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Expedition 380 Preliminary Report

NanTroSEIZE Stage 3: Frontal Thrust Long-Term Borehole Monitoring System (LTBMS)

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Abstract

The multiexpedition Integrated Ocean Drilling Program/International Ocean Discovery Program (IODP) Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) was designed to investigate fault mechanics and seismogenesis along subduction megathrusts through direct sampling, in situ measurements, and long-term monitoring in conjunction with allied laboratory and numerical modeling studies. Overall NanTroSEIZE scientific objectives include characterizing the nature of fault slip and strain accumulation, fault and wall rock composition, fault architecture, and state variables throughout the active plate boundary system. Expedition 380 was the twelfth NanTroSEIZE expedition since 2007. Refer to Kopf et al. (2017) for a comprehensive summary of objectives, operations, and results during the first 11 expeditions. Expedition 380 focused on one primary objective: riserless deployment of a long-term borehole monitoring system (LTBMS) in Hole C0006G in the overriding plate at the toe of the Nankai accretionary prism.

The LTBMS installed in Hole C0006G incorporates multilevel pore pressure sensing and a volumetric strainmeter, tiltmeter, geophone, broadband seismometer, accelerometer, and thermistor string. Similar previous LTBMS installations were completed farther upslope at IODP Sites C0002 and C0010. The ~35 km trench-normal transect of three LTBMS installations will provide monitoring within and above regions of contrasting behavior in the megasplay fault and the plate boundary as a whole, including a site above the updip edge of the locked zone (Site C0002), a shallow site in the megasplay fault zone and its footwall (Site C0010), and a site at the tip of the accretionary prism (the Expedition 380 installation at Site C0006). In combination, this suite of observatories has the potential to capture stress and deformation spanning a wide range of timescales (e.g., seismic and microseismic activity, slow slip, and interseismic strain accumulation) across the transect from near-trench to the seismogenic zone.

Expedition 380 achieved its primary scientific and operational goal with successful installation of the LTBMS to a total depth of 457 m below seafloor in Hole C0006G. The installation was conducted in considerably less time than budgeted, partly because the Kuroshio Current had shifted away from the NanTroSEIZE area after 10 y of seriously affecting D/V *Chikyu* NanTroSEIZE operations. After Expedition 380, the LTBMS was to be connected to the Dense Oceanfloor Network System for Earthquakes and Tsunamis in March 2018 using the remotely operated vehicle *Hyper-Dolphin* from the Japan Agency for Marine-Earth Science and Technology R/V *Shinsei Maru*.

Introduction and geological setting

Subduction zones account for ~90% of the global seismic moment release and can generate damaging earthquakes and tsunamis with potentially disastrous effects on heavily populated coastal areas (e.g., Lay et al., 2005; Moreno et al., 2010; Simons et al., 2011). Understanding the processes that govern the strength, nature, and distribution of slip along these plate boundary fault systems is crucial in evaluating earthquake and tsunami hazards. Characterizing fault slip behavior and mechanical state at convergent plate boundaries through direct sampling, near-field geophysical observations, measurement of in situ conditions, and shore-based laboratory experiments is a fundamental and societally relevant goal of current earth science and the overarching goal of the International Ocean Discovery Program (IODP) Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) project.

Expedition 380 was the twelfth IODP expedition since 2007 to address the NanTroSEIZE project's objectives. The fundamental scientific objectives of NanTroSEIZE include characterizing the nature of fault slip and strain accumulation, fault and wall rock composition, fault architecture, and state variables throughout the active plate boundary system through direct sampling, in situ measurements, downhole experiments such as walk-away vertical seismic profile, and long-term monitoring in conjunction with allied laboratory and numerical modeling studies (Tobin and Kinoshita, 2006). See Kopf et al. (2017) for the most recent comprehensive summary of the rationale and history of the NanTroSEIZE project and regional survey data. To date, NanTroSEIZE has involved coring, logging, and installation of long-term borehole observatories at 14 sites in a trench-normal transect across the Nankai Trough subduction zone offshore the Kii Peninsula in southwest Honshu Island. This transect runs from the Kumano Basin in the fore-arc region ~60 km landward of the trench axis to the Kashinosaki Knoll in the downgoing plate ~40 km seaward (Figures **F1**, **F2**).

The Nankai Trough is formed by subduction of the Philippine Sea plate to the northwest beneath the Eurasian plate at a rate of ~65 mm/y (Miyazaki and Heki, 2001; DeMets et al., 2010). The convergence direction is slightly oblique to the trench, and trench wedge turbidites and underlying Shikoku Basin hemipelagic sediments accrete at the deformation front. The Nankai Trough region has 1300 y of historical and archeological records of recurring great earthquakes that are typically tsunamigenic, including the 1944 Tonankai M8.2 and 1946 Nankaido M8.3 earthquakes (Ando, 1975; Hori et al., 2004). The rupture area and zone of tsunami generation for the 1944 event (within which the Expedition 380 site is located) are now reasonably well understood (Tanioka and Satake, 2001; Ichinose et al., 2003; Kikuchi et al., 2003; Baba and Cummins, 2005; Baba et al., 2005, 2006). Land-based off-shore geodetic studies suggest that the plate boundary thrust is currently strongly locked (Miyazaki and Heki, 2001; Yokota et al., 2016). Similarly, lower microseismicity levels near the updip edge of the rupture area of the 1940s earthquakes (Obana et al., 2001) imply significant interseismic strain accumulation on the megathrust.

Recent geological studies at the Nankai margin (Sakaguchi et al., 2011; Yamaguchi et al., 2011), direct observational evidence from the 2011 Tohoku earthquake (e.g., Fujiwara et al., 2011; Ito et al., 2013), and new results from both a seafloor cabled network and long-term borehole monitoring system (LTBMS) installations ~25–35 km landward of the trench along the NanTroSEIZE transect (Wallace et al., 2016; Araki et al., 2017) suggest that the décollement or frontal thrust are capable of storing and releasing elastic strain and may participate in both periodic slow slip events (SSEs) and megathrust earthquakes. Observations of very low frequency (VLF) earthquakes and tremor within or just below the accretionary prism in the drilling area (Obara and Ito, 2005; Ito and Obara, 2006; Obana and Kodaira, 2009; Sugioka et al., 2012) demonstrate that interseismic strain is not confined to slow elastic strain accumulation. New observations from two LTBMSs installed at IODP Site C0010 and Integrated Ocean Drilling Program Site C0002, located ~25–35 km from the trench, reveal repeating SSEs that extend to <25 km from the trench, are accompanied by low-frequency tremor, and recur approximately every 12–18 months (Araki et al., 2017). These SSEs may accommodate as much as 50% of the plate convergence budget, indicating that quasiperiodic accumulation and release of strain on the shallowest megathrust through slow slip plays an important role in the earthquake cycle. Monitoring of this region is therefore a high priority to detect interseismic strain accumulation and release to better understand outer wedge megathrust processes.

Expedition 380 returned to Site C0006 in the toe of the Nankai accretionary prism ~2 km landward of the trench axis (Figure **F3**). The sole objective of Expedition 380 was riserless installation of a LTBMS at ~450 m below seafloor (mbsf) in the hanging wall above the plate boundary fault. The objective was completed in Hole C006G. Site C0006 was logged and cored during two of the initial NanTroSEIZE expeditions, 314 and 316 (Kinoshita et al., 2009; Screaton et al., 2009). The LTBMS was of the same general design as the borehole observatories previously installed in Hole C0010 farther up the accretionary prism (Kopf et al., 2017) and Hole C0002 at the southeastern edge of the Kumano Basin above the prism (Expedition 332 Scientists, 2011). Those two LTBMS observatories are already connected to the Dense Oceanfloor Network System for Earthquakes and Tsunamis (DONET), and the LTBMS in Hole C0006G was scheduled to be connected in March 2018, shortly after Expedition 380. This transect of three observatories should provide unprecedented resolution of the state of stress and strain in the leading edge of the overriding plate from the near-trench region to the seismogenic zone on a wide range of timescales, with nearly real time data freely available to the scientific community.

