Site 395[1]

Expedition 336 Scientists[2]

Chapter contents

Site summary

Investigating coupled geochemical and microbial processes in active aquifers within the upper oceanic crust is the main science goal of Integrated Ocean Drilling Program (IODP) Expedition 336, and the primary objective is initiating multilevel subseafloor borehole observatories (CORKs). We planned to install one observatory in the Deep Sea Drilling Project (DSDP) Hole 395A (664 m deep) in the southeastern part of North Pond. Hole 395A was drilled during DSDP Leg 45 in 1975–1976, was logged repeatedly, and was then equipped with a first-generation CORK in 1997 during Ocean Drilling Program (ODP) Leg 174B (Becker, Malone, et al., 1998). Hole 395A is located in an area of exceptionally low conductive heat flow (Langseth et al., 1992) due to cooling of the uppermost basement by cold seawater, which recharges basement and is inferred to flow underneath the sediment cover in a northerly direction.

At the beginning of our operations at Site 395, the old Leg 174B CORK, including the entire 603 m internal string with thermistors, a data logger, and pressure sensors, was successfully pulled out of Hole 395A and secured on board the R/V *JOIDES Resolution*. The pressure and temperature data were downloaded, the thermistors were cut out of the string, and sections of the string were sampled for microbiological analyses. Further microbiological samples were obtained from the CORK's remotely operated vehicle (ROV) platform and wellhead elements. The hole was then logged with a new in situ deep ultraviolet (UV) (<250 nm) fluorescence tool for detecting microbial life in ocean floor boreholes—the Deep Exploration Biosphere Investigative tool (DEBI-t). Other logging data obtained included spectral gamma ray and temperature. A rock ledge in the borehole at ~180 meters below seafloor (mbsf) had to be bridged by lowering the logging bit to ~198 mbsf, but then an open-hole section of 405.7 m was logged (total depth reached was 603.5 m). The lowermost ~50 m of the hole was not logged because it was found to be filled with rubble during Leg 174B. The logging results are consistent with the data obtained by Bartetzko et al. (2001) and allow the distribution of massive basalt, pillow basalts, altered lava flows, and rubble zones (sedimentary breccia and hyaloclastite) to be distinguished.

A 530 m long, multilevel CORK observatory was assembled to perform long-term coupled microbiological, biogeochemical, and hydrological experiments. Assembling the observatory entailed preparing osmotically driven fluid samplers, microbial incubation

[1]Expedition 336 Scientists, 2012. Site 395. *In* Edwards, K.J., Bach, W., Klaus, A., and the Expedition 336 Scientists, *Proc. IODP,* 336: Tokyo (Integrated Ocean Drilling Program Management International, Inc.).
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[2]**Expedition 336 Scientists' addresses.**

experiments, seven temperature sensors, and two oxygen sensors. Packers at mid-point depths of 111, 149, and 463 mbsf were installed to isolate the borehole into three intervals characterized by different thermal and fluid flow regimes. Umbilicals containing fluid sampling lines attached to the outside of the CORK casing were designed to reach depths of 120, 430, and 506 mbsf. OsmoSamplers for fluid geochemistry and microbiology were lowered on Spectra rope inside the slotted or perforated CORK casing to sample four intervals: 112–140, 233–261, 409–438, and 491–527 mbsf. The CORK wellhead was instrumented with sensors for monitoring pressures in the four zones isolated by packers and with OsmoSamplers for retrieving fluid samples from the lowermost zone.

The assembly and installation proceeded well until the CORK head broke off during the final step of releasing the CORK running tool. The CORK head experienced forces that bent the wellhead and severed its 5 inch pipe ~4 m below the top of the reentry cone, parting the Spectra rope and the umbilicals and leaving the downhole tool string in place. On the basis of the portion of the CORK wellhead recovered, the upper end of the remaining 5 inch diameter cup packer subassembly near the seafloor (5 inch pipe mandrel) is not completely rounded; however, it may be open enough to allow recovery of the internal downhole samplers, sensors, and experiments in the future. Several stainless steel tubes likely extend above the cup packers and the top of the 5 inch casing. Damage to the stabilizing fins above the cup packers suggests that they may have been too large in diameter to enter the throat of the reentry cone (DSDP documentation indicated a 24 inch diameter, now thought to be less), which may have been the root cause of the installation failure. Indeed, similar damage was observed on the Leg 174B CORK that was recovered (it, too, did not fully land). The CORK pressure logging system was recovered along with the broken-off wellhead. The recorded data do not definitively resolve whether the downhole CORK packers actually inflated; however, no data are otherwise available to suggest that the packers did not inflate as intended. A plan is being formulated to recover the downhole instrument string in 4 y with an ROV.

Operations

Port call and transit to North Pond

Prior to Expedition 336, the *JOIDES Resolution* was berthed in Curaçao. Although Expedition 336 officially did not begin until 15 September 2011 in Barbados, all of the CORK hardware and experiments were sent to Curaçao in advance of the expedition. In addition, a few scientists and engineers boarded the ship in Curaçao and used the 2 day transit to Barbados to start preparing the CORK observatories and a new in situ tool for detecting microbial life in ocean floor boreholes—the DEBI-t.

Expedition 336 officially began with the first line ashore in Bridgetown, Barbados, at 0948 h on 15 September. Other than personnel transfers, only minor port call activities were planned; these began immediately after the early arrival of the ship. On Day 2 of the port call, the remaining scientists, engineers, technical staff, and crew boarded the ship in Barbados on 16 September. The vessel was then secured for sea and departed Bridgetown, Barbados, at 0742 h on 17 September. The pilot departed the vessel at 0812 h, and the vessel started the 986 nmi transit to Hole 395A (all times are local ship time, Universal Time Coordinated [UTC] – 3 h). We arrived over Hole 395A at 2330 h on 20 September, having averaged 11.4 nmi/h. At 0012 h on 21 September, the vessel was placed in dynamic positioning mode over Hole 395A and operations began. All operational tasks, along with task start and end times, are listed in Table **T1.**

Hole 395A

Operations for Hole 395A began by picking up the CORK pulling tool for the Hole 395A CORK and making it up to a pony drill collar. The rest of the bottom-hole assembly (BHA) was attached and the drill string was tripped to just above the seabed. At 2166 meters below rig floor (mbrf), tripping operations were temporarily halted to install the vibration-isolated television (VIT) camera system to begin running the subsea camera. It quickly became apparent that there was a problem with the sonar system on the camera system, and it had to be retrieved for repair. Tripping continued to 2824 mbrf, where operations were again suspended to install the camera system. Tripping operations resumed as the camera system was carefully lowered toward the seafloor. Periodically, the camera system winch was stopped and the hoisting function was engaged. At ~3700 mbrf, it became clear that the winch did not have sufficient power to retrieve the camera system. Drill pipe tripping operations continued while mechanics and engineers diagnosed the winch problem. When tripping operations were complete, the top drive was installed. However, from 1630 h on 21 September until 1630 h on 22 September, diagnostics and repair were performed on the camera system winch. After both the hydraulic motor and the hydraulic pump were changed, the winch was restored to working condition. The camera system was deployed and lowered carefully to the seafloor. The Hole 395A reentry cone and CORK were located, and the pulling tool was lowered over the CORK and latched on. The CORK was then picked up ~7 m, and the core line was deployed to retrieve the data logger, which was attached to a 600 m long thermistor string. After running an overshot three times and attempting to jar onto the top of the data logger, attempts to pull the thermistor string were suspended and the CORK was pulled to the surface along with the data logger/thermistor string. After the CORK was landed and secured in the moonpool, the recess where the top of the data logger was located was cleaned and the overshot was installed. The data logger was then jarred loose and all 600 m of the thermistor string, including 10 thermistors and the sinker bar, was removed at the rig floor. The thermistors were cut out of the string, and portions of the string were sampled for microbiological analysis. A lifting sub was installed on top of the CORK, and it was pulled through the rig floor and then moved to the starboard aft main deck for sampling. Next, the stinger, made up of three joints of 5.5 inch drill pipe, was broken down and laid out for additional microbiological sampling. After the rig floor was cleared of CORK pulling tools, the logging bit and BHA were made up and the drill string was tripped back to seafloor. There was a break in tripping operations after running Stand 70 to deploy the camera system, which was lowered to the bottom, following the bit. Hole 395A was reentered after 19 min of maneuvering. After rigging up to log with the DEBI-t microbiology string (DEBI-t, natural spectral gamma ray, and temperature), the tool string was run into the hole to log Hole 395A. After a 45 min interval to repair the logging winch, the tools were run down into the hole. The logging tool was unable to pass a section of the hole at 4670 mbrf (~186 mbsf), and after repeated attempts the logging string was pulled back to the surface and rigged down. On the basis of previous logs, we inferred that the tool string could not pass this section because it was hanging up on a ledge. After the logging bit was lowered ~21 m below the ledge, we were able to make two runs with the microbiology logging string all the way to the depth objective of 600 mbsf. The logging string was not lowered farther to keep it from landing on the bottom of the hole and causing potential damage to the tools.

