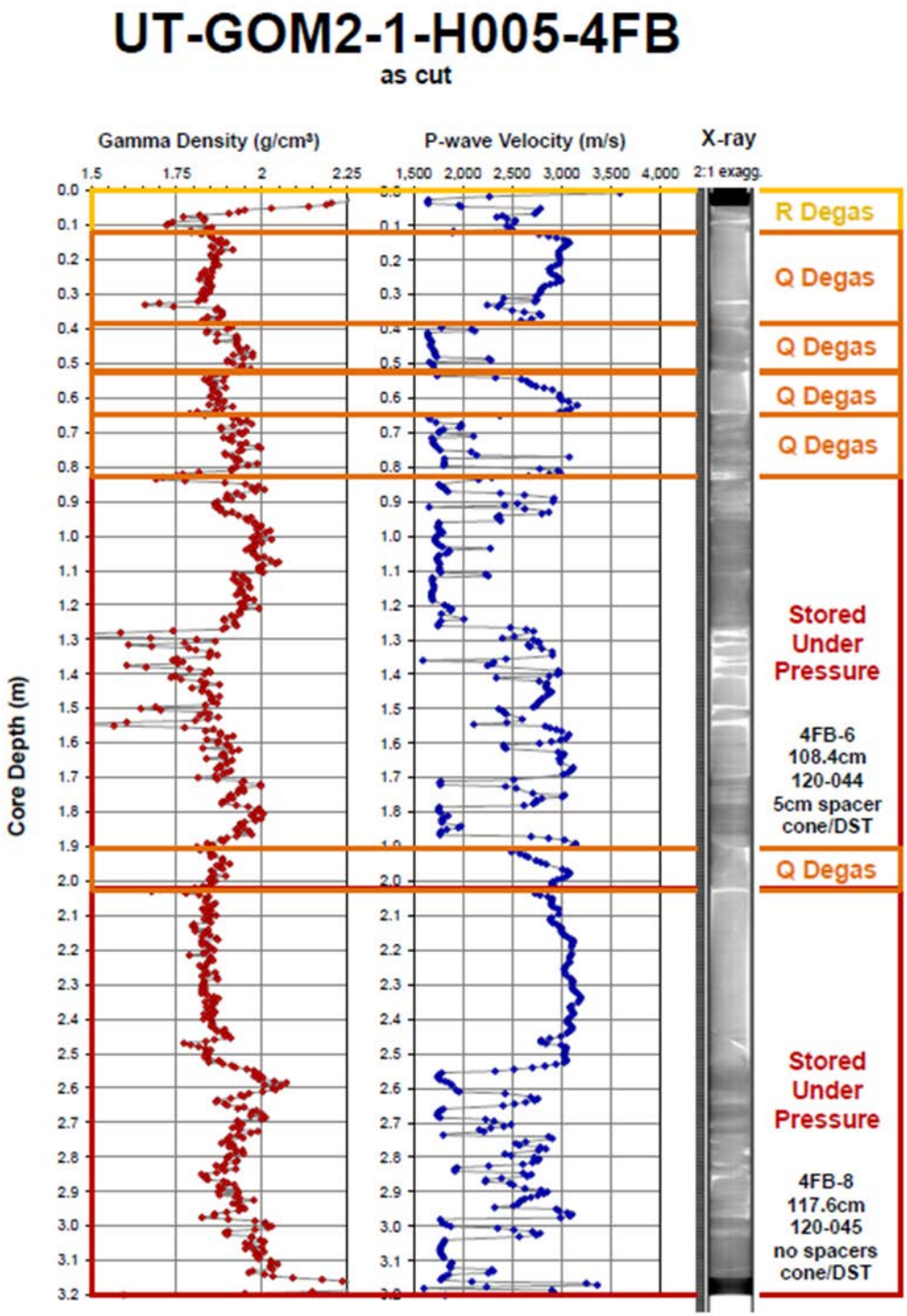

Figure 4.4.4 UT-GOM2-1-H005-04FB PCATS data and section cuts. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

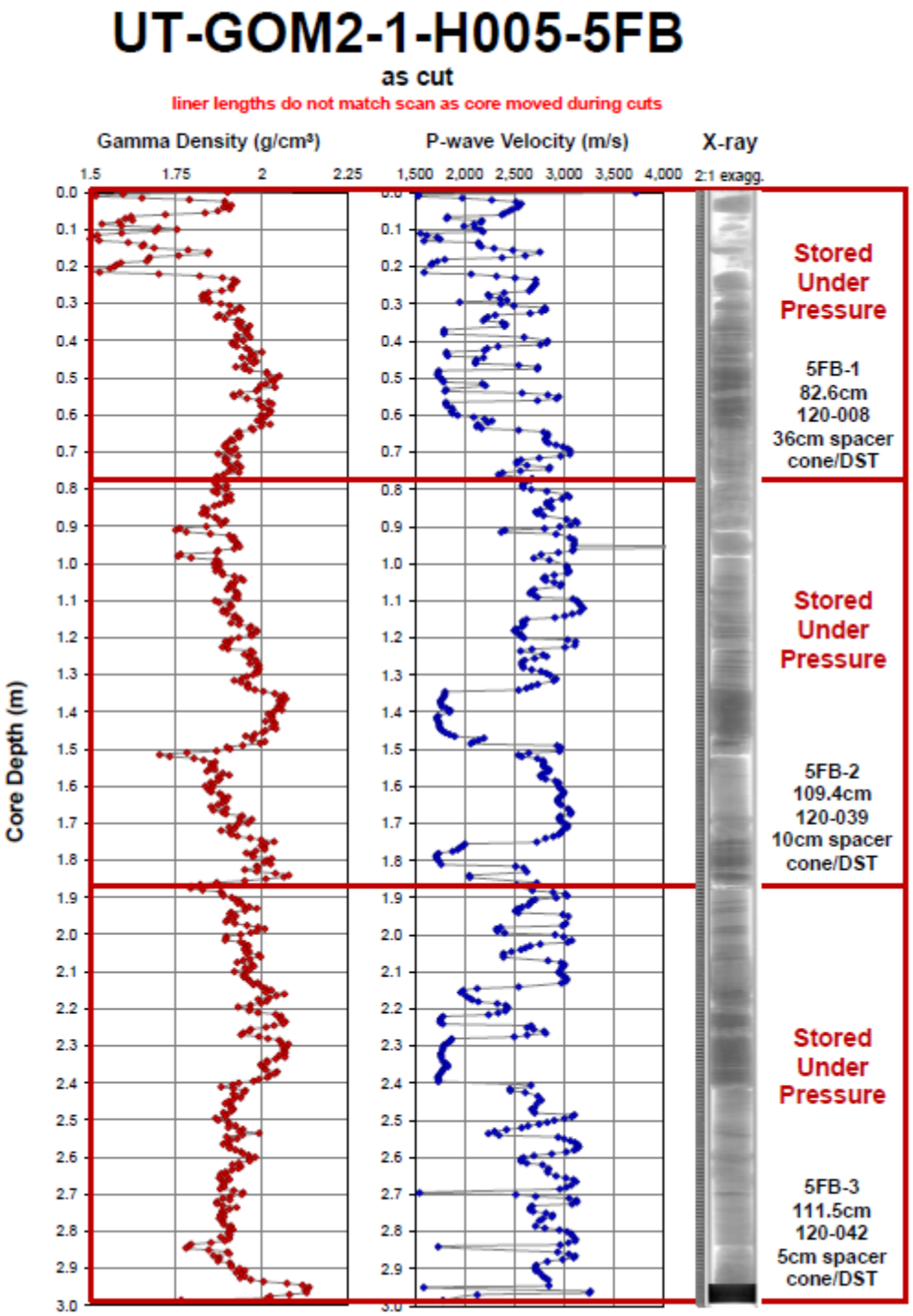

Figure 4.4.5 UT-GOM2-1-H005-05FB PCATS data and section cuts. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

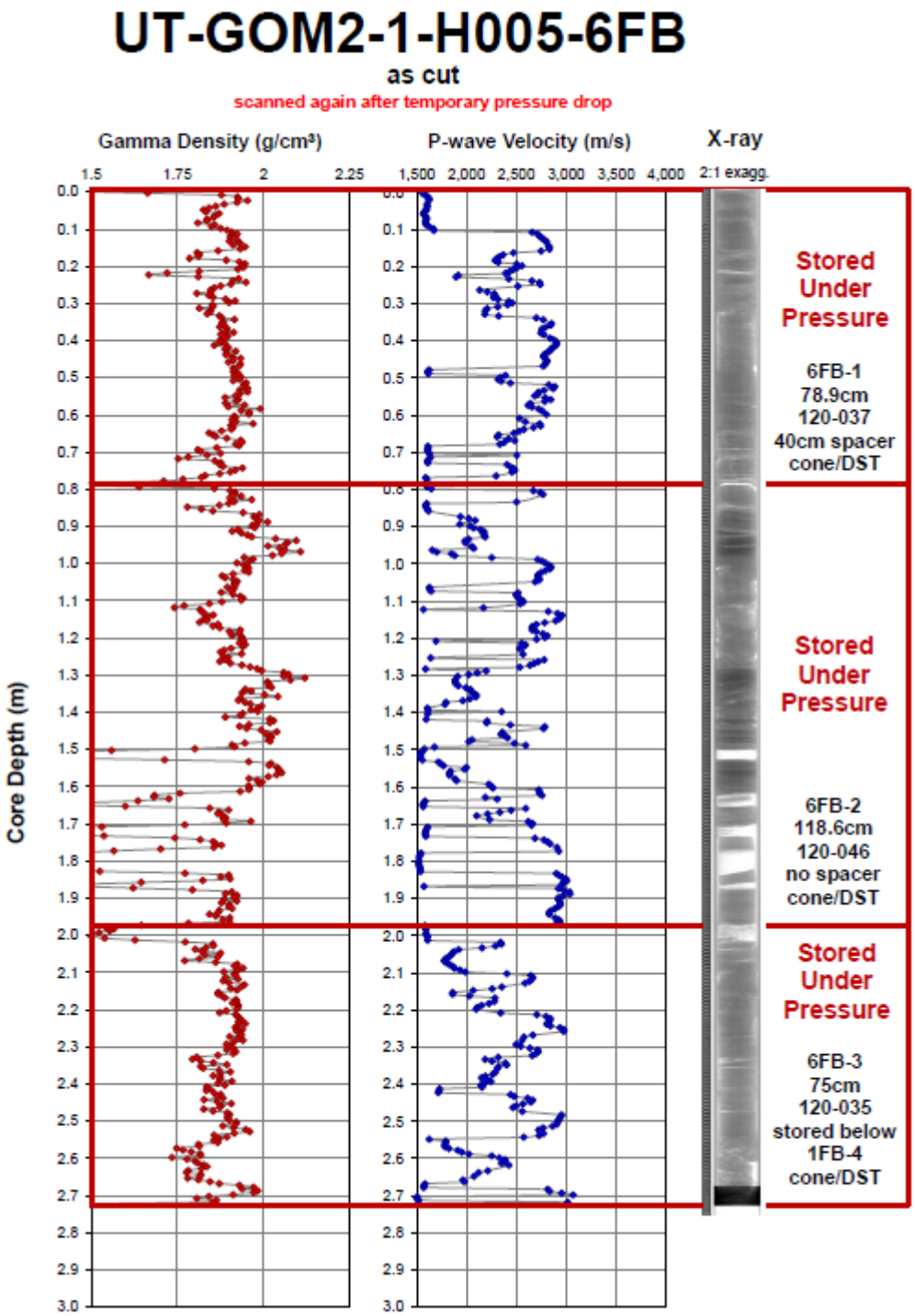

Figure 4.4.6 UT-GOM2-1-H005-06FB PCATS data and section cuts. Data taken prior to a seal failure that depressurized this core. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

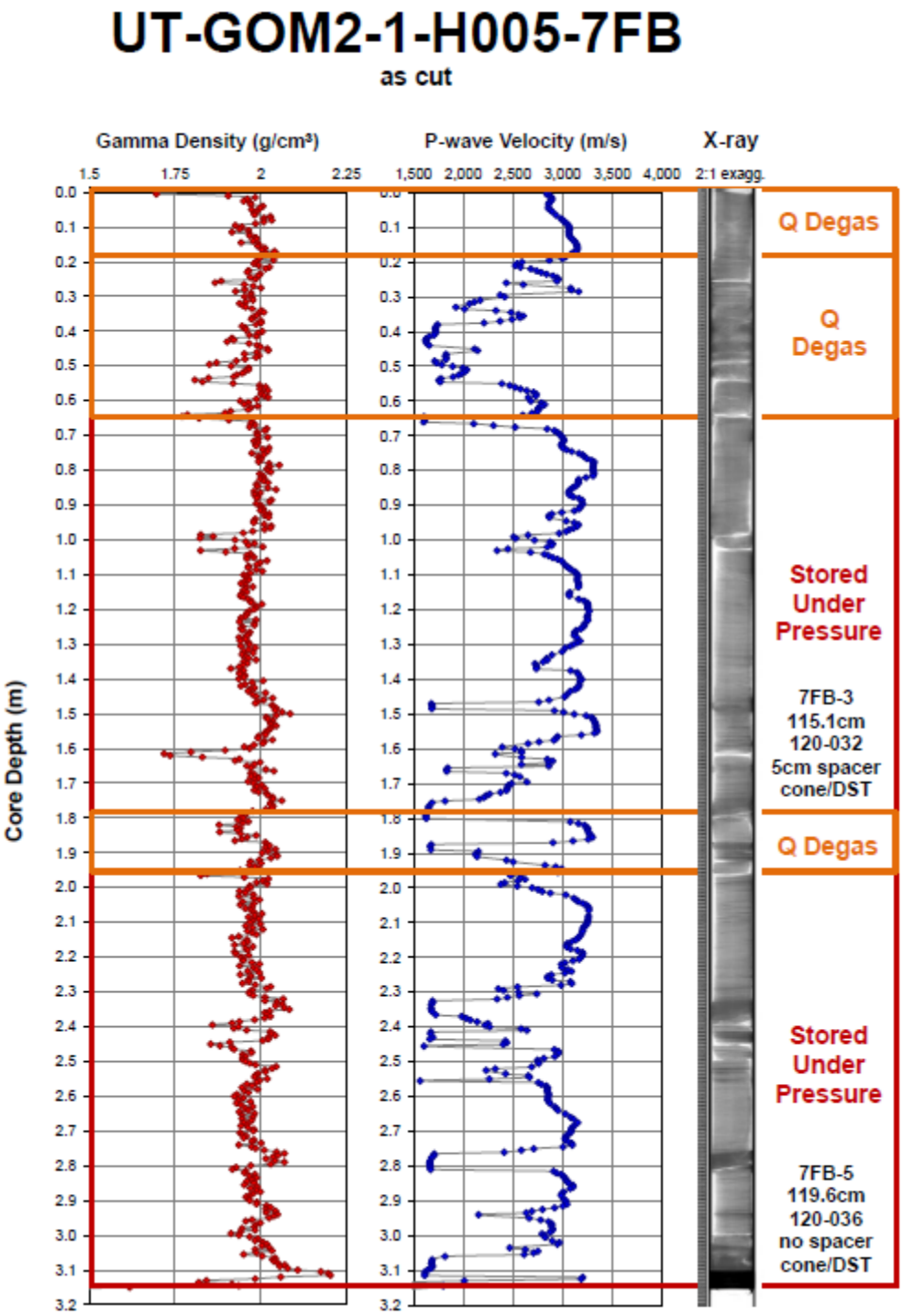

Figure 4.4.7 UT-GOM2-1-H005-07FB PCATS data and section cuts. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

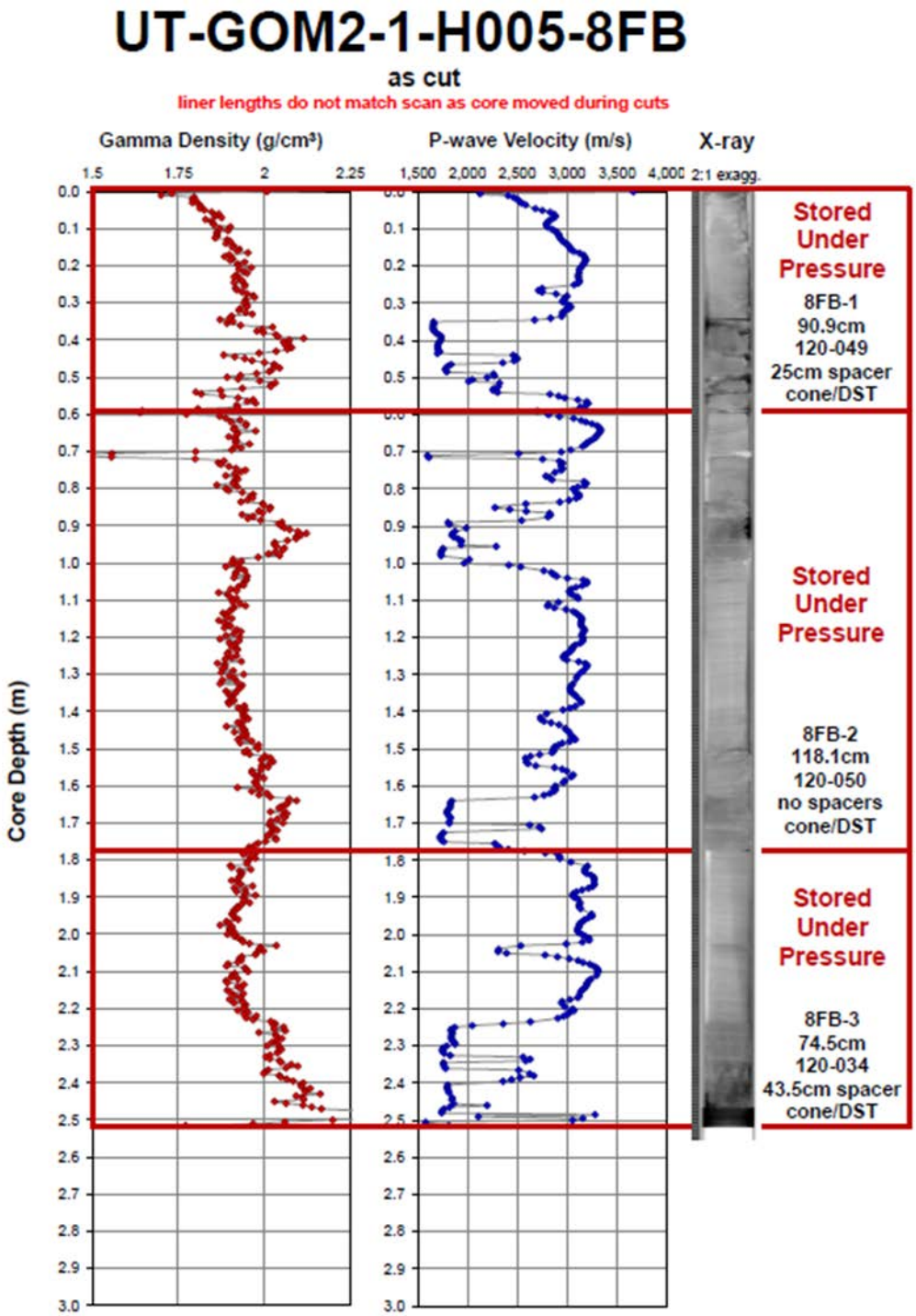

Figure 4.4.8 UT-GOM2-1-H005-08FB PCATS data and section cuts. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

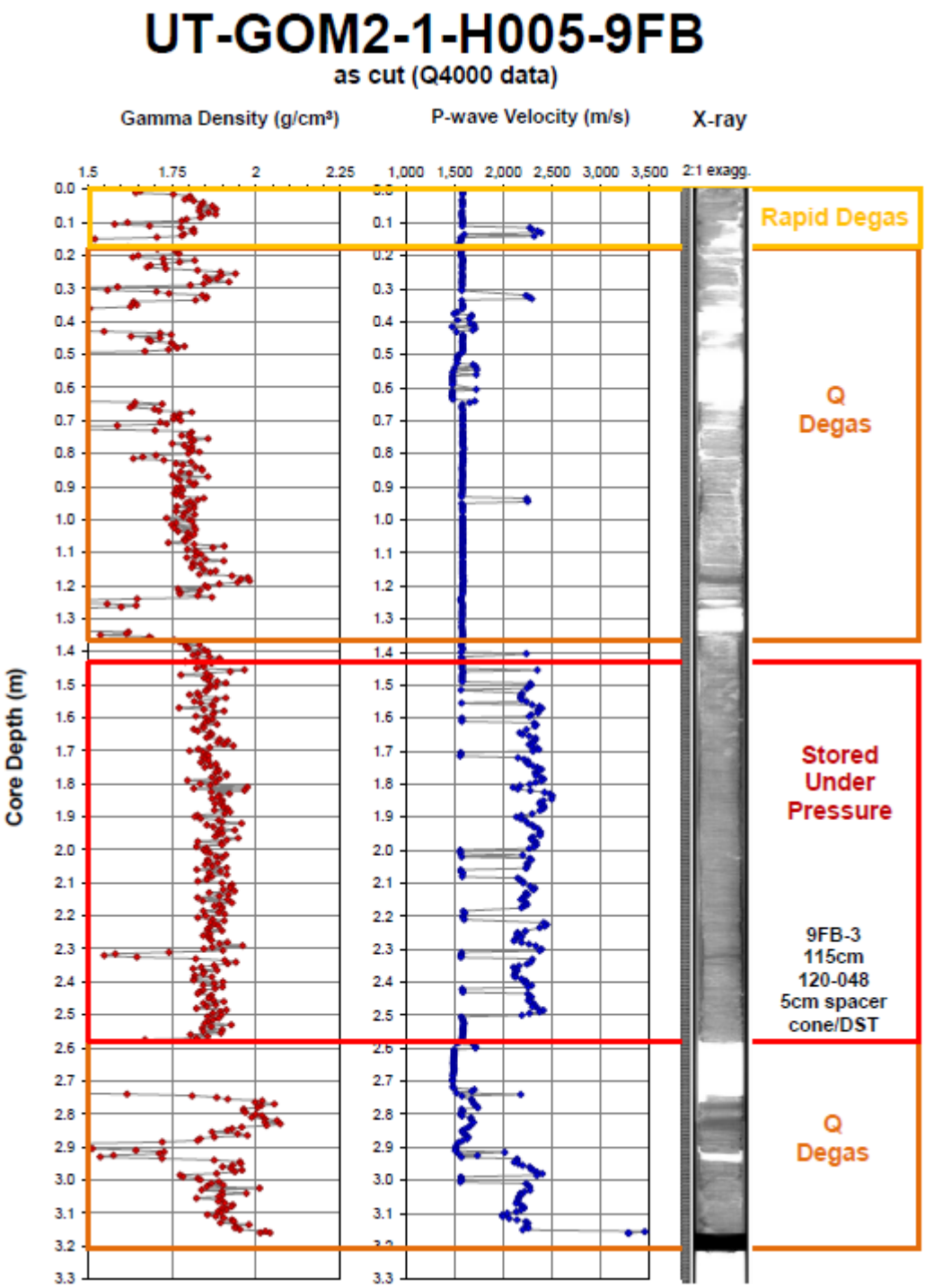

Figure 4.4.9 UT-GOM2-1-H005-09FB PCATS data and section cuts. Gamma density, P-wave velocity and both X-ray images were acquired onboard the D/V Q4000. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

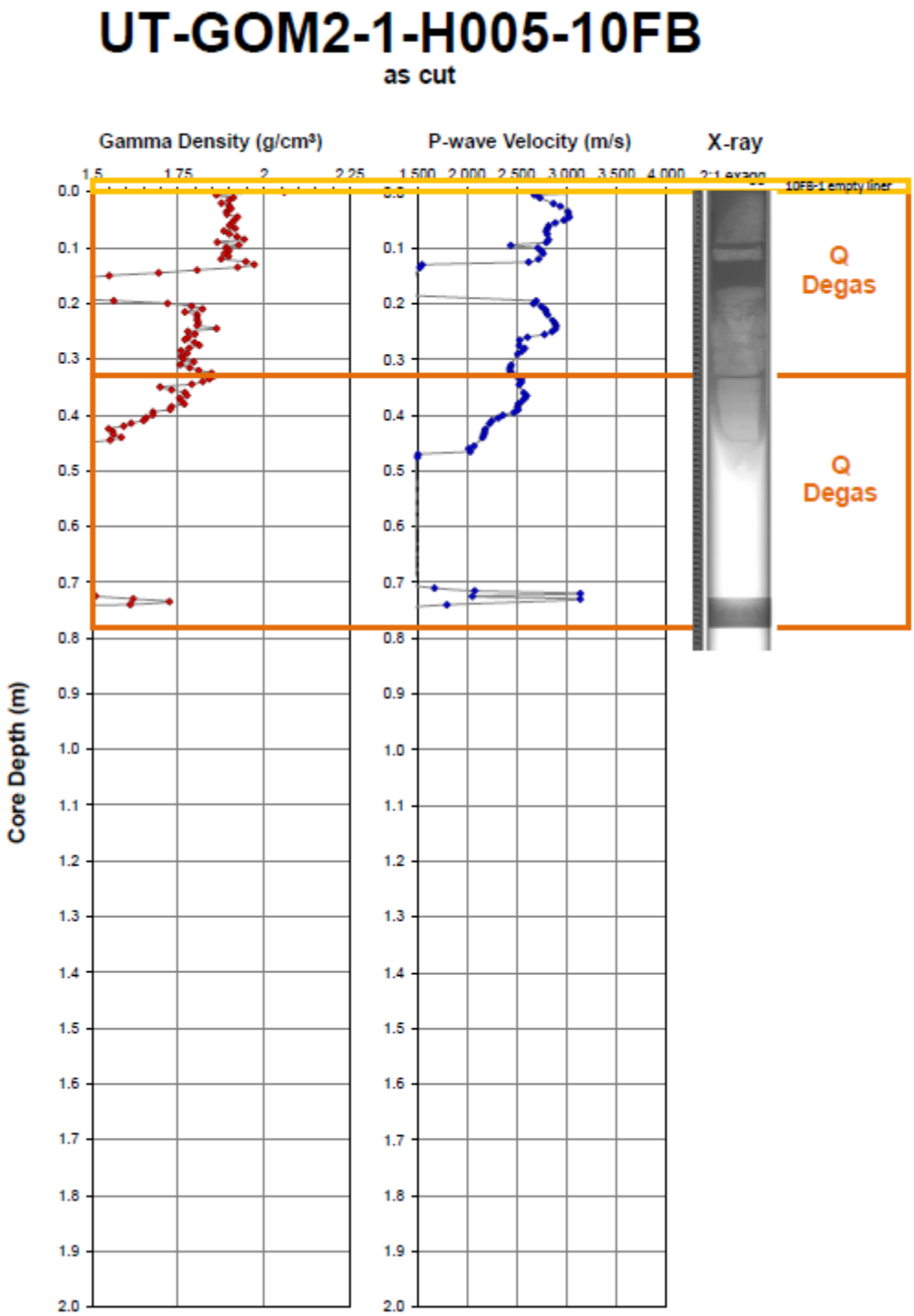

Figure 4.4.10 UT-GOM2-1-H005-10FB PCATS data and section cuts. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

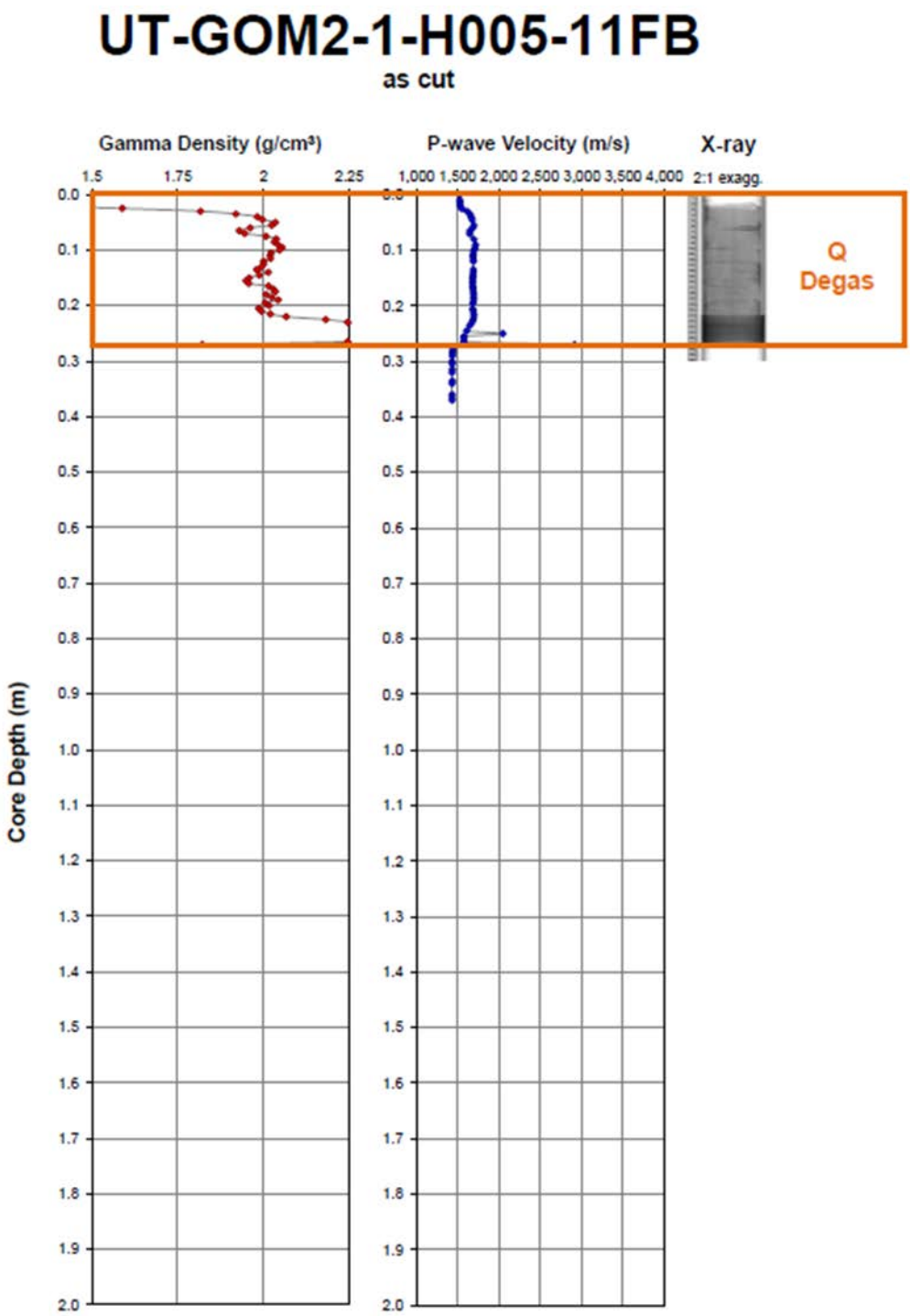

Figure 4.4.11 UT-GOM2-1-H005-11FB PCATS data. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

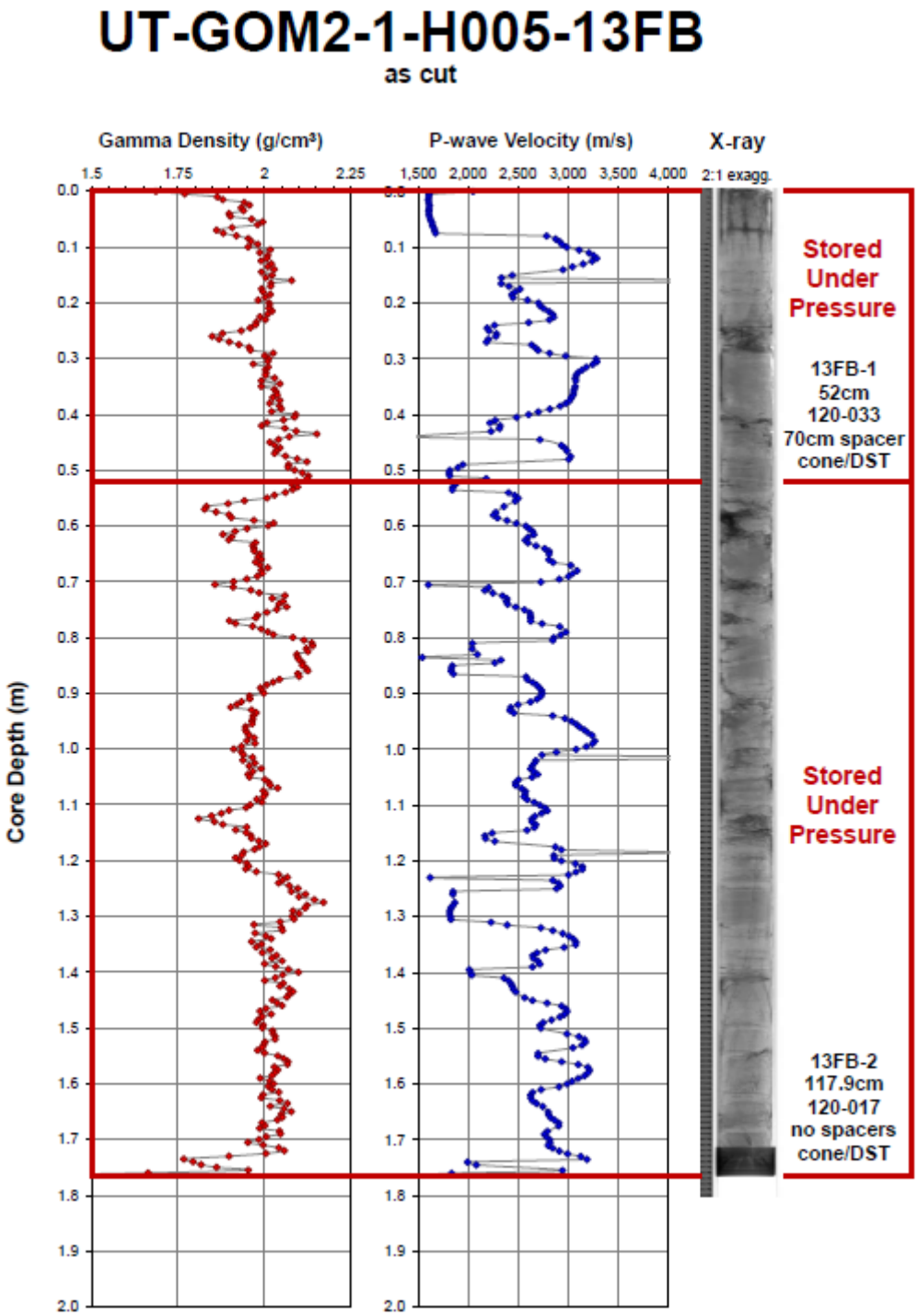

Figure 4.4.12 UT-GOM2-1-H005-13FB PCATS data and section cuts. Gamma density, P-wave velocity and the X-ray image were acquired at Intermoor (Port Fourchon). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

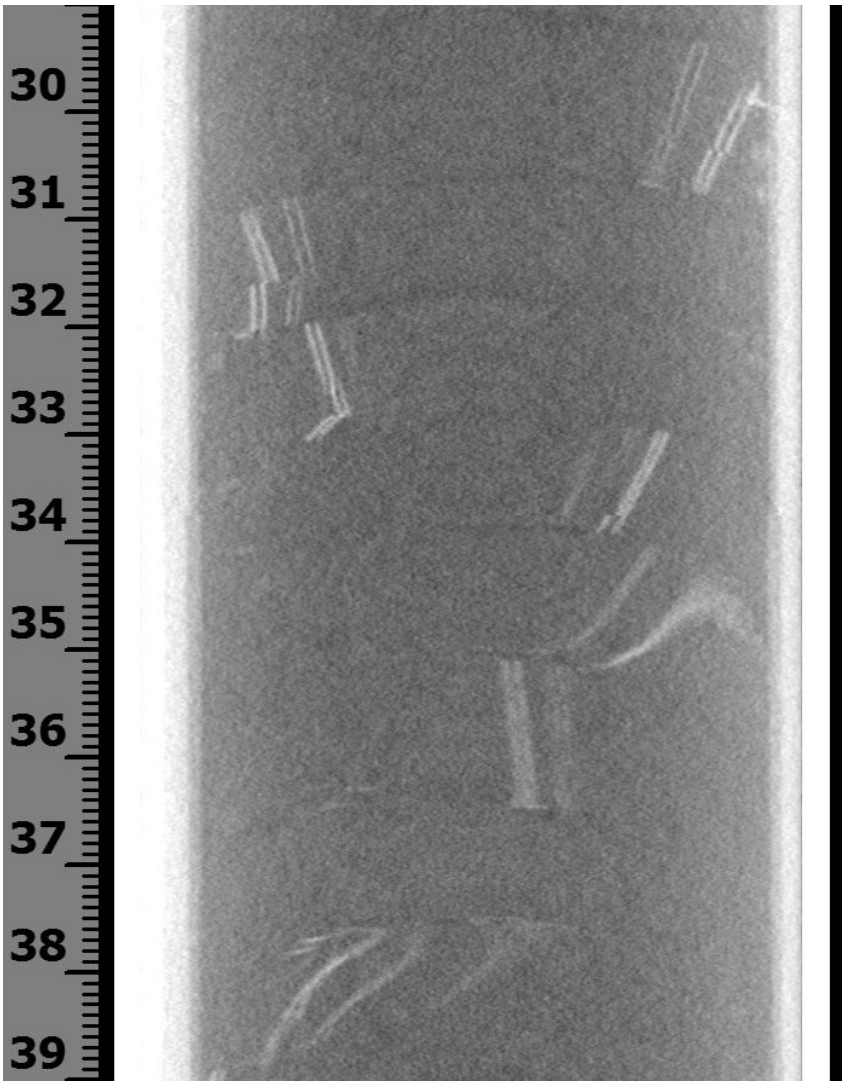

Figure 4.4.13 UT-GOM2-1-H005-01FB X-ray CT XZ slab image. Image shows low-density veins in soft sediment. Sediment has been broken at ~1-cm intervals and rotated with respect to the sediment above and below. Apparent millimeter scale doubling of vein features is an artifact of the CT reconstruction. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