Operations

Expedition 380 began in the port of Shimizu, Shizuoka Prefecture (Japan), on 12 January 2018. The first few days were spent quayside, loading cargo and supplies. The science party boarded the *Chikyu* on 12 January and participated in the shipboard prespud meeting on 14 January. The *Chikyu* sailed from Shimizu at 0900 h on 15 January, arriving on location at Site C0006 by 0300 h on 16 January. Operation details can be found in Table **T1**.

Site C0006

After arrival at Site C0006, four transponders were dropped while making up and running the 20 inch casing began. Running stopped to install the underwater television (UWTV) on the drill pipe. The UWTV was run down to 7 m above the 20 inch casing shoe. The vessel shifted to tag the seabed, and the Hole C0006G location and water depth (3902 m below rotary table [BRT]; 3873.5 m from mean sea level) was confirmed before jetting in.

Hole C0006G

Jetting in for Hole C0006G commenced and reached 65 mbsf on 18 January 2018. The UWTV was retrieved so that drill down could commence. After reaching 399 mbsf, the drill string was picked up to 66 mbsf while the UWTV was run to check the drill-ahead tool (DAT). The DAT and the UWTV were recovered in the moonpool. On 19 January, the 9⅝ inch casing was made up, and it was run to 388 m BRT by 20 January. The UWTV was opened and set around the drill pipe and then run down to the Activation Kit so that the UWTV's cameras could monitor the kit's pressure. The casing and casing hanger running tool (CHRT) were run to 3854 m BRT in preparation for reentering Hole C0006G. The wellhead was found, and the casing was run in on 21 January. Cementing the 9⅝ inch casing began on 21 January and was completed the next morning. Once the cementing was finished, the running tool was unlocked from the casing hanger and the entire string was pulled out of the hole to prepare for running the bicenter bit bottom-hole assembly (BHA). This BHA was run down to begin drilling out cement. Several Hydrolift Power Swivel (HPS) stalls were observed. Drilling stopped, and the BHA was pulled out of the hole on the morning of 24 January. The bicenter bit showed damage with no appreciable advance; therefore, a drill-out-cement BHA was made up and run in the hole. The Hole C0006G wellhead was reentered on 24 January. Drilling and reaming out the cement began again and continued to 409 mbsf. The drill-out-cement BHA was pulled out of the hole and laid down on 25 January. The derrick stopped for HPS and traveling block maintenance, which was completed by the evening of 25 January.

The bicenter bit (Table **T2**) was made up again and run to 3870 m BRT on 26 January. The UWTV was run to 7 m above the bit to help with wellhead reentry. After reentering, the bit was run to 407 mbsf. Operations paused until the UWTV was recovered in the moonpool. The bicenter bit BHA drilled to total depth (495 mbsf) by 2030 h, and the hole was swept twice and spotted with saltwater gel. A wiper trip to 393 mbsf showed no excessive drag, indicating that the hole was in good condition. Schlumberger set a special Protect Zone treatment at the bottom of the hole. The bicenter BHA was pulled out of the hole on 27 January. A scraper run confirmed that the casing section was uncontaminated by cement (Table **T3**). After the scraper runs, the ROV platform was made up on the working cart in the moonpool and run with the UWTV on 28 January. During the running and landing, the two downward-looking camera lights failed. The remaining upward-looking camera light were tilted down to observe the ROV platform landing. The UWTV was recovered on the surface, and the scraper BHA was pulled out of the hole and laid down by 0200 h on 29 January.

The LTBMS completion string run began at 1230 h on 29 January with 3.5 inch tubing, and the strainmeter and instrument carrier were run downhole to the moonpool, where the sensors were connected to sensor cables. The hydraulic line from the pressure port (Port 1) was connected to a flatpack to be run all the way up to the LTBMS CORK head and pressure sensing unit (PSU). Cable attachments, tie bands, and metal straps were used to secure the hydraulic lines and sensor cables to the strainmeter and instrument carrier and 3.5 inch tubing. A series of communication tests of each sensor cable was performed before and after adding the swellable packer and before the sensor cables were terminated by the Teledyne ODI engineers.

On 31 January, the ODI engineers then started the molding, soldering, and termination process. After the initial molding and soldering, a sensor communication test confirmed good communication, and termination proceeded. Termination was completed early on 1 February, and another sensor communication check confirmed good communication through the ODI underwater mateable connectors (UMC) to the sensors. After wrapping the sensor cables onto the LTBMS CORK cable bay, another communication check discovered that the seismometer could not receive commands. Troubleshooting ended with cutting the ODI connection and checking sensor communication with the bare cable. Successful communication meant that the cable needed to be reterminated, a task that was completed by 0730 h on 2 February. Checks confirmed that communication with the seismometer was fully functional (sending commands and receiving correct responses). The ODI cable was fixed onto the LTBMS CORK head, and all UMCs were fixed to the acoustic modem. Sensor checks through the acoustic modem confirmed good performance, and the LTBMS CORK head was dunked into the moonpool for 5 min to bleed out air from the hydraulic lines. The LTBMS CORK head was then picked up, the three-way valves were set to "OCEAN," the two-way sampling valves were closed, and all valve handles were fixed in position with plastic tie wraps. The LTBMS was set so that the Activation Kit could be picked up and pressurized with N2 and blowout preventer fluid, a task that was finished by 1930 h. The completion string and Activation Kit and hydraulically activated running tool (HART) were all run to 1400 m BRT. While waiting for the UWTV, the scientists performed another sensor check with the acoustic modem. By 0115 h on 3 February, the UWTV reached the Activation Kit and confirmed that it was holding pressure. Running the completion string and UWTV continued to 2000 m BRT for another Activation Kit pressure check. The pressure check was completed, and the completion string was run to 3880 m BRT, where it paused to let the UWTV catch up. The scientists again checked the sensors before the observatory reentered Hole C0006G. The UWTV found a small leak in the strainmeter assemblage during a circulation test, possibly from an imperfect or cracked weld on the cement bypass conduit. After discussion, Operations Superintendent, Offshore Installation Manager, and Co-Chief scientists decided that this leak would not impact cementing.

The wellhead was reentered at 0930 h on 3 February, and the LTBMS assembly was slowly run into the wellhead, landing at 1615 h. Post-landing cementing started after a final communication with the sensors; all were healthy. At 2100 h, the UWTV sent the release command by acoustic modem to the Activation Kit. Neither the first command nor a following acoustic command activated the release mechanism, so mechanical release by running the UWTV guide funnel over the Activation Kit trigger pins was attempted. Between 2100 h on 3 February and 0645 h on 5 February, multiple attempts at triggering the manual release failed. Release was finally activated at 0645 h on 5 February after two modifications to the UWTV guide funnel and 14 passes of the UWTV guide funnel past the Activation Kit pins.

The drill string was cleaned, pulled out of the hole, and laid down, and moonpool equipment was secured in preparation for sailing back to Shimizu. The *Chikyu* arrived off Shimizu by 1630 h on 6 February and anchored offshore. At 0900 h on 7 February, the pilot boarded and guided the vessel to quayside. The gangplank was lowered, and the expedition scientists disembarked.

NanTroSEIZE LTBMS transect

The Expedition 380 LTBMS in Hole C0006G was the third LTMBS installed in the NanTroSEIZE transect. Previously, a LTBMS was installed in Hole C0002G during Expedition 322 in 2010 (Expedition 332 Scientists, 2011) and another one was installed in Hole C0010A during Expedition 365 (Saffer et al., 2017). With the addition of the Expedition 380 installation, the array of three LTBMS observatories now extends ~35 km landward from the toe of the accretionary prism. The transect spans locations within and above regions of contrasting behavior in the megasplay fault zone and plate boundary as a whole. Note that recent studies and discussion suggest that the "megasplay" below Site C0002 is more likely to be the active plate boundary (which can mechanically connect either to the décollement or the shallow out-of-sequence thrusts), whereas the underlying reflector (top of oceanic crust) is probably not active (Moore et al., 2007; Strasser et al., 2009). The LTBMS sites include a site above the updip edge of the "locked" zone (Site C0002), a shallow site in the splay fault zone and its footwall side (Site C0010), and a site at the tip of the accretionary prism (Site C0006, Expedition 380). Placing the LTBMSs at these sites was motivated by observed slip in the 11 March 2011 Tohoku earthquake, which indicated that at some margins, coseismic rupture may propagate along the plate boundary all the way to the trench (e.g., Fujiwara et al., 2011). The importance of the last is emphasized by newly observed, repeating SSEs within <25 km of the trench (Araki, et al., 2017). The suite of NanTroSEIZE observatories has the potential to capture, in unprecedented detail, seismic and microseismic activity, slow slip, and interseismic strain accumulation across a transect from the near trench to the seismogenic zone. Such temporally continuous and spatially distributed observations are necessary to understand how each part of the plate boundary functions through the seismic cycle of megathrust earthquakes.