After logging was concluded, the drill bit was also lowered to 600 mbsf to check for obstructions and make sure the hole was ready for the new CORK to be installed. When no obstructions were encountered, the string was pulled out of the hole and tripped back to the surface. After the drill line was slipped and cut, assembly of the new Hole 395A lateral CORK (L-CORK) commenced. The parts composing the main body of the CORK are listed in Table **T2.** The complete configuration of the CORK as deployed is shown in Figure **F1.** The configuration of the internal OsmoSampler string as deployed is documented in Table **T3.** Around midnight on 26 September, all casing, packers, umbilicals, and the CORK were assembled from the bottom to the top. Although the perforated casing was coated with epoxy to minimize the amount of exposed steel, the coated steel casing was washed with 10% ethanol and painted with an underwater curable epoxy paint. The deepest umbilical screens were deployed at the transition between the drill collars and 5.5 inch perforated casing. Umbilicals were secured with stabilizers (two per joint, with additional stabilizers near packers and screens) and sturdy plastic zip ties. Duct tape was used near packers to secure fittings. The CORK included a combination of steel and fiberglass casing. Details of connections, lubricants, and glues are presented in **Edwards et al.** (2012) and **Orcutt et al.** (2012).

The CORK was lowered ~10 mbrf to purge the pressure lines of air. The CORK was then raised to the moonpool and all of the purge valves were closed. All but one of the valves in the microbiology and geochemistry bays were closed. The open valve was attached to a fast-flow OsmoSampler with both standard and microbiology OsmoSamplers.

Next, we lowered the CORK to ~100 mbrf to ensure the camera system sleeve would pass freely over the CORK head. The OsmoSampler instrument string was then assembled and lowered inside the CORK. An attempt to land and latch the top plug was made, but the top plug could not be latched. The CORK was pulled back and landed in the moonpool, and an attempt was made to latch the top plug at the rig floor level. After numerous attempts with two different top plugs, it was finally decided to run the top plug without the latch being engaged; however, the top plug will still work as a gravity seal given the underpressured hydrologic system. When the CORK was pulled to the surface to check the top plug, it was apparent that the lateral valve and flow meter interface had broken off the lateral port on the CORK body. The port was then sealed with a 4 inch cap. It is unclear how the breakage occurred, and this type of valve was deployed successfully on two CORKs during IODP Expedition 327, on the CORK at ODP Site 1200, and on four cement deep-sea delivery vehicles.

Finally, we started lowering the CORK to the seafloor. The camera system was installed during the deployment and lowered to the bottom following the CORK. When the casing string stinger was just above the seabed, the drill string was spaced out for reentry and Hole 395A was reentered at 2003 h. The casing was carefully lowered into Hole 395A while observing the weight and carefully watching the string at known critical depths in the borehole (based on previous logging data). We then installed the top drive, and the drill string was spaced out to land the CORK. The CORK apparently landed, and over the next 2 h the packers were inflated to 1400 psi according to the inflation procedure and appeared to hold pressure; however, there was no slight decrease in pressure, typical of packers inflation. Simultaneously, the camera system was pulled to the surface, and we began putting together the ROV platform. At 0800 h the ROV platform had reached the CORK head and was released. The release was not smooth, with one side of the platform releasing before the other side. Eventually, the platform completely released and appeared to settle into position. An initial attempt was made to release the running tool from the CORK. After ~45 min of attempting to release the running tool, the camera was retrieved to remove the ROV platform release mechanism and slings in order to allow the camera to get a closer view of the CORK running tool. While the camera was being pulled to the surface, the driller lost the 10,000 lb of overpull that was being maintained on the CORK. At the time, we assumed that the running tool had released. However, when the camera system was lowered back to the seafloor to make a visual check of the CORK installation, we observed that the CORK head was no longer inside the reentry cone but was still attached to the running tool, offset from the reentry cone, and had broken off from the CORK casing below. We retrieved the camera system and drill string. Once the CORK head was back at the moonpool, we began to survey the damage (Fig. **F2**). The CORK head was then raised up to the rig floor, the running tool was removed, and the CORK head was laid down.

The CORK head experienced forces that bent the body through the lower part of the instrument bays. Also, the welded connection between the cup packer subassembly and the L-CORK mandrel had failed ~4 m below the top of the reentry cone (see Figs. **F3, F4, F5, F6**). This part of the assembly was a slip fitting that was not welded completely, and little of the connection was welded. When the 5 inch pipe was severed, the Spectra rope and umbilicals were also cut, leaving the downhole tool string in place. On the basis of recovered pieces of casing and the upper end of the remaining 5 inch diameter cup packer subassembly, the 5 inch pipe mandrel near the seafloor is not completely rounded but might not be closed enough to restrict the recovery of the downhole samplers, sensors, and experiments. Several stainless steel tubes likely extend above the cup packers and the top of the 5 inch casing (Table **T4**). These tubes may impede recovery of the downhole instrument string. Schematics of the parts remaining in the uppermost Hole 395A CORK installation are shown in Figure **F7.**

After the 10.75 inch casing in Hole U1382A was released (see **"Operations"** in the "Site U1382" chapter [Expedition 336 Scientists, 2012b]), a camera survey was made of the Hole 395A reentry system to provide initial data for formulating a plan to recover the downhole instrument string in 4 y with an ROV. The ROV platform was slightly offset from the center of the reentry cone, which made it nearly impossible to see down into the casing where the remainder of the CORK must be located. One of the three sonar reflectors appears to be missing (Fig. **F8**), and some views of the ROV platform, which rests on the cone and is not latched, are suggestive of possible damage to the platform.

The CORK pressure logging system was recovered along with the broken-off wellhead. The recorded data, shown in Figure **F9,** do not definitively resolve whether or not the downhole CORK packers actually inflated. The seafloor gauge and three formation gauges show very similar slight increases in pressures after the time of attempted inflation, but the similarity to the seafloor gauge could be consistent with a tidal influence without inflation of the downhole packers. However, there may be no evidence that the packers did not inflate based on analysis of the overall volume of the system, inflated packers, packer setting line, drill string, and standpipe in relation to the pressure change observed. The inflated packer volume represents only ~0.1% of the total system volume. Thus, if the overall system is truly closed (i.e., there are no leaks), then no additional pumping would be required to inflate the packers after shutting in the inflation pressure. Also, the pressure change observed during the packer inflation process indicates, assuming a closed system, a volume change equal to ~25 times that of the total volume of the inflated packers. Some of this volume change is most likely leakage in the system. Thus, based on onboard data and initial analyses, we cannot say whether or not the packers are inflated; however, we have no reason to believe that they are not inflated.

Our next objective was to install a CORK in Hole U1382A (50 m west of Hole 395A) to monitor the uppermost basaltic crust. However, this plan was put on hold when we had to leave the area because of Tropical Storm Philippe. After the ship was secured for transit at 0215 h (29 September), we departed Hole 395A and headed to the northeast to avoid the approaching storm.

Engineering summary

The first North Pond objective, pulling the old CORK and thermistor string in Hole 395A, was successfully completed.

The new Hole 395A L-CORK, a design modified to fit DSDP reentry hardware, failed during the final stages of installation in the borehole. Preliminary analysis suggests that the bottom ~0.6 m of the L-CORK hung up, indicated by damage to the leading edge of the lowermost stabilizer fins (Fig. **F6, F4**). This exposed the L-CORK—designed to be much longer and narrower than usual to fit the DSDP-style cone while still accommodating broader science objectives (i.e., extended height for the bays in which the scientific experiments are placed)—to much higher bending loads than anticipated. It is believed the system cracked at a weld just above the landing seat, which led to even higher loads and bending of the wellhead itself and then eventual failure at the weld. A final report will be prepared once the L-CORK, video evidence, and instrumentation data are further reviewed (see **Edwards et al.,** 2012). However, examination of the recovered old Hole 395A CORK (Fig. **F10**) revealed damage to its stabilizer fins in the same area as the new Hole 395A L-CORK that failed. We also observed a noticeable lack of corrosion to its landing ring. Combine this with the inability of the old CORK to be latched-in during Leg 174B and one might assume it also landed high. The old CORK was shorter and more robust, especially in the area just above the landing ring, so it was exposed to much lower stress. As for why the CORKs landed high, we have very little information. One theory is that the interior diameter of the reentry cone's 24 inch transition pipe, through which the stabilizer fins must pass, is narrower than indicated on DSDP engineering diagrams.

CORK observatory

Hole 395A was drilled during DSDP Leg 45 (Melson, Rabinowitz, et al., 1979). The hole was cased through the sediment section with 11.75 inch casing to 112 mbsf. The hole was then drilled to 664 mbsf. Hole instabilities caused fill in the deepest ~60 m of the hole, but the remaining ~600 m was found to be open on revisits during DSDP Leg 78B and ODP Legs 109 and 174B. During Expedition 336 we lowered the DEBI-t and drill bit to 600 mbsf but did not encounter the bottom of the hole. Because of longstanding hole stability, we were confident in fabricating a multilevel CORK design that penetrated much of the open hole. The number of levels and placement of packers were determined on the basis of previous downhole logs and hydrologic (packer) tests, the desire to compartmentalize the upper crust and lower crust, and the diameter of instruments and seals.