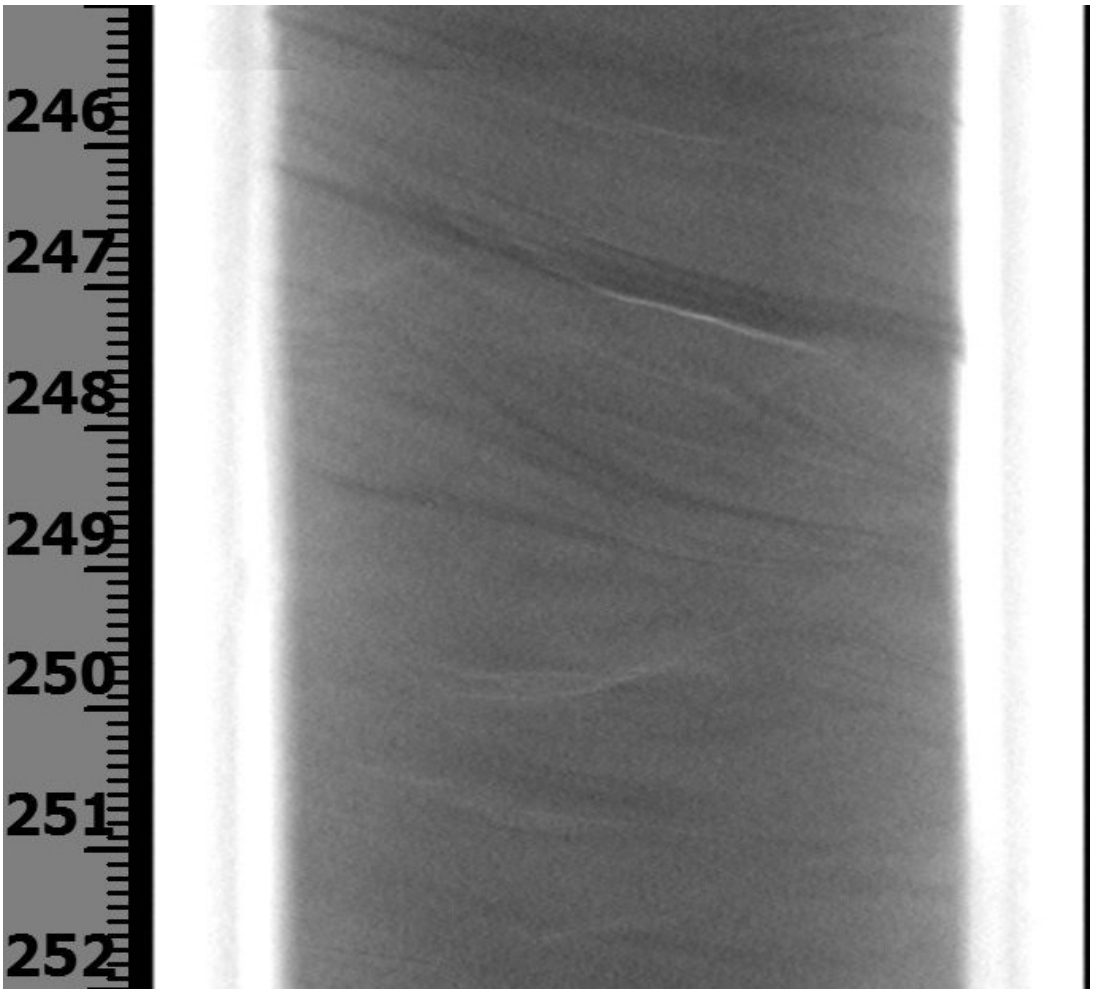

Figure 4.4.14 UT-GOM2-1-H005-05FB X-ray CT XZ slab image. An example of low-density veins which may be core disturbance or gas hydrate. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

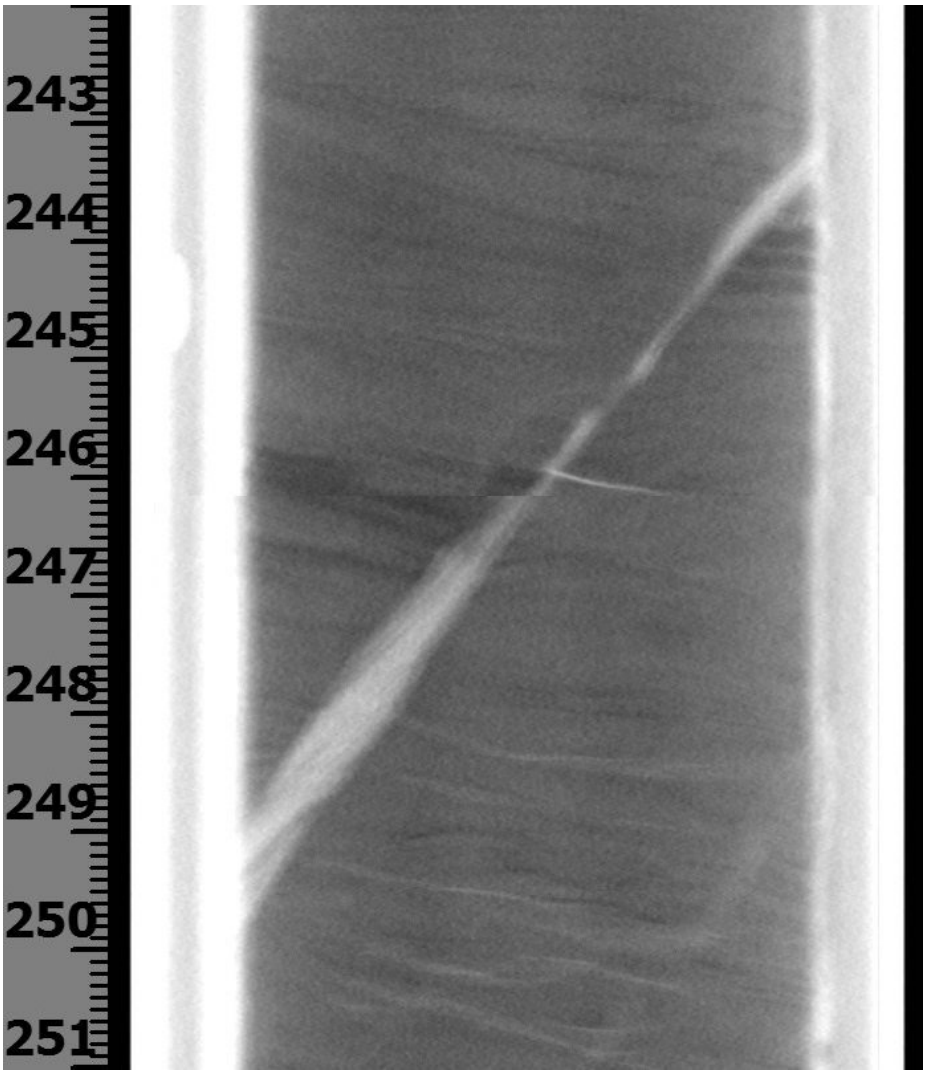

Figure 4.4.15 UT-GOM2-1-H005-04FB X-ray CT YZ slab image. An example of a possible fault with sediment displacement. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

Depressurization incident before and after

Core UT-GOM2-1-H005-6FB was the victim of a seal failure in PCATS and spent 5-10 minutes near atmospheric pressure and 6˚C. A set of nondestructive data was collected before the failure (Figure 4.4.6), and another set was collected once the core was re-pressurized (Figure 4.4.16). Expansion of gas pushed core material upwards and downwards; some sediment was lost out of the core catcher. Both densities and velocities of equivalent portions of core decreased after the incident. Much gas hydrate remained in the core as gas hydrate since velocities remained relatively high (2000-3000 m/s). Velocities were reduced on average by 500 m/s in any given core location, though whether this was due to loss of gas hydrate or addition of gas cracks cannot be determined from these data. Images collected directly after repressurization showed that the structure of most of the core has not been disturbed, so this core is still suitable for sedimentological studies (Figure 4.4.17).

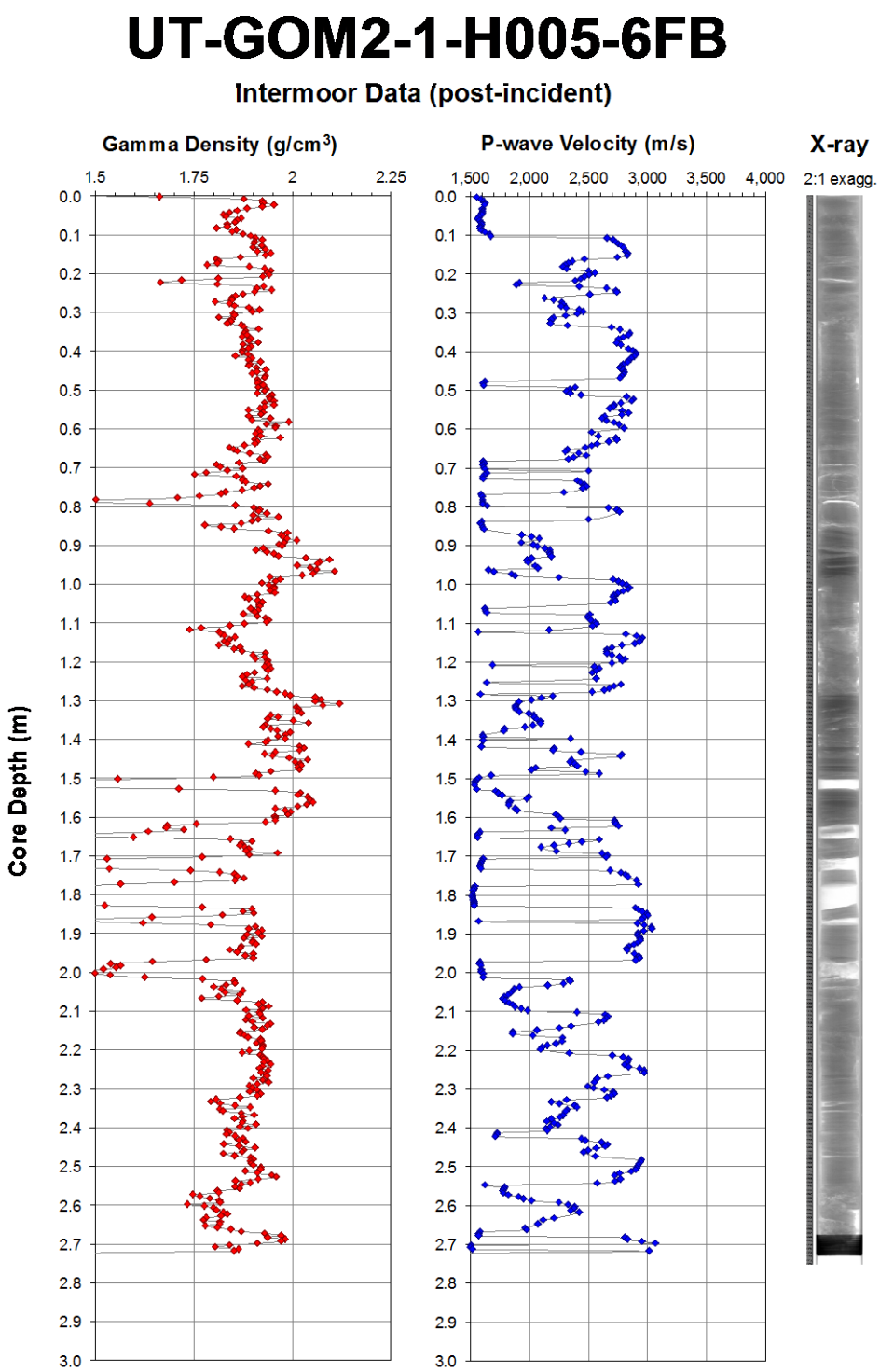

Figure 4.4.16 UT-GOM2-1-H005-06FB PCATS data after the PCATS seal failure and recovery. The core was outside of the methane hydrate stability zone for 5-10 minutes before it was re-pressurized. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

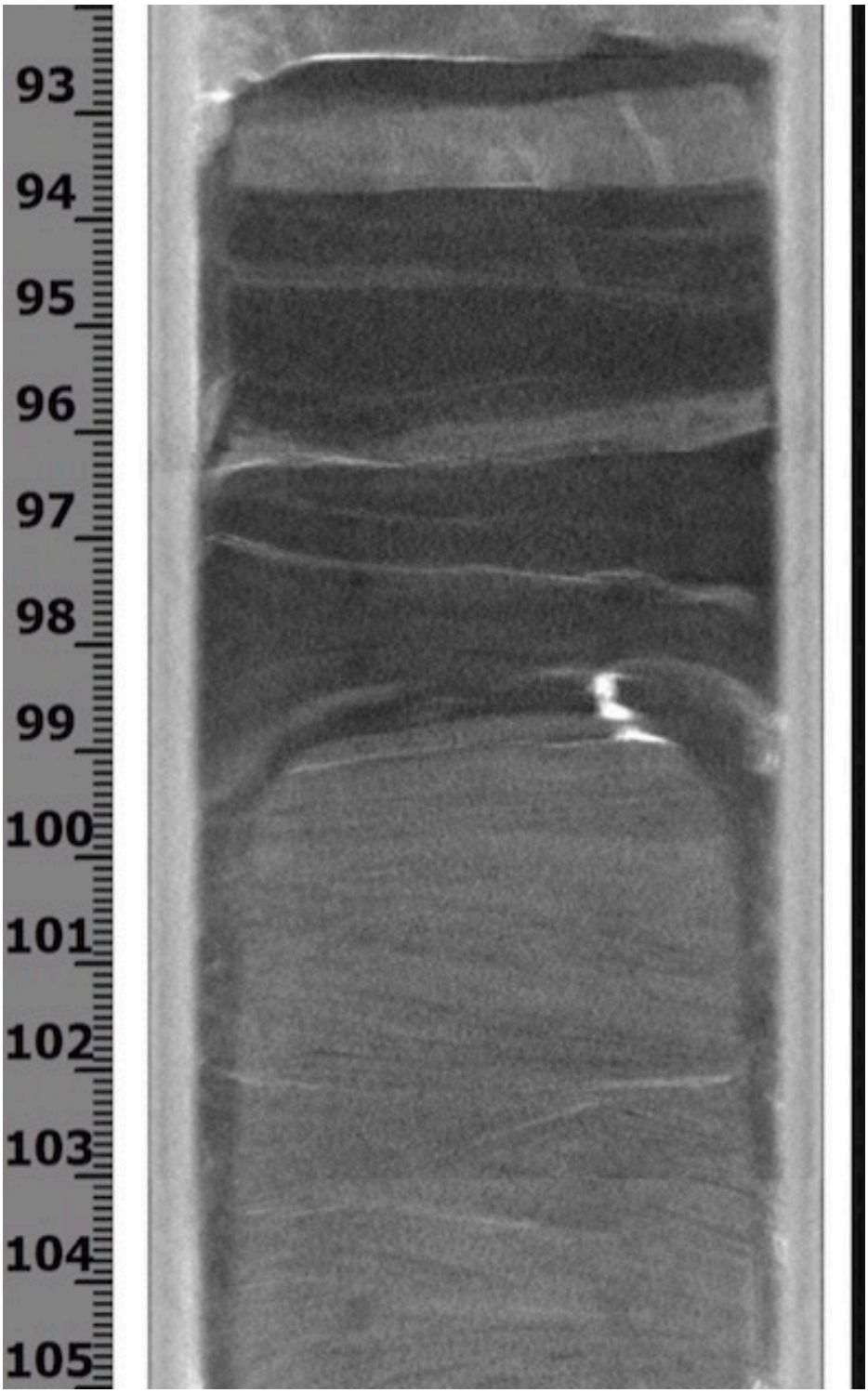

Figure 4.4.17 UT-GOM2-1-H005-06FB X-ray CT XZ slab after the PCATS seal failure and recovery. Detailed internal structure of the core was still maintained. This figure also shows compression of the dark, softer lithofacies 3 around the lithofacies 2 core. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

Core quality from nondestructive data

Rotary coring disturbance features were present in all cores. The periodic breakage of the lithofacies 2 core indicated that it was relatively hard and brittle. Description of some of the types of disturbance features encountered–core breaking, pieces rotating, infiltration of drilling mud, compression of softer lithofacies 3 material–was detailed in Chapter 3, Section 3.4 Physical Properties Some examples from H005 are shown in Figure 4.4.17 and Figure 4.4.18. The diameter of the recovered core varied along the core and between lithofacies, and impacted the calculation of gamma density and P-wave velocity.

Cores at the top of the hole (Cores UT-GOM2-1-H005-01FB and -02FB) have highly disturbed material at the top: 164 cm for Core UT-GOM2-1-H005-01FB and 30 cm for Core UT-GOM2-1-H005-02FB. This material is likely to be fill, or sediment that has fallen from shallower depths to land in the bottom of the hole.

In the middle of the cored interval (Cores UT-GOM2-1-H005-03FB to -08FB) the recovery was excellent and the X-ray showed that large lengths (up to 45 cm) of lithofacies 2 were recovered under pressure. Though this lithofacies did not fill the liner and thus the density and velocity need correcting, the clean cylinders cut in these cores should be amenable such a correction.

The deeper cores had more coring disturbance, which may have been due to the change in formation properties at this depth (see 4.6 Lithostratigraphy). Core UT-GOM2-1-H005-10FB was collected at the base of the main gas-hydrate-bearing zone, Core UT-GOM2-1-H005-11FB was drilled as a wash core with very high pump rates, and Core UT-GOM2-1-H005-13FB cored the thin lower hydrate interval. Core UT-GOM2-1-H005-13FB was broken into more pieces, as seen in the core X-rays (Figure 4.4.12), than cores taken from the upper hydrate zone, indicating that the lithology may be significantly different.

Cores UT-GOM2-1-H005-01FB to -07FB were cut with seawater as the drilling fluid, and Cores UT-GOM2-1-H005-8FB to -13FB were cut using barite-weighted drilling mud (see 4.2 Operations). The data presented for the cores cut with mud were collected after the cores had been stored for one to two weeks and transported dockside (with the exception of core UT-GOM2-1-H005-09FB which was processed on-board). In some of the cores the barite within the drilling mud has settled and redistributed around the core, which can be seen in the X-ray image and X-ray CT data (Figure 4.4.19). It was difficult to definitively point to examples of mud invasion within core pieces. Even Core UT-GOM2-1-H005-09FB, which spent 92 minutes outside of methane hydrate stability zone before being re-pressurized, does not show obvious cracks filled with drilling mud (Figure 4.4.19).

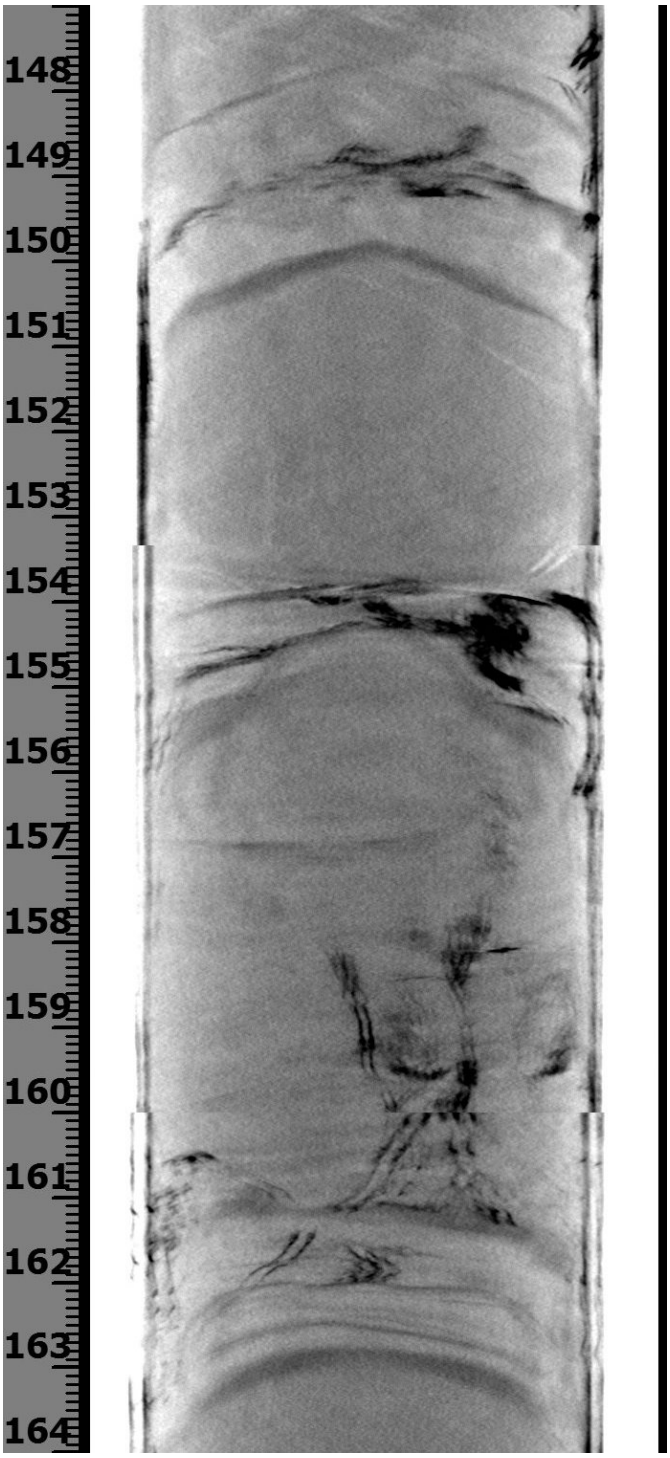

Figure 4.4.18 UT-GOM2-1-H005-13FB X-ray CT XZ slab image showing core disturbance. Biscuits of coherent core can develop pointed or curved top ends, with mud and disaggregated sediment between the pieces of core. Cracks in the sediment are seen filled with drilling mud in this core. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

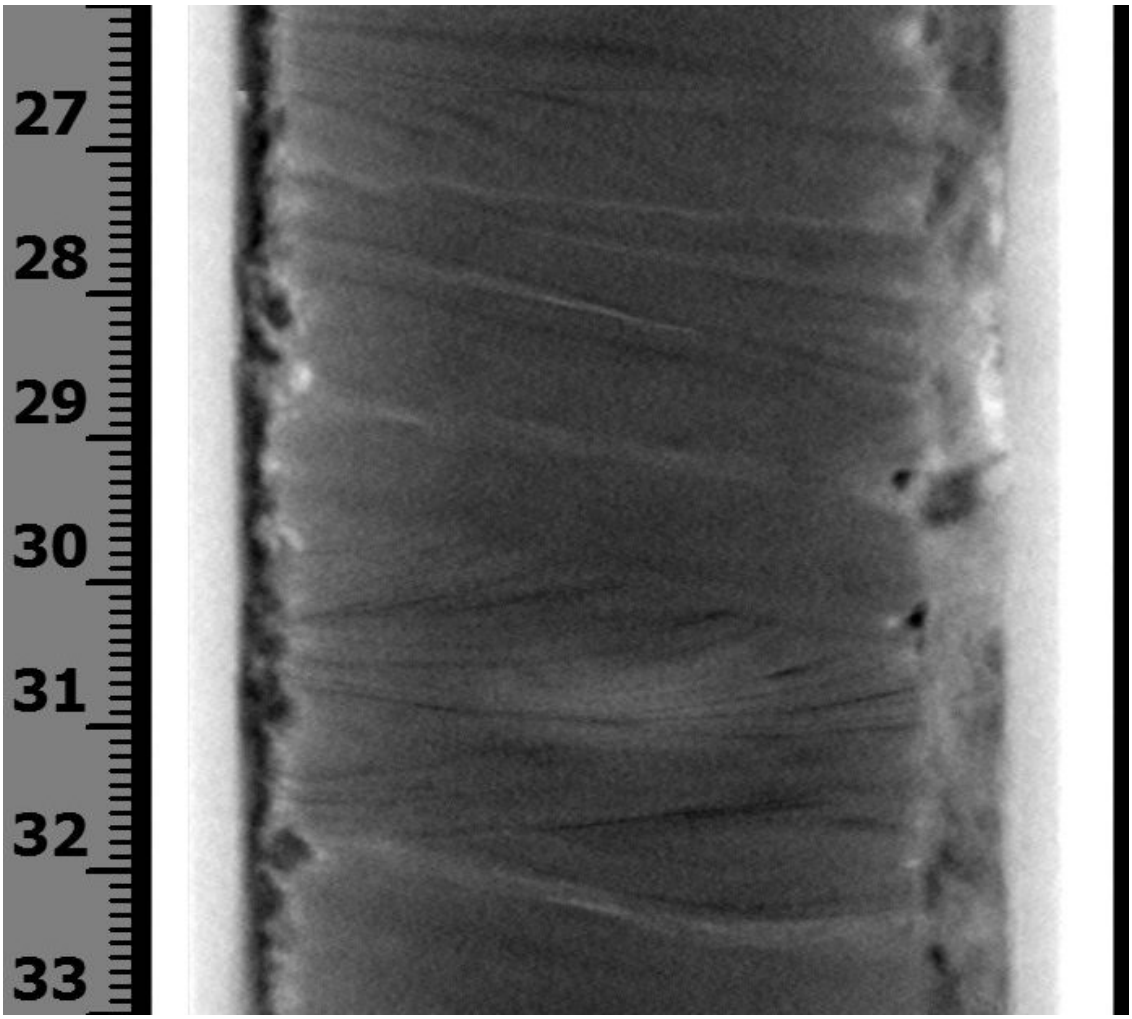

Figure 4.4.19 UT-GOM2-1-H005-09FB X-ray CT XZ slab image. Thin, light subhorizontal features are interpreted as cracks. Dark features are sedimentary structures which should be examined chemically for evidence of drilling fluid. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

Pressure Core Section Cut and Transfer

Cores were cut into sections for quantitative degassing (see section Quantitative Degassing), rapid degassing, and transferred to storage vessels for transport to UT where they will be further distributed to members of the hydrate science community. The cores were cut as show in Figure 4.4.1 to Figure 4.4.12. Table 4.4.1 shows a summary of the pressure core distribution.

Core	Recovered (cm)	fbrf	Section	Core Depth (cm)	Length (cm)	Allocation
UT-GOM2-1-H005-01FB	214	7645	1FB-1	0-69	69	Quantitative Degassing
UT-GOM2-1-H005-01FB	214	7645	1FB-2	69-163	94	Quantitative Degassing
UT-GOM2-1-H005-01FB	214	7645	1FB-3	163-184	21	Quantitative Degassing
UT-GOM2-1-H005-01FB	212	7645	1FB-4	184-214	30	UT
UT-GOM2-1-H005-02FB	153	8081	2FB-1	0-18	18	Quantitative Degassing
UT-GOM2-1-H005-02FB	153	8081	2FB-2	18-112.2	94.2	UT
UT-GOM2-1-H005-02FB	153	8081	2FB-3	112.2-152.7	40.5	UT
UT-GOM2-1-H005-03FB	304	8091	3FB-1	0-115.2	115.2	UT
UT-GOM2-1-H005-03FB	304	8091	3FB-2	115.2-132.7	17.5	Quantitative Degassing
UT-GOM2-1-H005-03FB	304	8091	3FB-3	132.7-159.2	26.5	Quantitative Degassing
UT-GOM2-1-H005-03FB	304	8091	3FB-4	159.2-236.5	77.3	UT
UT-GOM2-1-H005-03FB	304	8091	3FB-5	236.5-304.5	68	UT
UT-GOM2-1-H005-04FB	321	8101	4FB-1	0-12.7	12.7	Rapid Degassing
UT-GOM2-1-H005-04FB	321	8101	4FB-2	12.7-38.5	25.8	Quantitative Degassing
UT-GOM2-1-H005-04FB	321	8101	4FB-3	38.5-53.3	14.8	Quantitative Degassing
UT-GOM2-1-H005-04FB	321	8101	4FB-4	53.3-65	11.7	Quantitative Degassing
UT-GOM2-1-H005-04FB	321	8101	4FB-5	65-82.5	17.5	Quantitative Degassing
UT-GOM2-1-H005-04FB	321	8101	4FB-6	82.5-190.9	108.4	UT
UT-GOM2-1-H005-04FB	321	8101	4FB-7	190.9-202.9	12	Quantitative Degassing
UT-GOM2-1-H005-04FB	321	8101	4FB-8	202.9-320.5	117.6	UT
UT-GOM2-1-H005-05FB	303	8111	5FB-1	0-82.6	82.6	UT
UT-GOM2-1-H005-05FB	303	8111	5FB-2	82.6-192	109.4	UT
UT-GOM2-1-H005-05FB	303	8111	5FB-3	192-303.5	111.5	UT
UT-GOM2-1-H005-06FB	272	8121	6FB-1	0-78.9	78.9	UT
UT-GOM2-1-H005-06FB	272	8121	6FB-2	78.9-197.5	118.6	UT
UT-GOM2-1-H005-06FB	272	8121	6FB-3	197.5-272.5	75	UT
UT-GOM2-1-H005-07FB	314	8131	7FB-1	0-18.6	18.6	Quantitative Degassing
UT-GOM2-1-H005-07FB	314	8131	7FB-2	16.6-63.1	44.5	Quantitative Degassing
UT-GOM2-1-H005-07FB	314	8131	7FB-3	63.1-178.2	115.1	
UT-GOM2-1-H005-07FB	314	8131	7FB-4	178.2-194.8	16.6	Quantitative Degassing
UT-GOM2-1-H005-07FB	314	8131	7FB-5	194.8-314.4	119.6	UT
UT-GOM2-1-H005-08FB	283	8141	8FB-1	0-90.9	90.9	UT
UT-GOM2-1-H005-08FB	283	8141	8FB-2	90.9-209	118.1	UT
UT-GOM2-1-H005-08FB	283	8141	8FB-3	209-283.5	74.5	UT
UT-GOM2-1-H005-09FB	321	8151	9FB-1	0-18	18	Rapid Degassing
UT-GOM2-1-H005-09FB	321	8151	9FB-2	18-138	120	Quantitative Degassing
UT-GOM2-1-H005-09FB	321	8151	9FB-3	143-258	115	UT
UT-GOM2-1-H005-09FB	321	8151	9FB-4	258-321	63	Quantitative Degassing
UT-GOM2-1-H005-10FB	72	8161	10FB-2	0-32	32	Quantitative Degassing
UT-GOM2-1-H005-10FB	72	8161	10FB-3	32-76	44	Quantitative Degassing
UT-GOM2-1-H005-11FB	27	8166	11FB-1	0-27	27	Quantitative Degassing
UT-GOM2-1-H005-13FB	170	8185	13FB-1	0-52	52	UT
UT-GOM2-1-H005-13FB	170	8185	13FB-2	52-169.9	117.9	UT

Table 4.4.1 Pressure Core distribution. Cores were transferred to Quantitative degassing(pink), rapid degassing (white), and to UT (blue). All H005 Core distribution data can be found in the expedition data directory under H005 / Curation.

4.4.2 Depressurized Whole Core

Depressurized Core Section Cut and Transfer

As mentioned above, intervals of the core not recovered under pressure but with intact sediment were sampled for time sensitive analyses (see 4.7 Geochemistry and Microbiology). The remaining sections were split into 1 m sections or smaller, avoiding voids to maximize the length of the intact core. These sections were sent to Ohio State University and are described here and in 4.6 Lithostratigraphy.

Core	Recovered (cm)	fbrf	Section	Core Depth (cm)	Length (cm)	Depressurization	Allocation
UT-GOM2-1-H005-01FB	217.0	7645-7655	01FB-3	8	0	Q degas	Headspace gas
UT-GOM2-1-H005-01FB	217.0	7645-7655	01FB-3	8-21	13	Q degas	Microbiology
UT-GOM2-1-H005-01FB	217.0	7645-7655	01FB-3			Paste	Grain Size -SED at UT
UT-GOM2-1-H005-01FB	217.0	7645-7655	01FB-3	284		Core	Grain Size -Laser Geotek
UT-GOM2-1-H005-01FB	217.0	7645-7655	01FB-3	8-21	13	Q degas	Pore Water
UT-GOM2-1-H005-03FB	303.9	8091-8101	03FB-2	0	0		Headspace gas
UT-GOM2-1-H005-03FB	303.9	8091-8101	03FB-2			Paste	Grain Size -SED at UT
UT-GOM2-1-H005-03FB	303.9	8091-8101	03FB-2	420.25		Core	Grain Size -Laser Geotek
UT-GOM2-1-H005-03FB	303.9	8091-8101	03FB-3			Semiliquid	Grain Size -SED at UT
UT-GOM2-1-H005-03FB	303.9	8091-8101	03FB-3	420.45		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-2	422.25		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-2LINER	422		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-3	14	0		Headspace gas
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-3			Paste	Grain Size -SED at UT
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-3	422.45		Core	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-4			Liquid	Grain Size -SED at UT
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-4	422.6		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-5	4	0		Headspace gas
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-5A			Liquid	Grain Size -SED at UT
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-5A	422.78		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-5A2			Liquid	Grain Size -SED at UT
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-5A2	422.78		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-5B			Liquid	Grain Size -SED at UT
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-5B	422.74		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-5B2			Liquid	Grain Size -SED at UT
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-5B2	422.74		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	04FB-7	423.95		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-04FB	320.9	8101-8111	4FB-5	4-18	14	Q Degas	Pore Water
UT-GOM2-1-H005-07FB	320.9	8131-8141	07FB-1			Paste	Grain Size -SED at UT
UT-GOM2-1-H005-07FB	320.9	8131-8141	07FB-1	432.1		Core	Grain Size -Laser Geotek
UT-GOM2-1-H005-07FB	320.9	8131-8141	07FB-2	15	0		Headspace gas
UT-GOM2-1-H005-07FB	320.9	8131-8141	07FB-2			Paste	Grain Size -SED at UT
UT-GOM2-1-H005-07FB	320.9	8131-8141	07FB-2	432.4		Core	Grain Size -Laser Geotek
UT-GOM2-1-H005-07FB	320.9	8131-8141	07FB-4			Paste	Grain Size -SED at UT
UT-GOM2-1-H005-07FB	320.9	8131-8141	07FB-4	433.9		Core	Grain Size -Laser Geotek
UT-GOM2-1-H005-07FB	320.9	8131-8141	7FB-2	0-15	15	Q degas	Pore Water
UT-GOM2-1-H005-08FB	249.9	8141-8151	08FB-TOP			Liquid	Grain Size -SED at UT
UT-GOM2-1-H005-08FB	249.9	8141-8151	08FB-TOP	435		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-1	0	0		Headspace gas
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-1		23	Q degas	XCT
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-2	35	0		Headspace gas
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-2		85	Q degas	XCT
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-2A	437.8		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-2B	437.8		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-4	24	0		Headspace gas
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-4		13	Q degas	XCT
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-4		35	Q degas	XCT
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-4A	439.8		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-09FB	270.0	8151-8161	09FB-4B	439.8		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-09FB	270.0	8151-8161	9FB-2	5-20	15	Q degas	Microbiology
UT-GOM2-1-H005-10FB	43.9	8161-8166	10FB-2	440.15		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-10FB	43.9	8161-8166	10FB-3	440.5		Disaggregated	Grain Size -Laser Geotek
UT-GOM2-1-H005-11FB	27.1	8166-8176	11FB-1	441.15		Core	Grain Size -Laser Geotek
UT-GOM2-1-H005-12FB	164.9	8176-8185	12FB-1		12	Failed pressure core	XCT
UT-GOM2-1-H005-12FB	164.9	8176-8185	12FB-2	30	0	Failed pressure core	Headspace gas
UT-GOM2-1-H005-12FB	164.9	8176-8185	12FB-2	30-45	15	Failed pressure core	Pore Water
UT-GOM2-1-H005-12FB	164.9	8176-8185	12FB-2	45-60	15	Failed pressure core	Microbiology
UT-GOM2-1-H005-12FB	164.9	8176-8185	12FB-2		30	Failed pressure core	XCT
UT-GOM2-1-H005-12FB	164.9	8176-8185	12FB-3	64	0	Failed pressure core	Headspace gas
UT-GOM2-1-H005-12FB	164.9	8176-8185	12FB-3	64-81	17	Failed pressure core	Pore Water
UT-GOM2-1-H005-12FB	164.9	8176-8185	12FB-3	81-92	11	Failed pressure core	Microbiology
UT-GOM2-1-H005-12FB	164.9	8176-8185	12FB-3		64	Failed pressure core	XCT

Table 4.4.2 Depressurized Core distribution. Cores were transported to Geochemistry, Microbiology, Grain Size, and Convnetional Core Analyses. All H005 Core distribution data can be found in the expedition data directory under H005 / Curation.

X-ray CT

The depressurized core sections were shipped to Ohio State and scanned using a CereTom XCT. Table 4.4.3 lists all of the depressurized cores and core sections that were scanned in H005. This list also includes bonus core sections; these bonus core sections are additional material that flowed in through the bottom of the coring tool and was lodged between the liner and the rabbit.

The XCT illustrates that core recovery in the depressurized core sections was poor. Unlike the pressurized core, sedimentary layering and cross-laminations were observed in only a few in small, cm thick, sections (Figure 4.4.20 and Figure 4.4.21). Most of the cores were not intact and are highly disturbed, containing soupy mixture, air-bubble rich sections or broken fragments. Drilling mud was visible in some intact sections, often concentrating on the edges of the core barrel or between layers of core (Figure 4.4.20).

Because the core samples were depressurized during core recovery and were not scanned with PCATS, it is not possible to definitively identify lithofacies in the same manner as the pressure cores, or determine if the core previously contained gas hydrate. In some cases, we have made estimates of lithofacies type based on visual core description (see 4.6 Lithostratigraphy).

			Depth in section (cm)				
Core	Type	Section	From	To	Length (cm)*	Depth, top of core (mbsf)	Depth, top of core (fbrf)
UT-GOM2-1-H005-							
9	FB	1	0	23	23	437	8151
9	FB	2	53	138	85	437	8151
9	FB	4	258	271	13	437	8151
9	FB	4	282	317	35	437	8151
12	FB	1	0	12	12	444	8176
12	FB	2	0	30	30	444	8176
12	FB	3	76	140	64	444	8176
Bonus Sec1	FB	1	0	60	60	N/A	N/A
Bonus Sec2	FB	2	60	160	100	N/A	N/A

Table 4.4.3 H005 cores that were collected but did not hold pressure. These cores were scanned and documented at Ohio State. All H005 XCT data can be found in the expedition data directory under H005 / Physical Properties / XCT.