The LTBMS in Hole C0006G shares the same general design as the two LTBMSs previously installed in Holes C0002G and C0010A. The Hole C0006G LTBMS includes an array of sensors designed to monitor slow crustal deformation (e.g., strain, tilt, and pore pressure as a proxy for strain), seismic events such as VLF earthquakes, hydrologic transients associated with strain events, ambient pore pressure, and temperature. To ensure the long-term and continuous monitoring necessary to capture events that occur over a wide range of timescales, the borehole observatory will be connected to a submarine cabled observation network (DONET; **http://www.jamstec.go.jp/donet/e**) in March 2018 to provide power and allow for higher sampling rates than can be achieved in a standalone mode. The Site C0002 and C0010 LTBMSs are already connected to this network, and the data can be viewed and downloaded at two open-access observatory data portals, J-SEIS (**http://join-web.jamstec.go.jp/join-portal/en**) and the NanTroSEIZE Observatory Data Portal (**http://offshore.geosc.psu.edu/about**).

Selection of LTBMS monitoring zones from previous results at Site C0006

No new coring or logging was conducted during Expedition 380. Site C0006 was originally drilled during Expedition 314 with measurement while drilling (MWD) or logging while drilling (LWD) to 885.5 mbsf in two holes ~30 m apart. Site C0006 was cored with four holes during Expedition 316 to a maximum depth of 603 mbsf. The LTBMS design and operational plan were based on these previous results, especially the continuous logging profiles. Therefore, the new Expedition 380 LTBMS Hole C0006G was positioned midway between the two Expedition 314 MWD/LWD holes (C0006A and C0006B).

From examination of the Site C0006 cores, Expedition 316 Scientists (2009) identified three primary lithologic units (Figure **F4**). Unit I extends from the seafloor to ~27 mbsf and comprises trench to slope transition facies. Unit II is composed of trench deposits divided into four subunits based mainly on variations in silt and sand content, with significant repetition of sequences caused by numerous thrust faults. Unit II extends to ~407 mbsf in Hole C0006E and ~450 mbsf in Hole C00006F. Subunit IIA comprises mainly sand-dominated trench wedge deposits, Subunit IIB comprises mixed sand-mud trench wedge deposits, Subunit IIC comprises mud-dominated trench wedge deposits, and Subunit IID comprises deep-marine basin to mud-dominated trench transition deposits. Unit III comprises late Miocene to Pleistocene deep-marine basin deposits.

Four primary logging units (Figure **F2**) were identified based on differing trends and LWD log responses (Expedition 314 Scientists, 2009). Logging Unit I (0–197.8 m LWD depth below seafloor [LSF]) was interpreted as sandy and muddy deposits. Logging Unit II (197.8–428.3 m LSF) was interpreted as mud with occasional thick sand layers. Logging Unit III (428.3–711.5 m LSF) was identified as alternating beds of mud and sand and is divided into two subunits. The boundary between logging Units II and III might be a fault zone (Figure **F4**), but this interpretation is not certain. Logging Unit IV (711.5 m LSF to total depth) was interpreted as underthrust, coarse, trench-fill sediments. The main frontal thrust was identified by a sudden decrease in gamma ray values (from ~90 to 20–50 gAPI) across the Unit III/IV boundary.

Based on these results, the target zone for the main LTBMS instrument package (strainmeter/seismometer/tiltmeter/pressure) was selected within the deepest part of logging Unit II at ~410–425 mbsf (Figure **F4**). Here, the formation was expected to be relatively competent mudstones suitable for monitoring formation pressure and deformation in the hanging wall at the frontal toe of the prism. With the main package at 410–425 mbsf, the LTBMS design also allowed for (1) a deeper pressure monitoring screen at ~455–456 mbsf within the open hole below the boundary between logging Units II and III and (2) placement of the five thermistor cable sensors from ~412 to 237 mbsf spanning much of Unit IIC.

As described in Operations, the LTBMS was successfully installed as of 5 February 2018. At the final sensor checks, all instruments and sensors tested properly with one minor exception, the deepest sensor on the five-sensor thermistor cable. The final configuration of the installed LTBMS is illustrated in Figure **F5**.

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Table T1. Operations log, Expedition 380. Local ship time = UTC + 9 h. (Continued on next three pages).