On the basis of temperature, caliper, and spontaneous potential data, three distinct hydrologic zones were identified for compartmentalization (Becker, Malone, et al., 1998; Bartetzko et al., 2001) (Fig. **F11**). The upper zone (112–147 mbsf) represents an opportunity to focus on the extent of sediment–basalt exchange of microbes and ions. This upper crustal portion was sealed with a combination packer (inflatable and swellable) in the 11.75 inch casing, and the borehole was sealed with an inflation packer against the wall of the basaltic formation at the lower portion of the interval. In this interval, slotted casing was deployed from 114 to 140 mbsf. The middle zone ranges from 147 to 462 mbsf. The deeper section of the borehole was sealed with an inflation packer. In this depth range the spontaneous potential data are consistent with multiple zones of fluid influx. To capture some of this flow, two slotted casing sections were deployed from 211 to 282 mbsf and from 409 to 436 mbsf. Depths greater than 462 mbsf represent the lower crustal zone, which is less permeable and warmer than the two zones above. Here a combination of slotted and perforated casing and drill collars was used from 473 to 532 mbsf.

Because of the need to keep the CORK in tension, heavy perforated drill collars were used at the bottom of the CORK assembly. The deepest section of the CORK comprises (from the bottom up) a bullnose that is not restricted (terminates at 532.8 mbsf), six perforated 6 inch drill collars, a crossover, a section of perforated 5.5 inch casing, a crossover to fiberglass, three 4.5 inch slotted fiberglass casings, a single nonslotted fiberglass casing, a crossover, a landing seat (2.875 inch), and an inflatable packer. All steel portions are coated with either Xylan, TK-34XT, or Amerlock to reduce reactivity (**Edwards et al.,** 2012; **Orcutt et al.,** 2012). However, steel that was exposed as a result of handling operations was painted with a fast-drying epoxy paint (Alocit 28) that could dry in the water while the CORK was being lowered below the rig floor. The casing exposed to the middle and upper sections is fiberglass, some of which was slotted (**Edwards et al.,** 2012), except for the packer that separates the upper and middle sections. Like the exposed steel below, the exposed steel on the packer was painted with the Alocit epoxy. Above the combination packer is steel casing, which was untreated because this section is within the Hole 395A 11.75 inch casing and is not exposed to the formation. Umbilicals with internal stainless steel or Tefzel tubing were strapped to the outside of the casing and connected to miniscreens located at ~120, 430, and 506 mbsf. At each depth, four miniscreens were deployed and attached to stainless steel tubes (one with ⅛ inch diameter and two with ¼ inch diameter) and a Tefzel tube (0.5 inch diameter). An additional 0.5 inch stainless steel tube was used to inflate the packers, which have a check valve that opens at 25 psi.

Downhole samplers and experiments

The downhole tool string consists of four sets of six different OsmoSampler packages, dissolved oxygen sensors and recorders, miniature temperature recorders, sinker bars, sealing plugs, and interspersed sections of ⅜ inch (0.95 cm) Spectra rope (Table T3). Complete details of this deployment are provided in Edwards et al. (2012), but a summary is provided here for completeness. The general features of OsmoSamplers are summarized in detail in Wheat et al. (2011).

In brief, OsmoSampler packages consist of a series of small-bore tubing, osmotic pumps, and in some cases microbial substrate materials (Flow-through Osmo Colonization System [FLOCS]; Orcutt et al., 2010, 2011). Each package includes a 0.5 inch (1.27 cm) stainless steel strength member and stainless steel couplers to attach to other packages, line, sinker bars, or sealing plugs. All of the pump parts, excluding the membranes and O-rings, are made from polyvinyl chloride (PVC). Membranes were purchased from Alzet (2ML1), and O-rings are silicon based. Sample tubing is ¹⁄₁₆ inch copper or Teflon with an inner diameter of ~1.19 mm and a length of 1000 ft (304 m). This tubing is spooled onto rods such that the rod and tubing fit within the inner diameter of a protective tube of clear PVC. The OsmoSampler packages were made with two different outer diameters (2.875 inch [7.30 cm] and 2.5 inch [6.35 cm]) in order to fit within the confines of the borehole, which was constrained by the inner diameter of the three landing seats that isolate the three monitoring intervals inside the 4.5 inch casing (tapered gravity seals).

Six types of OsmoSampler packages were deployed: standard, gas, acid addition, BioOsmoSampling System (BOSS), enrichment, and microbiology (MBIO) (Wheat et al., 2011). The standard package consists of three Teflon sample coils and a pump with either eight or five membranes, with more membranes for the larger diameter packages. Similarly, the gas package has three copper sample coils, with the number of membranes depending on the outer diameter of the tubing. The acid-addition package is a standard package with two additional Teflon coils and an additional one-membrane pump at the intake. This pump draws borehole fluids into one coil while expelling saturated salt from the pump into the other coil filled with dilute subboiled HCl (20 mL 6N HCl in 500 mL of deionized distilled [18.2 MΩ] water). This acid-filled coil is attached to a tee, with the other tee positions connected to a short inlet to sample borehole fluids and to the intake of the equivalent of a standard OsmoSampler package. The BOSS package is identical to the acid-addition package, except that a solution of 2 mL of saturated $HgCl_2$ in 75% RNAlater (Ambion) replaces the dilute acid solution. The enrichment package also has the same configuration, but a solution of 1.2 mM nitrate in sterile seawater replaces the dilute acid solution, and a FLOCS microbial colonization experiment (Orcutt et al., 2011, see below) is connected to the tee that leads to the standard package. Fluids flow through two FLOCS columns before reaching the first Teflon sample coil. Attached to the FLOCS is a series of mineral chips that are exposed directly to the formation. The MBIO package consists of two standard packages, each with a FLOCS experiment attached to the intake. Only one FLOCS column is attached to each standard package, and mineral chips are included and exposed to the formation.

To investigate the activity and diversity of microorganisms in deep basement, microbial colonization experiments with defined mineral substrates are placed in the formation to encourage in situ growth seeded by planktonic microorganisms in the borehole fluids. The concept, design, and demonstration of the FLOCS is discussed in detail elsewhere (Orcutt et al., 2010, 2011; Wheat et al., 2011) and is only briefly outlined here. The design of the FLOCS units used during Expedition 336 is described in Edwards et al. (2012). The Hole 395A CORK instrument string contains a total of eight FLOCS units: four in the enrichment OsmoSampler packages and four in the MBIO packages. The enrichment OsmoSampler FLOCS units pull formation fluids mixed with enrichment solution through two serially connected chambers (Table T3) containing cassettes of different substrates (basalts, olivine, siderite, sphalerite, chalcopyrite, pyrrhotite, hematite, pyrite, and glass wool and beads; for details see Edwards et al., 2012). Separate osmo pumps irrigate each chamber of the FLOCS unit in the MBIO OsmoSampler packages. One chamber contains basalts, olivine, siderite, sphalerite, chalcopyrite, pyrrhotite, and hematite; the other chamber contains larger volumes of glassy basalt and pyrite, plus glass wool and beads. All of the FLOCS have eight panels of rock chips (2–4 chips/panel, ~3 mm × 3 mm) mounted on one side of the FLOCS body to allow passive colonization on polished rock chips (as opposed to the slow advective pumped colonization in the chambers; see Edwards et al., 2012, for details). The enrichment OsmoSampler FLOCS contains grids of barite, Hole 395 basalts, sphalerite, pyrite, goethite, and hematite. The MBIO OsmoSampler FLOCS contains grids of rhyolite, glassy basalt, Hole 395A basalt, olivine, chalcopyrite, pyrrhotite, and magnetite.

Attempts were made to minimize potential contamination of the FLOCS experiments. All rock substrates were autoclaved prior to use, and gloves were worn during assembly of the units. Prior to connection to the OsmoSampler package, the chambers of all FLOCS units were flushed with ethanol, distilled water, and filter-sterilized (0.2 µm mesh) Site 395 surface seawater, and the exterior of the FLOCS body with the mounted rock-chip panels was washed in a sterile Whirl-Pak bag with ethanol and kept closed in baked (450°C) aluminum foil wrappers. Assembled OsmoSampler packages sat for 1–2 days prior to deployment, with the intake for the FLOCS chambers connected to a syringe of sterile filtered seawater. The rock-chip panels were exposed to minimally circulating air during this time (i.e., circulation was restricted to the few small openings in the OsmoSampler package sleeves).

Autonomous temperature and oxygen measurement probes were deployed at different locations along the instrument string (Table **T3**). Two novel dissolved-oxygen probes (Aanderaa Optode 4330, thermal couplers, and digital recorders) were deployed in the uppermost section and the lower middle sections of the CORK. Because of their diameter, these instruments could not pass below the deepest landing seat. These recorders were programmed to measure dissolved oxygen and temperature once per day, with enough memory and battery life to record data for ~5 y. Excluding the two temperature sensors in the dissolved-oxygen probes, seven other temperature probes were deployed. These probes were purchased from Antares and Onset, and they fit within holes drilled into the plastic couplers in the OsmoSampler packages. Both probes provide a dynamic range that covers the expected temperatures (2°–30°C), but the Antares probes have greater sensitivity (see **Edwards et al.,** 2012).