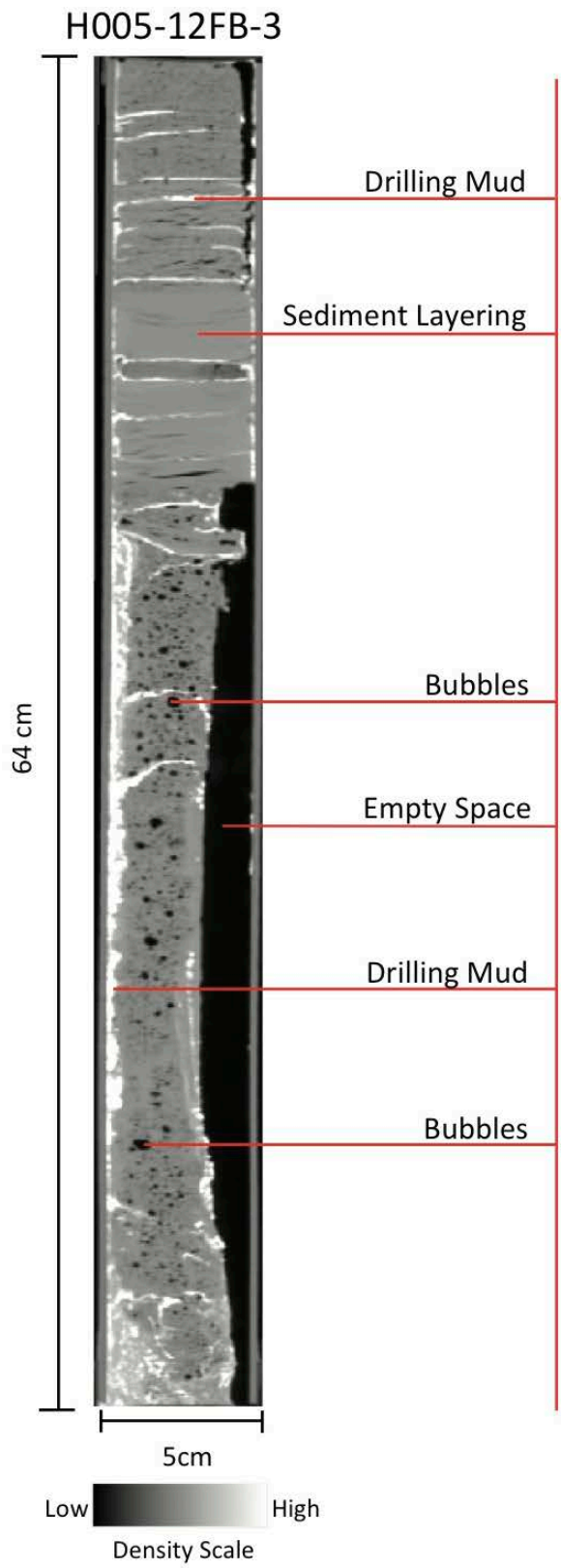

Figure 4.4.20 UT-GOM2-1-H005-12FB XCT scan showing arifacts of poor core recovery. All H005 XCT data can be found in the expedition data directory under H005 / Physical Properties / XCT.

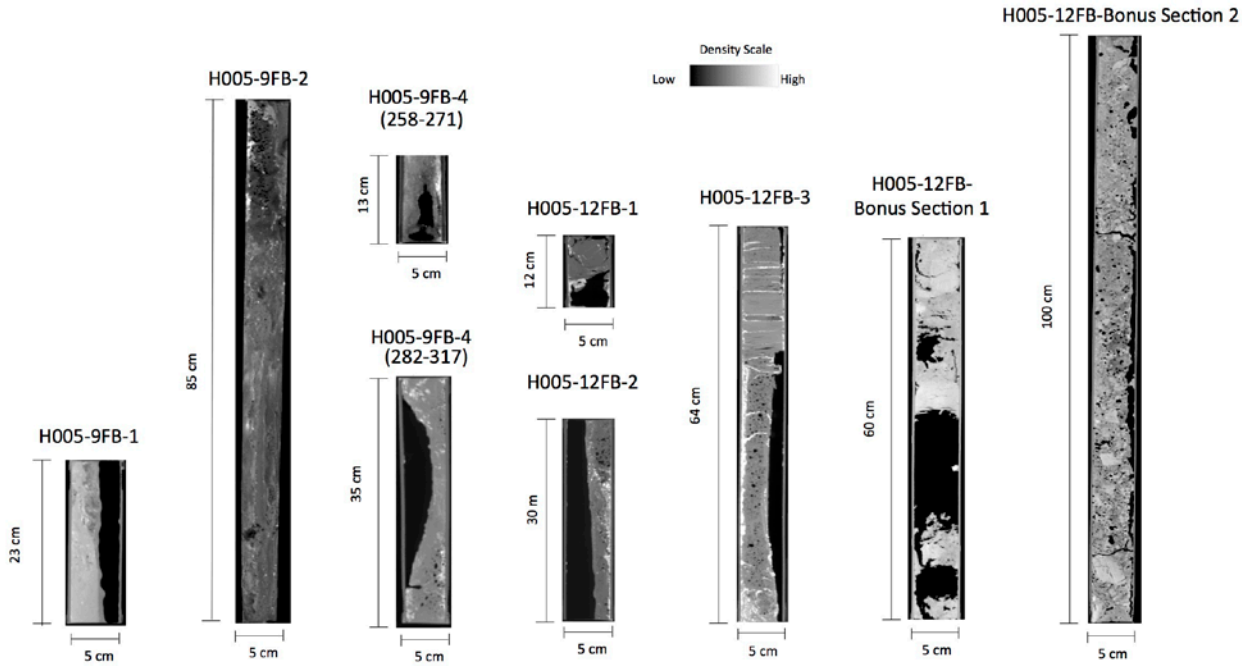

Figure 4.4.21 An XCT slice from each depressurized core section. All H005 XCT data can be found in the expedition data directory under H005 / Physical Properties / XCT.

4.5 Quantitative Degassing

4.5.1 Overview

In this section of the expedition report the results of quantitative degassing experiments from H005 (Cores UT-GOM2-1-H005-01FB, -02FB, -03FB, -04FB, -07FB, -09FB, -10FB, and -11FB) are reviewed, including pressure-volume relationships, total methane content, and hydrate saturation. Overall, 18 sections were quantitatively degassed from H005 from Cores UT-GOM2-1-H005-01FB, -03FB, -04FB, -07FB, -09FB, -10FB, and -11FB (Table 4.5.1). In general sections were chosen to represent lithofacies 1, 2, and 3 (as defined in 4.6 Lithostratigraphy); however, some sections were mixed lithofacies chosen based on core condition or the need to depressurize sections while making cuts for storage. Most degassing experiments were performed over less than twelve hours while several were performed for multiple days. All degassing data are available in the H005 data directory under Quantitative Degassing.

Hole	Core	Section	Depth in core - top (cm)	Depth in core - bottom (cm)	Depth - top (mbsf)	Depth - bottom (mbsf)	Section length (cm)	Section volume (L)	Lithofacies	Total methane (L)	Hydrate saturation	Degassing duration (hr)
H005	01FB	1	0	69	282.55	283.24	69	1.40	Fall in	0.67	1	4.9
H005	01FB	2	69	163	283.24	284.18	94	1.91	Fall in	1.38	1	4.2
H005	01FB	3	163	184	284.18	284.39	21	0.43	1	0.72	3	3.9
H005	02FB	1	0	18	415.44	415.62	18	0.36	Fall in	0.63	3	2.6
H005	03FB	3	132.7	159.2	419.82	420.08	26.5	0.54	2	25.03	71	16.5
H005	04FB	2	12.7	38.5	421.67	421.92	25.8	0.52	2	24.4	71	16.0
H005	04FB	3	38.5	53.3	421.92	422.07	14.8	0.30	3	3.45	18	123.1
H005	04FB	4	53.3	65	422.07	422.19	11.7	0.24	2	10.77	69	142.5
H005	04FB	5	65	82.5	422.19	422.36	17.5	0.35	3	6.91	30	6.9
H005	04FB	7	190.9	202.9	423.45	423.57	12	0.24	2	12.9	81	14.4
H005	07FB	1	0	18.6	430.68	430.87	18.6	0.38	2	18.55	75	12.4
H005	07FB	2	18.6	63.1	430.87	431.31	44.5	0.90	2+3	30.9	52	11.7
H005	07FB	4	178.2	194.8	432.46	432.63	16.6	0.34	2+3	12.45	56	10.9
H005	09FB	2	18	138	436.96	438.16	120	2.43	Uncertain/2+3	122.75	77	18.1
H005	09FB	4	258	321	439.36	439.99	63	1.28	Uncertain/2+3	40.71	49	14.8
H005	10FB	2	0	32	439.83	440.15	32	0.65	2	27.97	66	22.0
H005	10FB	3	32	76	440.15	440.59	44	0.89	2	7.31	12	9.1
H005	11FB	1	0	27	441.35	441.62	27	0.55	3	0.3	1	4.9

Table 4.5.1 H005 Lithofacies, total gas evolved and hydrate saturation.

The length of sections degassed ranged from 11.7 to 120 cm and the volume of gas produced ranged from 0.3 to 122.75 L (Table 4.5.2). The bulk hydrate saturations (S_h) of the degassed sections ranged from 1 to 81 %. Generally, lithofacies 1 and 3 are characterized by lower hydrate saturation (3 to 27%, mean: 16%), while lithofacies 2 has higher saturation (55 to 87 %, mean 71%) (Figure 4.5.1 and Figure 4.5.2). See Expedition Report Chapter 2, Section 2.5 Quantitative Degassing for a detailed description of how hydrate saturation was calculated. The bulk variation in hydrate saturation with lithology is consistent with the bulk changes in P-wave velocity and gamma density that helped define these lithofacies (see 4.4 Physical Properties and 4.6 Lithostratigraphy).

Lithofacies 2 was sampled as seven different quantitatively degassed core sections: UT-GOM2-1-H005 -03FB-3, -04FB-2, -04FB-4, -04FB-7, -07FB-1, -10FB-2, and -10FB-3. These sections were chosen based on intervals of predominately high P-wave saturation and lower density (see 4.4 Physical Properties and 4.6 Lithostratigraphy). The length of sections degassed containing lithofacies 2 ranged from 9.5 to 32 cm and the volume of gas produced ranged from 7.31 to 27.97 L (Figure 4.5.4 to Figure 4.5.10) with an average of 19.2 cm and 17.93 L respectively. 81 evolved gas samples were collected and analyzed from cores of lithofacies 2 (see 4.7 Geochemistry and Microbiology). The average hydrate saturation estimate for the five core sections of lithofacies 2 is 71%, ranging from 55 to 87%.

Lithofacies 3 was represented in three different core sections: UT-GOM2-1-H005-04FB-3, -04FB-5, and -11FB-1. A third sample, UT-GOM2-1-H005-03FB-2 was degassed but the log sheet was lost. These sections were chosen based on intervals of predominately lower P-wave saturation and higher density (see 4.4 Physical Properties and 4.6 Lithostratigraphy). The length of sections degassed containing lithofacies 3 ranged from 14.8 to 27 cm (average 16 cm) and the volume of gas produced ranged from 0.3 to 6.91 L (average 3.5 L) (Figure 4.5.11 and Figure 4.5.12). The average hydrate saturation estimate for the cores of lithofacies 3 is 24% and ranged from 18 to 30%.

In four different core sections both lithofacies 2 and 3 were present in the same section or the lithofacies was uncertain: UT-GOM2-1-H005-07FB-2, -07FB-4, -09FB-2, and -09FB-4. Two quantitatively degassed sections from Core UT-GOM2-1-H005-07B contain both lithofacies 2 and 3. Sections from Core UT-GOM2-1-H005-09B were partially dissociated (see 4.3 Pressure Coring) and difficult to identify the facies represented in the core. The length of multiple lithofacies core sections degassed ranged from 16.6 to 120 cm (average 52 cm) and the volume of gas produced ranged from 12.45 to 122.75 L (average 51.70 L) (Figure 4.5.13 to Figure 4.5.17). The average hydrate saturation estimate for multiple or uncertain lithofacies material is 52% ranging from 49 to 77%.

Based on PCATS scans, three different core sections likely are composed of highly disturbed fall-in material rather than formation from the coring interval: UT-GOM2-1-H005 -01FB-1, -01FB-2, -02FB-1. The length of fall-in core sections degassed ranged from 18 to 94 cm (average 16.5 cm) and the volume of gas produced ranged from 0.63 to 1.38 L (average 0.89 L) (Figure 4.5.18 to Figure 4.5.20). A total of 3 gas samples were collected and analyzed in total from the fall-in material core sections (see 4.7 Geochemistry and Microbiology). The average hydrate saturation estimate for fall-in material core sections is 2% ranging from 1 to 3%.

			Hydrate saturation (%)	
	# of sections	Length range (cm)	Range	Mean
Lithofacies 1	1	21	-	3
Lithofacies 2	7	10 - 32	55 - 87	71
Lithofacies 3	3	14.8 - 27	1 - 27	16
Multiple/uncertain lithofacies	4	16.6 - 120	49 - 77	52
Fall-in material	3	18 - 94	1 -3	2

Table 4.5.2 Range and mean of hydrate saturation for the lithofacies present.

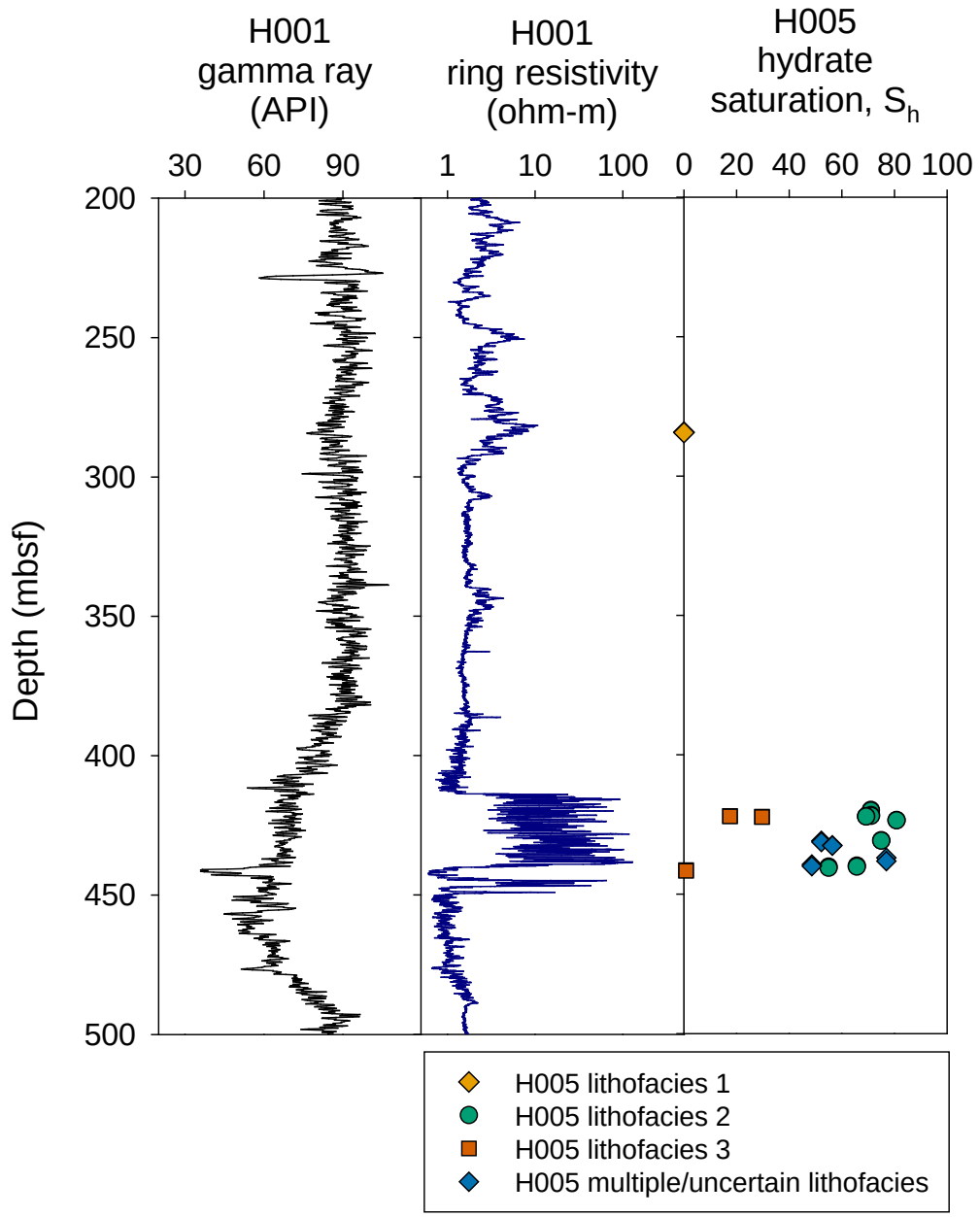

Figure 4.5.1 Hydrate saturation with depth versus H001 LWD resistivity. Fall-in material samples are not shown. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

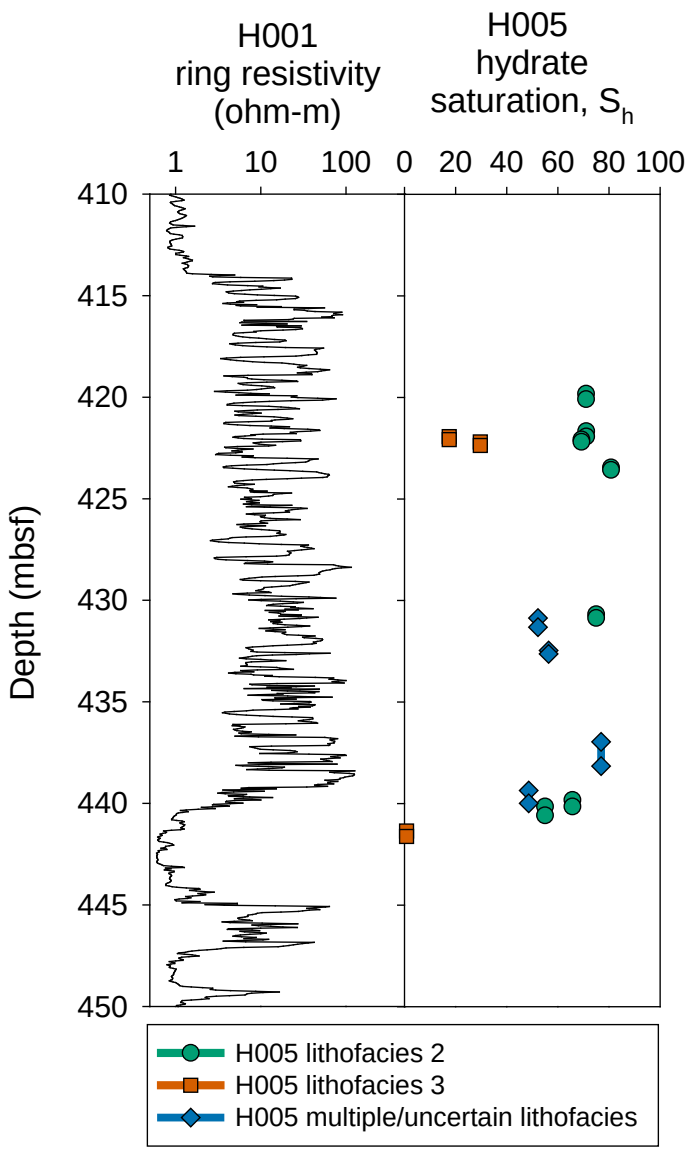

Figure 4.5.2 Hydrate saturation with depth versus H001 LWD resistivity detail. Fall-in material samples are not shown. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

4.5.2 Test Results

UT-GOM2-1-H005-01FB-1

Section UT-GOM2-1-H005-01FB-1, composed of likely fall-in material from the borehole, released a total of 0.67 L of methane from a 69 cm section of core (Figure 4.5.3). No pressure rebounds were observed indicating hydrate dissociation, although up to a 1% hydrate saturation is possible if all released methane was from hydrate. The collected gas was composed of 86.5% methane by volume with 13.5% nitrogen and oxygen contamination, and one sample was collected for post-cruise analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 5 hr.

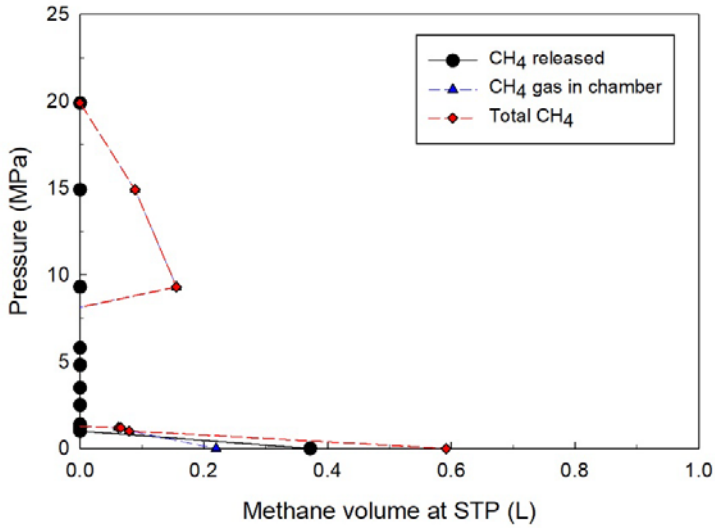

Figure 4.5.3 UT-GOM2-1-H005-01FB-1 pressure versus cumulative volume released. UT-GOM2-1-H005-01FB-1 is likely composed of fall-in material from the borehole. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-01FB-2

Section UT-GOM2-1-H005-01FB-2, composed of likely fall-in material from the borehole, released a total of 1.38 L of methane from a 94 cm section of core (Figure 4.5.4). No pressure rebounds were observed indicating hydrate dissociation, although up to a 1% hydrate saturation is possible if all released methane was from hydrate. The collected gas was composed of 89% methane by volume with 11.0% nitrogen and oxygen contamination, and one sample was collected for post-cruise analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 4 hr.

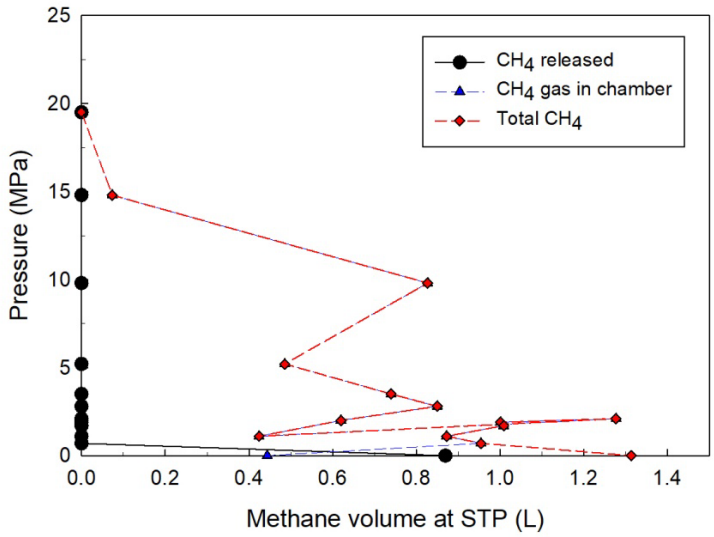

Figure 4.5.4 UT-GOM2-1-H005-01FB-2 pressure versus cumulative volume released. UT-GOM2-1-H005-01FB-2 is likely composed of fall-in material from the borehole. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-01FB-3

Section UT-GOM2-1-H005-01FB-3, composed of lithofacies 1, released a total of 0.72 L of gas (Figure 4.5.5) from a 21 cm long section of core towards the base of the core (Figure 4.4.1). One gas sample was collected and analyzed indicating the gas is composed of 84.1% methane by volume with 15.9% nitrogen and oxygen contamination (see 4.7 Geochemistry and Microbiology). In addition one gas sample was collected in a copper tube for further shore-based analysis. Hydrate dissociation was observed starting at 5.3 MPa as indicated by rebounds in pressure after each fluid release. Only one pressure rebound was recorded implying that Lithofacies 1 does contain a small amount of hydrate (bulk S_h <3%). Degassing was performed over 4 hr.

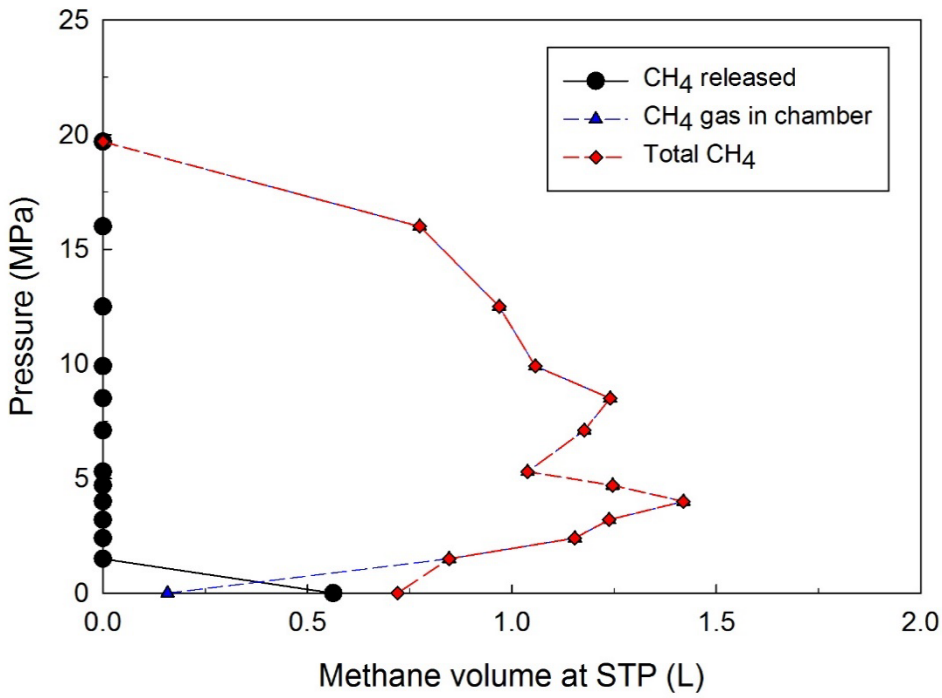

Figure 4.5.5 UT-GOM2-1-H005-01FB-3 pressure versus cumulative volume released. UT-GOM2-1-H005-01FB-3 contains lithofacies 1. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-02FB-1

Section UT-GOM2-1-H005-02FB-2, a highly disturbed section composed of likely fall-in material from the borehole, released a total of 0.63 L of methane from an 18 cm section from the top of the core (Figure 4.5.6). No pressure rebounds were observed indicating hydrate dissociation, although up to a 3% hydrate saturation is possible if all released methane was from hydrate. The collected gas was composed of 89.9% methane by volume with 10.1% nitrogen and oxygen contamination, and one sample was collected for post-cruise analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 4 hr.

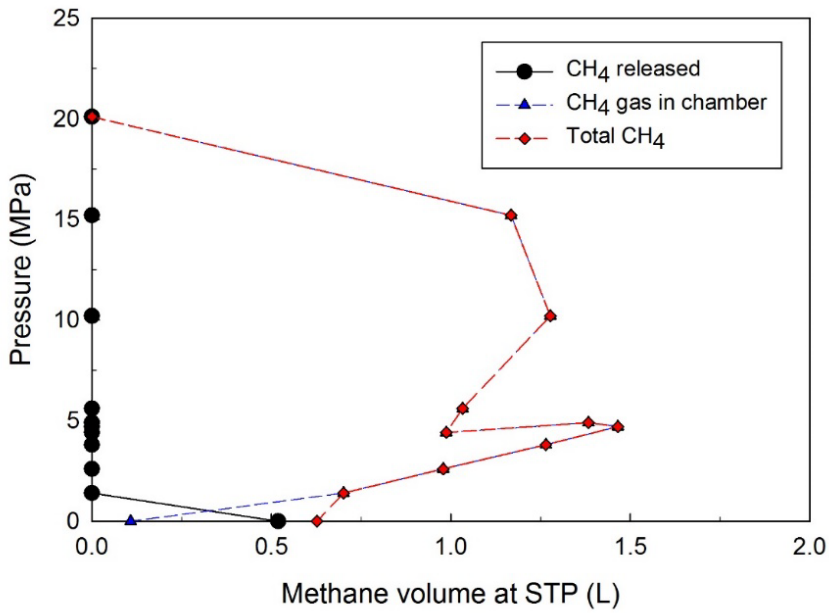

Figure 4.5.6 UT-GOM2-1-H005-02FB-1 pressure versus cumulative volume released. UT-GOM2-1-H005-02FB-1 represents fall in material from an unknown depth within H005. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-03FB-3

Section UT-GOM2-1-H005-03FB-3, composed of lithofacies 2, released a total of 25.03 L of methane from a 26.5 cm section (Figure 4.5.7). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 71% was calculated. The average collected gas contained 98.0% methane by volume with 2.0% nitrogen and oxygen contamination, and three samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 17 hr.

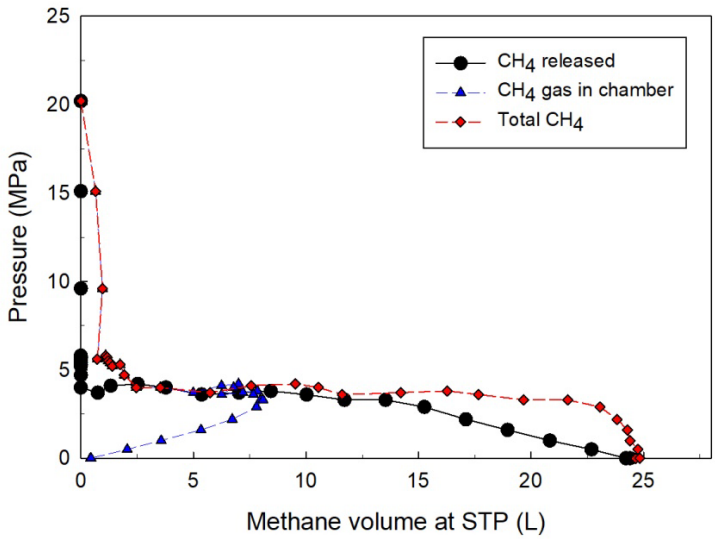

Figure 4.5.7 UT-GOM2-1-H005-03FB-3 pressure versus cumulative volume released. UT-GOM2-1-H005-03FB-3 represents lithofacies 2. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-04FB-2

Section UT-GOM2-1-H005-04FB-2, composed of lithofacies 2, released a total of 24.4 L of methane from a 25.8 cm section (Figure 4.5.8). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 71% was calculated. The gas contained 96.5% methane by volume with 3.5% nitrogen and oxygen contamination, and three samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 16 hr.

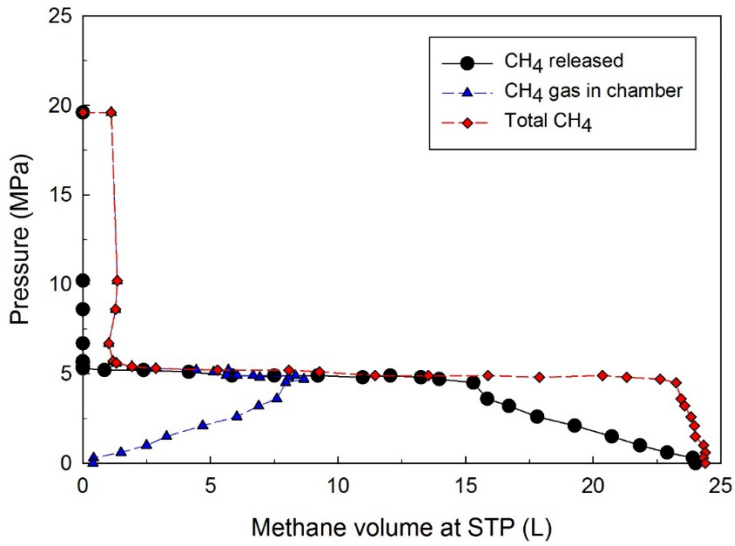

Figure 4.5.8 UT-GOM2-1-H005-04FB-2 pressure versus cumulative volume released. UT-GOM2-1-H005-04FB-2 represents lithofacies 2. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-04FB-3

Section UT-GOM2-1-H005-04FB-3, composed of lithofacies 3, released a total of 3.45 L of methane from a 14.8 cm section (Figure 4.5.9). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 18% was calculated. The average gas contained 90.1% methane by volume with 9.9% nitrogen and oxygen contamination, and two samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 123 hr.

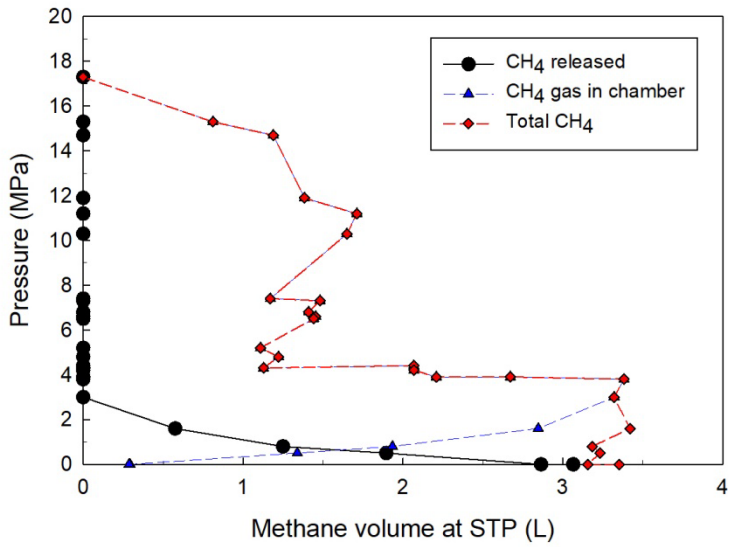

Figure 4.5.9 UT-GOM2-1-H005-04FB-3 pressure versus cumulative volume released. UT-GOM2-1-H005-04FB-3 containing lithofacies 3. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-04FB-4

Section UT-GOM2-1-H005-04FB-4, composed of lithofacies 2, released a total of 10.77 L of methane from an 11.7 cm section (Figure 4.5.10). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 69% was calculated. The average gas contained 96.2% methane by volume with 3.8% nitrogen and oxygen contamination, and three samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 143 hr.

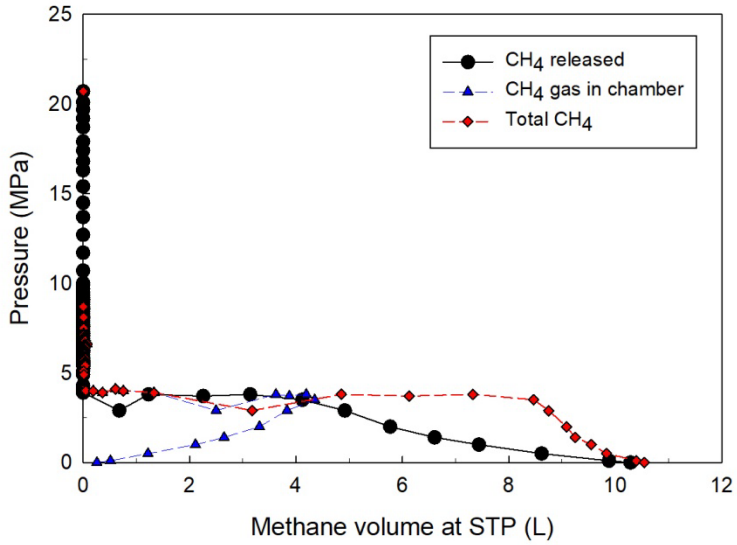

Figure 4.5.10 UT-GOM2-1-H005-04FB-4 pressure versus cumulative volume released. UT-GOM2-1-H005-04FB-4 contains lithofacies 2. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-04FB-5

Section UT-GOM2-1-H005-04FB-5, composed of lithofacies 3, released a total of 6.91 L of methane from a 17.5 cm section (Figure 4.5.11). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 30% was calculated. The average gas contained 96.5% methane by volume with 3.5% nitrogen and oxygen contamination, and three samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 7 hr.

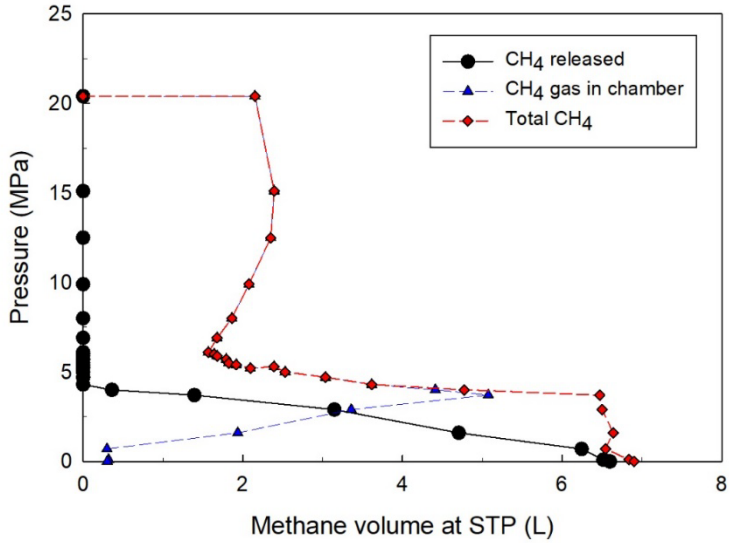

Figure 4.5.11 UT-GOM2-1-H005-04FB-5 pressure versus cumulative volume released. UT-GOM2-1-H005-04FB-5 represents lithofacies 3. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-04FB-7

Section UT-GOM2-1-H005-04FB-7, composed of lithofacies 2, released a total of 12.9 L of methane from a 12.0 cm section (Figure 4.5.12). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 81% was calculated. The average gas contained 92.9% methane by volume with 7.1% nitrogen and oxygen contamination, and three samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 15 hr.

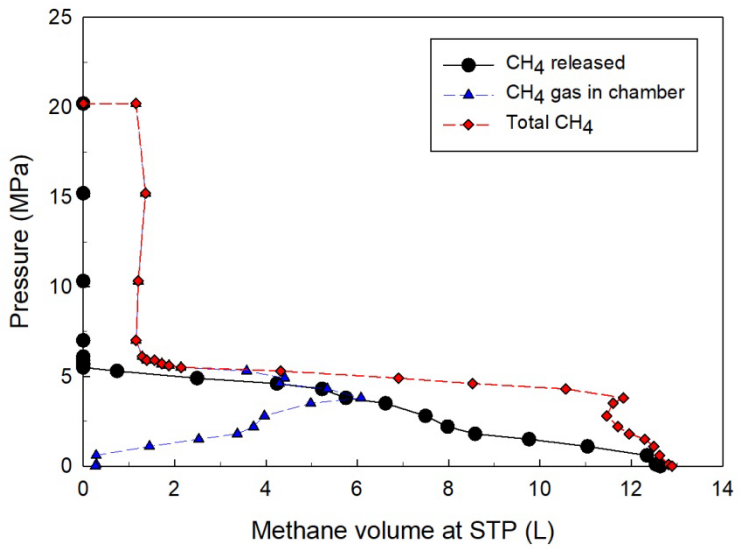

Figure 4.5.12 UT-GOM2-1-H005-04FB-7 pressure versus cumulative volume released. UT-GOM2-1-H005-04FB-7 contains lithofacies 2. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-07FB-1

Section UT-GOM2-1-H005-07FB-1, composed of lithofacies 2, released a total of 18.55 L of methane from an 18.6 cm section of core (Figure 4.5.13). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 75% was calculated. The average gas contained 97.8% methane by volume with 2.2% nitrogen and oxygen contamination, and two samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 12 hr.