Operation	Date (2018)	Local ship time (h) Start	Finish	Notes	Total operation time (h)	Cumulative (h)	Days
Science party boards D/V *Chikyu* at Shimizu harbor	12–15 Jan	0000	0900		81.00	81.00	3.38
Chikyu sails from Shimizu to Site C0006	15 Jan	0900	0000		15.00	96.00	4.00
Arrive at Site C0006	16 Jan	0000	0300		3.00	99.00	
Deploy 4 transponders by free fall	16 Jan	0300	0845		5.75	104.75	
Make up and run 20 inch casing (CSG)	16 Jan	0845	2100	Mark CSG yellow 2 m from CSG shoe and in white every 1 m above	12.25	117.00	
Make up and run 12-1/4 inch inner string bottom-hole assembly (BHA)	16 Jan	2100	2330		2.50	119.50	
Troubleshoot closed-circuit TV (CCTV) server failure	16 Jan	2330	0000		0.50	120.00	5.00
Troubleshoot CCTV server failure (continued)	17 Jan	0000	0100		1.00	121.00	
Lower string and attach drill-ahead tool (DAT) to wellhead	17 Jan	0100	0230	On working cart; confirm sliding sleeve locked at 1500 psi	1.50	122.50	
Pick up 20 inch CSG and confirm jetting BHA to protrude 5 inches from CSG shoe	17 Jan	0230	0400		1.50	124.00	
Troubleshoot CCTV server failure	17 Jan	0400	0530		1.50	125.50	
Continue to run 20 inch CSG to 3800 m BRT	17 Jan	0530	1815		12.75	138.25	
Open rotating guide roller (RGR) door and install underwater TV (UWTV) on drill pipe	17 Jan	1815	1930		1.25	139.50	
Run UWTV to 7 m above 20 inch CSG shoe	17 Jan	1930	2145	Paint 50 and 100 m marks on UWTV cable	2.25	141.75	
Adjust vessel position and tag on sea bed	17 Jan	2145	2215	Confirm water depth: 3900 m BRT (3871.5 m below mean sea level [MSL])	0.50	142.25	
20 inch CSG jetting from 3900 to 3932 m BRT (0–32 mbsf)	17 Jan	2215	0000		1.75	144.00	6.00
Continue running 20 inch CSG from 3930 to 3954 m BRT (30–54 mbsf)	18 Jan	0000	0315	Wellhead stickout from seafloor = 6 m	3.25	147.25	
Drill down from 3954 to 3965 m BRT (54–65 mbsf)	18 Jan	0315	0345	Wash down to 65 mbsf, pump 250–400 gal/min × 4.5–7.3 MPa	0.50	147.75	
Retrieve UWTV to surface	18 Jan	0345	0700	Confirm DAT body condition w/NuStar; slow pumping w/75 gal/min during retrieval	3.25	151.00	
Drill down from 3965 to 4299 m BRT (65–399 mbsf)	18 Jan	0700	2300		16.00	167.00	
Sweep out 10 m^3 of saltwater gel (SWG) ×2 and spot 12 m^3 of SWG	18 Jan	2300	2345	Sweep 5 m^3 SWG every stand; avgerage rate of penetration (ROP) = 27.1 m/h	0.75	167.75	
Wiper trip from 4299 to 4261 m BRT (399–361 mbsf)	18 Jan	2345	0000	Observe excess drag at 4296 m BRT (160 kN) and 4295 m BRT (200 kN)	0.25	168.00	7.00
Continue wiper trip from 4261 to 3957 m BRT (361–57 mbsf)	19 Jan	0000	0215	4 m below 20 inch CSG shoe	2.25	170.25	
Sweep out 10 m^3 of SWG ×2 and spot 12 m^3 of SWG	19 Jan	0225	0315	HPS at 10 rpm × 0.8 kNm	0.83	171.08	
Pick up string to 3966 m BRT (66 mbsf)	19 Jan	0315	0400	No excess drag (4298–3966 m BRT)	0.75	171.83	
Run UWTV to 10 m above wellhead	19 Jan	0400	0700		3.00	174.83	
Recover DAT from wellhead	19 Jan	0700	0815	No damage to DAT; DAT did not release until 120 kNm OP w/400 gal/min × 3 MPa ("X" times)	1.25	176.08	
Recover UWTV to surface	19 Jan	0815	1000		1.75	177.83	
Pull out of hole (POOH) to surface	19 Jan	1000	2300	Bit in gauge	13.00	190.83	
Make up and run 9-5/8 inch CSG	19 Jan	2300	0000		1.00	191.83	7.99
Continue to make up and run 9-5/8 inch CSG to 388 m BRT	20 Jan	0000	0745	Fill up w/seawater every 10 joints	7.75	199.58	
Pick up CHRT for handling and connect to 9-5/8 inch CSG hanger on RTS	20 Jan	0745	0915		1.50	201.08	
Lower 9-5/8 inch CSG to moonpool and secure on working cart	20 Jan	0915	1000		0.75	201.83	
Release casing hanger running tool (CHRT) at working cart and pick up to rotary table and lay out	20 Jan	1000	1045		0.75	202.58	
Lower subsea tool (SST) and stab into 9-5/8 inch CSG and secure to CSG hanger	20 Jan	1045	1115		0.50	203.08	
Pick up and run Activation Kit w/CHRT to SSTs/ACME thread and 9-5/8 inch CSG hanger	20 Jan	1115	1330		2.25	205.33	
Charge Activation Kit accumulators	20 Jan	1330	1645	Charge w/7000 psi N2 and 10000 psi blowout preventer (BOP) fluid	3.25	208.58	
Run 9-5/8 inch CSG to 1410 m BRT	20 Jan	1645	1945	Fill up every 10 stands	3.00	211.58	
Run UWTV to Activation Kit for pressure monitoring	20 Jan	1945	2215		2.50	214.08	
Run 9-5/8 inch CSG and UWTV to 2020 m BRT	20 Jan	2215	0000		1.75	215.83	8.99
Continue running 9-5/8 inch CSG w/UWTV to 3854 m BRT	21 Jan	0000	0630	Fill up every 10 stands	6.50	222.33	
Reenter Hole C0006G	22 Jan	0630	1000	Adjust vessel position, finding holes drilled during previous Expeditions 314 and 316	3.50	225.83	
Run in hole 9-5/8 inch CSG to 4273 m BRT (373 mbsf)	23 Jan	1000	1130		1.50	227.33	
Pick up and make up cement stand and adjust Activation Kit so UWTV can view pressure gauges	24 Jan	1130	1145	Confirmed accumulator pressure and unlock pressures at 4275.5 m BRT	0.25	227.58	
Land 9-5/8 inch CSG hanger on wellhead	25 Jan	1145	1545	Observed wellhead sinking by 2 m while applying 120 kNm slack off (SO) weight; wellhead sank by 1 m more while applying 200 kNm SO weight; after 15 min no more sinking observed; applied 230 kNm SO weight for 5 min, no more sinking	4.00	231.58	
Troubleshoot cementing (CMTG) line leakage	26 Jan	1545	2200		6.25	237.83	
9-5/8 inch CSG CMTG	27 Jan	2200	0000		2.00	239.83	9.99

Table T1 (continued). (Continued on next page.)