The remaining elements of the downhole tool string include the sinker bar, sealing plugs, and Spectra rope. A sinker bar was placed at the bottom of the string to help pull the string elements into the hole. Both the sinker bars and the sealing plugs are made of stainless steel and coated with Xylan. Three different sealing plugs were fabricated with sealing surfaces with diameters of 3.375, 3.125, and 2.875 inches. The Spectra rope (⅜ inch) allowed us to space out the OsmoSampler packages, sinker bars, and plugs to achieve the scientific goal of isolating and sampling specific horizons. In Table **T3** the exact lengths of Spectra rope are provided, as well as the expected length when taking into account a stretch of 1.5%. Note that some of the Spectra depths in the table exceed that of the hole. This additional Spectra rope was desired to ensure that the plugs would reach the sealing seats.

Scientific and operational implications

The CORK was deployed from the drillship and lowered about 100 m below the ship. The downhole instrument string was deployed, but the seafloor (top) plug did not latch after several attempts. The CORK was retrieved, and the top of the wellhead was brought to the rig floor. Several attempts with two different top plugs had the same result. Given that this hole is slightly underpressured, the top plug was deployed as a nonlatching gravity seal. Although the wellhead was exposed, the ball valve on the wellhead was replaced by a plug because the ball valve was cracked during the initial lowering. During repairs, the inner CORK tubing was filled with water to the level of the ball valve port. This water remained, indicating the upper gravity plug (3.375 inch) was sealed.

The CORK was then deployed and apparently landed in the reentry cone. During subsequent operations the wellhead underwent compressional forces that bent the wellhead and severed it above the cup packers, ~4 m below the reentry cone. This act also parted the Spectra rope and the umbilicals, leaving the downhole tool string in place. On the basis of recovered pieces of the wellhead, the CORK tubing near the seafloor is likely not completely rounded, but it may not be closed enough to restrict recovery of the downhole samplers, sensors, and experiments. Several stainless steel tubes likely extend above the cup packers and the top of the 4.5 inch casing. These tubes may impede recovery of the downhole instrument string. A plan is being formulated to recover the downhole instrument string in 4 y with an ROV.

The CORK pressure logging system was recovered along with the broken-off wellhead. The recorded data do not definitively resolve whether or not the downhole CORK packers actually inflated. The seafloor gauge and three formation gauges show very similar slight increases in pressures after the time of attempted inflation, but the similarity to the seafloor gauge could be consistent with a tidal influence without inflation of the downhole packers.

Microbiology

This section documents samples taken on 23 September 2011 from the old Hole 395A CORK ROV platform, thermistor cable, and CORK wellhead elements. This CORK observatory was installed in 1997 during ODP Leg 174B (Becker and Davis, 1998; Becker et al., 1998; Becker, Malone, et al., 1998).

The old Hole 395A CORK and ROV platform were picked up from the seafloor by a recovery tool and transported through the water column for ~9 h during the pipe trip before recovery in the moonpool. In the moonpool, rust deposits/mats on the ROV platform were sampled using autoclaved metal tools and sterile 50 mL conical vials, sterile Whirl-Pak bags, and sterile deoxyribonuclease (DNase)/ribonuclease (RNase)–free 1.5 mL centrifuge tubes. Immediately after collection, the samples were stored on ice until processing in the laboratory a few hours later.

As shown in Figure **F12**, several different areas of the platform were sampled, with multiple samples originating from the same spot in some cases. Samples were labeled according to the area where they were collected. Table **T5** lists the different samples that were collected and how they were processed.

After the ROV platform was sampled and cut off of the CORK body, the thermistor cable was pulled out of the top of the CORK wellhead on the rig floor using Yale grips and instrument string lifting tools. Note that the thermistor cable was exposed to the water column during the pipe trip and ROV platform sampling. Each Yale gripped section was pulled up into the derrick and suspended in mid-air for as long as 10 min before being pulled down on the rig floor for cutting out the thermistors and adjacent cable sections. Rig floor workers wore fresh nitrile gloves, and handling of the cable around the sampling locations surrounding the thermistors was minimized when possible to avoid contamination. A ~1 m section immediately below each thermistor section was secured, and then this section (along with the adjacent thermistor) was cut out with rig floor loppers (not sterilized). The thermistor was immediately cut off, and the subsequent thermistor cable cut between the locations where it had been handled into ~10–15 cm pieces and placed directly into sterile Whirl-Pak bags or conical vials, all of which were stored on ice until processing a few hours later. Note that samples were labeled 1–10, with 1 equaling the shallowest thermistor, although this numbering sequence is in reverse of the thermistor labeling (i.e., microbiology Thermistor 1 samples equate with Becker's Thermistor 10 samples; Table **T6**). Scrapings of mineral deposits were also collected into 1.5 mL eppitubes from the cable sinker bar (N = 8), the packer inflation element (N = 11; Fig. **F13**), and the stinger (N = 3; Table **T7**).

Enrichments were initiated on board for some of the samples to select for iron-oxidizing bacteria. Prior to inoculation, six 150 mL serum bottles were filled with 60 mL autoclaved and filter sterilized seawater. Each was stoppered and then brought to and maintained at a boil for 5 min with a 22.5 gauge needle as a pressure outlet. After 5 min, another needle was inserted, from which flowed nitrogen gas at 2–4 psi. The bottle was flushed with nitrogen while boiling for 5 min. At this point, both needles were removed and the bottles were allowed to cool on the bench top. In an anaerobic chamber, a "tip of spatula" amount of material from the CORK ROV platform Area 9D and Packer 1 samples (Tables **T5, T7**) were added into two bottles each. Additionally, the ThermStr-5 sample, representing a mid-depth string sample, was shaken in a Whirl-Pak bag with 50 mL autoclaved seawater. The bag was then vortexed for 90 s to shake loose any colonizing microbes on the external polyethylene rope. One milliliter of this water was used as inoculum in one bottle. After inoculation, 0.25 g of steel wool was added to all bottles, and 15% of headspace was replaced with pure O_2. One bottle was treated as a negative control (no inoculum).

Enrichments were also established for anaerobic heterotrophs. Media consisted of 1 L of GYPS (see **"Microbiology"** in the "Methods" chapter [Expedition 336 Scientists, 2012a]) that was autoclaved, dispensed into 60 mL serum vials through a 0.2 µm mesh filter, stoppered, and then boiled for 5 min with a needle vent, followed by boiling while purging with nitrogen gas. Cultures were inoculated in an anaerobic chamber, as described above, and incubated in the dark at 10°C.

Enrichments were also established to isolate high pressure–adapted heterotrophs from Hole 395A CORK rust and the thermistor cable. Rust samples (~100 µL) were mixed with 25 mL of Marine Broth 2216 or 1:10 diluted Marine Broth 2216 (for oligotrophic heterotrophs) in glass bottles. Samples were stored at 4°C for shore-based experiments. Thermistor cable samples were also stored at 4°C in sterile Whirl-Pak bags for shore-based experiments. In the shore-based laboratory, high-pressure incubation will be utilized to enrich and select for high pressure–adapted microorganisms (see **"Microbiology"** in the "Methods" chapter [Expedition 336 Scientists, 2012a]). Isolated high pressure–adapted microorganisms will then be characterized and compared with other deep-sea high-pressure microorganisms isolated from different ocean provinces.

Downhole logging

Downhole logging measurements obtained from Hole 395A include natural total and spectral gamma ray, temperature, and deep UV (<250 nm)–induced fluorescence. Following some initial issues with a rock ledge in the borehole, an open-hole section of 405.74 m was logged with the microbiology combination (microbiology combo) tool string (197.76 m [pipe depth]) to 603.5 mbsf. The microbiology combo, which includes the logging equipment head-mud temperature (LEH-MT) (cablehead with temperature measurement), the Hostile Environment Natural Gamma Ray Sonde (HNGS), the General Purpose Inclinometry Tool (GPIT), the Lamont Multifunction Telemetry Module (MFTM), the Lamont Modular Temperature tool (MTT), and the DEBI-t, was the only tool string deployed in Hole 395A (Fig. **F14**).

Logging operations

Downhole logging of Hole 395A started once the old CORK was removed at 0335 h on 24 September 2011 (all times are ship local, UTC – 3 h) (see Table **T8** for more logging operation details). We aimed to log a relatively undisturbed hole with the microbiology combo; therefore, there was no traditional hole preparation. For full logging operational details, please see **"Operations."** The drill pipe was fitted with a logging bit that was initially set at 54 mbsf for logging, but note that casing is present in the hole to 112 mbsf.