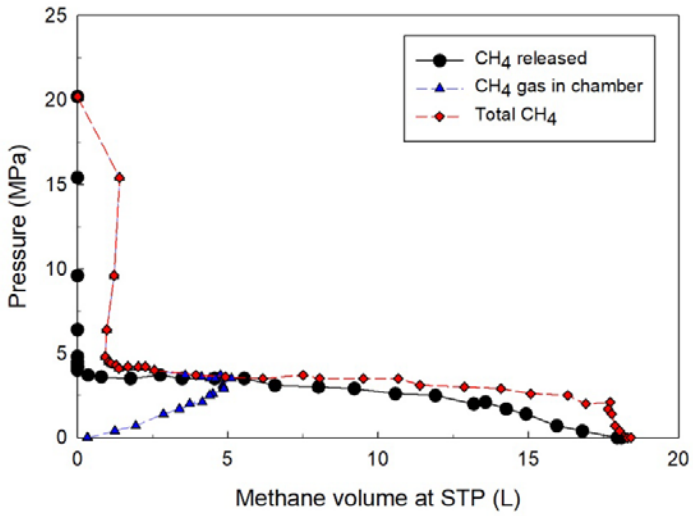

Figure 4.5.13 UT-GOM2-1-H005-07FB-1 pressure versus cumulative volume released. UT-GOM2-1-H005-07FB-1 containing lithofacies 2. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-07FB-2

Section UT-GOM2-1-H005-07FB-2, composed of both lithofacies 2 and 3, released a total of 30.9 L of methane from a 44.5 cm section of core (Figure 4.5.14). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 52% was calculated. The average gas contained 98.1% methane by volume with 1.9% nitrogen and oxygen contamination, and three samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 12 hr.

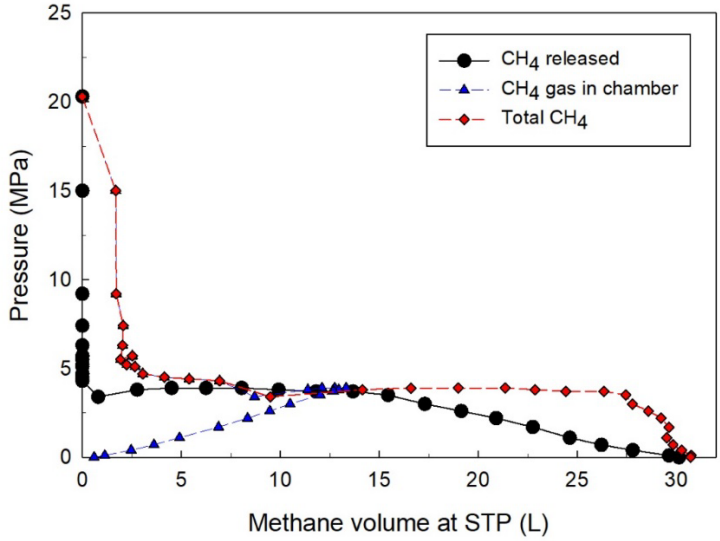

Figure 4.5.14 UT-GOM2-1-H005-07FB-2 pressure versus cumulative volume released. UT-GOM2-1-H005-07FB-2 represents a mix of lithofacies 2 and 3. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-07FB-4

Section UT-GOM2-1-H005-07FB-4, composed of lithofacies 2 and 3, released a total of 12.45 L of methane from a 16.6 cm section of core (Figure 4.5.15). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 56% was calculated. The average gas contained 97.5% methane by volume with 2.5% nitrogen and oxygen contamination, and three samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 11 hr.

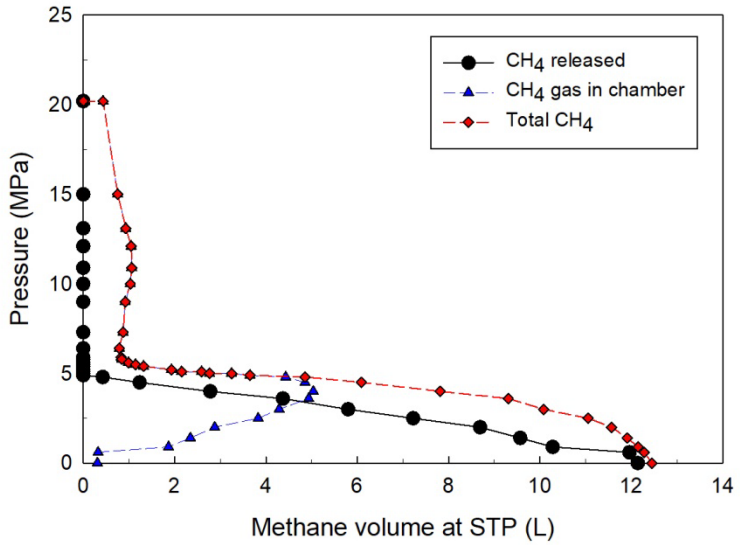

Figure 4.5.15 UT-GOM2-1-H005-07FB-4 pressure versus cumulative volume released. UT-GOM2-1-H005-07FB-4 represents a mix of lithofacies 2 and 3. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-09FB-2

Section UT-GOM2-1-H005-09FB-2, composed of uncertain and likely multiple lithofacies, released a total of 122.75 L of methane from a 120.0 cm section of core (Figure 4.5.16). Core UT-GOM2-1-H005-09FB partially dissociated during recovery making lithofacies interpretation difficult. Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 77% was calculated. The average gas contained 98.1% methane by volume with 1.9% nitrogen and oxygen contamination, and two samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 11 hr.

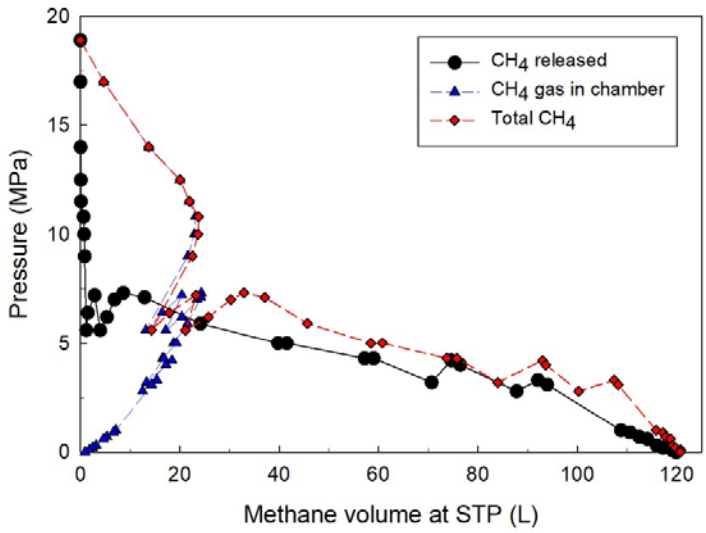

Figure 4.5.16 UT-GOM2-1-H005-09FB-2 pressure versus cumulative volume released. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-09FB-4

Section UT-GOM2-1-H005-09FB-4, composed of uncertain and likely multiple lithofacies, released a total of 40.71 L of methane from a 63.0 cm section of core (Figure 4.5.17). Core UT-GOM2-1-H005-09FB partially dissociated during recovery making lithofacies interpretation difficult. Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 49% was calculated. The average gas contained 97.1% methane by volume with 2.9% nitrogen and oxygen contamination, and two samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 15 hr.

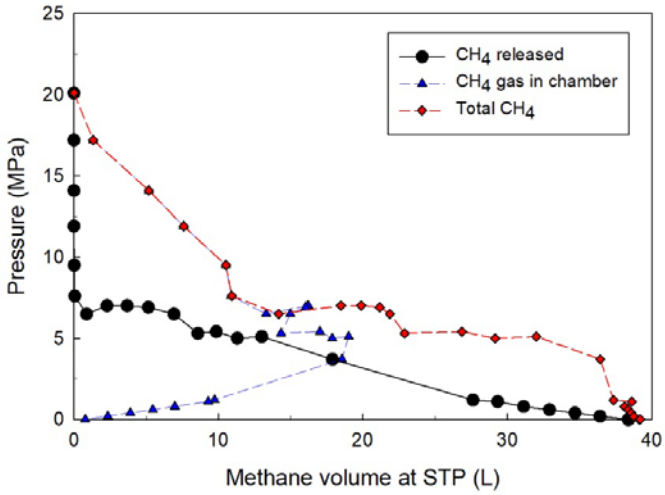

Figure 4.5.17 UT-GOM2-1-H005-09FB-4 pressure versus cumulative volume released. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-10FB-2

Section UT-GOM2-1-H005-10FB-2, composed of lithofacies 2, released a total of 27.97 L of methane from a 32.0 cm section of core (Figure 4.5.18). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 66% was calculated. The average gas contained 96.5% methane by volume with 3.5% nitrogen and oxygen contamination, and three samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 22 hr.

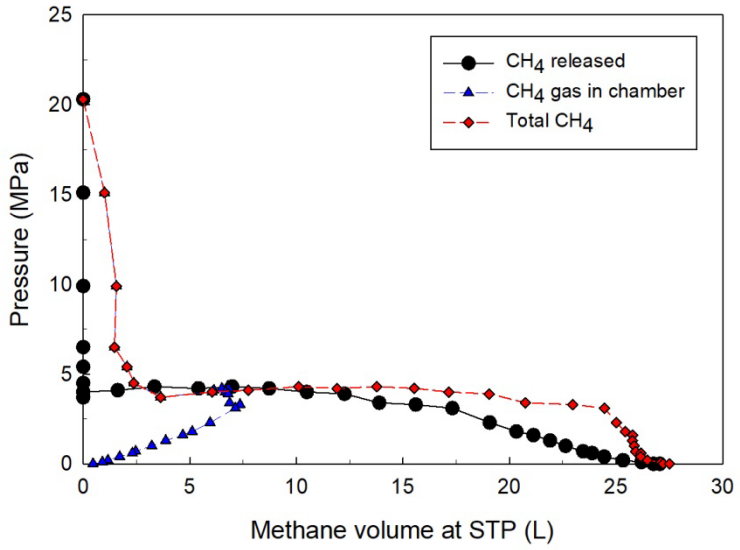

Figure 4.5.18 UT-GOM2-1-H005-10FB-2 pressure versus cumulative volume released. UT-GOM2-1-H005-10FB-2 containing lithofacies 2. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-10FB-3

Section UT-GOM2-1-H005-10FB-3, composed of lithofacies 2, released a total of 7.31 L of methane from a 44.0 cm section of core (Figure 4.5.19). Pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 12% was calculated. The average gas contained 96.9% methane by volume with 3.1% nitrogen and oxygen contamination, and two samples were collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 9 hr.

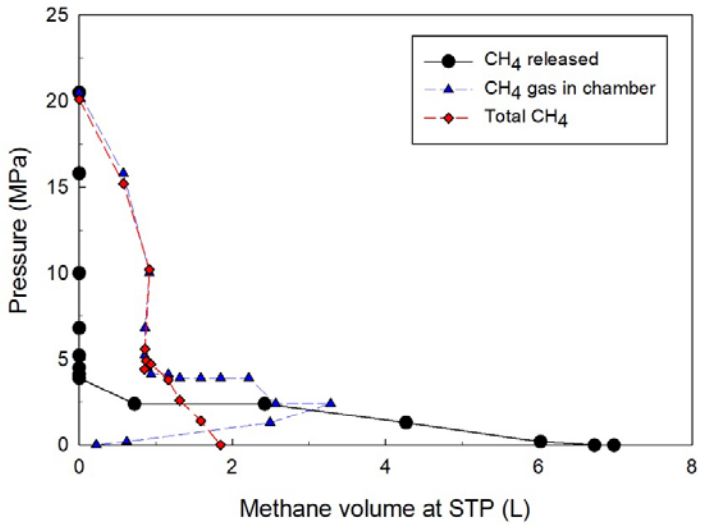

Figure 4.5.19 UT-GOM2-1-H005-10FB-3 pressure versus cumulative volume released. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

UT-GOM2-1-H005-11FB-1

Section UT-GOM2-1-H005-11FB-1, composed of lithofacies 3, released a total of 0.3 L of methane from a 27.0 cm section of core (Figure 4.5.20). No pressure rebounds were observed indicating hydrate dissociation, and a bulk hydrate saturation of 1% was calculated if all the methane was from hydrate. One sample contained 85.4% methane by volume with 14.6% nitrogen and oxygen contamination, and one sample was collected for post-expedition analysis (see 4.7 Geochemistry and Microbiology). Degassing was performed over 5 hr.

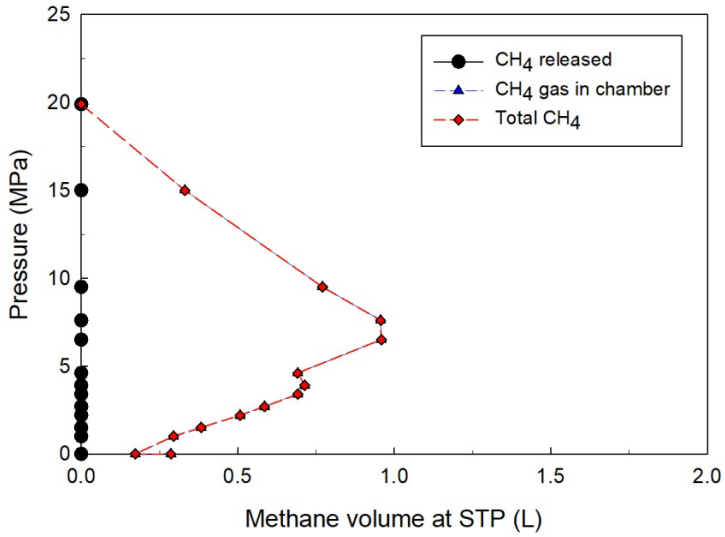

Figure 4.5.20 UT-GOM2-1-H005-11FB-1 pressure versus cumulative volume released. All H005 Quantitative Degassing data can be found in the expedition data directory under H005 / Quantitative Degassing.

4.6 Lithostratigraphy

In this section four lithostratigraphic data sets are detailed including: X-ray and CT-scans, smear slides, visual description of core, and laser-particle size analyses. The recovered strata is categorized into two Lithostratigraphic Units that are composed of smaller-scale lithofacies. These lithofacies are defined by characteristics described below (Table 4.6.1).

		Lithostratigraphic Unit I	Lithostratigraphic Unit II	
		Lithofacies 1	Lithofacies 2	Lithofacies 3
PCATS physical properties analysis	Density	~2.0 g/cm3	~1.9 g/cm3	2.0-2.1 g/cm3
	P-wave velocity	1700 m/s	2500-3250 m/s	1700-2000 m/s
	X-ray Ct scan	Dark, with cm-scale bedding and steeply dipping fractures.	Light, with ripple-laminated sets up to 2 cm thick.	Dark and massive, with some lighter layers. No crossbedding.
Laser-particle size analysis	Dominant lithology	silty clay	sandy silt	clayey silt with sand

Table 4.6.1 Defining characteristics of the lithologic units within recovered H005 pressure core. Smear slide and visual descriptions are not included due to the effects of depressurization obscuring the lithofacies as defined by PCATS physical properties measured while under pressure.

4.6.1 Lithostratigraphic Units

Two Lithostratigraphic Units were recognized at this location from the original H001 LWD data acquired by the Chevron JIP (Boswell et al., 2012; Collett et al., 2010). As shown in Figure 4.6.1, Lithostratigraphic Unit I extends from the seafloor to ~391 mbsf, had a low gamma ray value and is interpreted to be hemipelagic mud (upper grey zone). At H005, Lithostratigraphic Unit I was recovered between 7645 – 7655 fbrf (284 to 287 mbsf). Lithostratigraphic Unit II begins at 391 mbsf and is a 100 m (330 ft) thick sand-rich interval (yellow zone) based on the interpretation of the gamma ray, caliper, and resistivity data. Within this 330 ft sand-rich interval, there are three zones of high resistivity and high velocity where hydrate is interpreted to be present (green in Lithologic Units). The uppermost zone is 86 ft thick. In the sections where hydrate is not inferred to be present in this sand-rich interval, significant borehole washout is present as indicated from the enlarged borehole (caliper) and low density values. Within H005, Lithostratigraphic Unit II was recovered between 8081-8193 fbsf (417 – 450 mbsf).

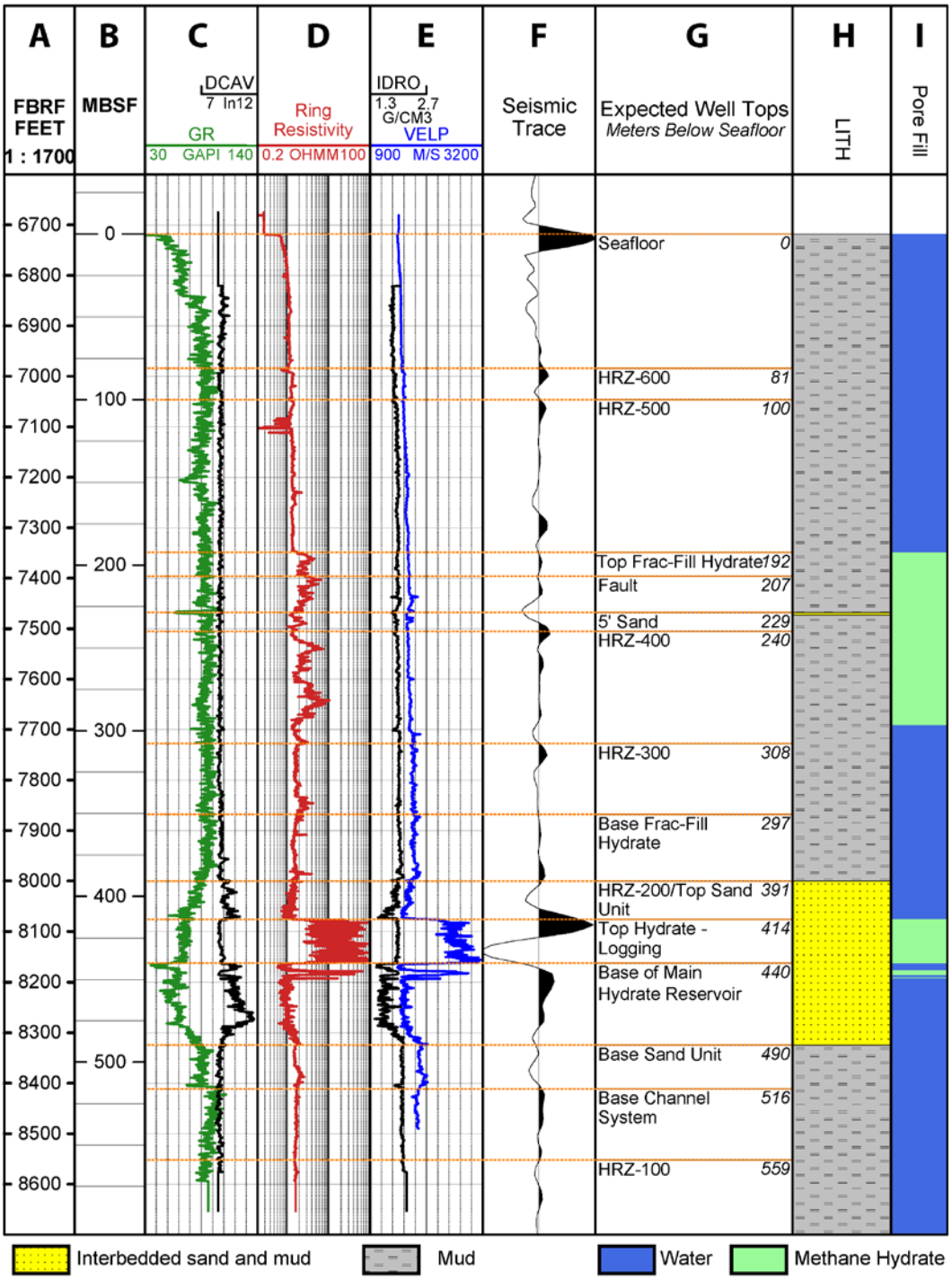

Figure 4.6.1 H001 interpreted stratigraphic surfaces, Lithology, and Pore Fill. Columns C, D, and E illustrate H001 LWD data. GR-Gamma Ray, DCAV-calipers, IDRHO-bulk density, VELP-compressional velocity. F) Seismic trace at the GC 955 location (courtesy of Western Geco). G) Interpreted stratigraphic surfaces. H) Interpreted Lithology. I) Pore Fill documents whether the rock is 100% water saturated (blue) or contains hydrate (green). H001 results have been discussed in detail (Boswell et al., 2012; Collett and Boswell, 2012; Collett et al., 2010).

Lithostratigraphic Unit I

Lithostratigraphic Unit I was sampled with a single core: UT-GOM2-1-H005-01FB, from depths of 7645 – 7655 fbrf (284 to 287 mbsf). The majority of this core was interpreted to be composed of cuttings or loose material from the borehole wall that were not circulated out of the hole (Core Depth 0-165 cm). However, the base of the core (Core Depth 165-208 cm) was recovered intact.

Lithofacies 1

All of the material in Lithostratigraphic Unit I is classified as lithofacies 1. Based on PCAST measurements, lithofacies 1 has a P-wave velocity of approximately 1700 m/s and a core density of ~2.0 g/cm3 (Figure 4.6.2) (see 4.4 Physical Properties and Core Transfer). X-ray scans show cm-scale bedding observed by subtle variations in density (Figure 4.6.3). Thin (mm-scale) wispy intervals of low density material are present. These intervals are interpreted to be possible hydrate-filled fractures that intersect bedding at a steep angle (see 4.3 Pressure Coring).

A single laser-particle size analysis was performed on lithofacies 1 that shows this lithofacies is composed of 52% clay, 48% silt and 0% sand, with a median grain size of 3 μm (see 4.6.2 Laser-particle size analysis).

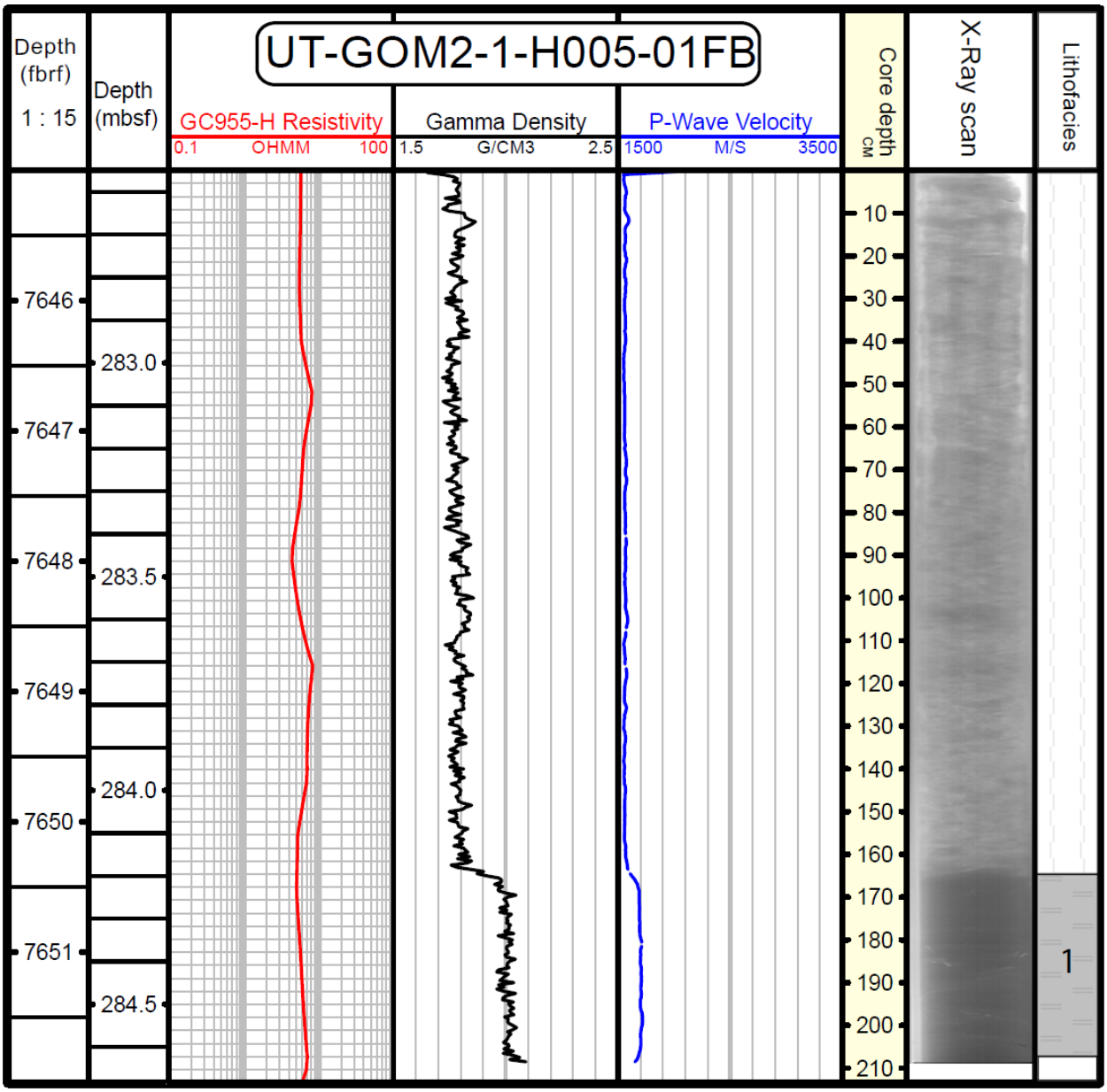

Figure 4.6.2 UT-GOM2-1-H005-01FB log and Lithofacies identification versus H001 LWD resistivity. UT-GOM2-H002-4CS is within Lithostratigraphic Unit I. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

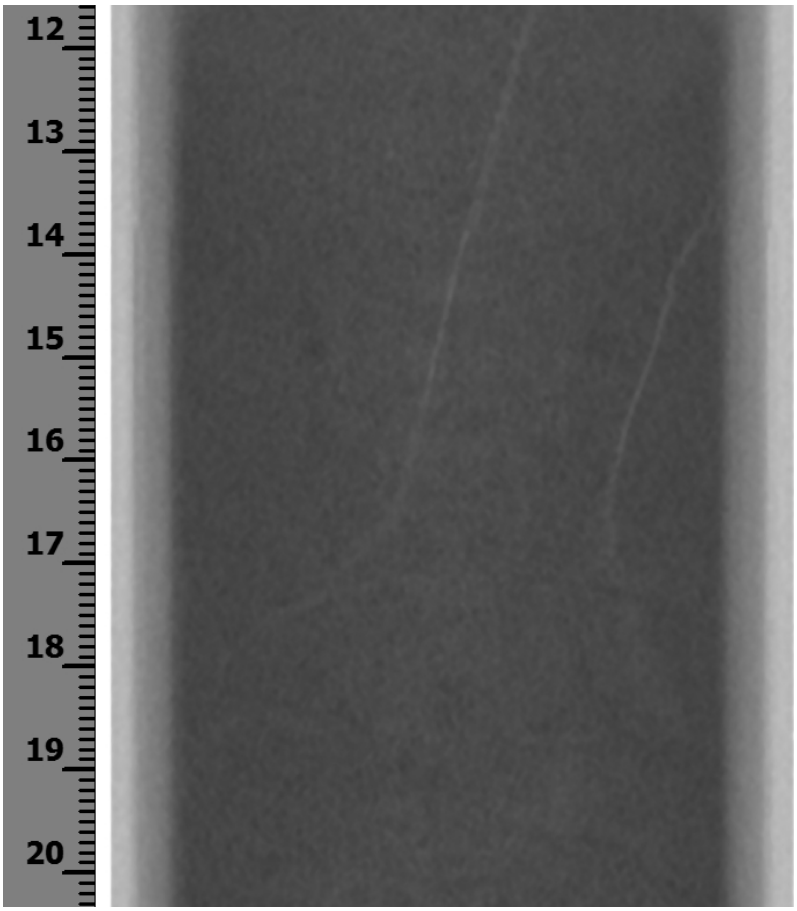

Figure 4.6.3 UT-GOM2-1-H005-01FB Detail of X-ray scan of lithofacies 1. Images shows high angle fractures and a lack of sedimentary structures. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

Lithostratigraphic Unit II

Lithostratigraphic Unit II is penetrated by cores UT-GOM2-1-H005-02FB through UT-GOM2-1-H005-13FB, between depths of 8081-8193 fbsf (417 – 450 mbsf). Lithostratigraphic Unit II contains two interbedded lithofacies: lithofacies 2 and lithofacies 3. Lithofacies 2 and lithofacies 3 were originally distinguished on-board on the basis of X-rays, gamma density, and P-wave velocity measurements from PCATS (see 4.4 Physical Properties and Core Transfer). These lithofacies repeat in variable thickness and frequency throughout Lithostratigraphic Unit II. Lithofacies 2 appears lighter (less dense), has a higher P-wave velocity, and a lower density than lithofacies 3 (Figure 4.6.4). Subsequent analyses demonstrated that lithofacies 2 and 3 have distinct differences as described below.

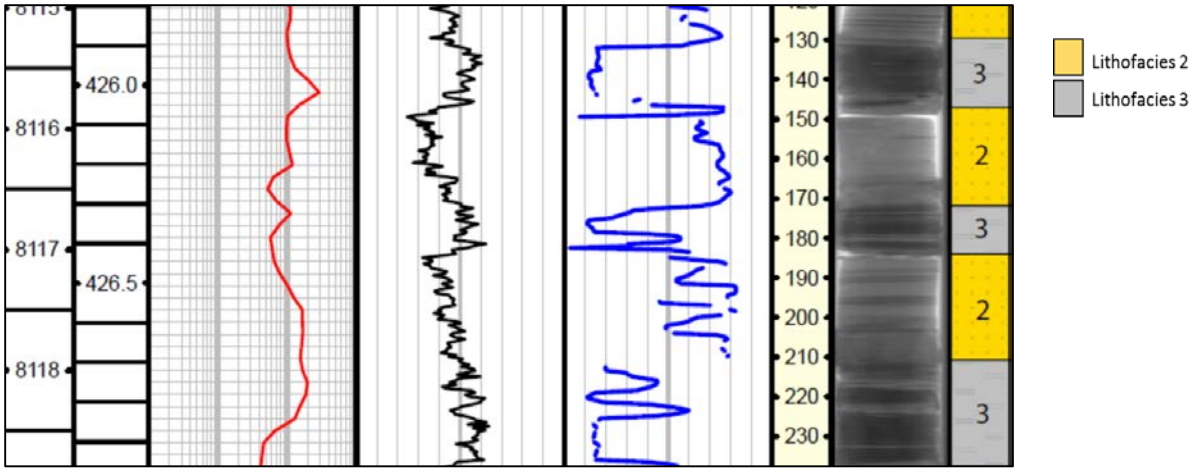

Figure 4.6.4 UT-GOM2-1-H005-05FB Detail of log and Lithofacies identification versus H001 LWD resistivity. UT-GOM2-1-H005-05FB has alternating layers of lithofacies 2 and lithofacies 3. Lithofacies were picked on-board based on density, compressional velocity, and X-ray images of sections at least 10 cm in thickness. Lithofacies 2 has a low density and high compressional velocity, while lithofacies 3 has a higher density and low compressional velocity. In some cases, lithofacies 3 is almost entirely dark in X-ray (130-148 cm), while in other cases there are thin, lighter layers within lithofacies 3 (212-240 cm). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

Lithofacies 2

Lithofacies 2 is composed of sandy silt beds with low density (~1.9 g/cm^3) and high velocity (2500-3250 m/s) (see 4.4 Physical Properties and Core Transfer). Ripple laminations and/or cross-laminations are present, with sets measuring up to 2 cm thick (Figure 4.6.5 and Figure 4.6.6). Preliminary grain size analysis shows that on average this lithofacies is composed of 50% silt, 45% sand, and 5% clay with a median grain size of 51 μm (see Laser diffraction particle size analysis). Based on preliminary observations, core quality and disturbance appears to be influenced by the lithofacies. Lithofacies 2 is generally less disturbed and provides longer, more intact sections within the liner with only minor biscuiting, rotation, and barreling (Figure 4.6.6). Within this lithofacies there may be minor intervals of mm- to cm-scale of low P-wave velocities that suggest finer scale interbeds that we also observed in the depressurized core (Figure 4.6.6). Lithofacies 2 was encountered within cores UT-GOM2-1-H005-02FB through -11FB, and -13FB (Figure 4.6.7 to Figure 4.6.15, Figure 4.6.17).

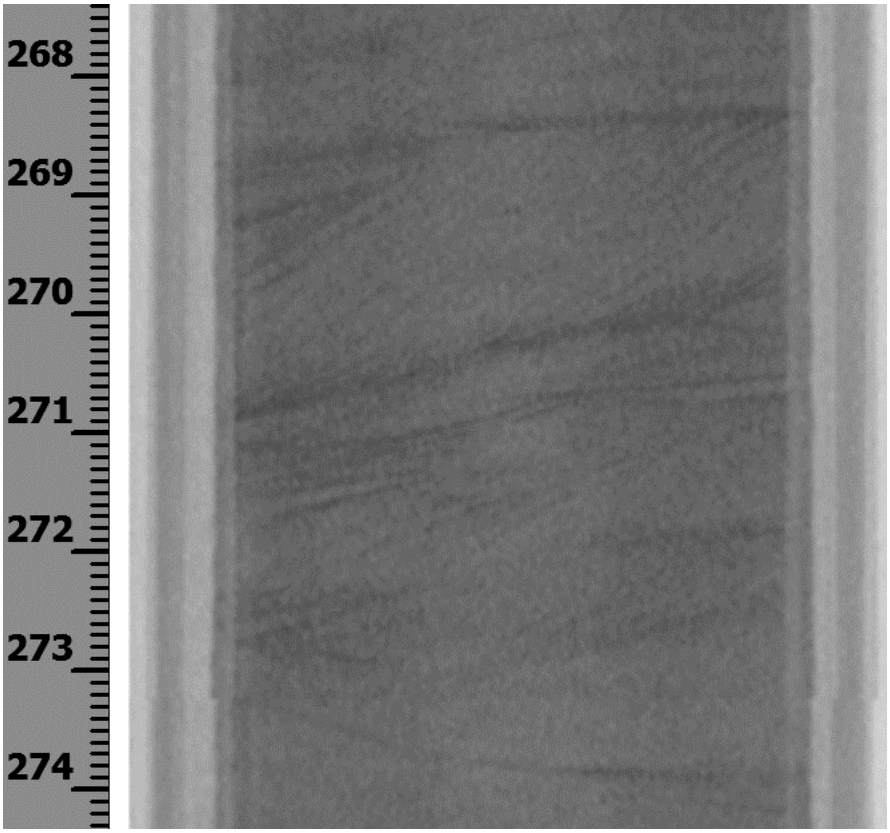

Figure 4.6.5 UT-GOM2-1-H005-03FB X-ray CT slab image. Image of lithofacies 2 with cross-laminations visible. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

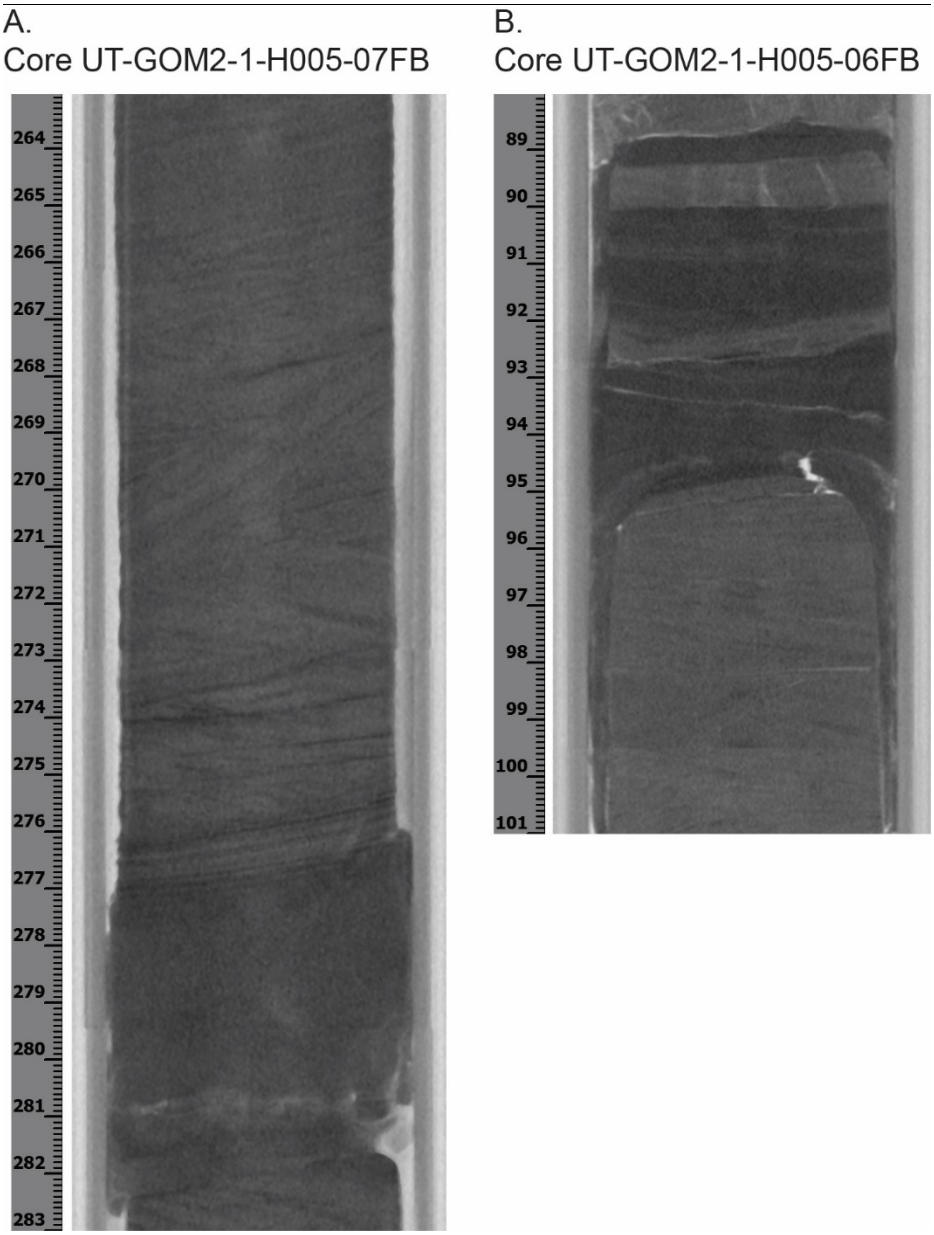

Figure 4.6.6 UT-GOM2-1-H005-07FB and UT-GOM2-1-H005-06FB Xray images. Images shows Interbedding of lithofacies 2 and 3. A: Core UT-GOM2-1-H005-07FB showing lithofacies 2 (263-276 cm) with rippled cross-laminations and lithofacies 3 (276-283 cm). B: Core UT-GOM2-1-H005-06FB showing interbedded lithofacies 2 and 3. Lithofacies 2 shows a sharp cut of the formation with often a slight gap between the core and core liner, while lithofacies 3 often fills the entire core liner and flows around the edges of adjacent lithofacies 2 intervals. Lithofacies 3 is predominately dark in X-ray images, but some sections do contain 0.1-1.0 cm thick sections of lighter material. The lighter material within lithofacies 3 does not contain ripple cross-lamination. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

Lithofacies 3

Lithofacies 3 is composed of beds of clayey silt with sand to silt with clay and sand, characterized by high density (2.0-2.1 g/cm^3) and low velocity (~1700-2000 m/s) (see Physical Properties). In X-ray images this lithofacies is generally massive and is more deformed than lithofacies 2 (Figure 4.6.6). Preliminary grain size analysis shows this unit is composed of 59% silt, 21% clay, and 20% sand on average, with a median grain size of 23 µm (see Laser diffraction particle size analysis). Lithofacies 3 is commonly interbedded with lithofacies 2. Within this lithofacies there may be minor intervals of mm- to cm-scale of high P-wave velocities that suggest finer scale interbeds that we also observed in the depressurized core (Figure 4.6.6). These lower density interbeds lack the ripple lamination present in lithofacies 2. Lithofacies 3 is generally more disturbed with more frequent shearing and often flows around adjacent sections of lithofacies 2 (Figure 4.6.6). Lithofacies 3 was encountered within cores UT-GOM2-1-H005-02FB through -9FB, as well as -11FB and -13FB (Figure 4.6.7 to Figure 4.6.14, Figure 4.6.16, Figure 4.6.17).