Operation	Date (2018)	Local ship time (h) Start	Finish	Notes	Total operation time (h)	Cumulative (h)	Days
Continue 9-5/8 inch CMTG	22 Jan	0000	0145	Observe top and bottom plug released by pressure drop	1.75	241.58	
Unlock CHRT from 9-5/8 inch CSG hanger by acoustic command from Activation Kit	22 Jan	0145	0215	Slack off 226 kN and send acoustic signal to release	0.50	242.08	
POOH to 4297 m BRT	22 Jan	0215	0300	Pick up string to clear SST from well head	0.75	242.83	
Break circulation in string	22 Jan	0300	0330	Volume w/600 gal/min × 5.0 MPa	0.50	243.33	
Recover UWTV to surface	22 Jan	0330	0430		1.00	244.33	
POOH to surface	22 Jan	0430	1515		10.75	255.08	
Make up and run 8-1/2 inch × 9-7/8 inch bicenter bit BHA to 3870 m BRT	22 Jan	1515	0000	Conduct motor shallow test w/200 gal/min × 0.4 MPa	8.75	263.83	10.99
Make up and run 8-1/2 inch × 9-7/8 inch bicenter bit BHA to 3853 m BRT	23 Jan	0000	0400		4.00	267.83	
Break circulation in string	23 Jan	0400	0430	Volume 400 gal/min × 6.2 MPa	0.50	268.33	
Run UWTV to 7 m above bit	23 Jan	0430	0530		1.00	269.33	
Lower bit with UWTV to 3857 m BRT	23 Jan	0530	0600		0.50	269.83	
Reenter Hole C0006G	23 Jan	0600	0745	RIH to 3924 m BRT and standby for recovering UWTV	1.75	271.58	
Recover UWTV	23 Jan	0745	0930		1.75	273.33	
Run in hole to 4159 m BRT (259 mbsf)	23 Jan	0930	1030		1.00	274.33	
Wash down from 4159 to 4223.5 m BRT (259–323.5 mbsf)	23 Jan	1030	1130	Tag top of cement at 4207 m BRT (307 mbsf); tag float collar at 4223.5 m BRT (323.5 mbsf)	1.00	275.33	
Drill out cement from 4223.5 to 4225.5 m BRT (323.5–325.5 mbsf)	23 Jan	1130	1445	Stall HPS at 4225.5 m BRT (325.5 mbsf) repeatedly with no progress	3.25	278.58	
POOH 8-1/2 inch × 9-7/8 inch bicenter bit with motor BHA	23 Jan	1445	0000		9.25	287.83	11.99
Continue POOH 8-1/2 inch × 9-7/8 inch bicenter bit w/motor BHA	24 Jan	0000	0200		2.00	289.83	
Make up and run in hole (RIH) 8-1/2 inch drill-out-cement (DOC) BHA	24 Jan	0200	1015	Fill up every 15 stands	8.25	298.08	
Run UWTV to 7 m above bit	24 Jan	1015	1245	Shift RGR to aft and working cart to well center	2.50	300.58	
Lower bit w/UWTV to 3895 m BRT	24 Jan	1245	1315		0.50	301.08	
Reenter Hole C0006G	24 Jan	1315	1400	RIH to 3917.5 m BRT (17.5 mbsf) before recovering UWTV	0.75	301.83	
Recover UWTV to surface	24 Jan	1400	1515		1.25	303.08	
RIH to 4182 m BRT (282 mbsf)	24 Jan	1515	1615		1.00	304.08	
Wash down from 4182 to 4225 m BRT (282–325 mbsf)	24 Jan	1615	1715	Tag top of cement at 4225 m BRT (325 mbsf)	1.00	305.08	
Drill out cement from 4225 to 4291 m BRT (325–391 mbsf)	24 Jan	1715	2115	Sweep out 5 m^3 SWG four times	4.00	309.08	
Ream down from 4291 to 4299 m BRT (325–399 mbsf)	24 Jan	2115	2145		0.50	309.58	
Drill down from 4299 to 4309 m BRT (399–409 mbsf)	24 Jan	2145	2215	Average ROP = 19.4 m/h	0.50	310.08	
Sweep out 5 m^3 of SWG twice and spot 5 m^3 of SWG	24 Jan	2215	2230		0.25	310.33	
Wiper trip from 4309 to 4299 mBRT (409 to 399 mbsf)	24 Jan	2230	2245	From 4309 to 4299 m BRT (409–399 mbsf) observed no excess drag	0.25	310.58	
Clean and sweep out 5 m3 of SWG	24 Jan	2245	2300		0.25	310.83	
Drop Churchill drift	24 Jan	2300	2330	Chase w/400 gal/min and rotate at 40 rpm; spot 5 m^3 of SWG	0.50	311.33	
POOH 8-1/2 inch DOC BHA	24 Jan	2330	0000		0.50	311.83	12.99
Continue POOH 8-1/2 inch DOC BHA to surface	25 Jan	0000	0915	Confirm Churchill drift landed on Churchill drift catcher sub	9.25	321.08	
Lay down DeepSea EXPRESS cement head and rig up Hybrid plug container cement head stand	25 Jan	0915	1430	Move vessel 1 nmi from well center	5.25	326.33	
Slip and cut drilling line	25 Jan	1430	2145	Service HPS and traveling block	7.25	333.58	
Make up and run 8-1/2 inch × 9-7/8 inch bicenter bit BHA to 3870 m BRT	25 Jan	2145	0000	Paint bit and sub yellow; mark every 1 m from bit to 10 m and at 50 and 100 m	2.25	335.83	13.99
Continue to make up and run 8-1/2 inch × 9-7/8 inch bicenter bit with motor BHA to 3870 m BRT	26 Jan	0000	0830	Fill up every 15 stands	8.50	344.33	
Run UWTV to 7 m above bit	26 Jan	0830	1000		1.50	345.83	
Lower bit w/UWTV to 3895 m BRT	26 Jan	1000	1015		0.25	346.08	
Reenter Hole C0006G	26 Jan	1015	1130		1.25	347.33	
Run in hole to 4307 m BRT (407 mbsf)	26 Jan	1130	1330	From 4223 to 4307 m BRT (323–407 mbsf) no excessive drag observed	2.00	349.33	
Pick up BHA from 4307 to 4283 m BRT (407–383 mbsf) to retrieve UWTV	26 Jan	1330	1345		0.25	349.58	
Recover UWTV on surface	26 Jan	1345	1530		1.75	351.33	
Drill down to 4395 m BRT (495 mbsf)	26 Jan	1530	2030		5.00	356.33	
Sweep hole with 5 m^3 Hi-vis ×2 and spot 10 m^3 Hi-vis	26 Jan	2030	2045	Pump 600 gal/min × 11 MPa; HPS 30 rpm × 0.1 6 kNm	0.25	356.58	
Wiper trip from 4395.0 to 4293.0 m BRT (495–393 mbsf)	26 Jan	2045	2145	No observed excessive drag; hole condition good	1.00	357.58	
Circulate and reciprocate drill string	26 Jan	2145	2345	HPS 5 rpm × 0–1.5 kNm; pump 200 gal/min × 1.1 MPa	2.00	359.58	
Spot Protect Zone by Schlumberger cement unit	26 Jan	2345	0000	Mix and pump 6.8 bbl × liner gel; pump 33.2 bbl × Protect Zone	0.25	359.83	14.99
Continue to spot Protect Zone	27 Jan	0000	0115	Pump 1.0 bbl × liner gel; pump 294.1 bbl × seawater; return = 4.0 bbl	1.25	361.08	
Pull up string to 4328 m BRT (428 mbsf)	27 Jan	0115	0145		0.50	361.58	
Sweep out 10 m^3 of SWG and spot 10 m^3 of SWG	27 Jan	0145	0230	400 gal/min × 4.5 MPa	0.75	362.33	
POOH to surface	27 Jan	0230	1145	Lay out jar, mud motor, float sub, and bicenter bit	9.25	371.58	
Service Hydrolift Power Swivel (HPS)	27 Jan	1145	1230		0.75	372.33	

Table T1 (continued). (Continued on next page.)

Operation	Date (2018)	Local ship time (h) Start	Finish	Notes	Total operation time (h)	Cumulative (h)	Days
Pick up and make up hybrid cement stand and rack back	27 Jan	1230	1530		3.00	375.33	
Make up and run 9-5/8 inch scraper BHA to 3818 m BRT	27 Jan	1530	0000	Paint bit and sub yellow; paint every 1 m from bit to 10 m and once for 50 and 100 m marks	8.50	383.83	15.99
Continue to make up and run 9-5/8 inch scraper BHA to 3870 m BRT	28 Jan	0000	0015		0.25	384.08	
Run UWTV to 7 m above bit	28 Jan	0015	0215		2.00	386.08	
Lower bit w/UWTV to 3895 m BRT	28 Jan	0215	0400	Adjust vessel to well center	1.75	387.83	
Reenter Hole C0006G and RIH w/CSG scraper to 4189 m BRT (289 mbsf)	28 Jan	0400	0500		1.00	388.83	
Recover UWTV on surface	28 Jan	0500	0730	Sweep out 5 m^3 SWG and spot 10 m^3 SWG	2.50	391.33	
Scrape 9-5/8 inch CSG between 3980 and 3960 m BRT (80–60 mbsf; swellable packer set depth)	28 Jan	0730	0830	Conduct UWTV postdive checks	1.00	392.33	
Install releaser for remotely operated vehicle (ROV) platform on UWTV and confirm payload #2	28 Jan	0830	0945	Check releaser resistance	1.25	393.58	
Assemble ROV platform on working cart	28 Jan	0945	1215	Install sensor cables and flatpack on spollers on forward pipe rack	2.50	396.08	
Pick up UWTV and connect 3 ropes to ROV platform	28 Jan	1215	1330		1.25	397.33	
Run UWTV w/ROV platform	28 Jan	1330	1615	Observe UWTV light malfunction for camera #1; other light OK; confirm ROV platform landing by UWTV and check slack off; activate releaser and UWTV pull up to confirm all ropes released w/no overpull	2.75	400.08	
Recover UWTV on surface	28 Jan	1615	1800		1.75	401.83	
POOH 9-5/8 inch scraper BHA to 873 m BRT	28 Jan	1800	0000		6.00	407.83	16.99
Continue POOH 9-5/8 inch scraper BHA to surface	29 Jan	0000	0200	Make up bull nose, circulation sub, and float collar w/3-1/2 inch tubing (TBG)	2.00	409.83	
Prepare long-term borehole monitoring system (LTBMS) completion running	29 Jan	0200	0530	Arrange moonpool carts and completion guide roller (CGR) and RGR for completion sensor cable and flatpack running	3.50	413.33	
Run LTBMS completion to 61 m BRT	29 Jan	0530	1230	Install miniscreens above bull nose. Strainmeter health check on middle pipe rack.	7.00	420.33	
Install sensor cables on each sensor in moonpool	29 Jan	1230	1530	Strainmeter, seismometer, tiltmeter/combo, and thermister	3.00	423.33	
#1 sensor health check	29 Jan	1530	1730	Confirm all sensors still healthy	2.00	425.33	
Continue to run LTBMS to 147 m BRT	29 Jan	1730	0000		6.50	431.83	17.99
Continue to run LTBMS to 147 m BRT	30 Jan	0000	0030		0.50	432.33	
#2 sensor health check	30 Jan	0030	0215	Confirm all sensors healthy at ~100 m MSL	1.75	434.08	
Resume running LTBMS to 409 m BRT	30 Jan	0215	1330	Apply tie wraps and SUS bands to flatpack and sensor cables to 3-1/2 inch TBG	11.25	445.33	
#3 sensor health check	30 Jan	1330	1400	Confirm all sensors still healthy	0.50	445.83	
Cable installation through swellable packer	30 Jan	1400	1630		2.50	448.33	
#4 sensor health check	30 Jan	1630	1715	Confirm all sensors healthy after passing cables through swellable packer	0.75	449.08	
Resume running LTBMS to 448 m BRT	30 Jan	1715	2000		2.75	451.83	
Make up and run LTBMS CORK head to moonpool	30 Jan	2000	2300		3.00	454.83	
Set flatpack termination on LTBMS CORK head	30 Jan	2300	0000	Flatpack set so side with printing AGAINST TBG; first hydraulic line to miniscreens on LEFT side, looking AT flatpack against TBG; hydraulic line to strainmeter on RIGHT side, looking AT flatpack	1.00	455.83	18.99
Continue flatpack termination on the LTBMS CORK head	31 Jan	0000	0045	#5 sensor health check; all sensors GOOD	0.75	456.58	
Measure the sensor cable (3 each) for cutting and termination preparation	31 Jan	0045	0430	Slack off and cut sensor cables 11 m above bottom of CORK cable bay; shift BOP cart and termination container to facilitate termination	3.75	460.33	
Terminate sensor cables by ODI engineers	31 Jan	0430	0000	Perform sensor cable splice and curing. #6 sensor check: all GOOD.	19.50	479.83	19.99
Continue sensor cable termination	1 Feb	0000	0015		0.25	480.08	
#7 Sensor check: all GOOD	1 Feb	0015	0100		0.75	480.83	
Install terminated sensor cables on LTBMS CORK head	1 Feb	0100	0515		4.25	485.08	
#8 Sensor check: one cable FAIL	1 Feb	0515	0600	Strainmeter and tiltcombo sensor cable communication GOOD; seismometer cable communication: uplink OK; downlink commands NOGO	0.75	485.83	
Investigate sensor cable failure	1 Feb	0600	1500	Repeated tests of seismometer sensor cable repeat FAIL. Resolve by cutting ODI connector and testing bare sensor cable: communication GOOD.	9.00	494.83	
Retermination of seismometer sensor cable by ODI engineers	1 Feb	1500	0000	Initial sensor check: GOOD	9.00	503.83	20.99
Continue retermination	2 Feb	0000	0730	Two sensor communication checks (#9 and #10): GOOD	7.50	511.33	
Install reterminated ODI sensor cable on LTBMS CORK cable bay	2 Feb	0730	0915		1.75	513.08	
#11 densor check: reterminated cable GOOD	2 Feb	0915	1230	All ODI connections hooked to acoustic modem and tested: GOOD	3.25	516.33	
Run and secure LTBMS CORK head on wellhead support frame on working cart	2 Feb	1230	1415	CORK head run into moonpool and hydraulic lines filled with seawater; picked up and moved to working cart	1.75	518.08	