In a first attempt, the microbiology combo tool string was lowered into Hole 395A at 0500 h on 24 September (see Table **T8** for more operational details). The wireline heave compensator (WHC) was optimized while the tool string was in the pipe in order to minimize any disturbance in the hole, but because of the very low levels of heave (<0.5 m peak to peak), the WHC was not used for logging operations. At 0952 h, following some effort, the run was aborted because of an impassable rock ledge in the hole at 174 m wireline log depth below seafloor (WSF). The tool was returned to the surface and was rigged down by 1410 h. To remove the ledge issue in Hole 395A, the logging bit was run down past the obstruction and set lower at 197.76 m drilling depth below seafloor (DSF) in readiness for a second logging attempt.

The microbiology combo tool string was lowered into the hole at 1610 h (24 September). For tool and measurement acronyms, see **"Downhole logging"** in the "Methods" chapter (Expedition 336 Scientists, 2012a). The tool string performed a full downlog starting from 4448 m wireline log depth below rig floor (WRF) to the total planned logging depth (note that we did not want to tag the bottom of Hole 395A with the DEBI-t), a full uplog into casing, a second downlog to total logging depth, and a second uplog. The final uplog ended when the tool string crossed the seafloor (inside the drill string and casing), marked by a peak in natural radioactivity visible in the HNGS gamma ray measurement. The seafloor was detected at 4496 m WRF, which is within 2 m of the drillers seafloor depth estimate from ODP Leg 174B. The microbiology combo tool string reached the rig floor and was rigged down at 0330 h on 25 September, at which time logging operations in Hole 395A were completed.

Data processing and quality assessment

The logging data were recorded on board the *JOIDES Resolution* by Schlumberger and archived in Digital Log Interchange Standard (DLIS) format. Data were sent via satellite transfer to shore, processed, and transferred back to the ship for archiving in the shipboard database. Processing and data quality notes are given below. The DEBI-t data recorded to SD memory card (video and full systems and fluorescence data in binary format) were also sent via satellite for archiving; however, data conversion and depth matching of the DEBI-t to the other final depth-matched log data) were done on board (see **"Downhole logging"** in the "Methods" chapter [Expedition 336 Scientists, 2012a]).

Depth shifts applied to the logging data were performed by selecting a reference (base) log (usually the total gamma ray log from the run with the greatest vertical extent and no sudden changes in cable speed) and aligning features in equivalent logs from other tool string passes by eye. In the case of Hole 395A, the base log was the gamma ray profile from Pass 1 (main) of the Azimuthal Resistivity Imager (ARI) tool string run during Leg 174B. The original logs were first shifted to the seafloor (4496 m WRF), which was determined by the step in the gamma ray value. This depth did not differ from the seafloor depth given by the drillers.

Proper depth shifting of wireline logging depths measured during Expedition 336 to downhole data collected during Leg 174B was essential for verifying the new data collected and to look for any changes in values in the formation left open to fluid circulation for 14 y. The seafloor was the only target that offered potential wireline logging depth references. However, it should be noted that data acquired at the seafloor/seawater interface resulted from logging through the BHA and casing, so data from this interval are of poor quality and highly attenuated and should only be used qualitatively. However, they are adequate to pick out the seafloor. The quality of wireline logging data was assessed by evaluating whether logged values are reasonable for the lithologies encountered during Leg 174B, by checking the consistency between different passes of the same tool, and by checking the most recently collected data against previous measurements. Specific details of the depth adjustments required to match logging runs/data are available in the logging processing notes on the log database for Hole 395A (**iodp.ldeo.columbia.edu/DATA/**).

Preliminary results

Downhole logging measurements obtained from Hole 395A include natural total and spectral gamma ray, temperature, and fluorescence. The results are summarized below.

Gamma ray measurements

Standard, computed, and individual spectral contributions from ^{40}K, ^{238}U, and ^{232}Th were part of the gamma ray measurements obtained in Hole 395A with the HNGS (see Table **T6** in the "Methods" chapter [Expedition 336 Scientists, 2012a]). The total gamma ray measurements through the BHA and casing show three main anomalies from the seafloor to ~197 m wireline log matched depth below seafloor (WMSF) (Fig. **F15**), and the open-hole gamma ray measurements cover a total of 388.22 m downhole (from 112 mbsf, where casing was set). The slightly shorter overall coverage of this tool compared with the DEBI-t is the result of the HNGS being ~17 m higher in the tool string (Fig. **F14**).

Gamma ray measurements in basaltic oceanic crust are typically low (e.g., Bartetzko et al., 2001; Barr et al., 2002), and the lithologic units penetrated and logged in Hole 395A follow this trend. Total spectral gamma ray (HSGR) values obtained with the HNGS in Hole 395A range from 0.012 to 16.451 gAPI, with a mean of 6.73 gAPI. Potassium values are relatively low, with values ranging between 0.0002 and 0.73 wt% and a mean of 0.32 wt% (Fig. **F16**), which is a much larger range than values obtained from core measurements during Leg 174B (0.10–0.29 wt%; Shipboard Scientific Party, 1979). Uranium values range between 0.001 and 1.54 ppm and have a mean of 0.52 ppm. Thorium values range from 0.001 to 2.02 ppm, with a mean of 2.63 ppm. Comparison of gamma ray data collected during Expedition 336 to that collected during Leg 174B shows good agreement (Fig. **F16**). The downhole variation in gamma ray intensity collected most recently displays the same saw-tooth pattern recorded during Leg 174B (Bartetzko et al., 2001). However, in open hole, total gamma ray values are marginally higher (~5 gAPI) in the most recently collected data set than those taken 14 y ago. This increase could be driven by alteration of the formation nearest the borehole (over the last 14 y), or it could be simply instrument related. The data collected during this expedition and Leg 174B both used the HNGS; however, calibrations can vary.

Temperature

Temperature ranges from 1.94° to 18.42°C in Hole 395A. Downhole logging measurements were taken as soon as the old CORK was removed so that an undisturbed temperature profile could be obtained. Over the drilling and downhole measurement history of Hole 395A, temperature has been measured four times, including this expedition (DSDP Leg 78B and ODP Legs 109 and 174B) (Fig. **F17**). Considering all of these temperature measurements, Hole 395A has behaved consistently over time. Each of the temperature logs shows strongly depressed borehole temperatures that are near isothermal to ~300 m WMSF. From 404 m WMSF all of the temperature profiles taken in Hole 395A exhibit temperatures above 3°C (Fig. **F17**). The temperature profiles recorded during Expedition 336 are nearly identical to those determined during Leg 174B. Most notable is the sudden change in the temperature gradient below a brecciated zone at ~425 mbsf. That zone has been proposed to correspond to the deepest aquifer below which seawater can no longer recharge into the formation and heat transport is conductive (Becker et al., 1998). The similarity of the temperature records indicates that the hydrological state has not changed in the past 14 y.

Fluorescence

Fluorescence data from the DEBI-t indicate the presence of particulate organic matter throughout Hole 395A (Fig. **F18**). There is a general trend in the signal intensity as the instrument descends through the borehole, and this trend appears to be a reflection of changes in the intensities of the 360, 380, and 455 nm bands. It is possible that the initial intensity variation that occurs in these channels between 197 and 250 m WMSF is a result of the decreased influence of material in the fluids diffusing the logging pipe. However, the change in intensity that occurs between 340 and 455 nm is quite sudden at the horizon where the instrument clears the pipe; thus, any subsequent influence from any material discharging from the logging pipe may be minimal.

A second change in the intensity of specific bands is discernible at ~450 m WMSF. This change coincides with the temperature profile, reflecting a shift in the influence of ocean bottom water compared to water from the surrounding aquifer. At this horizon there is a decrease in intensity in the 300 and 455 nm bands and a slight increase in intensity in the 340 and 360 nm bands. These changes in intensity may reflect a change in the organic concentration, as well as the types of organics found in the lower portions of Hole 395A, where the water has reached a state of equilibrium.

Excitation with a 224 nm source induces a peak fluorescence emission at 300 nm for spores and 320 nm for bacteria (Bhartia et al., 2010). Although there is evidence of a bacterial signature, the signal intensities suggest cell densities that are at limit of detection for DEBI-t, based on laboratory calibrations. Thus, we are unable to quantify the bacterial biomass within Hole 395A. However, the signal corresponding to spores (300 nm) was much greater, and suggested a spore or sporelike density of up to 10^6 spores/mL. Although the fluorescence from these channels shows some variation, the general trend indicates that biomass is distributed throughout the borehole.

DEBI-t also recorded video information, which indicated that there was a large amount of particulate material within the hole. The majority of this material appeared to be oxidized iron particles, as well as some floccular material. The high particle load within Hole 395A makes it difficult to ascertain how much of the signal collected by DEBI-t came from the wall and how much from the water column. Nevertheless, the uniform distribution of particulate matter throughout the hole would seem to correlate with the relatively homogenous biosignal seen in the logging runs.

Log units

Electrofacies (EFA) for Hole 395A defined by Bartetzko et al. (2001) were primarily defined using resistivity, *P*-wave velocity, density, and total gamma ray logs, in addition to a sequence of eruptive units (Fig. **F15**).