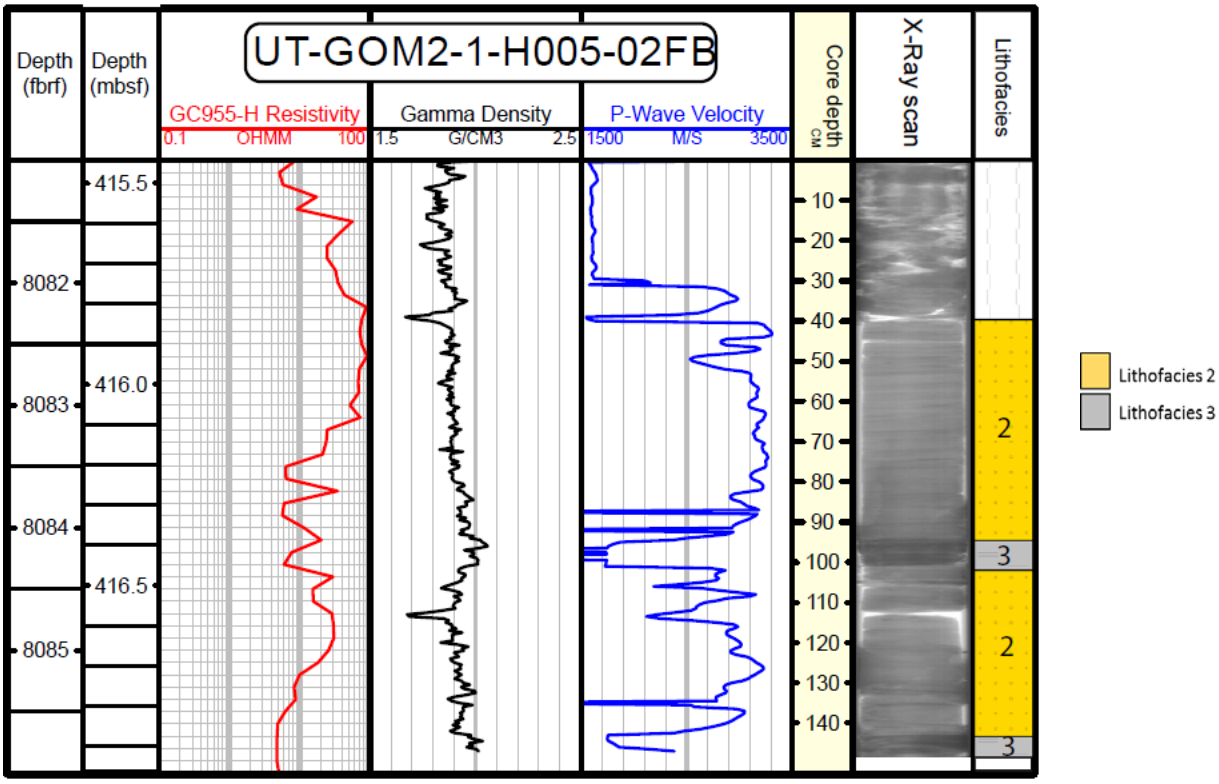

Figure 4.6.7 Log plot of Core UT-GOM2-1-H005-02FB. The ring resistivity log for the GC955-H well is shown to the left. Interpreted lithofacies is displayed to the right. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

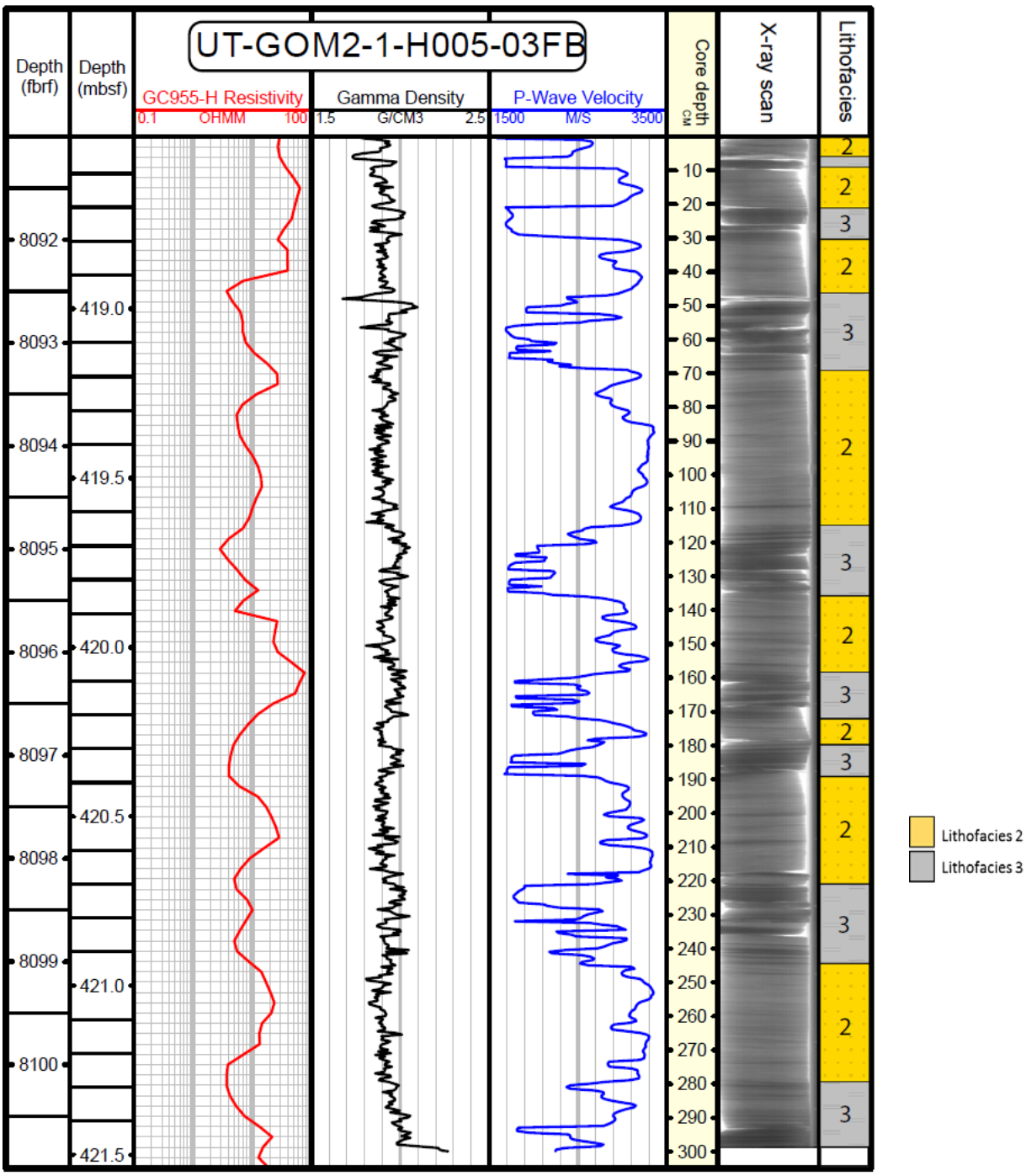

Figure 4.6.8 Log plot of Core UT-GOM2-1-H005-03FB. The ring resistivity log for the GC955-H well is shown to the left. Interpreted lithofacies is displayed to the right. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

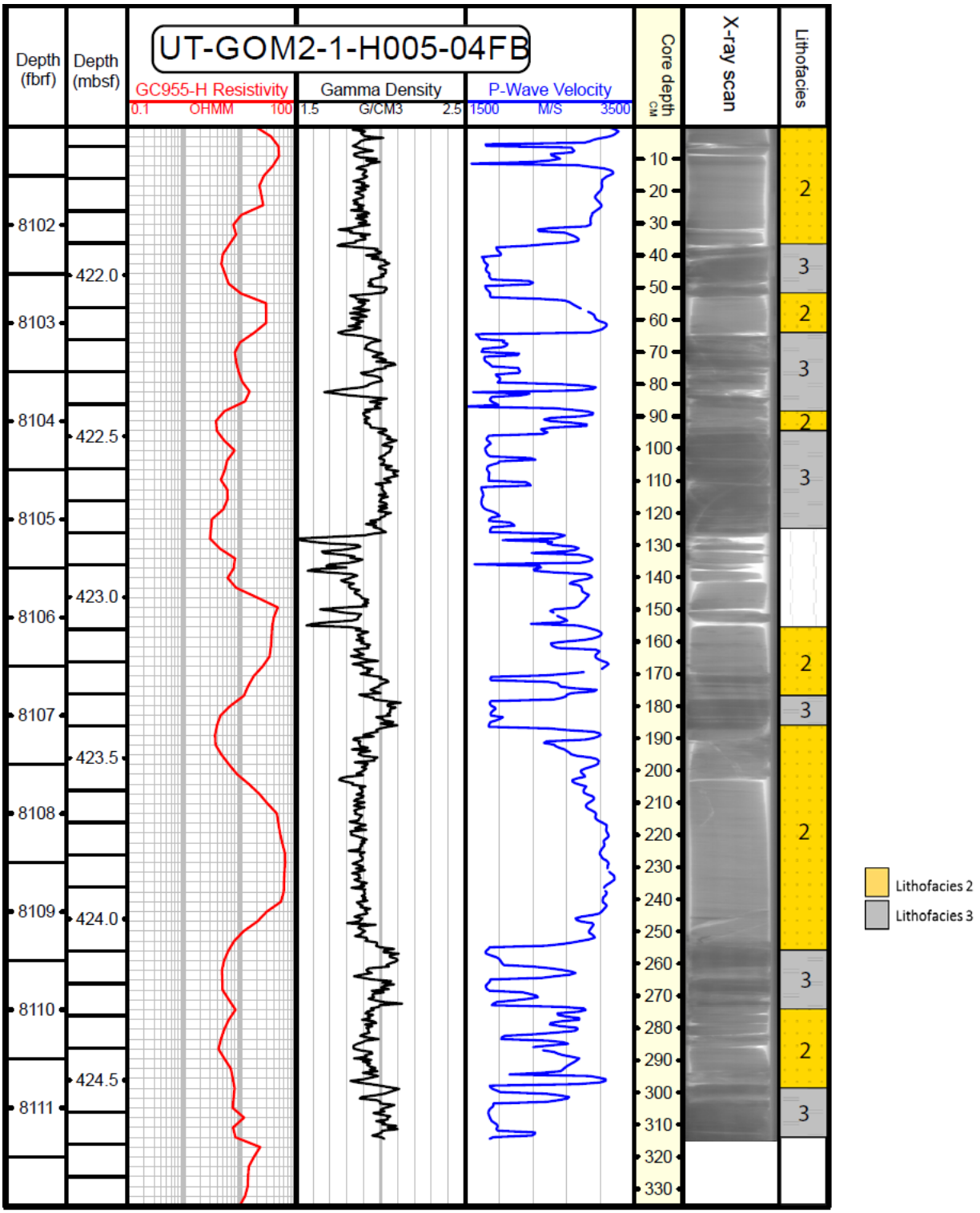

Figure 4.6.9 Log plot of Core UT-GOM2-1-H005-04FB. The ring resistivity log for the GC955-H well is shown to the left. Interpreted lithofacies is displayed to the right. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

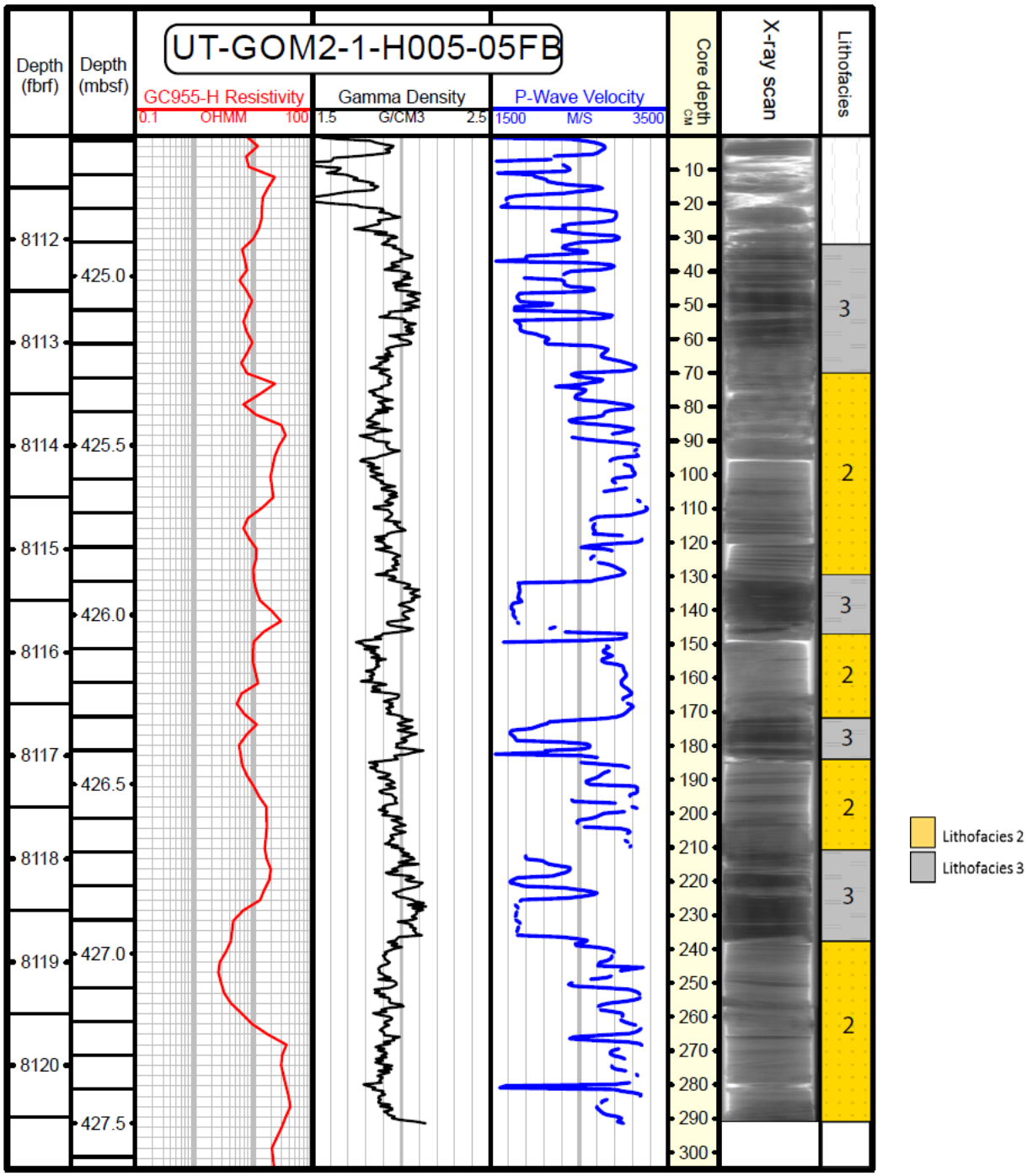

Figure 4.6.10 Log plot of Core UT-GOM2-1-H005-05FB. The ring resistivity log for the GC955-H well is shown to the left. Interpreted lithofacies is displayed to the right. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

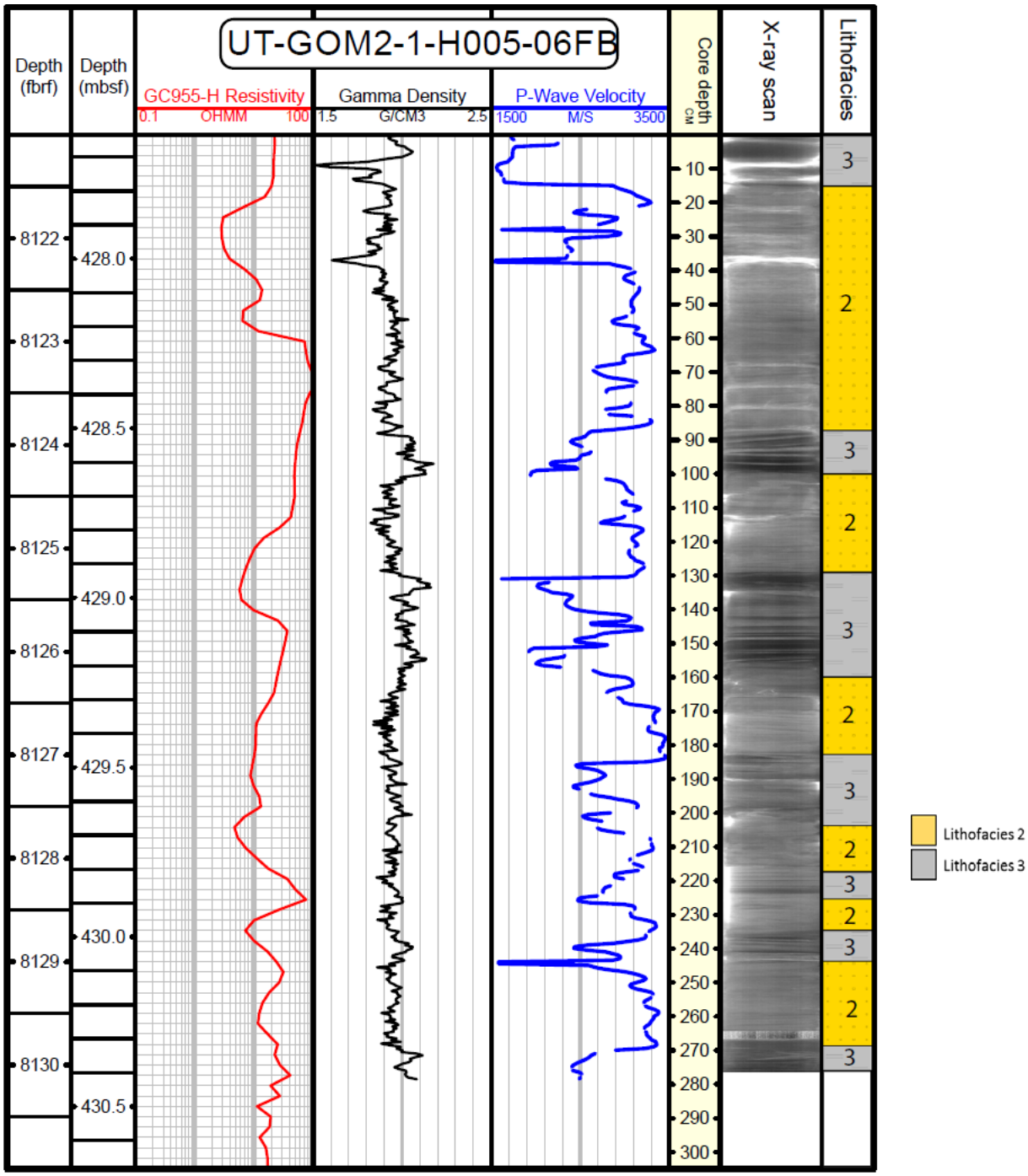

Figure 4.6.11 Log plot of Core UT-GOM2-1-H005-06FB. The ring resistivity log for the GC955-H well is shown to the left. Interpreted lithofacies is displayed to the right. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

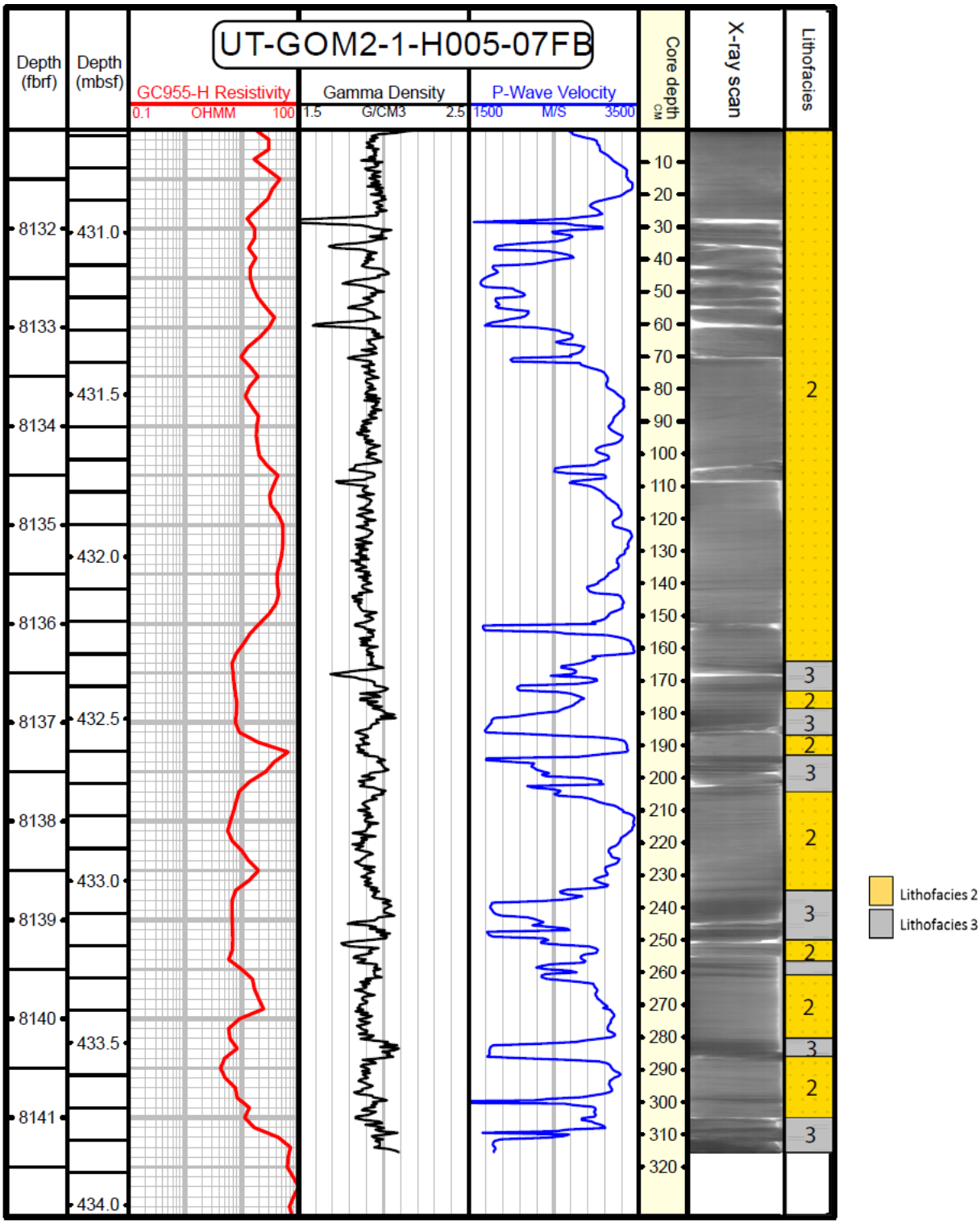

Figure 4.6.12 Log plot of Core UT-GOM2-1-H005-07FB. The ring resistivity log for the GC955-H well is shown to the left. Interpreted lithofacies is displayed to the right. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

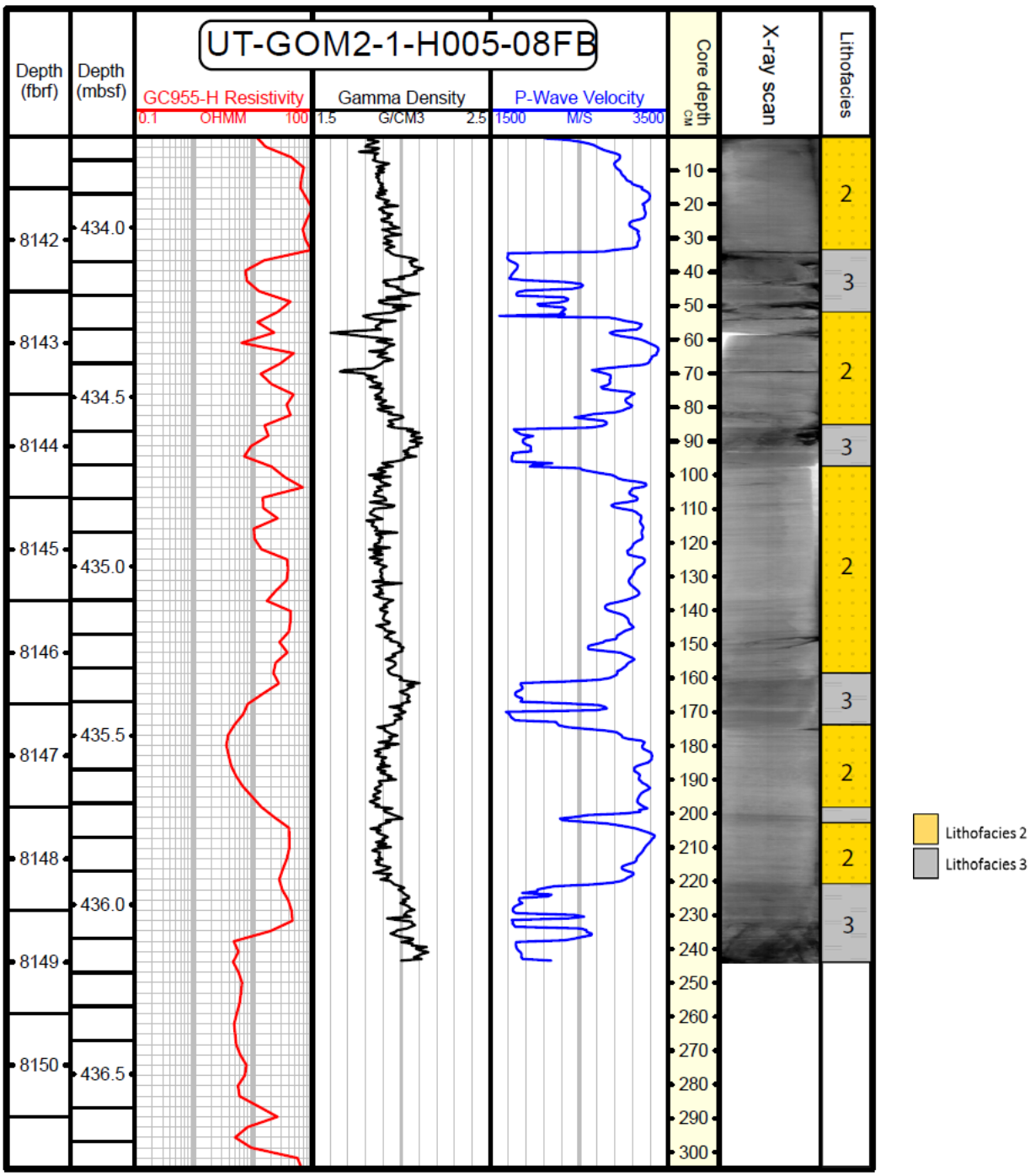

Figure 4.6.13 Log plot of Core UT-GOM2-1-H005-08FB. The ring resistivity log for the GC955-H well is shown to the left. Interpreted lithofacies is displayed to the right. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

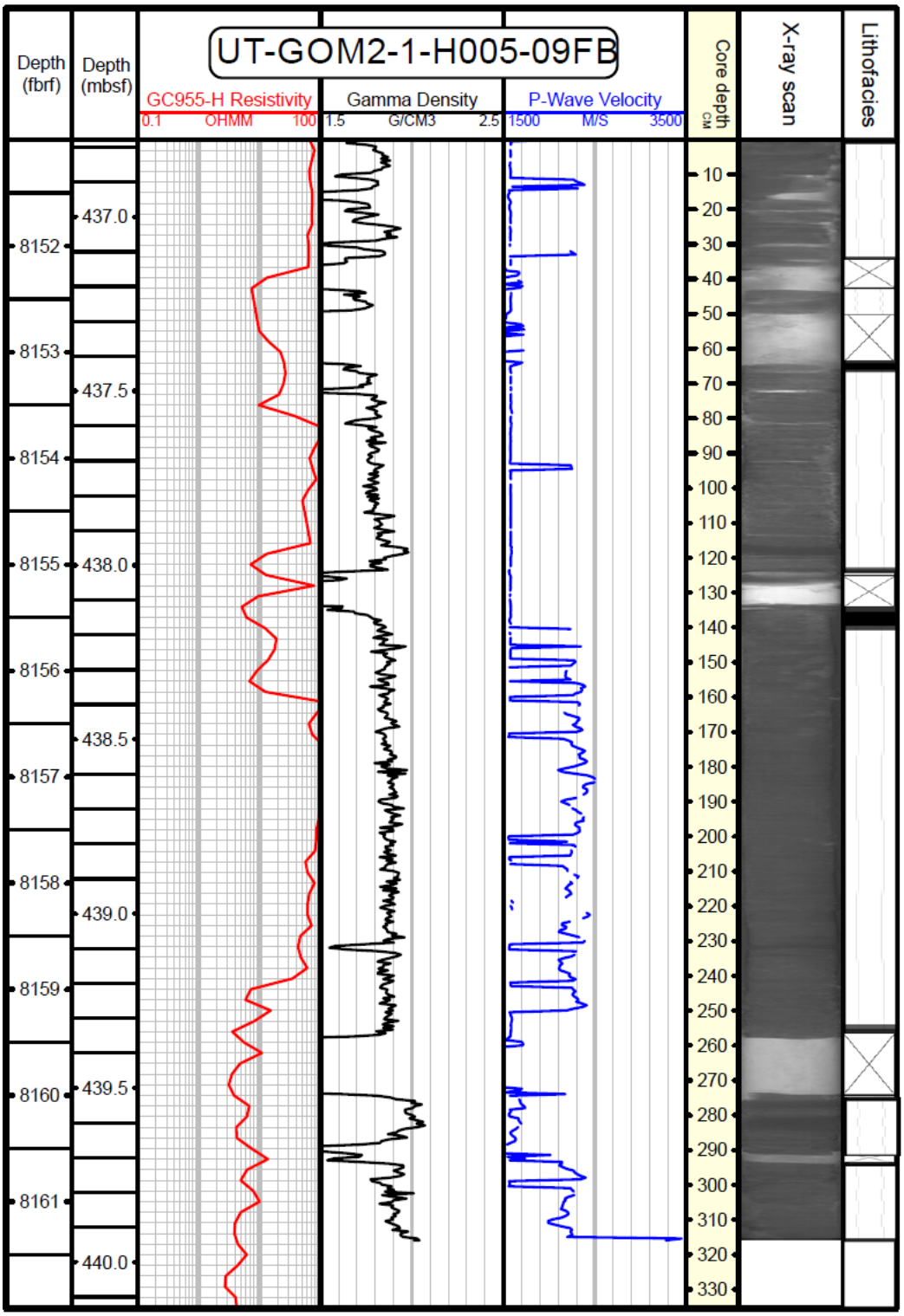

Figure 4.6.14 Log plot of the UT-GOM2-1-H005-09FB. The ring resistivity log for the GC955-H well is shown to the left. It was not possible to interpret lithofacies due to the partial dissociation of the core during recovery (see 4.3 Pressure Coring). All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

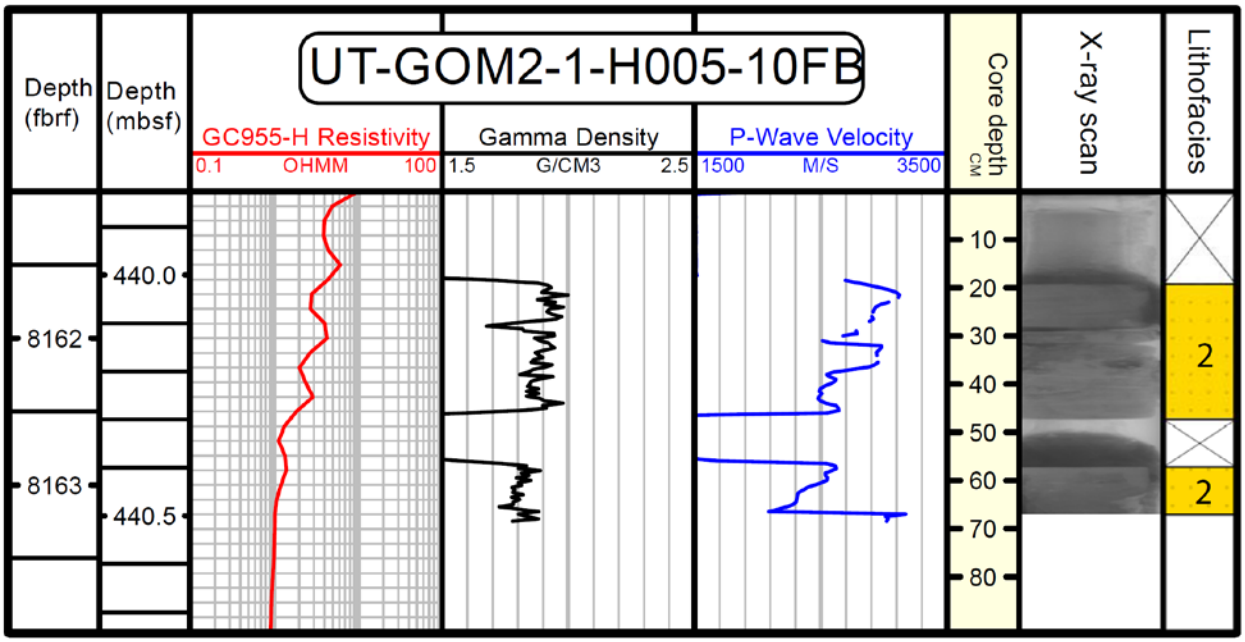

Figure 4.6.15 Log plot of Core UT-GOM2-1-H005-10FB. The ring resistivity log for the GC955-H well is shown to the left. The lithofacies from this core is mostly lithofacies 2. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

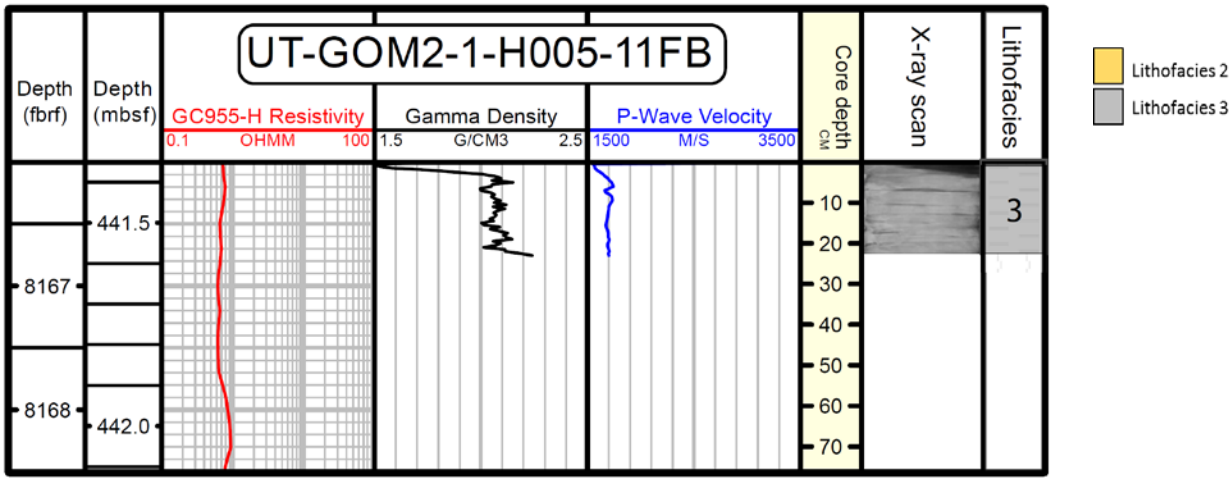

Figure 4.6.16 Log plot of Core UT-GOM2-1-H005-11FB. The ring resistivity log for the GC955-H well is shown to the left. This core is entirely lithofacies 3. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

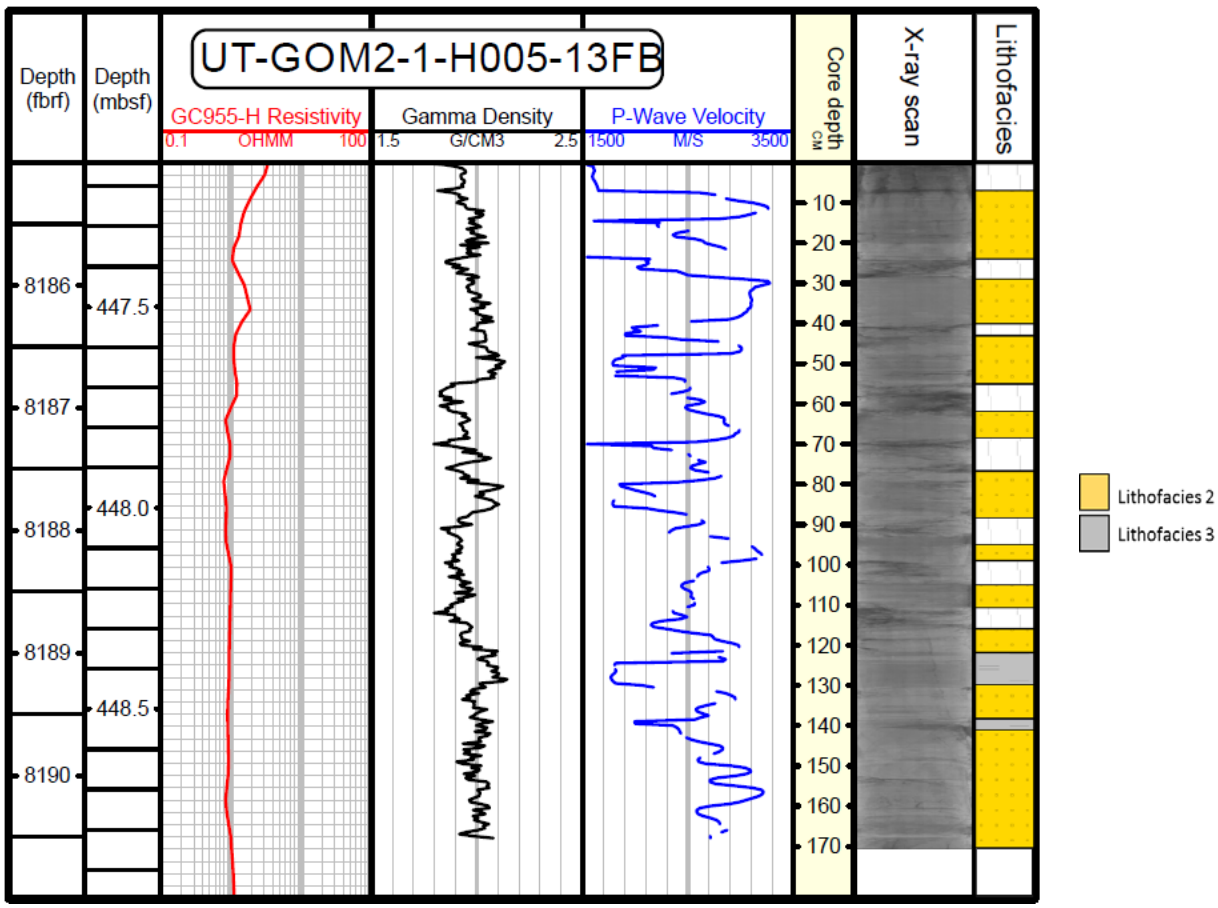

Figure 4.6.17 Log plot of Core UT-GOM2-1-H005-13FB. The ring resistivity log for the GC955-H well is shown to the left. Interpreted lithofacies is displayed to the right. All H005 Physical property and CT data can be found in the expedition data directory under H005 / Physical Properties.