Table T1 (continued).

Operation	Date (2018)	Local ship time (h) Start	Finish	Notes	Total operation time (h)	Cumulative (h)	Days
Retrieve hydraulically activated running tool (HART) handling tool	2 Feb	1415	1530		1.25	519.33	
Pick up and run Activation Kit w/HART	2 Feb	1530	1700	HART activated and 2 shear pins installed by NuStar	1.50	520.83	
Charge Activation Kit accumulators	2 Feb	1700	1930	Charge N2: 7200 psi; function fluid: 10,000 psi	2.50	523.33	
Run LTBMS completion assembly w/Activation Kit to 1400 m BRT	2 Feb	1930	2245	Fill up every 10 stands with seawater; #1 water column sensor test: GOOD	3.25	526.58	
Run UWTV	2 Feb	2245	0000		1.25	527.83	21.99
Continue to run UWTV w/Activation Kit	3 Feb	0000	0115	Accumulator pressure (acoustic) 8500 psi; (mechanical) 8500 psi	1.25	529.08	
Run LTBMS completion assembly w/Activation Kit to 2400 m BRT	3 Feb	0115	0345	Fill up every 10 stands with seawater	2.50	531.58	
Run UWTV to Activation Kit at ~2000 m BRT	3 Feb	0345	0400	Confirm accumulator pressure	0.25	531.83	
Run LTBMS completion assembly w/Activation Kit to 3880 m BRT	3 Feb	0400	0800	Fill up every 10 stands with seawater; #2 water column sensor test: GOOD	4.00	535.83	
Run UWTV to 3873 m BRT	3 Feb	0800	0930	Break circulation 350 gal/min × 6.64 MPa; observe leak between instrument carrier and strainmeter	1.50	537.33	
Reenter Hole C0006G and run LTBMS CORK completion to 4357 m BRT (457 mbsf)	3 Feb	0930	1600		6.50	543.83	
Land LTBMS CORK head on wellhead	3 Feb	1600	1615		0.25	544.08	
Postlanding sensor communication test: GOOD	3 Feb	1615	1645		0.50	544.58	
Cement LTBMS CORK completion string assembly	3 Feb	1645	2100		4.25	548.83	
Release HART from LTBMS CORK head by acoustic release of Activation Kit	3 Feb	2100	2215	Slack off 60 kN and send #1 signal to Activation Kit from UWTV; NO release; send #2 signal to Activation Kit from UWTV; NO release; attempt mechanical release by UWTV, indicator did NOT shift; NO release	1.25	550.08	
Pick up UWTV to surface and tighten UWTV sleeve for mechanical release attempt	3 Feb	2215	0000		1.75	551.83	22.99
Continue retightening UWTV guide funnel for mechanical release attempt	4 Feb	0000	0100		1.00	552.83	
Run UWTV to Activation Kit	4 Feb	0100	0215		1.25	554.08	
Attempt to release HART by mechanical release by Activation Kit	4 Feb	0215	0330	Several passes by the UWTV over the mechanical releases and increase in tension on UWTV observed; no release	1.25	555.33	
Recover UWTV to surface to cock guide funnel	4 Feb	0330	0400	Guide funnel tilted to apply greater pressure to mechanical release.	0.50	555.83	
Run UWTV to Activation Kit	4 Feb	0400	0515		1.25	557.08	
Attempt to release HART by mechanical release by Activation Kit	4 Feb	0515	0630	Several passes by the UWTV over the mechanical releases and increase in tension on UWTV observed; changed vessel heading to 110° port while rotating string 90° clockwise; no release	1.25	558.33	
Recover UWTV to surface to modify guide funnel	4 Feb	0630	1015	Applied rubber sheeting (5 mm) to inside of guide funnel to decrease inner diameter of guide funnel on mechanical release.	3.75	562.08	
Run UWTV to Activation Kit	4 Feb	1015	1130		1.25	563.33	
Attempt to release HART by mechanical release by Activation Kit	4 Feb	1130	1200	Several passes by the UWTV over the mechanical releases and increase in tension on UWTV observed; no release	0.50	563.83	
Recover UWTV to surface to change modifications to guide funnel	4 Feb	1200	2000	Welded metal plates (12 mm) to inside of guide funnel after removing rubber sheeting	8.00	571.83	
Run UWTV to Activation Kit	4 Feb	2000	2145		1.75	573.58	
Attempt to release HART by mechanical release by Activation Kit	4 Feb	2145	2230	UWTV could not pass Activation Kit pins; taper ~45°	0.75	574.33	
Arrange cement head for wireline job	4 Feb	2230	2345		1.25	575.58	
Recover UWTV to surface	4 Feb	2345	0000		1.25	576.83	24.03
Continue recovering UWTV to surface	5 Feb	0000	0415	Recover UWTV and modify guide funnel 12 mm plate taper to ~30°	4.25	581.08	
Run UWTV to Activation Kit	5 Feb	0415	0530		1.25	582.33	
Release HART from LTBMS CORK head by mechanical release by Activation Kit	5 Feb	0530	0645	Pass UWTV pass Activation Kit pins 14 times; observe hydraulic fluid output from HART	1.25	583.58	
Flush drill string	5 Feb	0645	1115	Rack back cement stand; drop sponge and pump 800 gal/min × 10 MPa	4.50	588.08	
POOH completion string	5 Feb	1115	1400		2.75	590.83	
Drop Churchill drift	5 Feb	1400	1430		0.50	591.33	
POOH and lay down completion string to surface	5 Feb	1430	2300		8.50	599.83	
Secure moon pool equipment for sailing	5 Feb	2300	0000		1.00	600.83	25.03
Sail for Shimizu	6 Feb	0000	2000		20.00	620.83	
Arrive off Shimizu; anchorage	6 Feb	1630	2400		7.50	628.33	26.18
Off Shimizu; board pilot; arrive quayside	7 Feb	0000	1030		10.50	638.83	26.62
Expedition 380 ends	7 Feb	1030	—				

Table T2. Bottom-hole assembly (BHA) record, Expedition 380. XO = crossover, DC = drill collar, DAT = drill-ahead tool, CSG = casing, F/S = float shoe, BTC = buttress thread coupling, ER = easy running, F/C = float collar, HGR = hanger, SST = subsea tool, CHRT = casing hanger running tool, DP = drill pipe, CMT = cement, STB = stabilizer, IF = internal flush.