Four EFAs were identified from the logs by Bartetzko et al. (2001): (1) massive basalt, (2) altered lava flows, (3) pillow basalts, and (4) rubble zones. (Note that all of the following log values were taken from Bartetzko et al., 2001.) The massive basalts (1) are characterized by high average density values of 2.8 g/cm³, high formation resistivities ranging from 50 to 500 Ωm, and high *P*-wave velocities of 6100 m/s, on average. Total gamma ray values are low, with an average value of 1.8 gAPI. Altered lava flows (2) were not identified in the cores, but their log responses show a stronger influence of alteration and fracturing than the massive basalts. Resistivity and density values are lower in the altered lava flows than in massive basalts, with resistivity varying between 25 and 100 Ωm. The average density value is 2.7 g/cm³, and total gamma ray values are higher compared to massive basalts, with a mean value of 3.8 gAPI. Pillow basalts (3) of Hole 395A are described as fine- to very fine grained glassy rocks with varying degrees of alteration. The significantly higher fracturing and associated alteration in pillow basalts, as well as the high porosity of interpillow areas, produce characteristic log responses. Fractures and voids fill with seawater, and conductive clay minerals may also preferentially concentrate in these voids, causing the measured resistivity log to decrease. Typical values range between 15 and 200 Ωm. Additionally, there are associated low density values of ~2.5 g/cm³, low *P*-wave velocities of ~4.9 km/s, and high total gamma ray values (mean value = 6.2 gAPI). The final rubble zone (4) electrofacies was given to intervals where significant borehole enlargements strongly influenced the log responses.

The EFA log devised by Bartetzko et al. (2001) is divided into three intervals (100–169, 182–417, and 430–590 mbsf) separated by thick rubble zones. The section between 182 and 417 mbsf is composed of alternating pillow basalts and lava flows (both massive and altered). The upper- and lowermost intervals consist exclusively of pillow basalts. In the uppermost interval, the lithology is homogeneous and uniform log responses were noted (Fig. **F15**). The lowermost interval below 430 mbsf is characterized by increasing log properties with depth, especially electrical resistivity. Bartetzko et al. (2001) attribute this trend to the dominant effect of a decrease in fracture porosity caused by closure from the increasing overburden. Although, Bartetzko et al. (2001) do not provide a classification of different electrofacies for the lowermost interval, they report that the core results indicate that only pillow basalts and breccias are present and the existence of massive basalts is unlikely. Hence, they present a realistic uniform pillow basalt classification for this lower region.

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Figure F1. Schematic of Hole 395A subseafloor borehole observatory (CORK) configuration. Red "X" marks the portion of the CORK head that broke off during the final step of installation (see text for explanation).

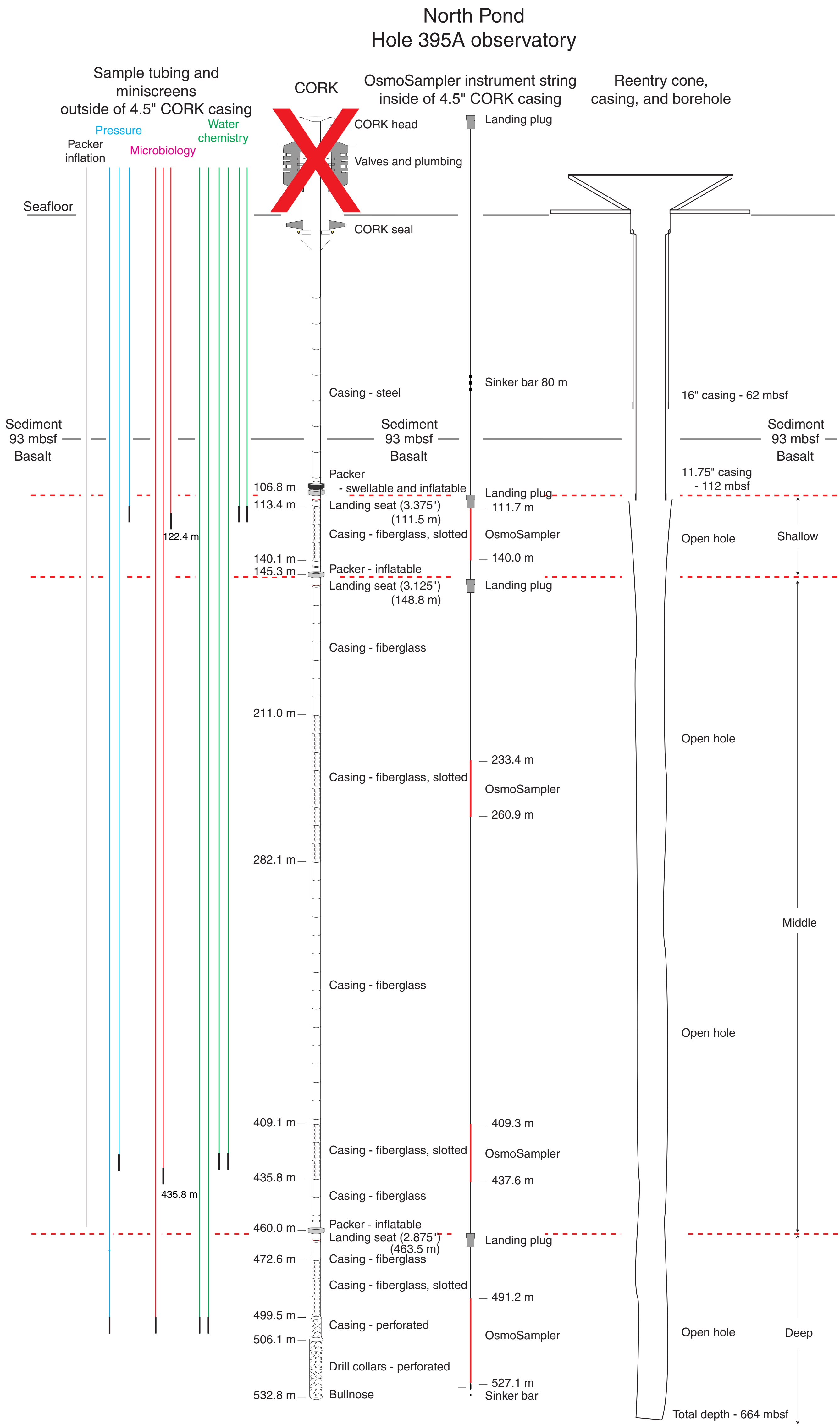

Figure F2. Photograph of damaged CORK head being recovered in the moonpool.

Figure F3. Photograph of Hole 395A L-CORK configuration before deployment, showing extension required to fit the old Deep Sea Drilling Project (DSDP)-style reentry cone and stabilizer fins that should have passed through the 24 inch transition casing.