Visual Description

Depressurized core sections were split and described visually on-shore. For H005, this included Core UT-GOM2-1-H005-12FB, which did not maintain pressure during core retrieval, and sections from UT-GOM2-1-H005-09FB which was quantitatively degassed. Nine total depressurized core sections were analyzed visually for color, texture, and sedimentary structures (Table 4.6.2). This analysis was conducted on cores that failed to maintain pressure, and as a result, it is not possible to ascribe a lithofacies to these samples. Visible bubbles, which were observed on the split core face of H005 12FB-3 and H005 FB-Bonus_1 (Figure 4.6.18), illustrate the process of dewatering or degassing experienced by these cores as pressure was lost during recovery.

The lithology of the samples alternates between clay and silt (Figure 4.6.18), which range in thickness from 0.5 to 87 cm. The silt and clay intervals vary in color from light olive grey to olive grey (5Y 5/2 to 5Y 3/2 on the Munsell Soil Chart (Munsell Color Company, 1994). Millimeter-scale laminations are common within the silt beds. Possible authigenic carbonate was observed in H005 12FB-1. Photos of depressurized cores may be found in the H005 data directory under Lithostratigraphy.

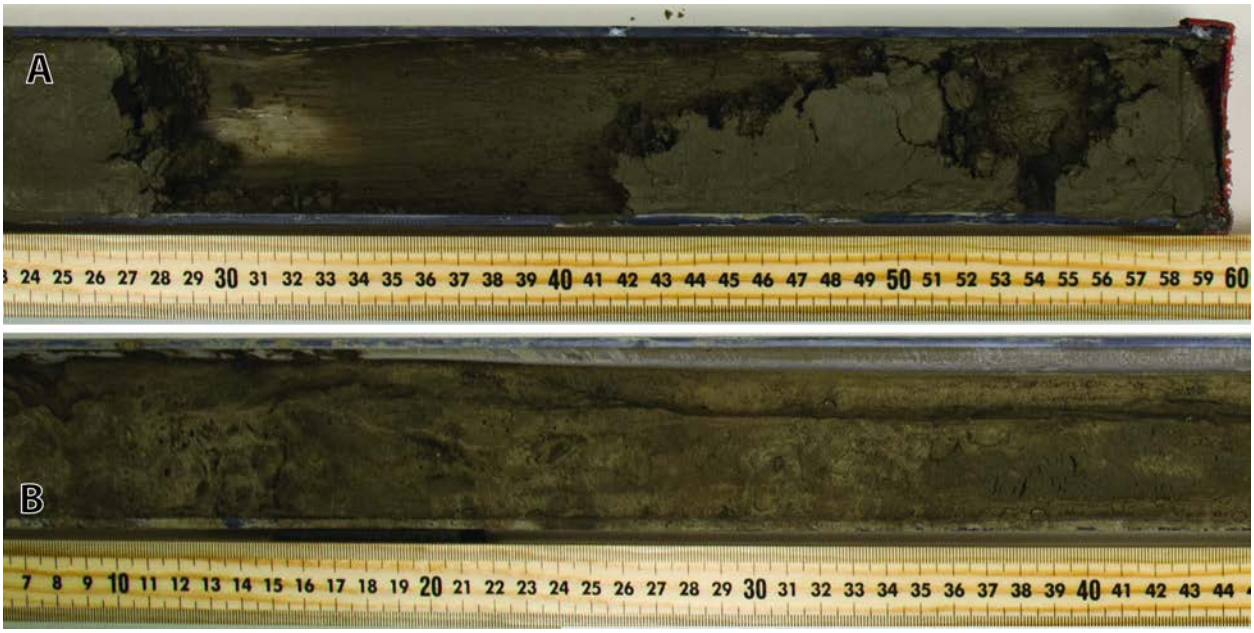

Figure 4.6.18 H005 depressurized core photos. A. Core FB Bonus-1, with visible bubbles in mud at 52-57 cm., B. Core UT-GOM2-1-H005-009FB-2, a silt-rich section with dewatering structures throughout. All H005 Core Photos can be found in the expedition data directory under H005 / Lithostratigraphy / Core Photos.

Sample	Depth (cm)	Color	Dominant Lithology	Comments
H005 09FB-1	0-23	Light olive grey (5Y 5/2)	Silt	seems compacted, no laminations visible
H005 09FB-2	53-138	Olive grey (5Y 3/2)	Silt	minor clay throughout, no lamination visible
H005 09FB-4	258-271	Light olive grey (5Y 5/2)	Clay	soft and soupy, possible drilling mud
	282-317	Olive grey (5Y 3/2)	Silt	dense, with some clay
H005 12FB-1	0-1	Light olive grey (5Y 5/2)	Clay	yellowish, possible authigenic carbonate
	9	Light olive grey (5Y 5/2)	Clay	yellowish, slightly harder, possible authigenic carbonate
	0-12	Olive grey (5Y 3/2)	Clay	firm
H005 12FB-2	12-30	Light olive grey (5Y 5/2)	Silt	seems compacted, no laminations visible
H005 12FB-3	76-82	Light olive grey (5Y 5/2)	Silt	with darker laminations (mm scale)
	82-87	Olive grey (5Y 3/2)	Clay and Silt	alternating in ~0.5 cm beds
	87-90	Olive grey (5Y 3/2)	Clay	-
	90-91	Light olive grey (5Y 5/2)	Silt	-
	91-100.5	Olive grey (5Y 3/2)	Clay	with darker laminations (mm scale) at 91.5 and 93 cm
	100.5-140	Light olive grey (5Y 5/2)	Silt	uniform, bedding visible from darker silt laminations (mm scale)
H005 FB-Bonus_1	0-28	Olive grey (5Y 3/2)	Clay	firm and soft, check XCT images for drilling mud
	28-50	-	-	Partial void space
	42-52	Olive grey (5Y 3/2)	Clay	firm and soft, check XCT images for drilling mud
	52-56	-	-	Void space
	56-60	Olive grey (5Y 3/2)	Clay	firm and soft, check XCT images for drilling mud
	24.5-64	Light olive grey (5Y 5/2)	Silt	uniform, bedding visible from darker silt laminations (mm scale)
H005 FB-Bonus_2	60-159.5	Olive grey (5Y 3/2)	Clay	firm in middle, soft clay on edge, check XCT images for drilling mud
	60-148	-	-	Rubbly clay texture, firm pieces, but broken
	148-153	Olive grey (5Y 3/2)	Clay	firm and intact clay bed
	153-159.5	-	-	Rubbly clay texture, firm pieces, but broken

Table 4.6.2 H005 Visual descriptions of depressurized core.

Smear Slide Analysis

Three of the depressurized samples from the visual description examination were selected for smear slide analysis in order to better document the mineralogical composition and texture with microscopic analysis. Two samples were selected from the silt-rich intervals (09FB-2 and 12FB-3), and one from a clay-rich interval (12FB-3). The results of the smear slide analysis are provided below (Table 4.6.3).

Sample		9FB-2	12FB-3	12FB-3
Core Depth (cm)		33	12	40
Depth (mbsf)		437.29	445.28	445.56
Estimated Texture	% Sand	1	0	2
	% Silt	99	1	98
	% Clay	trace	99	trace
Estimated Composition	Quartz	50%	3%	60%
	Feldspar	5%; microcline> plagioclase> orthoclase	3%; trace plagioclase	3%; microcline> plagioclase> orthoclase
	Heavy Minerals	trace rutile	-	trace zircon
	Opaques	2%	-	trace
	Amphibole	3%; green	-	2%; green
	Dolomite	trace	trace	trace
	Rock Fragments	40%; subrounded detrital carbonate (95%), igneous (5%)	-	35%; subrounded detrital carbonate (90%), igneous (10%)
	Calcareous nannofossils	-	trace	-
	Foraminifera	-	-	trace; planktonic

Table 4.6.3 H005 Smear slide analysis of three samples.

Based on smear slide description, grains in the silt interval sample were dominated by quartz (~50%), 3 types of feldspar (microcline>plagioclase>K-spar) (5%), and notable amphibole (up to 3%). Opaque and heavy minerals such as zircon were present in trace amounts. A significant fraction of the silt (20-50%) was composed of rock fragments that were dominated by detrital carbonate and igneous/volcanic lithic fragments, with occasional chert grains. Trace foraminifera were present, often containing framboidal pyrite. Mineral fragments were notably angular compared to rock fragments that were subrounded.

Grains in a smear slide from one clay interval were dominated by clay-sized minerals (99%) with a notable lack of biogenic grains. Calcareous nannofossils were present only in trace amounts while foraminifera and siliceous microfossils were not observed. Mineral grains visible in the silt fraction (up to 1%), contained quartz and plagioclase. Slightly subrounded dolomite rhombs were observed in trace amounts. See Chapter 3 H002, Figure 3.6.5 for Photomicrographs of smear slides from the dominant lithologies observed.

4.6.2 Laser diffraction particle size analysis

In Port Fourchon, 23 samples were analyzed with a Malvern Mastersizer for particle size distribution (Table 4.6.4). All of these samples are from sediments that were slowly depressurized during degassing experiments either on-board or dockside (see 4.5 Quantitative Degassing). Seven of the samples were from intact, depressurized core in the liner, while 16 were from disaggregated sediments that fell from the core liner after depressurization and were collected in bags. The length of sampling intervals ranges from 11.7 to 120 cm sections of core. In some cases (UT-GOM2-1-H005-04FB-2, -04FB-2LINER; -04FB-5A, -04FB-5A2; -04FB-5B, -04FB-5B2; -09FB-2A, -09FB-2B; -09FB-4A, and -09FB-4B), multiple samples were analyzed from the same core section. The majority of the samples are from sections of core that only contained a single lithofacies. Two samples (UT-GOM2-1-H005-07FB-2 and -07FB-4) contain both lithofacies. Two samples (UT-GOM2-1-H005-09FB-2A and -09FB-2B) contain uncertain lithofacies due to hydrate dissociation during recovery.

Sample Name	Core Depth (cm)	Source	Facies	% Sand > 61.58 µm	% Silt 1.93-61.58 µm	% Clay < 1.93 µm	d (0.1)	d (0.5)	d (0.9)
H005 01FB-3	165-185	Core	1	0.00	67.24	32.76	0.79	3.21	11.77
H005 03FB-2	115-132	Core	3	16.53	71.28	12.19	1.58	22.20	67.06
H005 03FB-3	132-160	Disaggregated	2	37.01	57.95	5.04	4.90	44.59	91.26
H005 04FB-2	12-38	Disaggregated	2	44.36	52.52	3.12	17.57	50.97	95.33
H005 04FB-2LINER	12-38	Disaggregated	2	40.44	56.49	3.07	17.77	48.26	91.02
H005 04FB-3	38-52	Core	3	17.11	68.59	14.27	1.38	16.38	70.80
H005 04FB-4	52-65	Disaggregated	2	40.18	56.46	3.36	10.20	47.68	92.68
H005 04FB-5A	65-82	Disaggregated	3	30.61	59.83	9.57	2.05	37.56	86.74
H005 04FB-5A2	65-82	Disaggregated	3	35.03	56.50	8.47	2.40	42.32	90.02
H005 04FB-5B	65-82	Disaggregated	3	15.35	68.31	16.34	1.21	12.52	66.72
H005 04FB-5B2	65-82	Disaggregated	3	15.86	67.68	16.46	1.19	12.84	67.56
H005 04FB-7	190-202	Disaggregated	2	40.34	56.61	3.05	13.00	47.52	94.65
H005 07FB-1	0-18	Core	2	54.31	43.80	1.88	25.42	58.42	108.02
H005 07FB-2	18-65	Core	3	11.63	71.48	16.89	1.12	14.20	58.83
H005 07FB-4	178-195	Core	2	53.41	43.03	3.56	11.44	57.80	107.61
H005 08FB-TOP	0?	Disaggregated	2	41.45	55.77	2.78	18.81	48.78	93.97
H005 09FB-2A	18-137	Disaggregated	2 & 3	29.76	65.15	5.09	5.75	39.58	82.51
H005 09FB-2B	18-137	Disaggregated	2 & 3	27.00	64.78	8.22	2.39	32.00	84.70
H005 09FB-4A	258-320	Disaggregated	2	37.12	52.75	10.12	1.91	41.04	98.85
H005 09FB-4B	258-320	Disaggregated	2	36.30	57.93	5.77	4.15	43.93	90.86
H005 10FB-2	0-32	Disaggregated	2	60.04	37.68	2.28	24.67	64.05	123.36
H005 10FB-3	32-78	Disaggregated	2	49.77	47.57	2.66	20.27	54.91	104.83
H005 11FB-1	0-28	Core	3	3.89	75.52	20.59	1.01	7.36	37.56
Facies 1 Average			1	0.00	67.24	32.76	0.79	3.21	11.77
Facies 2 Average			2	44.56	51.55	3.89	14.18	50.66	99.37
Facies 3 Average			3	18.25	67.40	14.35	1.49	20.67	68.16

Table 4.6.4 H005 Laser diffraction particle size analysis. Table shows sand-silt-clay percent, and 10th, 50th, and 90th percentiles. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size. See Chapter 2 Methods, Section 2.6 Lithostratigraphy for % sand/silt/clay calculations.

The laser diffraction particle size analyses from H005 shows distinct differences between the lithofacies (Figure 4.6.19, Figure 4.6.20). Lithofacies 1 is composed of 0% sand, 67% silt, and 33% clay, with a median grain size of 3.21 µm. On average, lithofacies 2 is much more sand-rich, with 44% sand, 53% silt, 3% clay, and a median grain size of 50.7 µm. Lithofacies 3 is composed of 18% sand, 67% silt, and 14% clay on average, with a median grain size of 20.67 µm.

The median grain size of analyzed sediments ranged from 3.2 to 64.05 µm (Table 4.6.4). Median grain size varies with depth (Figure 4.6.21). Within lithofacies 2, median grain size increases with depth, while median grain size decreases with depth within lithofacies 3.

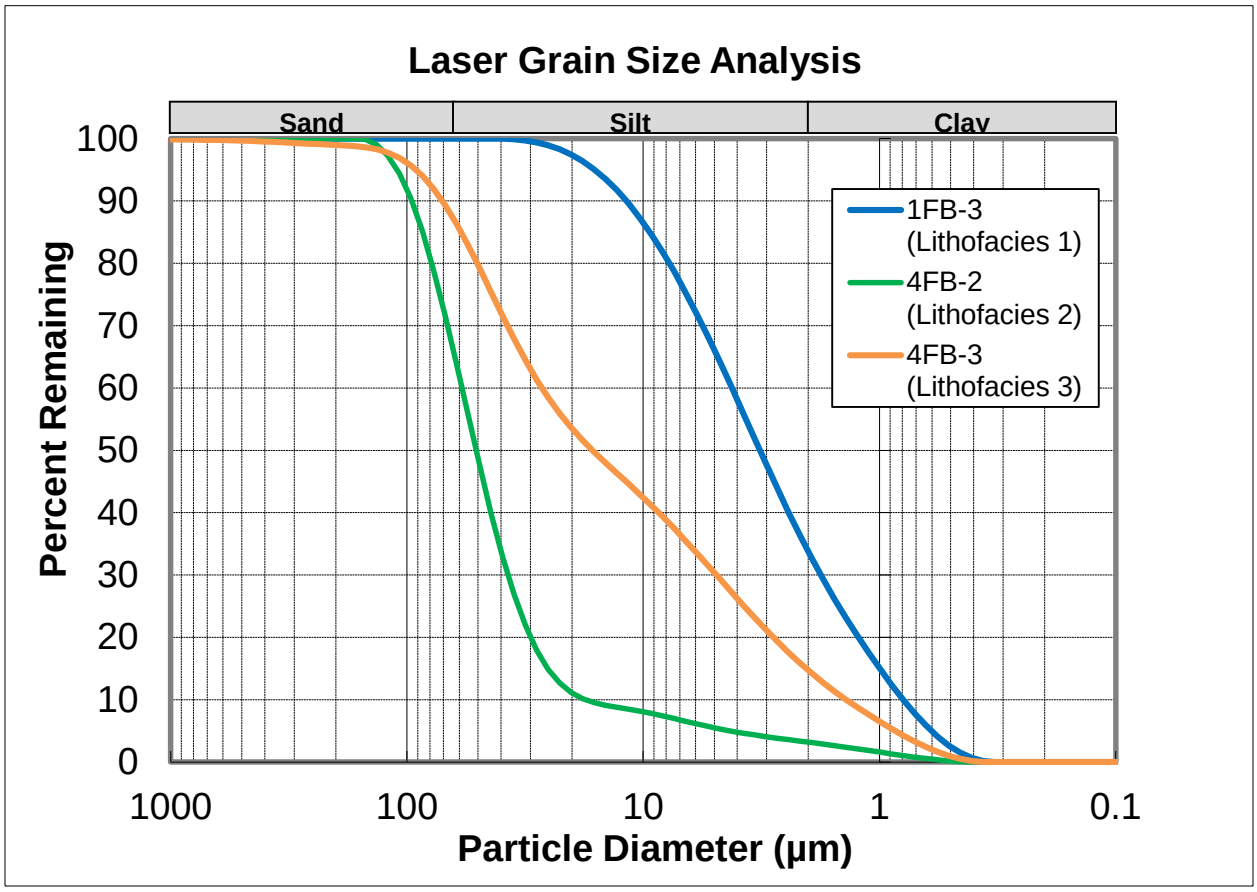

Figure 4.6.19 Laser grain size distribution for each of the lithofacies identified within H005. Representative samples for lithofacies were chosen based on the consistency of p-wave velocity, density, and X-ray images. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

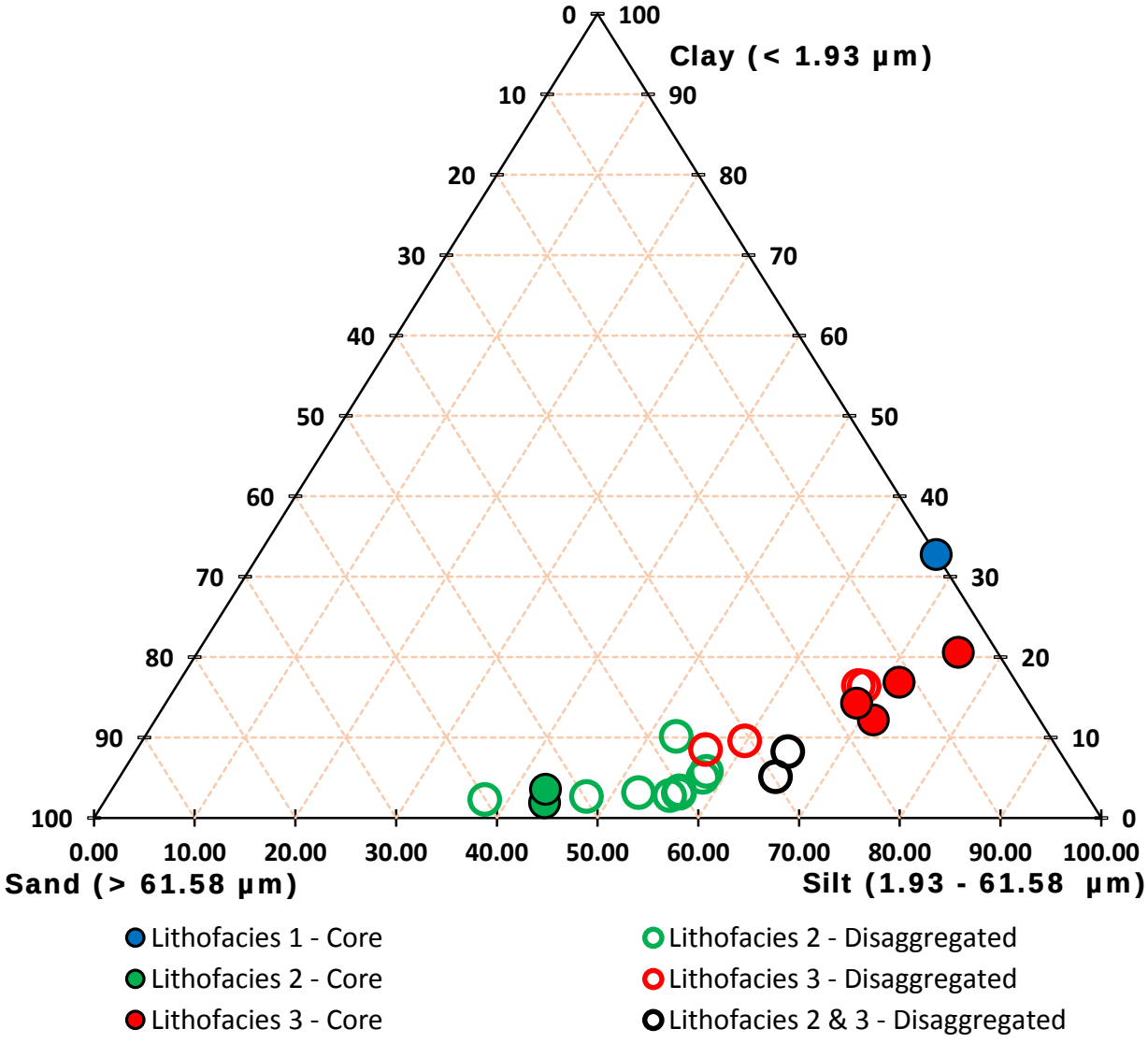

Figure 4.6.20 Ternary diagram of sediments used for sediment classification. Data points are from laser-particle size analysis. Both core (filled circles) and disaggregated samples (hollow circles) of H005 are plotted. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

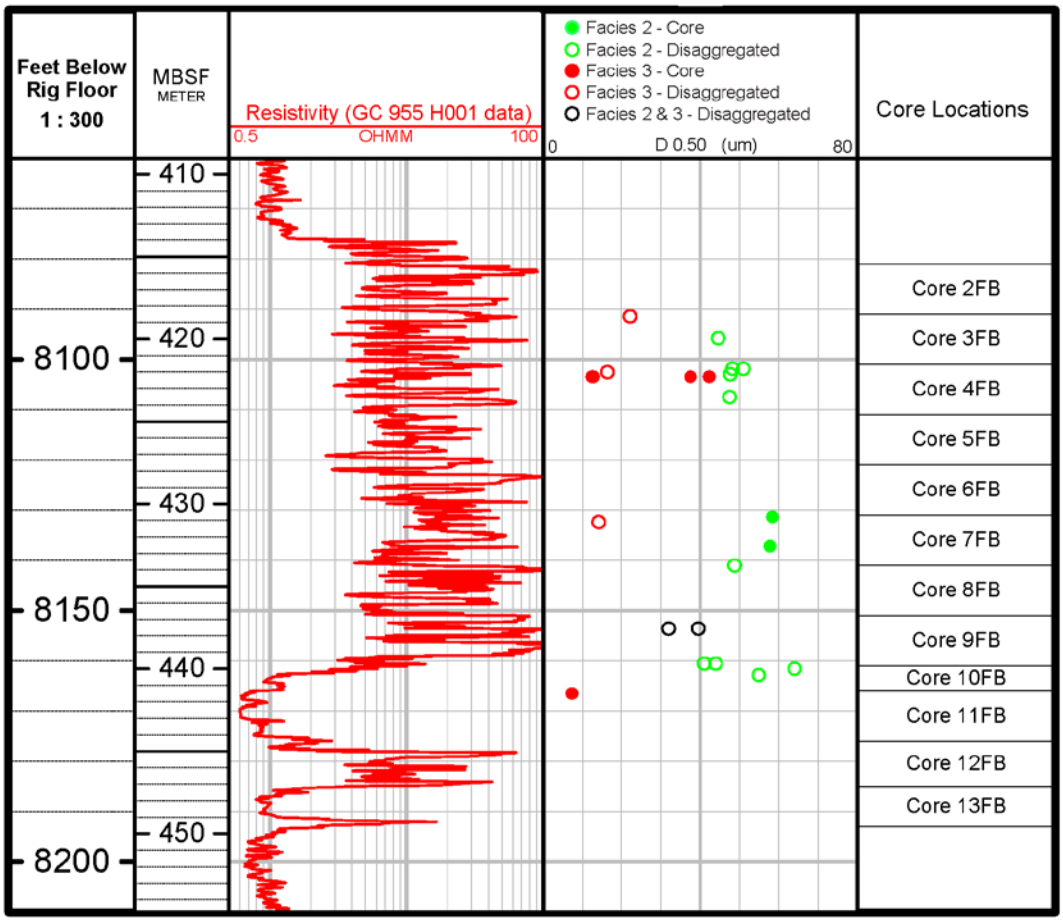

Figure 4.6.21 Downhole variation of median grain size versus H001 LWD data. D 0.50 data from laser particle size analysis.

UT-GOM2-1-H005-01FB

One sample from core H005 01FB was analyzed by laser diffraction (Figure 4.6.22). Sample H005 01FB-3 was identified as lithofacies 1 (Figure 4.6.2), and has a median grain size of 3.2 μm.

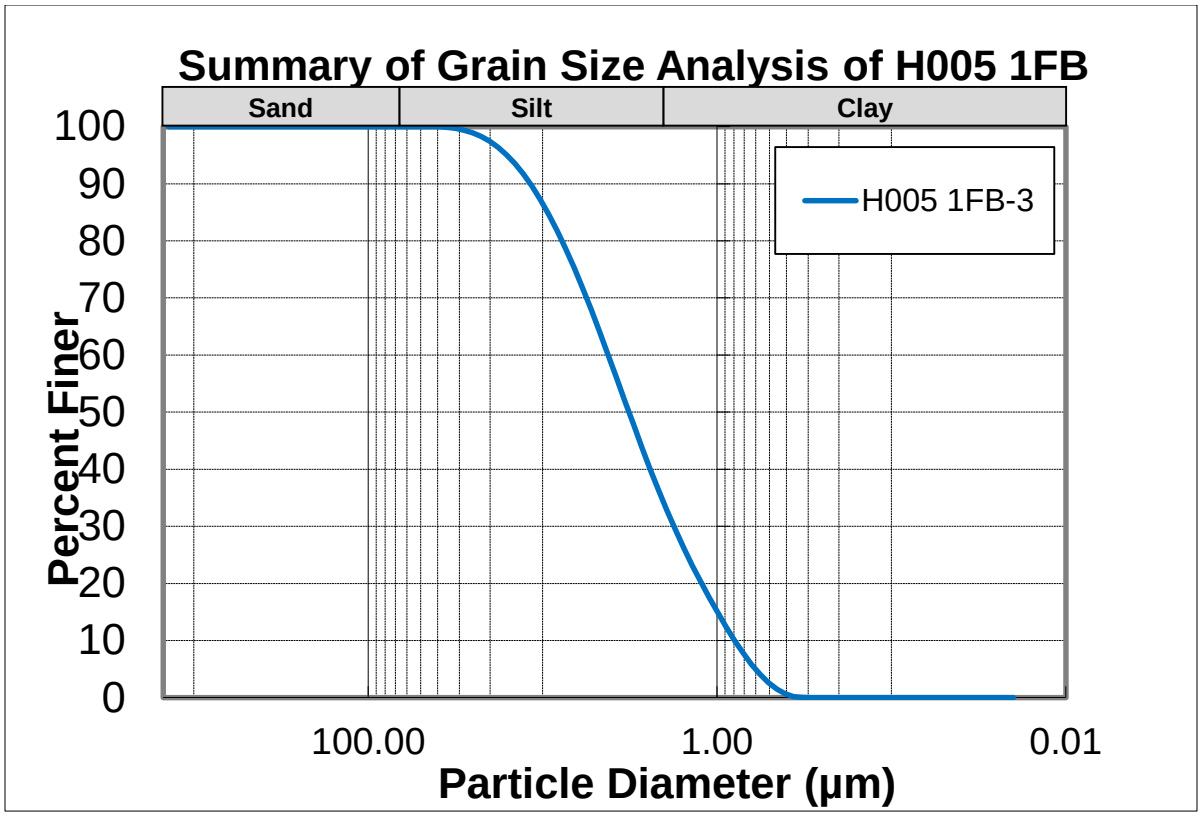

Figure 4.6.22 UT-GOM2-1-H005-01FB-3 Laser particle size analysis. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

UT-GOM2-1-H005-03FB

Two samples from core H005 03FB were analyzed by laser diffraction (Figure 4.6.23). Sample H005 03FB-2 was identified as lithofacies 3 (Figure 4.6.10), and has a median grain size of 22.2 µm. Sample H005 03FB-3 was identified as lithofacies 2 (Figure 4.6.8), and has a median grain size of 44.6 µm.

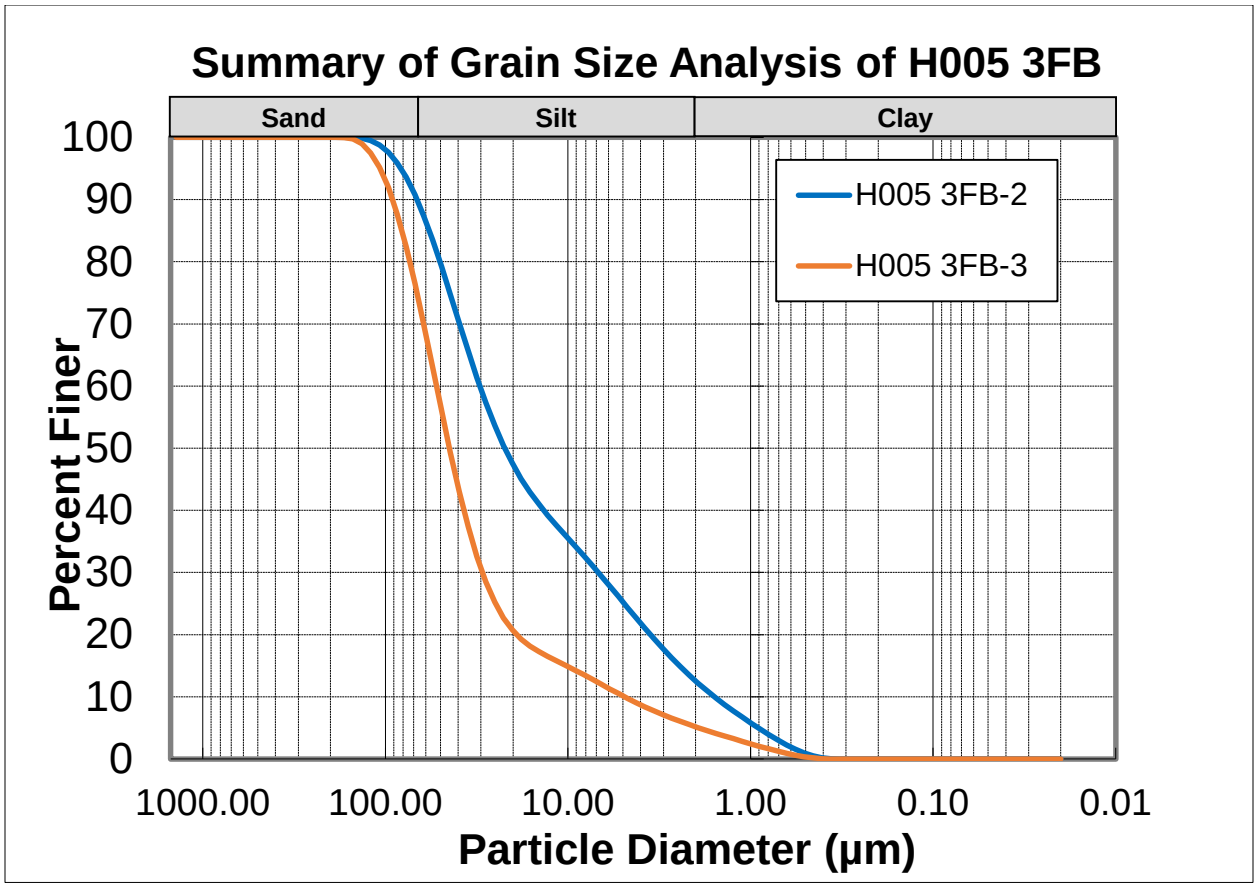

Figure 4.6.23 UT-GOM2-1-H005-03FB-3 Laser particle size analysis. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

UT-GOM2-1-H005-04FB

Nine samples from core H005 04FB were analyzed by laser diffraction (Figure 4.6.24). Sample H005 04FB-2 was identified as lithofacies 2 (Figure 4.6.9), and has a median grain size of 51.0 µm. Sample H005 04FB-2LINER was identified as lithofacies 2 (Figure 4.6.9), and has a median grain size of 48.3 µm. Sample H005 04FB-3 was identified as lithofacies 3(Figure 4.6.9), and has a median grain size of 16.4 µm. Sample H005 04FB-4 was identified as lithofacies 2 (Figure 4.6.9), and has a median grain size of 47.7 µm. Sample H005 04FB-5A was identified as lithofacies 3 (Figure 4.6.9), and has a median grain size of 37.6 µm. Sample H005 04FB-5A2 was identified as lithofacies 3 (Figure 4.6.9), and has a median grain size of 42.3 µm. Sample H005 04FB-5B was identified as lithofacies 3 (Figure 4.6.9), and has a median grain size of 12.5 µm. Sample H005 04FB-5B2 was identified as lithofacies 3 (Figure 4.6.9), and has a median grain size of 12.8 µm. Sample H005 04FB-7 was identified as lithofacies 2 (Figure 4.6.9), and has a median grain size of 47.5 µm.

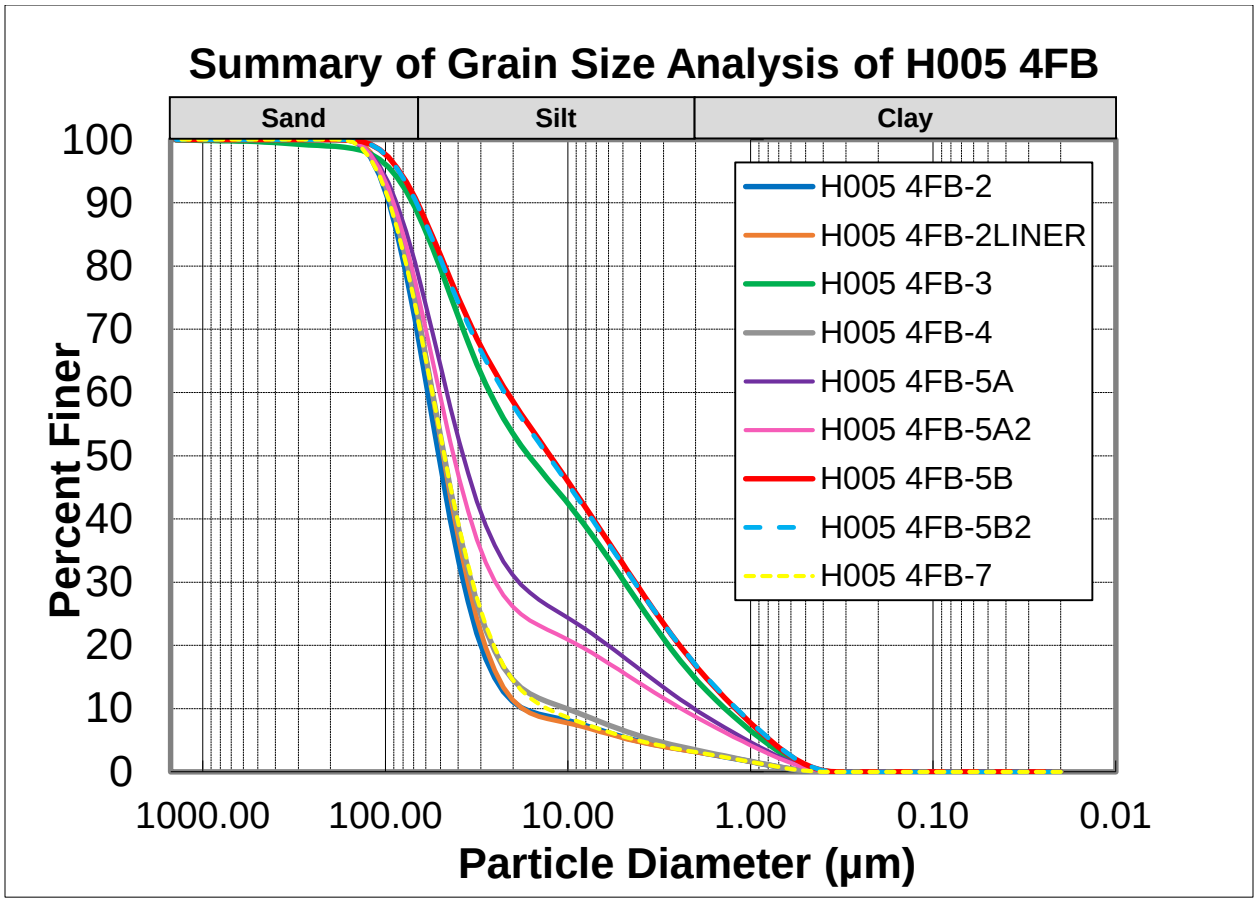

Figure 4.6.24 UT-GOM2-1-H005 04FB Laser particle size analysis. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

UT-GOM2-1-H005-07FB

Three samples from core H005 07FB were analyzed by laser diffraction (Figure 4.6.25). Sample H005 07FB-1 was identified as lithofacies 2 (Figure 4.6.12), and has a median grain size of 58.4 µm. Sample H005 07FB-2 was identified as lithofacies 3 (Figure 4.6.12), and has a median grain size of 14.1 µm. Sample H005 07FB-4 was identified as lithofacies 2 (Figure 4.6.12), and has a median grain size of 57.8 µm.