BHA type	BHA record
Inner string	12-1/4 inch bit, 9-5/8 inch motor, 8 inch screen sub, XO, 8 inch float sub with float, 12-1/4 inch stabilizer, 8-1/2 inch DC (4), 8 inch spacer sub (4), 8 inch pony collar, DAT, 8-1/2 inch coring DC 6 m pup (1), 8-1/2 inch coring DC (6), XO
9-5/8 inch CSG	(CSG) F/S joint, thread lock BTC (3 joints), XO, thread lock ER (1 joint), XO, F/C joint, 9-5/8 inch CSG (25 joints), 9-5/8 inch CSG 3 m pup, 9-5/8 inch CSG HGR (string) SST, XO, XO, Activation Kit w/CHRT, 8-1/2 inch coring DC (7), XO, 5 inch DP (30 stands), XO, 5-1/2 inch DP (25 stands + 3 m pup), XO, 6-5/8 inch Z140 (15 stands), 6-5/8 inch UD165 (30 stands), CMT stand
Bicenter bit	8-1/2 inch, 9-7/8 inch bicenter bit, 6-3/ 4inch DC (1), XO, 6-3/4 inch mud motor, float sub, 6-3/4 inch DC (3), XO, 8-1/2 inch STB, XO, 6-3/4 inch DC (3), 6-1/2 inch jar, 6-3/4 inch DC (6), XO, Churchill drift sub, XO
Drill-out-cement	8-1/2-inch bit, float sub, 6-3/4 inch DC 4 inch IF connection (3), 8-1/2 inch stab, XO, 6-3/4 inch DC (6), 6-1/2 inch jar, 6-3/4 inch DC (6), XO, Churchill drift sub
Bicenter bit	8-1/2 inch, 9-7/8 inch bicenter bit, 6-3/4 inch DC (1), XO, 6-3/4 inch mud motor, float sub, 6-3/4 inch DC (3), XO, 8-1/2 inch STB, XO, 6-3/4 inch DC (3), 6-1/2 inch jar, 6-3/4 inch DC (6), XO
Scraper	8-1/2 inch bit, 9-5/8 inch scraper, XO, 6-3/4 inch DC (3), XO, 8-1/2 inch stab, XO, 6-3/4 inch DC (3), jar, 6-3/4 inch DC (3), XO

Table T3. Drilling summary, Expedition 380. BRT = below rig table, MSL = below mean sea level.

Hole	Latitude	Longitude	Water depth (m BRT)	Water depth (m MSL)	Drilled interval (m)	Cased interval (m)	Total penetration (m)	Time on hole (days)
C0006G	33°01.6388′N	136° 47.6463′E	3900	3871.5	495	391	495	20

Figure F1. Location of Expedition 380 Site C0006 (solid red circle). Red-outlined circles = LTBMS Sites C0002 and C0010. Inset shows region in relation to Japan. Yellow arrows = computed far-field convergence vectors between Philippine Sea plate and Japan (Seno, 1993; Heki, 2007).

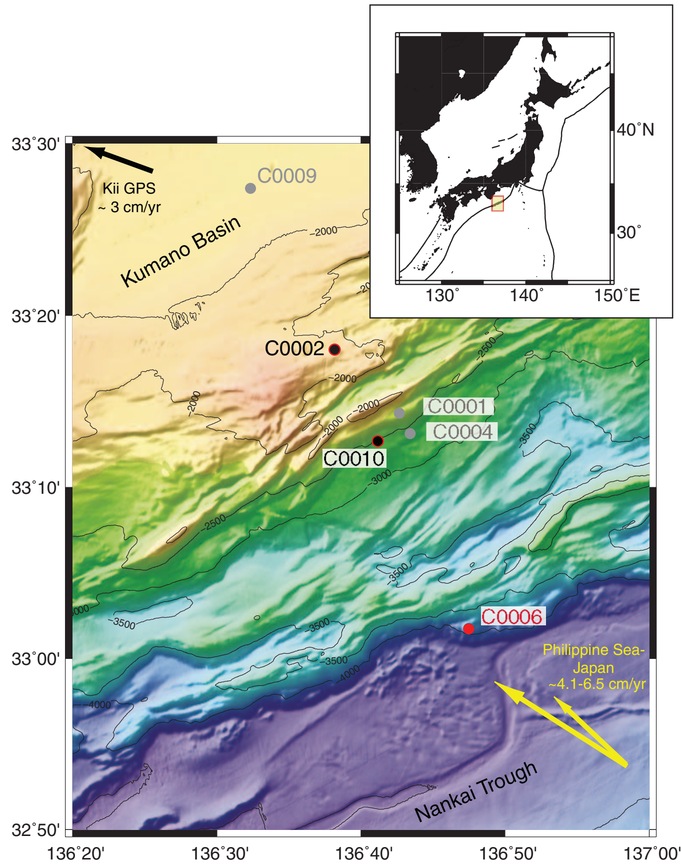

Figure F2. Interpreted seismic cross section of Kumano transect offshore and southeast of Kii Peninsula (modified from Moore et al., 2009; after Strasser et al., 2014) highlighting the three LTBMS Sites C0002, C0010, and C0006. NanTroSEIZE Sites C0013 and C0014 on the incoming Philippine Sea plate are not shown. VE = vertical exaggeration.

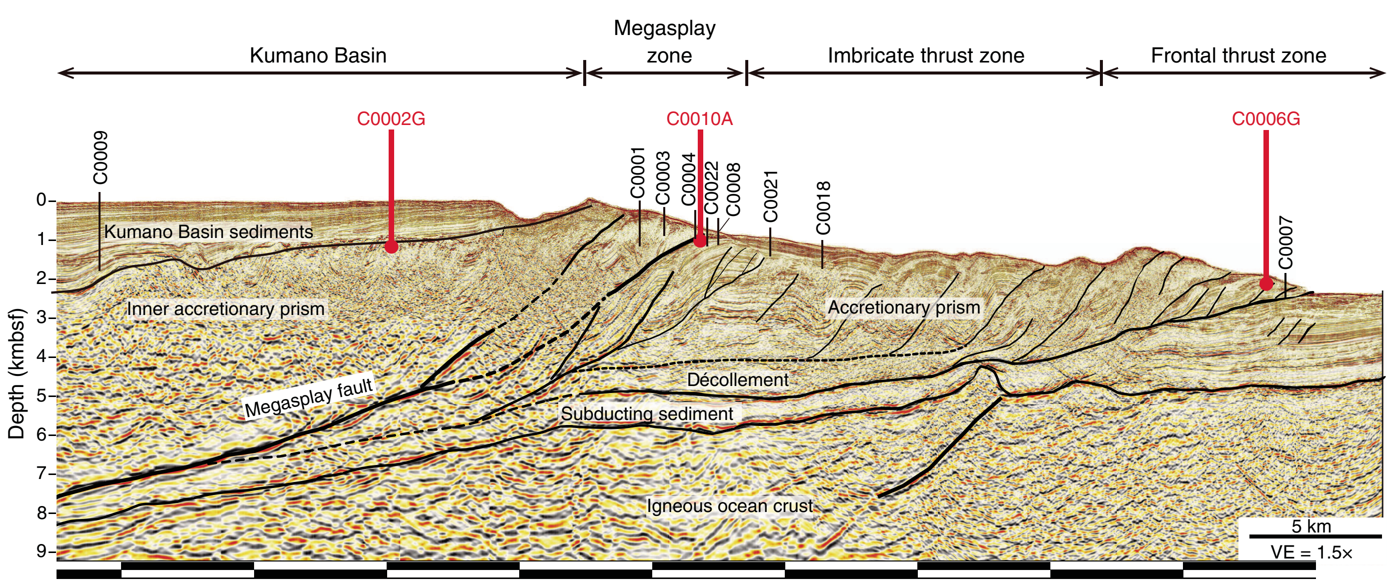

Figure F3. Interpreted seismic reflection depth section (In-line 2435) around Sites C0006 and C0007 based on integrated interpretation of core and log data from the boreholes with seismic imaging.