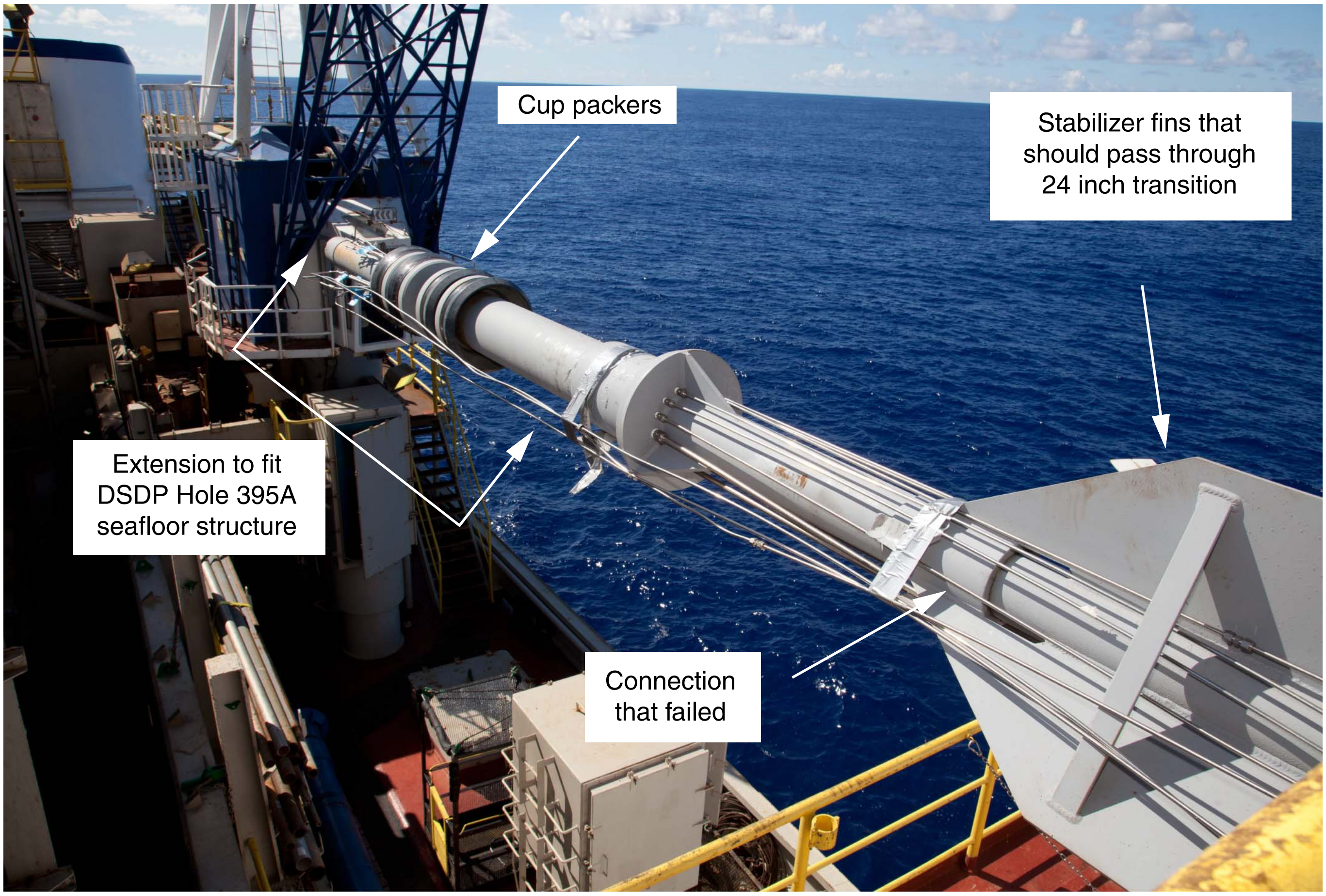

Figure F4. Photograph of broken casing in lower part of new L-CORK and deformed stabilizer fins that should have passed through the 24 inch transition inside the seafloor structure.

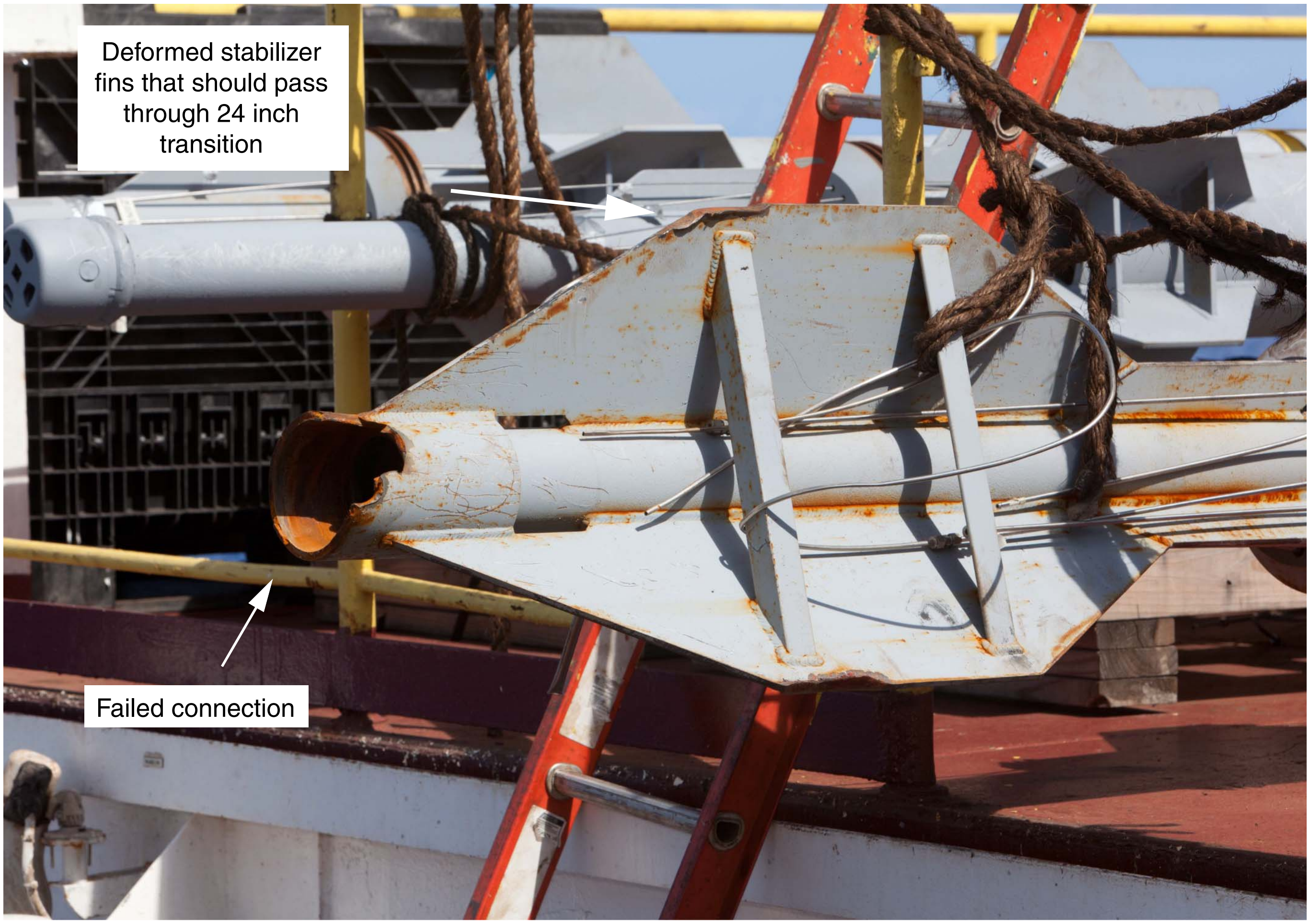

Figure F5. Close-up photograph of deformed ⅜ inch steel gussets between instrument bays.

Figure F6. Photograph of deformed stabilizer fins observed on the failed new CORK head.

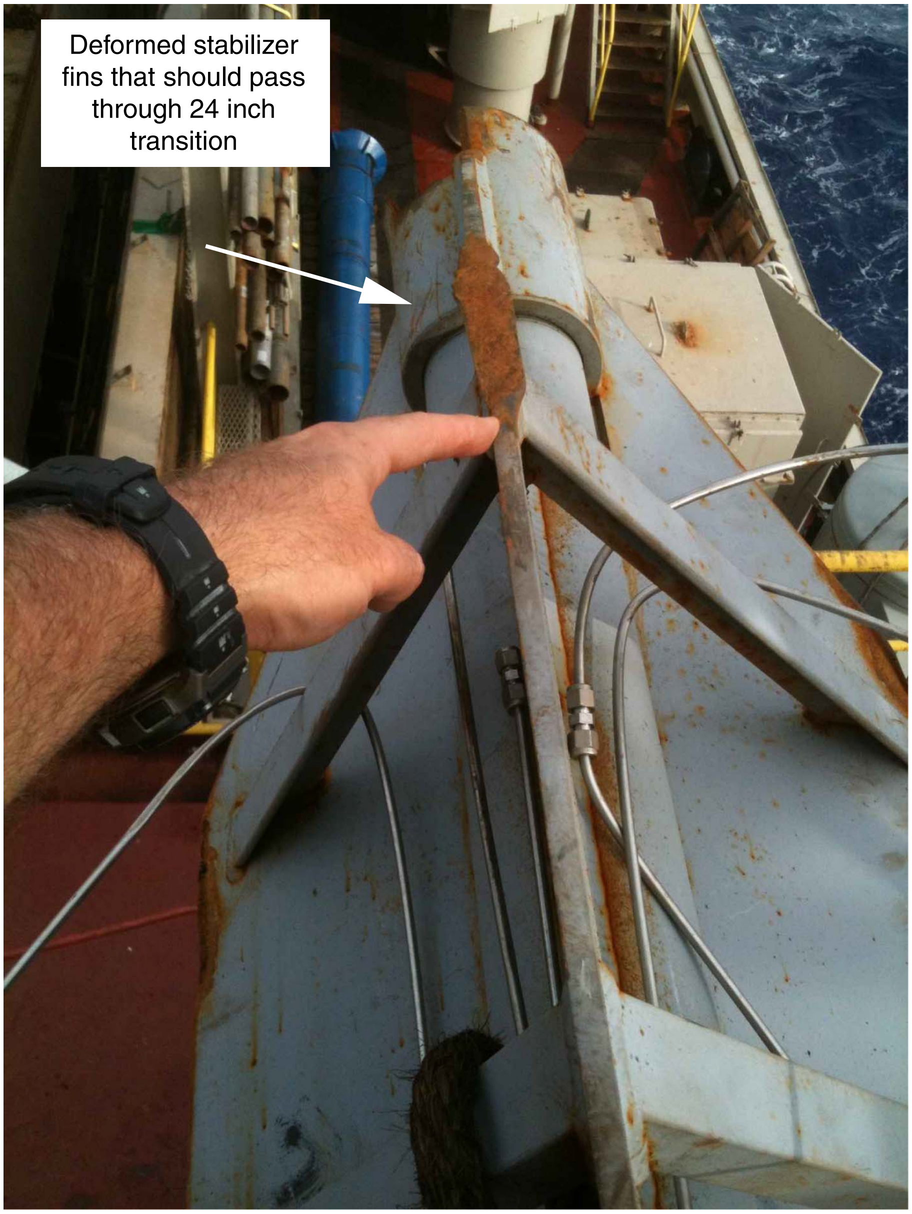

Figure F7. Cartoon drawings of current configuration of Hole 395A CORK completion. **A.** Completion as currently installed (see Fig. F8). **B.** Vertical cross-section without ROV platform. The CORK casing broke off ~4 m below top of reentry cone. **C, D.** View down into throat of reentry cone, showing inferred length of tubing remaining in hole based on observations of recovered CORK head; tubing is displayed as directly vertical but is likely not; red circles show location of top of 24 inch transition tubing through which we infer the CORK fins were not able to pass.