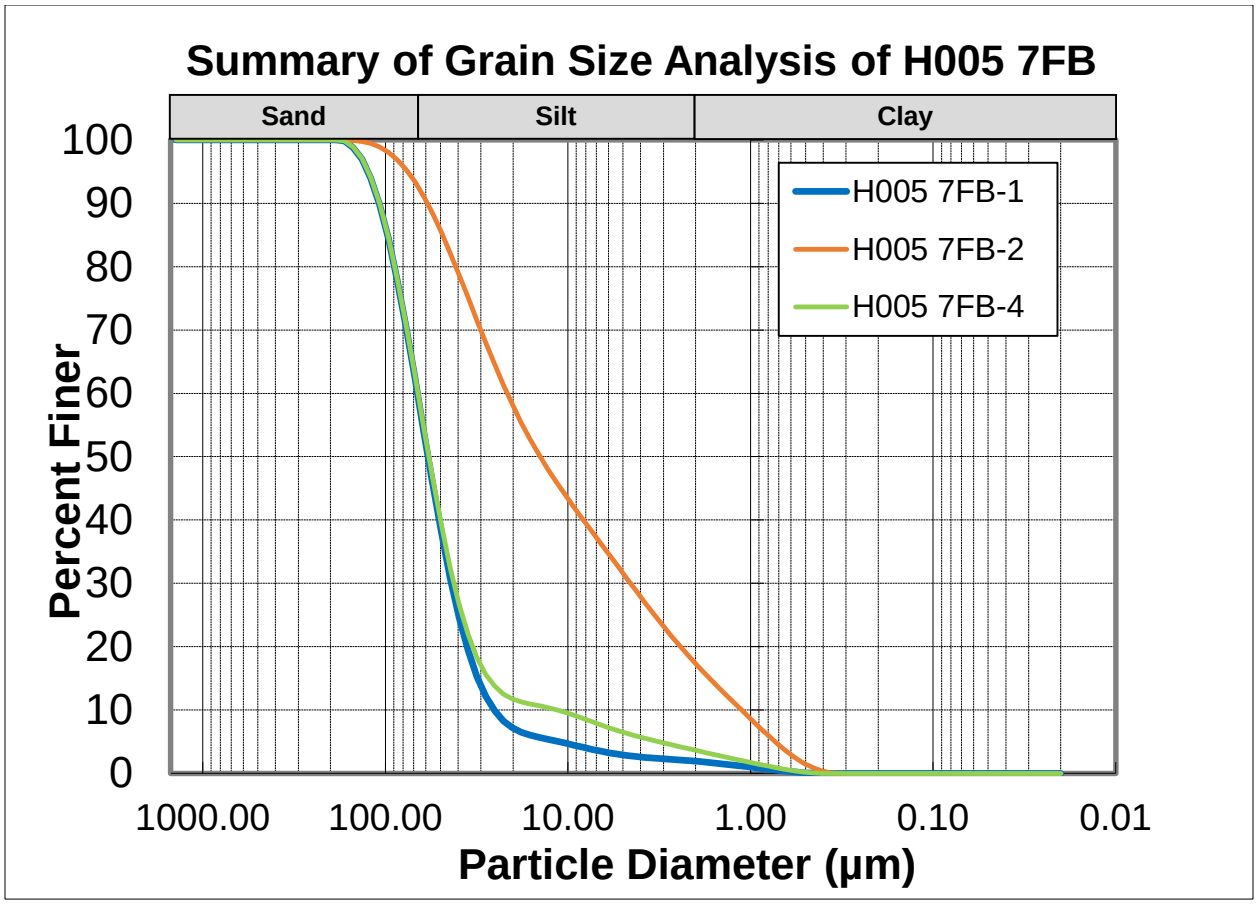

Figure 4.6.25 UT-GOM2-1-H005-07FB Laser particle size analysis. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

UT-GOM2-1-H005-08FB

One sample from core H005 08FB was analyzed by laser diffraction (Figure 4.6.26). Sample H005 08FB-TOP was collected from above the core liner and is likely fall-in material. This sample has a median grain size of 48.8 µm.

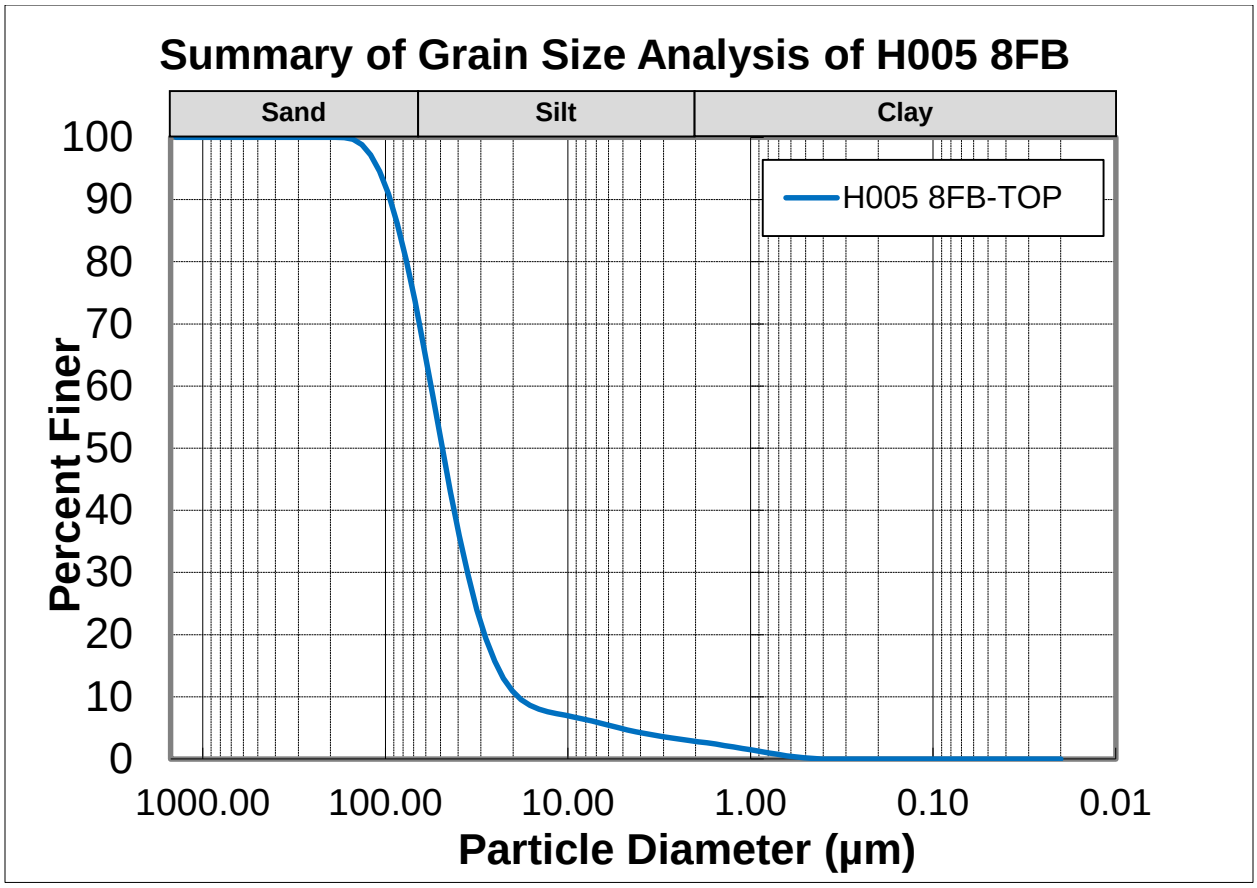

Figure 4.6.26 UT-GOM2-1-H005-08FB Laser particle size analysis. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

UT-GOM2-1-H005-09FB

Four samples from core H005 09FB were analyzed by laser diffraction (Figure 4.6.23). Samples H005 09FB-2A and 09FB-2B have a mix of both lithofacies 2 and lithofacies 3 (Figure 4.6.14), and a median grain size of 39.6 µm and 32.0 µm, respectively. Sample H005 09FB-4A and H005 09FB-4B were identified as lithofacies 2 (Figure 4.6.14), and have a median grain size of 41.0 µm and 43.9 µm, respectively.

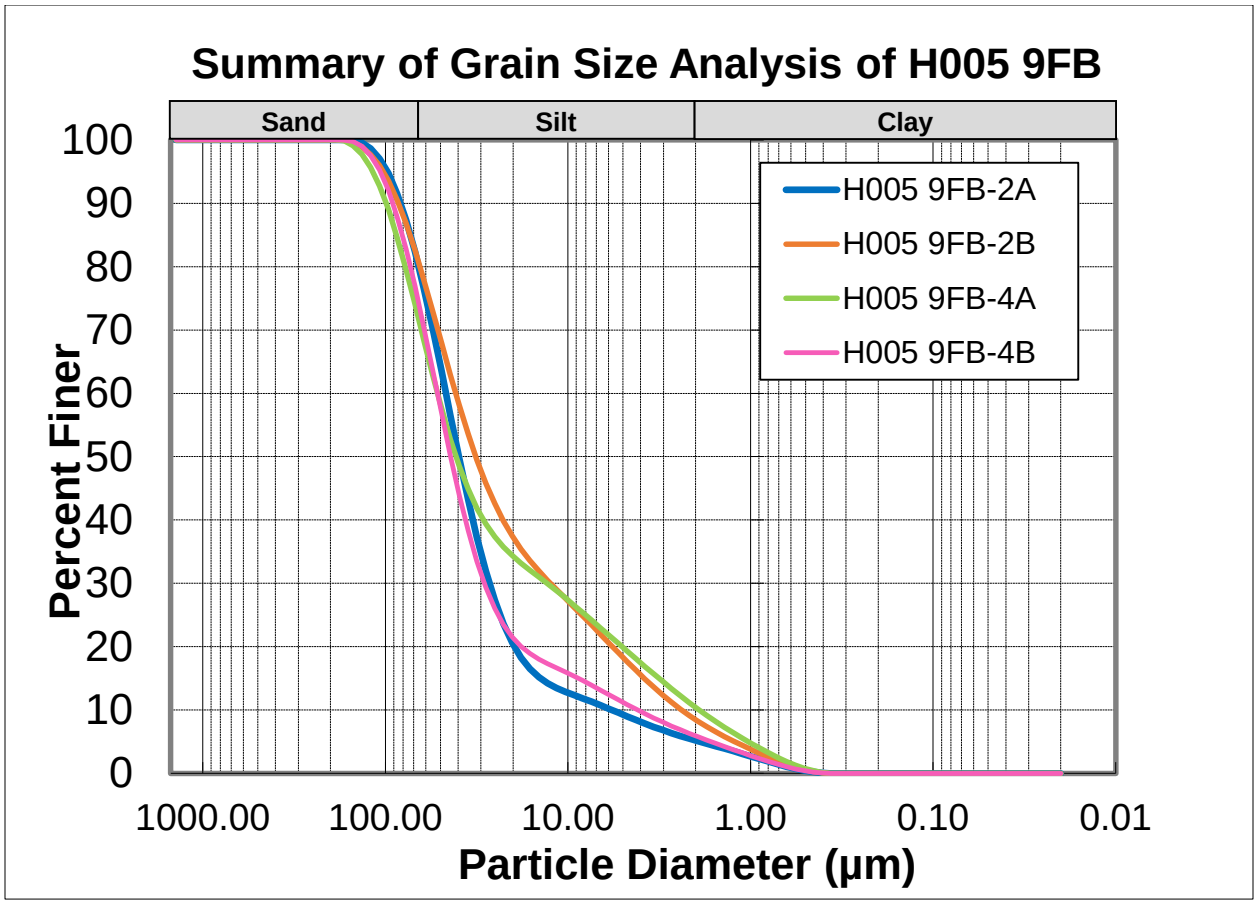

Figure 4.6.27 UT-GOM2-1-H005-09FB Laser particle size analysis. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

UT-GOM2-1-H005-10FB

Two samples from core H005 10FB were analyzed by laser diffraction (Figure 4.6.23). Sample H005 10FB-2 was identified as lithofacies 2 (Figure 4.6.15), and has a median grain size of 64.1 µm. Sample H005 10FB-3 was identified as lithofacies 2 (Figure 4.6.15), and has a median grain size of 54.9 µm.

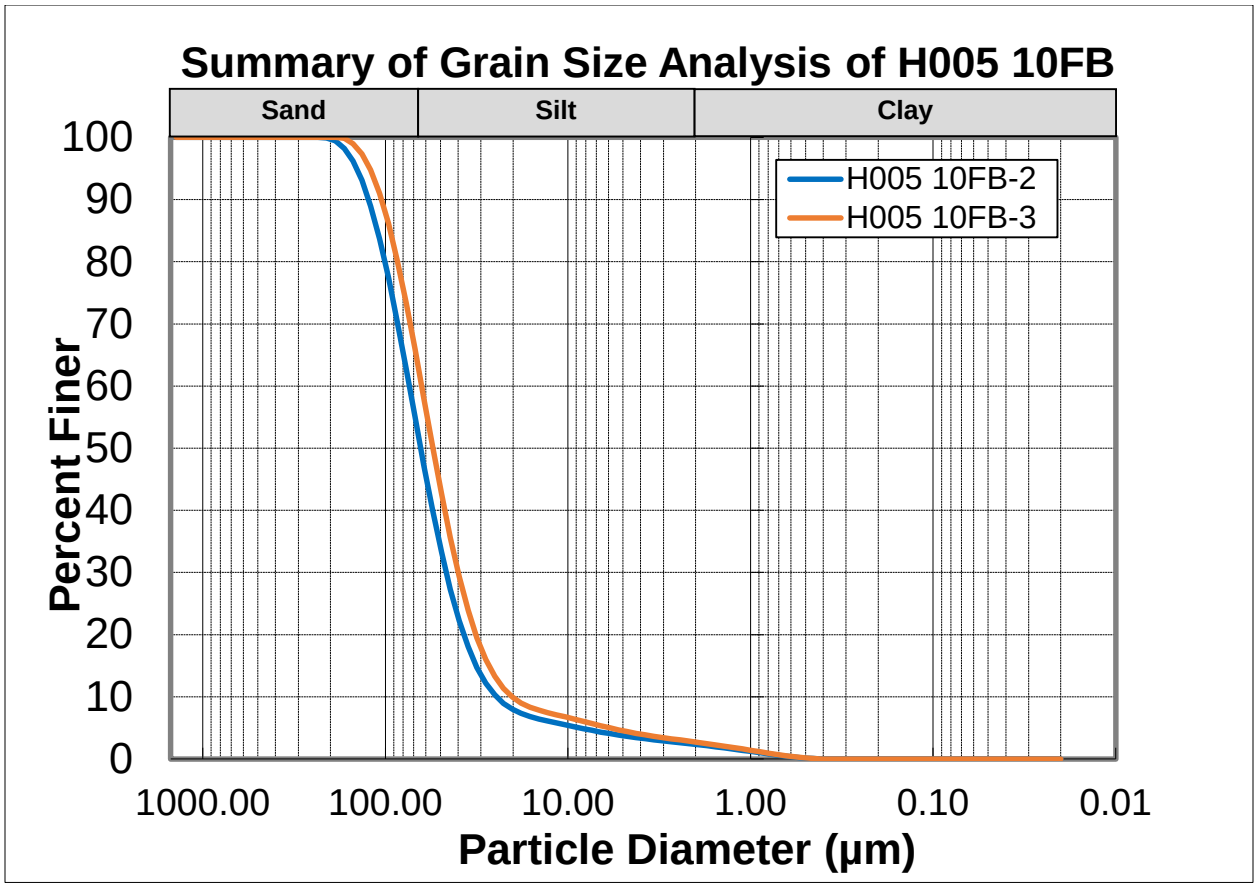

Figure 4.6.28 UT-GOM2-1-H005-10FB Laser particle size analysis. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

UT-GOM2-1-H005-11FB

One sample from core H005 11FB was analyzed by laser diffraction (Figure 4.6.23). Sample H005 11FB-1 was identified as lithofacies 3 (Figure 4.6.16), and has a median grain size of 7.4 µm.

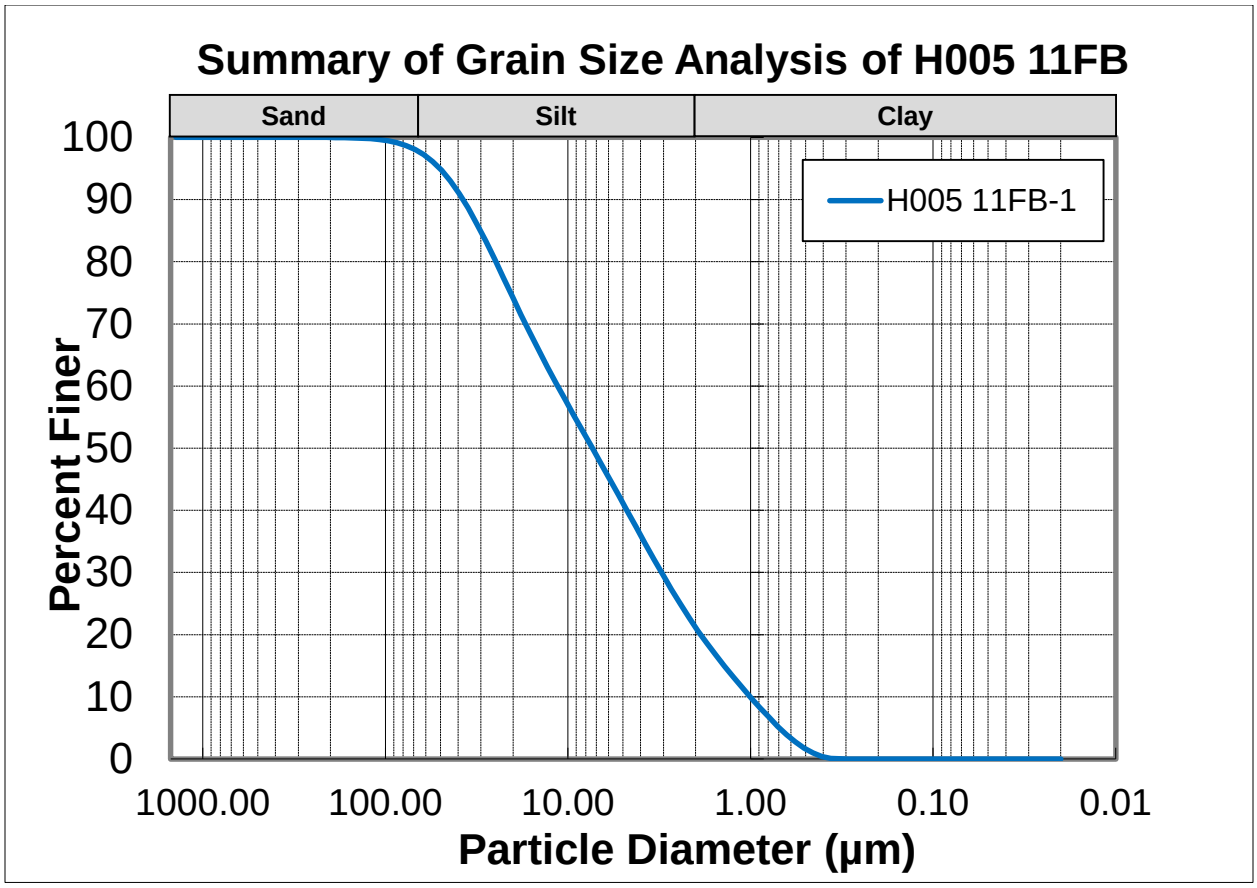

Figure 4.6.29 UT-GOM2-1-H005-11FB Laser particle size analysis. All H005 Laser Diffraction Particle size data can be found in the expedition data directory under H005 / Lithostratigraphy / Grain size.

4.6.3 Mineralogy

Using X-ray diffraction (XRD) we determined the bulk mineralogy of powdered 2 gram subsamples taken from H005 cores that were depressurized and sent to Ohio State. Subsampling took place in silt intervals (likely Lithofacies 2), denoted XRD-S, drilling mud intruded intervals, denoted XRD-M (likely Lithofacies 3).

XRD-S (Lithofacies 2) initial results show a composition of mainly quartz with minor amounts of albite, dolomite, calcite, muscovite, amphibole, chlorite and biotite (Figure 4.6.30). No specific clay mineralogical analyses (e.g. <2 µm, oriented samples) were performed. The identification of clay minerals from bulk powder XRD is limited due to slight differences in chemistry, polytype, and degree of order, which create many possible permutations of phyllosilicate structures.

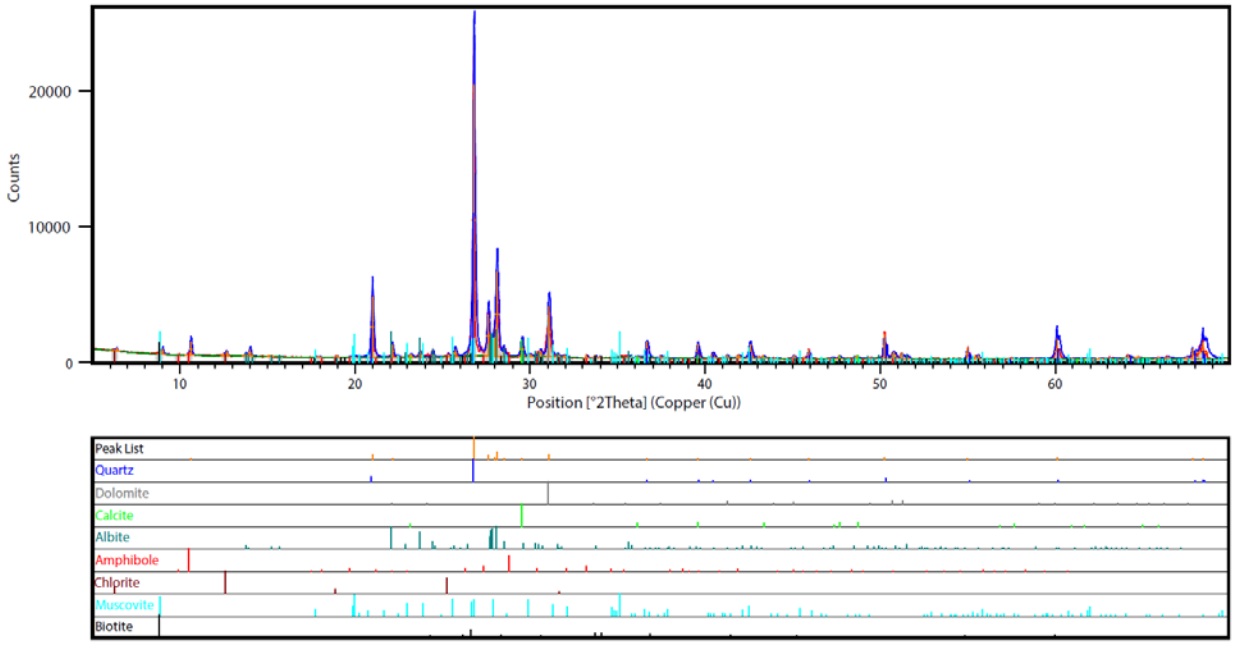

Figure 4.6.30 H005 example XRD spectra from a subsample of Core UT-GOM2-1-H005-03FB-3. Initial XRD results can be found in the H005 data directory under H005 / Lithostratigraphy / XRD.

4.6.4 Lithofacies Interpretation

Lithofacies 1 is composed of silty-clay (see Laser diffraction particle size analysis) with mm-scale fractures that may be filled with hydrate. The low average particle size suggests this unit was deposited in a low energy, hemipelagic environment.

Lithofacies 2 represents coarser sediment (sandy-silt and silty-sand) beds. This unit has the highest average grain size as well as the highest percentage of sand-sized grains (see Laser-particle size analysis). The high compressional velocities associated with lithofacies 2 are interpreted to host high saturations of methane hydrate. Cementation of grains by hydrate may explain why the least disturbed, most continuous coring intervals with high P-wave velocity are characterized by lithofacies 2.

Lithofacies 3 is interpreted to be a finer-grained, lower energy facies. This unit is composed of mostly silt with some sand and clay. The average grain size is less than half of that of lithofacies 2 (see Laser-particle size analysis). The relatively low compressional velocity and high density are interpreted to record either a low or no hydrate saturation, which may be related to lower porosity when compared to lithofacies 2. Lithofacies 3 is complicated in the fact that in some cases, this lithofacies is composed of alternating light and dark layers in X-rays, which may be the result of sedimentation during times of low energy (dark layers) and times of higher energy (light layers). A more robust analysis of lithofacies 3 is needed to determine whether or not it is in fact a separate unit, or simply a mixture of lithofacies 1 and lithofacies 2.

4.7 Geochemistry and Microbiology

4.7.1 Pressure core gases

Field analyses

A total of 141 samples from 16 pressure core degassing experiments (see 4.5 Quantitative Degassing) were analyzed on the gas chromatograph for methane, ethane, propane, n-butane, i-butane, nitrogen, and oxygen. These analyses indicate that methane is the dominant hydrocarbon (93.6 to 97.3% of all gas) in all samples with quantifiable ethane (44 to 118 ppmv) (Table 4.7.1 to Table 4.7.8). Propane was detected, but not quantifiable (<10 ppmv) in samples from Cores UT-GOM2-1-H005-04FB and -09FB. All samples had minor atmospheric contamination (0.18 to 1.19% O_2 and 1.25 to 5.21% N_2). Several of the analyzed samples contained major atmospheric contamination and were excluded from the above interpretation (shown in italics in the tables), due to likely error in syringe operation. Methane to ethane (C1/C2) varies from 7352 to 25803 with a mean of 11880 (Figure 4.7.1 and Figure 4.7.2).

Hole	Core	Section	Depth top (mbsf)	Depth bottom (mbsf)	Sample	Syringe	Oxygen	Nitrogen	Methane	Ethane	Propane
							%	%	%	ppm	presence
H005	01FB	1	282.55	283.24	1	6R	2.22	11.29	86.5	62	x
H005	01FB	2	283.24	284.18	1	21Y	1.86	9.12	89.0	59	x
H005	01FB	3	284.18	284.39	1	20Y	2.80	13.04	84.1	59	x

Table 4.7.1 UT-GOM2-1-H005-01FB Gas analysis. Propane detected marked by an x. Blue is used to distinguish separate sections of core. All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

Hole	Core	Section	Depth top	Depth bottom	Sample	Syringe	Oxygen	Nitrogen	Methane	Ethane	Propane
			mbsf	mbsf			%	%	%	ppm	presence
H005	02FB	1	415.44	415.62	1	1G	1.71	8.36	89.9	84	-

Table 4.7.2 UT-GOM2-1-H005-02FB Gas analysis. Propane detected marked by an x. . All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

Hole	Core	Section	Depth top	Depth bottom	Sample	Syringe	Oxygen	Nitrogen	Methane	Ethane	Propane
			mbsf	mbsf			%	%	%	ppm	presence
H005	03FB	3	419.82	420.08	1	14G	0.86	4.83	94.3	62	x
H005	03FB	3	419.82	420.08	2	15G	0.31	2.10	97.6	69	x
H005	03FB	3	419.82	420.08	3	16G	0.24	1.83	97.9	74	x
H005	03FB	3	419.82	420.08	4	17G	0.21	1.67	98.1	78	x
H005	03FB	3	419.82	420.08	5	18G	0.19	1.59	98.2	80	x
H005	03FB	3	419.82	420.08	6	19G	0.18	1.50	98.3	84	x
H005	03FB	3	419.82	420.08	7	20G	0.16	1.43	98.4	85	x
H005	03FB	3	419.82	420.08	8	21G	0.17	1.41	98.4	88	x
H005	03FB	3	419.82	420.08	9	22G	0.18	1.39	98.4	85	x
H005	03FB	3	419.82	420.08	10	23G	0.21	1.43	98.4	88	x
H005	03FB	3	419.82	420.08	11	24G	0.20	1.42	98.4	86	x
H005	03FB	3	419.82	420.08	12	25G	0.21	1.49	98.3	85	x
H005	03FB	3	419.82	420.08	13	26G	0.20	1.42	98.4	89	x
H005	03FB	3	419.82	420.08	14	27G	0.20	1.45	98.3	94	x
H005	03FB	3	419.82	420.08	15	28G	0.18	1.39	98.4	92	x
H005	03FB	3	419.82	420.08	16	29G	0.20	1.46	98.3	92	x
H005	03FB	3	419.82	420.08	17	30G	0.33	2.05	97.6	103	x

Table 4.7.3 UT-GOM2-1-H005-03FB Gas analysis. Propane detected marked by an x. . All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

Hole	Core	Section	Depth top	Depth bottom	Sample	Syringe	Oxygen	Nitrogen	Methane	Ethane	Propane
			mbsf	mbsf			%	%	%	ppm	presence
H005	04FB	2	421.67	421.92	1	12G	1.19	5.21	93.6	67	x
H005	04FB	2	421.67	421.92	2	13G	0.50	2.46	97.0	73	x
H005	04FB	2	421.67	421.92	3	14G	0.40	2.05	97.5	78	x
H005	04FB	2	421.67	421.92	4	15G	0.39	1.93	97.7	73	x
H005	04FB	2	421.67	421.92	5	16G	0.36	1.78	97.9	79	x
H005	04FB	2	421.67	421.92	6	17G	0.24	1.53	98.2	81	x
H005	04FB	2	421.67	421.92	7	18G	0.25	1.50	98.2	81	x
H005	04FB	2	421.67	421.92	8	19G	0.19	1.41	98.4	81	x
H005	04FB	*2*	421.67	421.92	*9*	*21G*	*3.27*	*12.01*	*84.7*	*74*	*x*
H005	04FB	2	421.67	421.92	10	22G	0.23	1.37	98.4	83	x
H005	04FB	2	421.67	421.92	11	23G	0.22	1.38	98.4	83	x
H005	04FB	2	421.67	421.92	12	24G	0.24	1.45	98.3	89	x
H005	04FB	2	421.67	421.92	13	25G	0.22	1.38	98.4	92	x
H005	04FB	3	421.92	422.07	1	1R	0.81	4.98	94.2	65	x
H005	04FB	*3*	421.92	422.07	*2*	*2R*	*4.79*	*18.43*	*76.8*	*59*	*x*
H005	04FB	*3*	421.92	422.07	*3*	*3R*	*21.84*	*77.55*	*0.6*	-	-
H005	04FB	3	421.92	422.07	4	4R	0.51	2.95	96.5	79	x
H005	04FB	3	421.92	422.07	5	5R	1.11	5.93	93.0	76	x
H005	04FB	4	422.07	422.19	1	1B	0.44	3.88	95.7	60	x
H005	04FB	4	422.07	422.19	2	2B	0.41	3.19	96.4	63	x
H005	04FB	4	422.07	422.19	3	3B	0.30	2.31	97.4	68	x
H005	04FB	*4*	422.07	422.19	*4*	*4B*	*0.94*	*4.72*	*94.3*	*68*	*x*
H005	04FB	4	422.07	422.19	5	5B	0.34	1.97	97.7	72	x
H005	04FB	4	422.07	422.19	6	6B	0.34	1.89	97.8	75	x
H005	04FB	4	422.07	422.19	7	7B	0.62	2.94	96.4	75	x
H005	04FB	4	422.07	422.19	8	8B	1.12	4.73	94.1	78	x
H005	04FB	4	422.07	422.19	9	9B	1.11	4.66	94.2	75	x
H005	04FB	4	422.07	422.19	10	10B	0.26	1.65	98.1	77	x
H005	04FB	5	422.19	422.36	1	7Y	1.11	5.23	93.7	65	x
H005	04FB	5	422.19	422.36	2	8Y	0.50	2.48	97.0	66	x
H005	04FB	5	422.19	422.36	3	9Y	0.35	1.84	97.8	71	x
H005	04FB	5	422.19	422.36	4	10Y	0.38	1.97	97.6	73	x
H005	04FB	5	422.19	422.36	5	11Y	0.58	3.01	96.4	72	x
H005	04FB	7	423.45	423.57	1	12Y	0.62	2.59	96.8	46	x
H005	04FB	7	423.45	423.57	2	13Y	0.53	2.35	97.1	47	x
H005	04FB	7	423.45	423.57	3	14Y	0.49	2.19	97.3	44	x
H005	04FB	7	423.45	423.57	4	15Y	0.40	1.77	97.8	49	x
H005	04FB	7	423.45	423.57	5	16Y	1.12	4.40	94.5	49	x
H005	04FB	*7*	423.45	423.57	*6*	*17Y*	*6.69*	*24.47*	*68.8*	*33*	*x*
H005	04FB	7	423.45	423.57	7	18Y	0.31	1.73	98.0	53	x

Table 4.7.4 UT-GOM2-1-H005-04FB Gas analysis. Propane detected marked by an x. Blue is used to distinguish separate sections of core. . All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

Hole	Core	Section	Depth top	Depth bottom	Sample	Syringe	Oxygen	Nitrogen	Methane	Ethane	Propane
			mbsf	mbsf			%	%	%	ppm	presence
H005	07FB	1	430.68	430.87	1	3Y	0.83	4.19	95.0	88	x
H005	07FB	1	430.68	430.87	2	4Y	0.48	2.81	96.7	90	x
H005	07FB	1	430.68	430.87	3	5Y	0.25	1.95	97.8	94	x
H005	07FB	1	430.68	430.87	4	6Y	0.23	1.75	98.0	95	x
H005	07FB	1	430.68	430.87	5	7Y	0.23	1.68	98.1	96	x
H005	07FB	1	430.68	430.87	6	8Y	0.20	1.53	98.3	98	x
H005	07FB	1	430.68	430.87	7	9Y	0.20	1.45	98.3	101	x
H005	07FB	1	430.68	430.87	8	10Y	0.18	1.30	98.5	100	x
H005	07FB	1	430.68	430.87	9	11Y	0.15	1.24	98.6	99	x
H005	07FB	1	430.68	430.87	10	12Y	0.15	1.19	98.7	106	x
H005	07FB	1	430.68	430.87	11	13Y	0.20	1.28	98.5	106	x
H005	07FB	1	430.68	430.87	12	14Y	0.18	1.22	98.6	106	x
H005	07FB	1	430.68	430.87	13	15Y	0.16	1.22	98.6	105	x
H005	07FB	1	430.68	430.87	14	16Y	0.13	1.15	98.7	106	x
H005	07FB	1	430.68	430.87	15	17Y	0.13	1.12	98.7	110	x
H005	07FB	1	430.68	430.87	16	18Y	0.14	1.06	98.8	116	x
H005	07FB	1	430.68	430.87	17	19Y	1.89	7.37	90.7	123	x
H005	07FB	2	430.87	431.31	1	26G	0.41	2.71	96.9	84	x
H005	07FB	2	430.87	431.31	2	27G	0.25	1.67	98.1	91	x
H005	07FB	2	430.87	431.31	3	28G	0.25	1.48	98.3	95	x
H005	07FB	2	430.87	431.31	4	29G	0.29	1.57	98.1	95	x
H005	07FB	2	430.87	431.31	5	30G	0.26	1.53	98.2	98	x
H005	07FB	2	430.87	431.31	6	1G	0.28	1.55	98.2	99	x
H005	07FB	2	430.87	431.31	7	2G	0.28	1.51	98.2	103	x
H005	07FB	2	430.87	431.31	8	3G	0.27	1.56	98.2	102	x
H005	07FB	2	430.87	431.31	9	4G	0.24	1.47	98.3	105	x
H005	07FB	2	430.87	431.31	10	5G	0.22	1.37	98.4	105	x
H005	07FB	2	430.87	431.31	11	6G	0.21	1.33	98.5	103	x
H005	07FB	2	430.87	431.31	12	7G	0.19	1.34	98.5	104	x
H005	07FB	2	430.87	431.31	13	8G	0.20	1.38	98.4	108	x
H005	07FB	2	430.87	431.31	14	9G	0.21	1.54	98.2	102	x
H005	07FB	2	430.87	431.31	15	10G	0.22	1.57	98.2	104	x
H005	07FB	2	430.87	431.31	16	11G	0.34	1.72	97.9	105	x
H005	07FB	2	430.87	431.31	17	12G	0.33	1.69	98.0	115	x
H005	07FB	2	430.87	431.31	18	13G	0.44	2.11	97.4	127	x
H005	07FB	4	432.46	432.63	1	22Y	0.38	2.59	97.0	96	x
H005	07FB	4	432.46	432.63	2	23Y	0.28	2.18	97.5	103	x
H005	07FB	4	432.46	432.63	3	24Y	0.20	1.45	98.3	113	x
H005	07FB	4	432.46	432.63	4	25Y	0.21	1.26	98.5	117	x
H005	07FB	4	432.46	432.63	5	26Y	0.25	1.44	98.3	114	x
H005	07FB	4	432.46	432.63	6	27Y	0.25	1.43	98.3	112	x
H005	07FB	4	432.46	432.63	7	28Y	0.27	1.45	98.3	118	x
H005	07FB	*4*	432.46	432.63	*8*	*29Y*	*0.86*	*3.90*	*95.2*	*109*	*x*
H005	07FB	4	432.46	432.63	9	30Y	0.26	1.79	97.9	116	x
H005	07FB	4	432.46	432.63	10	1Y	0.22	1.53	98.2	117	x
H005	07FB	4	432.46	432.63	11	2Y	0.83	4.55	94.6	127	x

Table 4.7.5 UT-GOM2-1-H005-07FB Gas analysis. Propane detected marked by an x. Blue is used to distinguish separate sections of core. . All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