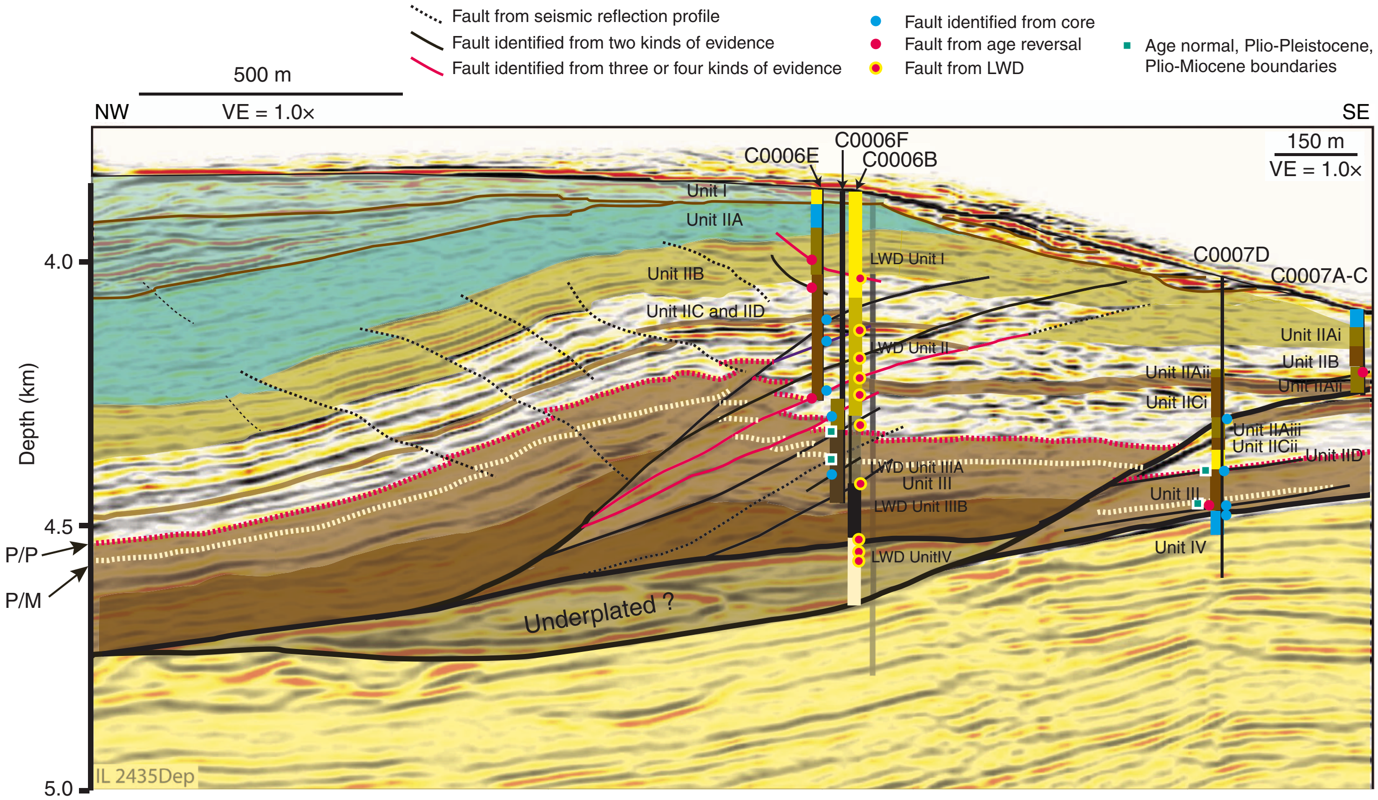

Figure F4. Seismic section, logging, and coring results used to determine configuration of the Expedition 380 LTBMS installation in Hole C0006G. This figure is available in an **oversized format**.

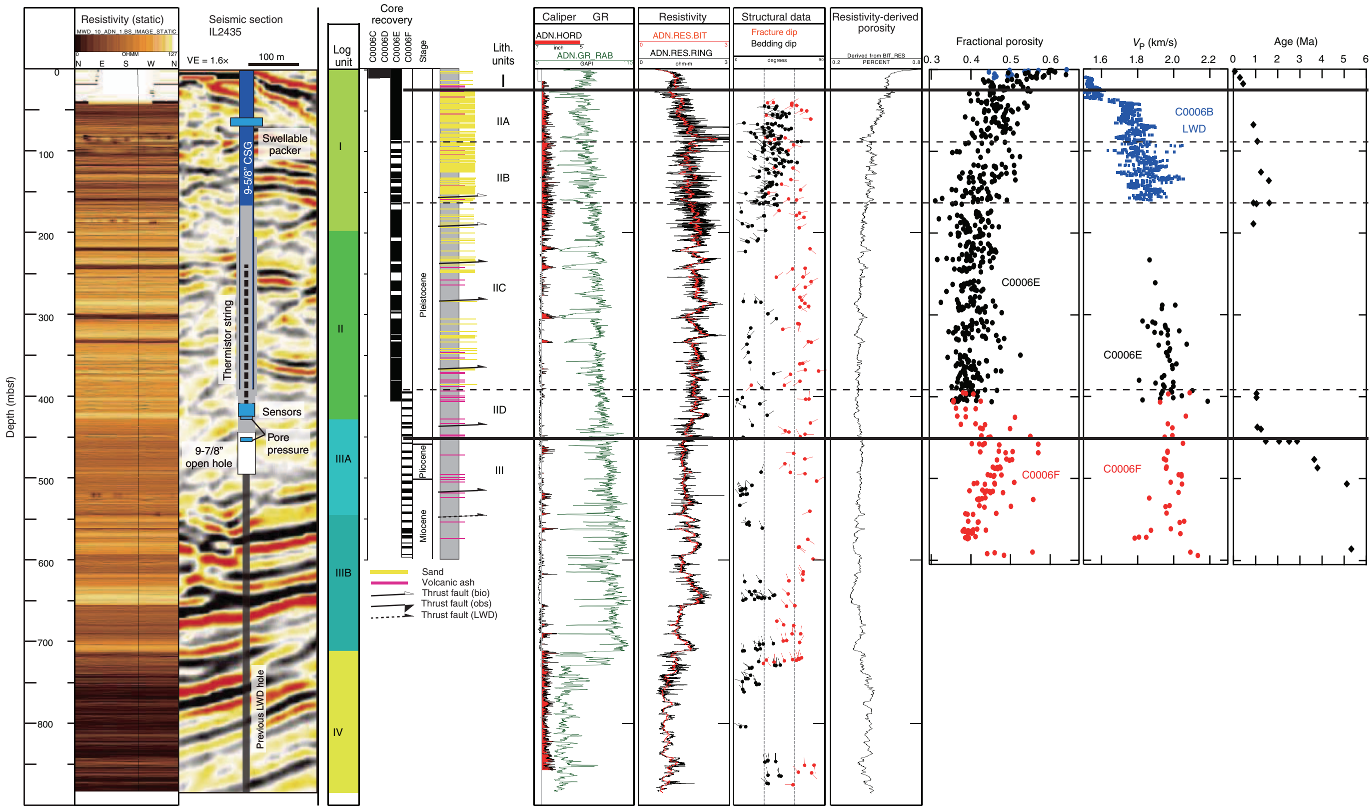

Figure F5. Schematic of Hole C0006G LTBMS as installed during Expedition 380.