Hole	Core	Section	Depth top	Depth bottom	Sample	Syringe	Oxygen	Nitrogen	Methane	Ethane	Propane
			mbsf	mbsf			%	%	%	ppm	presence
H005	09FB	2	436.96	438.16	1	11G	0.32	1.71	98.0	90	-
H005	09FB	2	436.96	438.16	2	12G	0.34	1.74	97.9	70	x
H005	09FB	2	436.96	438.16	3	13G	0.29	1.61	98.1	58	x
H005	09FB	*2*	436.96	438.16	*4*	*14G*	*20.5*	*79.1*	*0.3*	-	-
H005	09FB	2	436.96	438.16	5	15G	0.23	1.40	98.4	99	x
H005	09FB	2	436.96	438.16	6	16G	0.21	1.38	98.4	103	x
H005	09FB	2	436.96	438.16	7	17G	0.21	1.28	98.5	114	x
H005	09FB	2	436.96	438.16	8	18G	0.18	1.25	98.6	110	x
H005	09FB	2	436.96	438.16	9	19G	0.23	1.39	98.4	112	x
H005	09FB	2	436.96	438.16	10	20G	0.22	1.33	98.4	118	x
H005	09FB	4	439.36	439.99	1	6Y	0.54	2.78	96.7	93	x
H005	09FB	4	439.36	439.99	2	7Y	0.42	2.56	97.0	83	x
H005	09FB	4	439.36	439.99	3	8Y	0.55	2.74	96.7	81	x
H005	09FB	4	439.36	439.99	4	9Y	0.54	2.66	96.8	82	x
H005	09FB	4	439.36	439.99	5	10Y	0.32	1.77	97.9	74	x
H005	09FB	*4*	439.36	439.99	*6*	*11Y*	*9.5*	*42.4*	*48.1*	*49*	*x*

Table 4.7.6 UT-GOM2-1-H005-09FB Gas analysis. Propane detected marked by an x. Blue is used to distinguish separate sections of core. . All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

Hole	Core	Section	Depth top	Depth bottom	Sample	Syringe	Oxygen	Nitrogen	Methane	Ethane	Propane
			mbsf	mbsf			%	%	%	ppm	presence
H005	10FB	2	439.83	440.15	1	1G	0.59	2.99	96.4	69	-
H005	10FB	2	439.83	440.15	2	2G	0.25	1.73	98.0	69	-
H005	10FB	2	439.83	440.15	3	3G	0.44	1.82	97.7	70	-
H005	10FB	2	439.83	440.15	4	4G	0.45	1.82	97.7	69	-
H005	10FB	2	439.83	440.15	5	5G	0.41	1.88	97.5	69	-
H005	10FB	2	439.83	440.15	6	6G	0.40	1.84	97.6	73	-
H005	10FB	*2*	439.83	440.15	*7*	*7G*	*0.97*	*4.82*	*93.8*	*71*	-
H005	10FB	2	439.83	440.15	8	8G	0.41	1.84	97.6	71	-
H005	10FB	2	439.83	440.15	9	9G	0.65	3.24	95.8	76	-
H005	10FB	2	439.83	440.15	10	10G	0.86	4.41	94.3	73	-
H005	10FB	2	439.83	440.15	11	11G	0.97	3.81	94.8	83	-
H005	10FB	3	440.15	440.59	1	1Y	1.03	4.35	94.6	68	-
H005	10FB	3	440.15	440.59	2	2Y	0.41	2.00	97.6	75	-
H005	10FB	3	440.15	440.59	3	3Y	0.36	1.89	97.7	74	-
H005	10FB	3	440.15	440.59	4	4Y	0.24	1.53	98.2	80	-
H005	10FB	3	440.15	440.59	5	5Y	0.43	2.09	97.5	80	-
H005	10FB	3	440.15	440.59	6	6Y	0.95	3.55	95.5	89	-

Table 4.7.7 UT-GOM2-1-H005-10FB Gas analysis. Propane detected marked by an x. Blue is used to distinguish separate sections of core. . All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

Hole	Core	Section	Depth top	Depth bottom	Sample	Syringe	Oxygen	Nitrogen	Methane	Ethane	Propane
			mbsf	mbsf			%	%	%	ppm	presence
H005	11FB	1	441.35	441.62	1	21Y	2.34	12.28	85.4	33	-

Table 4.7.8 UT-GOM2-1-H005-11FB Gas analysis. Propane detected marked by an x. . All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

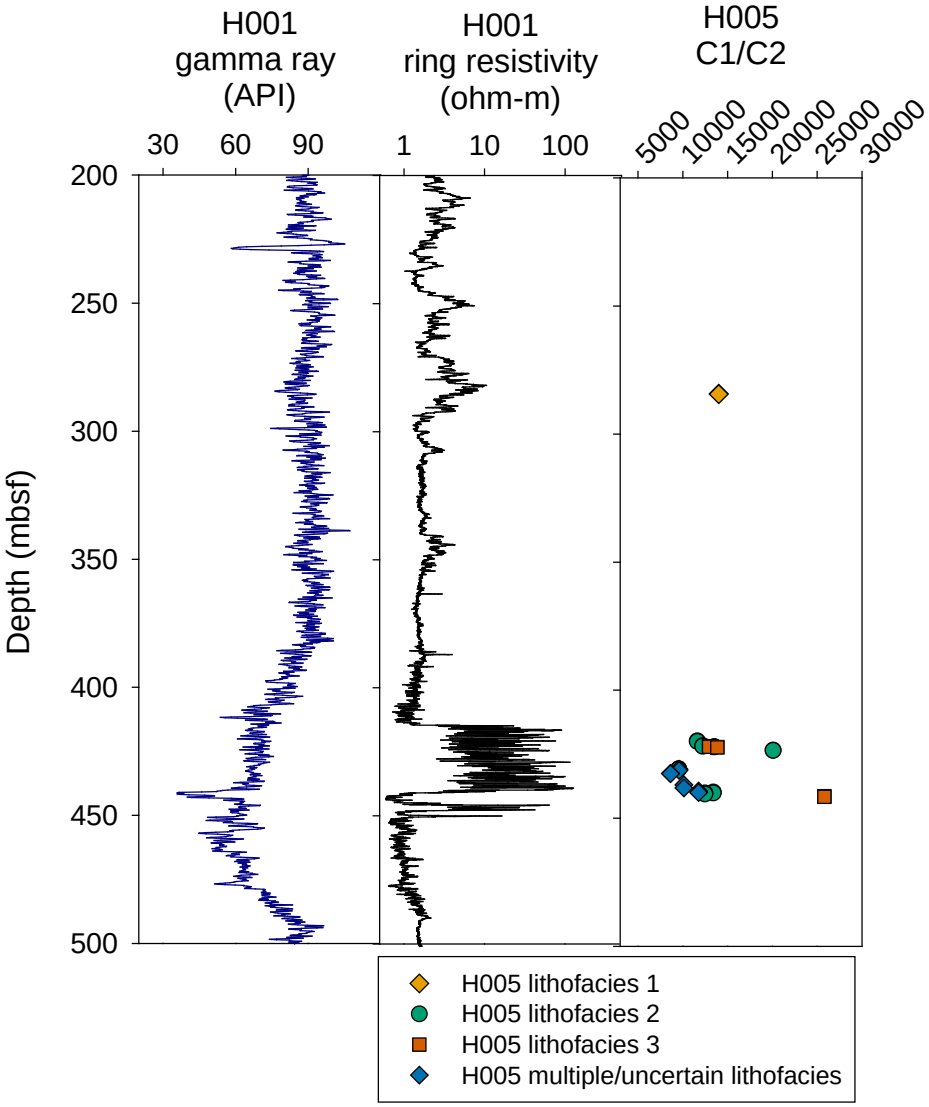

Figure 4.7.1 H005 Methane to ethane ratios (C1/C2) in versus H001 LWD data. Ratios are from the average composition of each degassed section. See 4.6 Lithostratigraphy for the description of lithofacies. All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

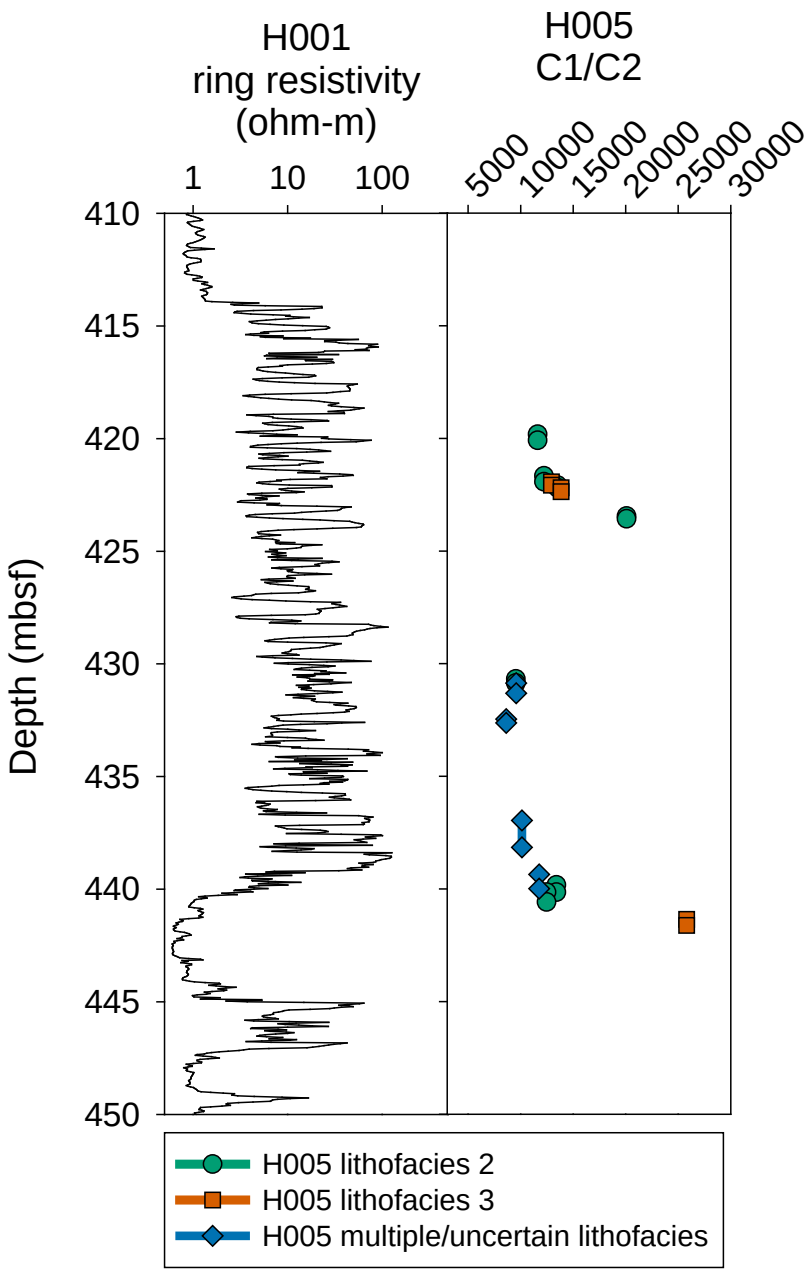

Figure 4.7.2 H005 Detail of methane to ethane ratios (C1/C2) in the main hydrate-bearing interval versus H001 LWD data. Ratios are from the average composition of each degassed section. See 4.6 Lithostratigraphy for the description of lithofacies. All H005 Gas Analysis data can be found in the expedition data directory under H005 / Geochemistry / Gas.

Field sampling

Between three to five gas samples per degassing experiment were collected in copper tubes for shore-based analyses. In total 41 samples were collected, including atmospheric blanks (Table 4.7.9).

Headspace gas samples were collected from the conventionalized core UT-GOM2-1-H005-12FB and the rapidly degassed section UT-GOM2-1-H005-09FB-1. Headspace gas samples were collected from quantitatively degassed sections UT-GOM2-1-H005-01FB-3, -03FB-2, -04FB-3, -04FB-5, -07FB-2, -09FB-1, -09FB-2, and -09FB-4.

Hole	Core	Section	Date	Time	Degassing pressure (bar)	Sample#	Chamber type	Comments/ corresponding syringe
UT-GOM2-1-H005	09FB	4	5/20/2017	19:47	75-70	13	bubble	#7 syringe yellow
UT-GOM2-1-H005	09FB	2	5/20/2017	22:01	91-72	14	bubble	#12 syringe green
UT-GOM2-1-H005	09FB	4	5/21/2017	3:20	4 to 0	15	bubble	
UT-GOM2-1-H005	09FB	2	5/21/2017	7:03	11 to 7	16	bubble	#18 syringe green
UT-GOM2-1-H005	10FB	3	5/27/2017	12:02	46-24	17	bubble	#1 syringe yellow
UT-GOM2-1-H005	10FB	3	5/27/2017	12:02	-	18	atmospheric blank	
UT-GOM2-1-H005	10FB	3	5/27/2017	15:01	2	19	bubble	#4 syringe yellow
UT-GOM2-1-H005	10FB	2	5/27/2017	17:30	0	20	atmospheric blank	
UT-GOM2-1-H005	10FB	2	5/27/2017	17:30	52-41	21	bubble	#1 syringe green
UT-GOM2-1-H005	10FB	2	5/28/2017	2:00	23-18	22	bubble	#8 syringe green
UT-GOM2-1-H005	10FB	2	5/28/2017	8:10	2 to 0	23	bubble	#10 syringe green
UT-GOM2-1-H005	04FB	5	5/28/2017	13:52	-	24	atmospheric blank	
UT-GOM2-1-H005	04FB	5	5/28/2017	13:52	40-27	25	bubble	#7 syringe yellow
UT-GOM2-1-H005	04FB	5	5/28/2017	15:30	16-7	26	bubble	#10 syringe yellow
UT-GOM2-1-H005	04FB	5	5/28/2017	16:00	7 to 0	27	bubble	#11 syringe yellow
UT-GOM2-1-H005	04FB	2	5/28/2017	19:26	-	28	atmospheric blank	
UT-GOM2-1-H005	04FB	2	5/28/2017	19:26	52 - 35	29	bubble	#12 syringe green
UT-GOM2-1-H005	04FB	7	5/28/2017	21:59	-	30	atmospheric blank	
UT-GOM2-1-H005	04FB	7	5/28/2017	21:59	53 - 29	31	bubble	#12 syringe yellow
UT-GOM2-1-H005	04FB	7	5/29/2017	3:02	28 - 21	32	bubble	#19 syringe green
UT-GOM2-1-H005	04FB	2	5/29/2017	4:42	32 - 26	33	bubble	#19 syringe yellow
UT-GOM2-1-H005	04FB	7	5/29/2017	7:36	6 to 0	34	bubble	#18 syringe yellow
UT-GOM2-1-H005	04FB	2	5/29/2017	8:28	3 to 0	35	bubble	#25 syringe green
UT-GOM2-1-H005					-	36	atmospheric blank	
UT-GOM2-1-H005						37		

Hole	Core	Section	Date	Time	Degassing pressure (bar)	Sample#	Chamber type	Comments/ corresponding syringe
UT-GOM2-1-H005	07FB	4	6/1/2017	14:35	-	38	atmospheric blank	
UT-GOM2-1-H005	07FB	4	6/1/2017	14:35	48-35	39	bubble	#22 syringe yellow
UT-GOM2-1-H005	07FB	2	6/1/2017	15:11		40	atmospheric blank	
UT-GOM2-1-H005	07FB	2	6/1/2017	15:11		41	bubble	#26 syringe green
UT-GOM2-1-H005	07FB	4	6/1/2017	17:47	14-8	42	bubble	#29 syringe yellow
UT-GOM2-1-H005	07FB	4	6/1/2017	19:01	0-0	43	bubble	#2 syringe yellow
UT-GOM2-1-H005	07FB	2	6/1/2017	20:03	22-17	44	bubble	#8 syringe green
UT-GOM2-1-H005	07FB	2	6/1/2017	21:52	4 to 1	45	bubble	#12 syringe
UT-GOM2-1-H005	07FB	1	6/2/2017	0:45	50-37	46	bubble	#3 syringe yellow
UT-GOM2-1-H005	07FB	1	6/2/2017	0:45	-	47	atmospheric blank	
UT-GOM2-1-H005	04FB	3	6/2/2017	2:31	31-16	48	bubble	#1 red syringe
UT-GOM2-1-H005	04FB	3	6/2/2017	2:31	-	49	atmospheric blank	
UT-GOM2-1-H005	07FB	1	6/2/2017	5:33	-	50	atmospheric blank	
UT-GOM2-1-H005	03FB	3	6/2/2017	7:13	-	51	atmospheric blank	
UT-GOM2-1-H005	03FB	3	6/2/2017	7:13	52-37	52	bubble	#14 syringe green
UT-GOM2-1-H005	07FB	1	6/2/2017	5:33	18-14	53	bubble	#15 syringe yellow
UT-GOM2-1-H005	07FB	1	6/2/2017	8:16	5 to 0	54	bubble	#18 syringe yellow
UT-GOM2-1-H005	07FB	1	6/2/2017	8:16	-	55	atmospheric blank	
UT-GOM2-1-H005	04FB	3	6/2/2017	9:29	17-8	56	atmospheric blank	
UT-GOM2-1-H005	04FB	3	6/2/2017	10:17	8 to 5	57	bubble	#3 red syringe
UT-GOM2-1-H005	04FB	4	6/2/2017	10:39	49-29	58	bubble	#1 syringe blue
UT-GOM2-1-H005	04FB	4	6/2/2017	10:39	-	59	atmospheric blank	
UT-GOM2-1-H005	03FB	3	6/2/2017	14:27	23-16	60	bubble	#26 syringe green
UT-GOM2-1-H005	01FB	3	6/2/2017	14:24	15-0	61	bubble	#20 syringe yellow
UT-GOM2-1-H005	01FB	3	6/2/2017	14:24	-	62	atmospheric blank	
UT-GOM2-1-H005	03FB	3	6/2/2017	16:15	5 to 0	63	bubble	#29 green
UT-GOM2-1-H005	01FB	1	6/2/2017	20:59	12 to 0	64	bubble	#6 syringe red
UT-GOM2-1-H005	01FB	1	6/2/2017	20:59		65	atmospheric blank	
UT-GOM2-1-H005	01FB	2	6/2/2017	22:01	8 to 0	66	bubble	#21 syringe yellow
UT-GOM2-1-H005	01FB	2	6/2/2017	22:01	-	67	atmospheric blank	
UT-GOM2-1-H005	02FB	1	6/2/2017	22:07	15-0	68	bubble	#1 syringe green

Hole	Core	Section	Date	Time	Degassing pressure (bar)	Sample#	Chamber type	Comments/ corresponding syringe
UT-GOM2-1-H005	02FB	1	6/2/2017	22:07	-	69	atmospheric blank	
UT-GOM2-1-H005	04FB	4	6/3/2017	4:02	30-20	70	bubble	#7 syringe blue
UT-GOM2-1-H005	04FB	4	6/3/2017	4:02	-	71	atmospheric blank	
UT-GOM2-1-H005	04FB	4	6/3/2017	7:15	7 to 1	72	bubble	no syringe

Table 4.7.9 H005 Gas samples. Bubble under chamber type indicates the sample was collected from the top of the bubbling chamber. See the expedition data directory under H005 / Curation.

4.7.2 Sedimentary gases

Headspace gas sampling

A total of 10 samples were collected for headspace gas analysis from cores UT-GOM2-1-H005-01FB, -04FB, -07FB, -09FB, and -12FB (Table 4.7.10).

Hole	Core	Section	Depth in section (cm)	Depth in hole (mbsf)	Date sampled	Time sampled
H005	09FB	1	0	436.78	5/20/2017	1410 hr
H005	09FB	4	24	439.60	5/21/2017	1005 hr
H005	09FB	2	35	437.31	5/21/2017	1030 hr
H005	12FB	2	30	444.82	5/21/2017	1430 hr
H005	12FB	3	64	445.80	5/21/2017	1545 hr
H005	04FB	5	4	422.23	5/28/2017	1700 hr
H005	07FB	2	15	431.02	6/2/2017	1420 hr
H005	04FB	3	14	422.06	6/2/2017	1440 hr
H005	01FB	3	8	284.26	6/2/2017	1840 hr
H005	03FB	2	0	419.64	6/2/2017	1800 hr

Table 4.7.10 H005 Headspace gas samples. See the expedition data directory under H005 / Curation.

4.7.3 Pore waters

Field sampling

Two whole round samples were collected for pore water analysis from the depressurized core UT-GOM2-1-H005-12FB (Table 4.7.11) that was not recovered at pressure (see 4.3 Pressure Coring). Additional interstitial water whole round samples were collected from quantitatively degassed sections UT-GOM2-1-H005-01FB-3, -04FB-5, and -07FB-2 (see 4.5 Quantitative Degassing).

Hole	Core	Section	Depressurization	Interval from (cm)	Interval to (cm)	Length (cm)	Depth top (mbsf)	Depth bottom (mbsf)	Date depressurized	Time depressurized	Date sampled	Time sampled	Lithofacies
H005	12FB	2	Failed pressure core	30	45	15	444.52	444.67	5/20/2017	21:52	5/21/2017	1430 hr	Unknown
H005	12FB	3	Failed pressure core	64	81	17	445.97	446.14	5/20/2017	21:52	5/21/2017	1430 hr	Unknown
H005	4FB	5	Q Degas	4	18	14	422.23	422.37	5/28/2017	16:00	5/28/2017	1430 hr	3
H005	7FB	2	Q degas	0	15	15	430.87	431.02	6/2/2017	13:30	6/2/2017	1430 hr	Multiple
H005	1FB	3	Q degas	8	21	13	284.18	284.31	6/2/2017	17:30	6/2/2017	1430 hr	1

Table 4.7.11 H005 Whole round samples for pore water analysis. See the expedition data directory under H005 / Curation.

Contamination control

Drilling fluid samples were collected once each day during coring corresponding to Cores UT-GOM2-1-H005-01FB, -03FB, -06FB, and -10-FB (Table 4.7.12). Cores UT-GOM2-1-H005-01FB, -03FB, and -06FB were drilled using seawater. Core UT-GOM2-1-H005-10FB was drilled using 10.5 ppg mud (see 4.2 Operations). PCATS water samples were collected after each core analysis both after the initial PCATS quick core scan and after full core scans and cutting (Table 4.7.13).

Expedition	Hole	Core	Type	Sample type	Date sampled	Time sampled
UT-GOM2-1	H005	1	FB	Drilling fluid	5/17/2017	1557 hr
UT-GOM2-1	H005	3	FB	Drilling fluid	5/18/2017	1325 hr
UT-GOM2-1	H005	6	FB	Drilling fluid	5/19/2017	940 hr
UT-GOM2-1	H005	8	FB	Drilling fluid	5/20/2017	1710 hr

Table 4.7.12 H005 Drilling fluid samples. See the expedition data directory under H005 / Curation.

Hole	Core	Type	Sample type	Date sampled	Time sampled
H005	02	FB	PCATS water	5/18/2017	2125 hr
H005	06	FB	PCATS water	5/19/2017	1740 hr
H005	05	FB	PCATS water	5/19/2017	1200 hr
H005	04	FB	PCATS water	5/19/2017	0740 hr
H005	07	FB	PCATS water	5/19/2017	2100 hr
H005	10	FB	PCATS water	5/21/2017	1610 hr
H005	13	FB	PCATS water	5/21/2017	2245 hr
H005	11	FB	PCATS water	5/28/2017	
H005	04	FB	PCATS water	5/28/2017	0920 hr
H005	08	FB	PCATS water	5/31/2017	1300 hr
H005	06	FB	PCATS water	6/1/2017	2130 hr
H005	03	FB	PCATS water	6/1/2017	1050 hr
H005	07	FB	PCATS water	6/1/2017	2130 hr
H005	07	FB	PCATS water	6/1/2017	2130 hr
H005	03	FB	PCATS water	6/2/2017	0925 hr
H005	01	FB	PCATS water	6/3/2017	0231 hr
H005	02	FB	PCATS water	6/3/2017	0248 hr
H005	13	FB	PCATS water	6/3/2017	0330 hr

Table 4.7.13 H005 PCATS water samples. See the expedition data directory under H005 / Curation.

Shore-based analyses

The five pore water whole round samples collected from H005 produced 1 to 11 mL of water for pore water analysis (Table 4.7.14). Salinity varied from 5.5 to 28 practical salinity units (psu). All salinity measurements were lower than seawater salinity. The one sample collected from UT-GOM2-1-H005-01FB, taken well above the main hydrate-bearing interval had the highest salinity (28 psu), while samples from within the main hydrate interval had lower salinities (5.5 to 18.5 psu) (Figure 4.7.3 and Figure 4.7.4). Sulfate concentrations ranged from 0.495 mM in UT-GOM2-1-H005-01FB-3 to 11.9 mM in -12BF-3, indicating that the fine-grained sample well above the main hydrate-bearing interval had minimal drilling contamination, whereas samples collected within the hydrate-bearing interval were moderately contaminated. Cl^- concentrations range from 111 to 493 mM (20-88% of seawater value), and Br^- concentrations range from 219 to 925 μM (25-107% seawater value). The drilling fluid used at H005 was more elevated in Cl^-, Br^-, and SO_4^{2-} concentrations than the fluid used at H002. The drilling fluid composition varied slightly between coring runs at H005. The drilling fluid composition will be used to correct the pore water geochemical data from contamination based on the SO_4^{-2} concentrations. The values of salinity and Cl^- reported here are maximum values.

Hole	Core	Section	Interval from (cm)	Interval to (cm)	Depth top (mbsf)	Depth bottom (mbsf)	Volume (mL)	Salinity (psu)	Cl^- (titration) (mM)	Cl^- (IC) (mM)	Br^- (mM)	SO_4^{2-} (mM)	Lithofacies	Comment
H005	01FB	3	8	21	284.18	284.31	8	28	493	500	0.9	0.5	1	
H005	04FB	5	4	18	422.23	422.37	9	18.5	331	339	0.6	6.6	3	
H005	07FB	2	0	15	430.87	431.02	11	5.5	111	107	0.2	3.1	Multiple	
H005	12FB	2	30	45	444.52	444.67	1	13	-	-	-	-	Unknown	
H005	12FB	3	64	81	445.97	446.14	7	16	273	281	0.5	11.9	Unknown	
H005	01FB	-	-	-	-	-	50		-	590	1.0	30.4	-	Drilling fluid
H005	02FB	-	-	-	-	-	50		580	-	-	-	-	Drilling fluid
H005	02FB	-	-	-	-	-	50		-	33.5	0.1	1.7	-	PCATS
H005	04FB	-	-	-	-	-	50		-	5.5	0.02	0.7	-	PCATS
H005	07FB	-	-	-	-	-	50		-	26.6	0.1	1.3	-	PCATS

Table 4.7.14 H005 Pore water and drilling fluid analyses, including salinity, chloride, and sulfate. All H005 Pore Water data can be found in the expedition data directory under H005 / Geochemistry / Pore Water.

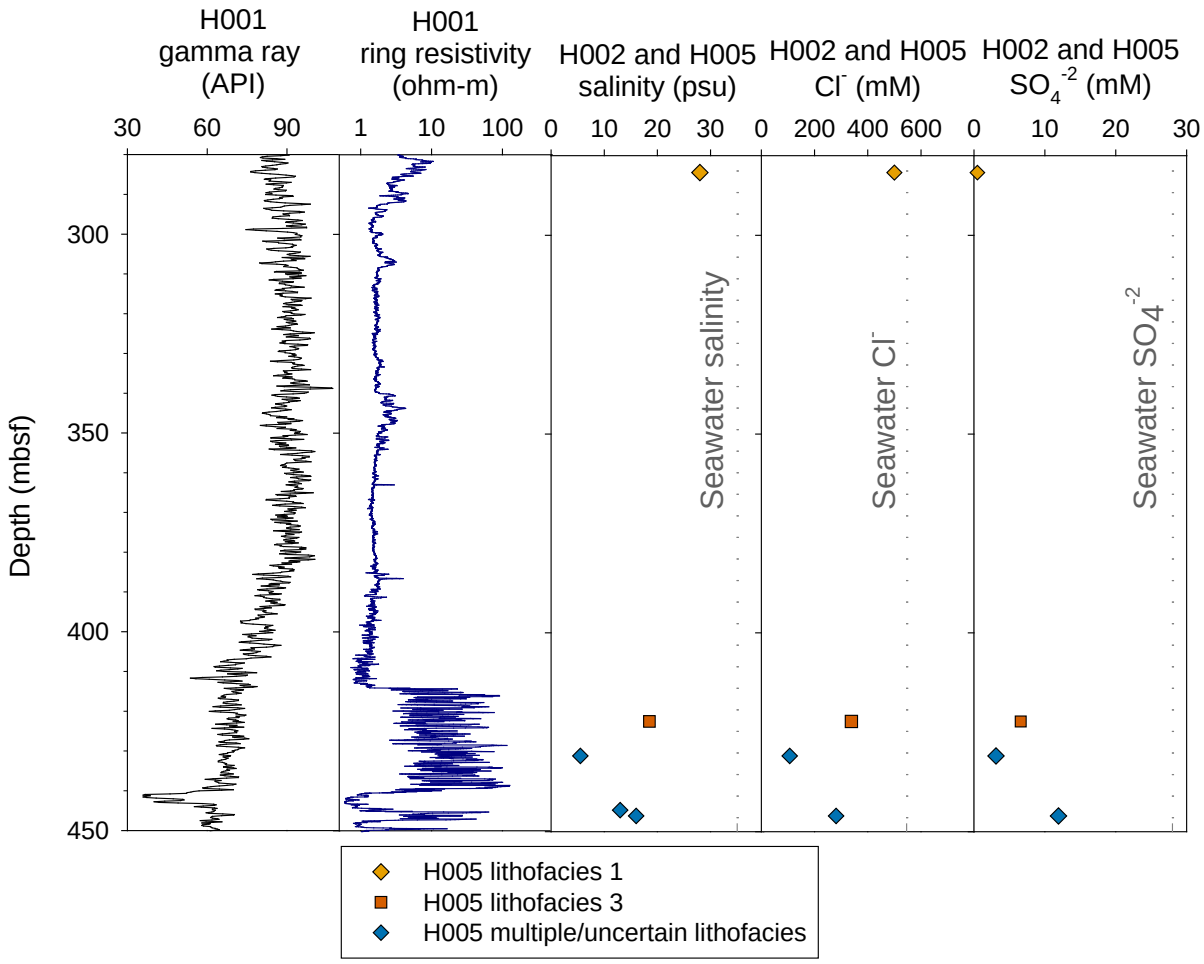

Figure 4.7.3 H002 and H005 Down hole variation in pore water chemistry versus H001 LWD resistivity. Background seawater salinity, chloride, and sulfate concentrations are shown See 4.6 Lithostratigraphy for descriptions of lithofacies. All H005 Pore Water data can be found in the expedition data directory under H005 / Geochemistry / Pore Water.

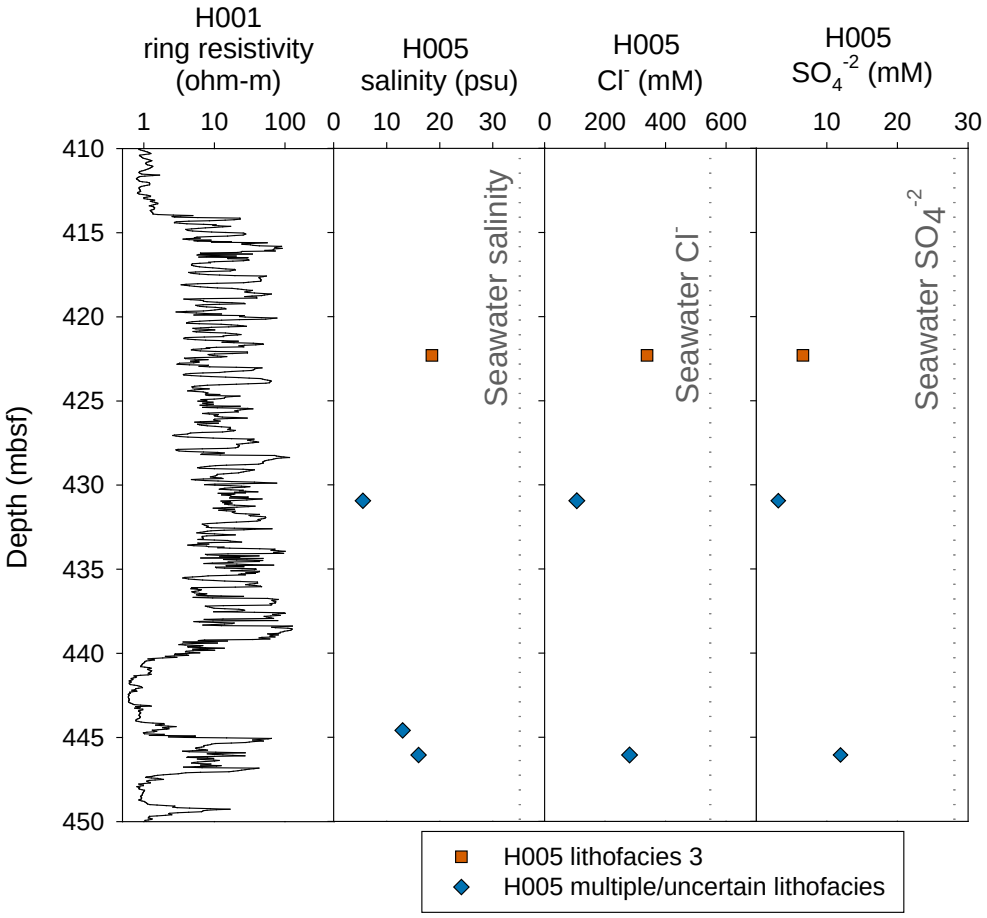

Figure 4.7.4 H005 Down core variation in pore water chemistry versus H001 LWD resistivity. Detail of the main hydrate bearing interval. Background seawater salinity, chloride, and sulfate concentrations are shown. See 4.6 Lithostratigraphy for descriptions of lithofacies. All H005 Pore Water data can be found in the expedition data directory under H005 / Geochemistry / Pore Water.

4.7.4 Microbiology

Field sampling

A total of 4 whole round samples were collected for microbiological analyses (Table 4.7.15). Two of these were collected from Core UT-GOM2-1-H005-12FB upon recovery at atmospheric pressure and two others were collected from quantitatively degassed sections.

Section	Depressurization	Interval from (cm)	Interval to (cm)	Length (cm)	Sample type	Date sampled	Time sampled
UT-GOM2-1-H005-09-FB-2	Q degas	5	20	15	Microbiology	5/21/2017	1040 hr

UT-GOM2-1-H005-12-FB-2	Failed pressure core	45	60	15	Microbiology	5/21/2017	1430 hr
UT-GOM2-1-H005-12-FB-3	Failed pressure core	81	92	11	Microbiology	5/21/2017	1545 hr
UT-GOM2-1-H005-01-FB-3	Q degas	8	21	13	Microbiology	6/2/2017	1840 hr

Table 4.7.15 H005 Whole round samples collected for microbiology. See the expedition data directory under H005 / Curation.

Contamination control

Splits of drilling fluid and PCATS water were collected and frozen for contamination control. These are the same as the interstitial water samples as described above and in Table 4.7.12 and Table 4.7.13.

4.8 Wireline Logging

To comply with U.S. government regulations, a VES Survey International GS2 gyroscope tool was run into the hole to measure borehole deviation and inclination (Figure 4.8.1). The tool is battery powered and data is stored in the tool's electronic memory and downloaded at the surface upon return to the rig floor. No other logging data was collected in this hole.

4.8.1 Operations

The final depth of H005 was 8193 fbrf. After retrieval of the final core at 0145 hr on 21-May-2017, the gyroscope tool was brought on the rig floor and attached to the slickline at 0210 hr. Following a job safety analysis meeting, at 0236 hr, the tool was lowered into the hole at 0250 hr. Survey data was collected at 100ft intervals between 6718 and 8100 fbrf.

The gyroscope was back on deck at 0415 hr, however, it was discovered that over half of the stations were not recorded. The tool was reattached to the slickline at 04:40 h and run into hole at 0445 hr. Following the second return of the tool to the rig floor at 0628 hr, it was confirmed that all the data was collected prior to continuing operations for cementing in H005.

4.8.2 Results

In total, E-W deviation and N-S deviation with depth was collected at 17 stations in H005, generally located ~100 ft apart. The resulting total deviation was ~3 ft to the northwest at total depth (Figure 4.8.2).

Figure 4.8.1 Photograph of the battery-powered GS2 gyroscope.

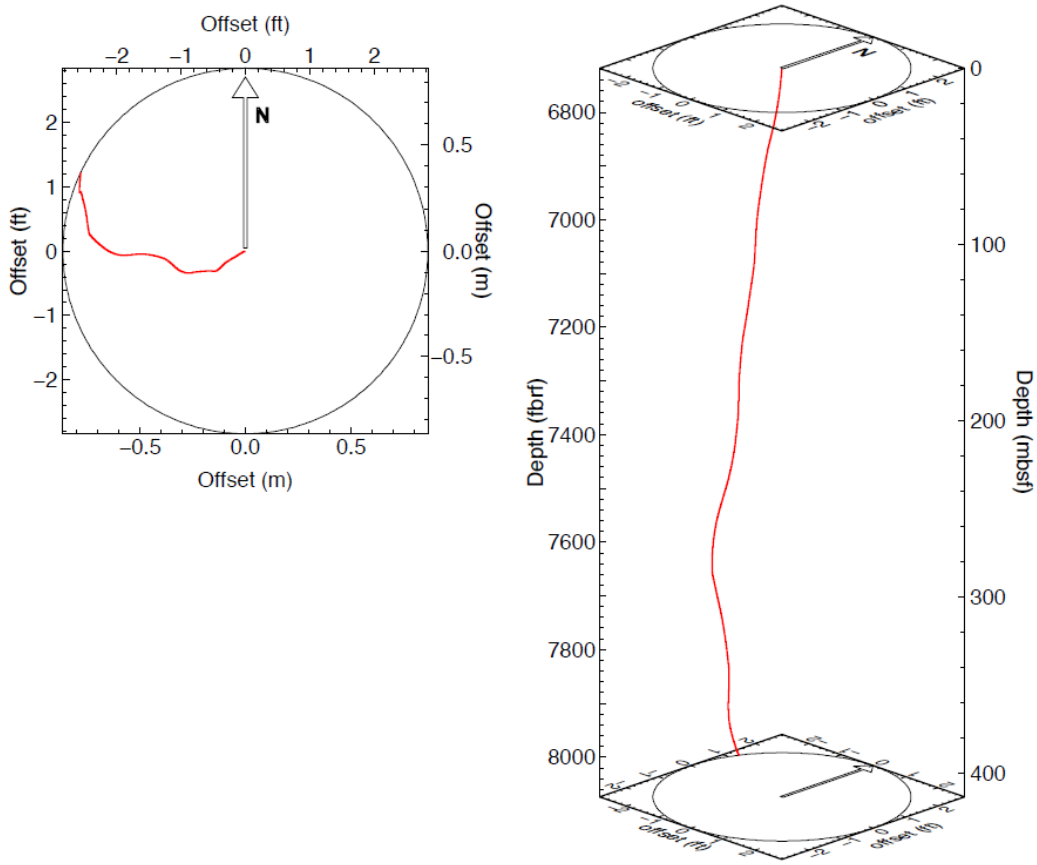

Figure 4.8.2 H005 Hole deviation and offset as measured by the gyroscope tool. All H005 survey data can be found in the expedition data directory under H005 / Wireline Logging.

4.9 References

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