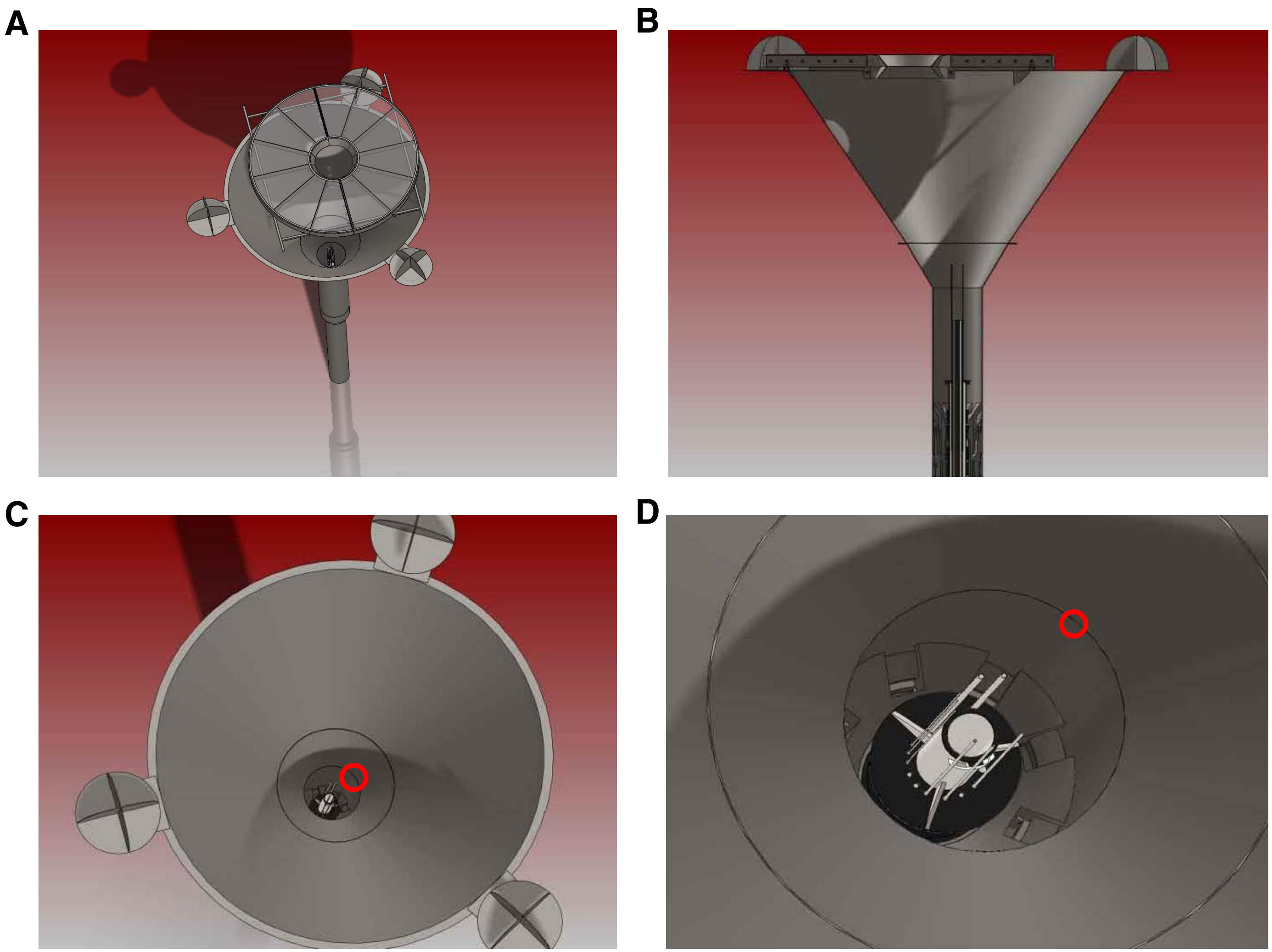

Figure F8. Near-bottom camera views of the current configuration of the Hole 395A CORK completion, showing reentry cone with off-center ROV platform. Tube extending down from the top in both images is the drill string with 10.75 inch casing running tool.

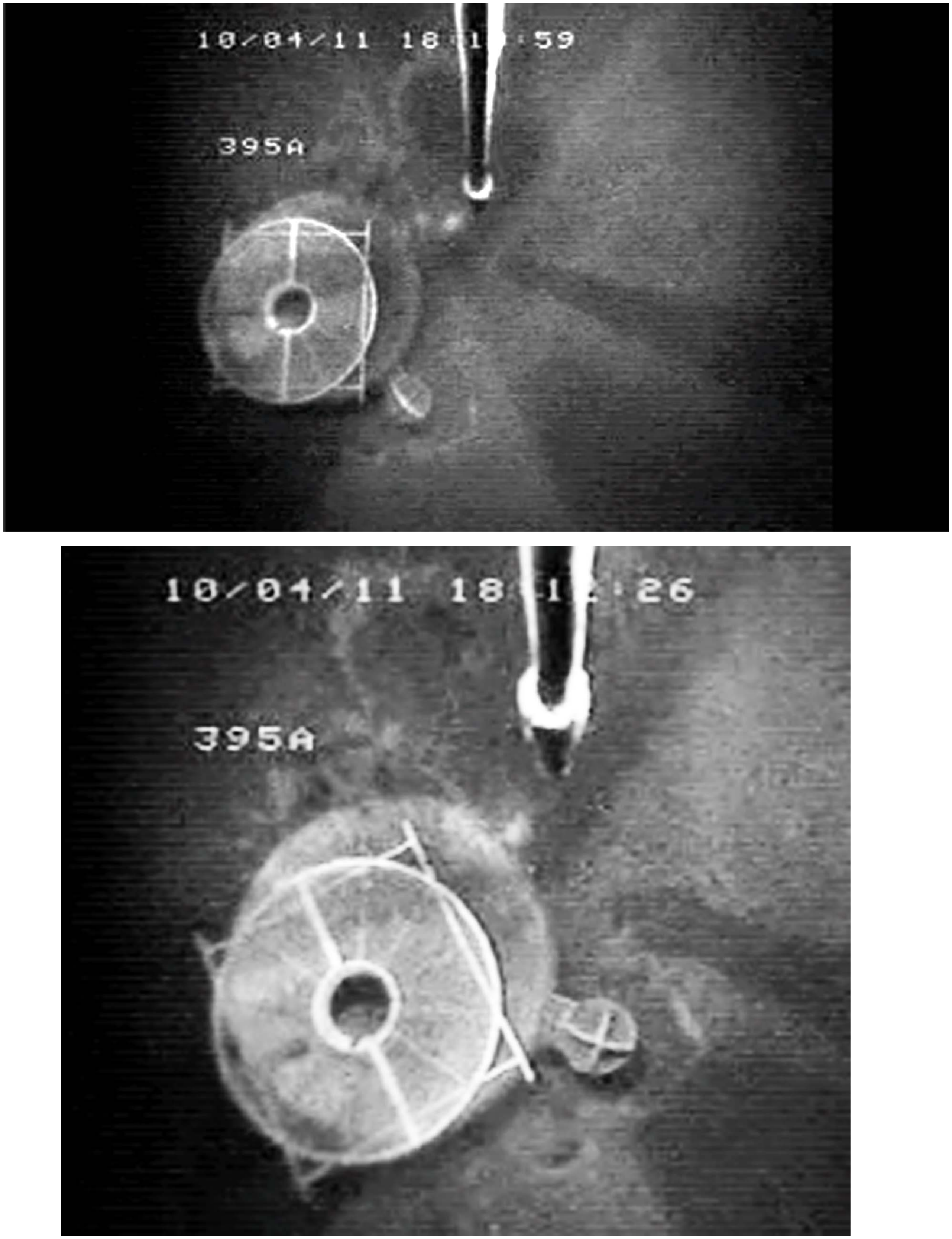

Figure F9. Plot of new subseafloor borehole observatory (CORK) pressure data recorded during attempted landing, attempted packer inflation, remotely operated vehicle (ROV) platform installation, attempted unjarring of CORK running tool, and ultimately CORK head failure. Labeled times are Universal Time Coordinated (UTC); ship local time is UTC – 3 h.

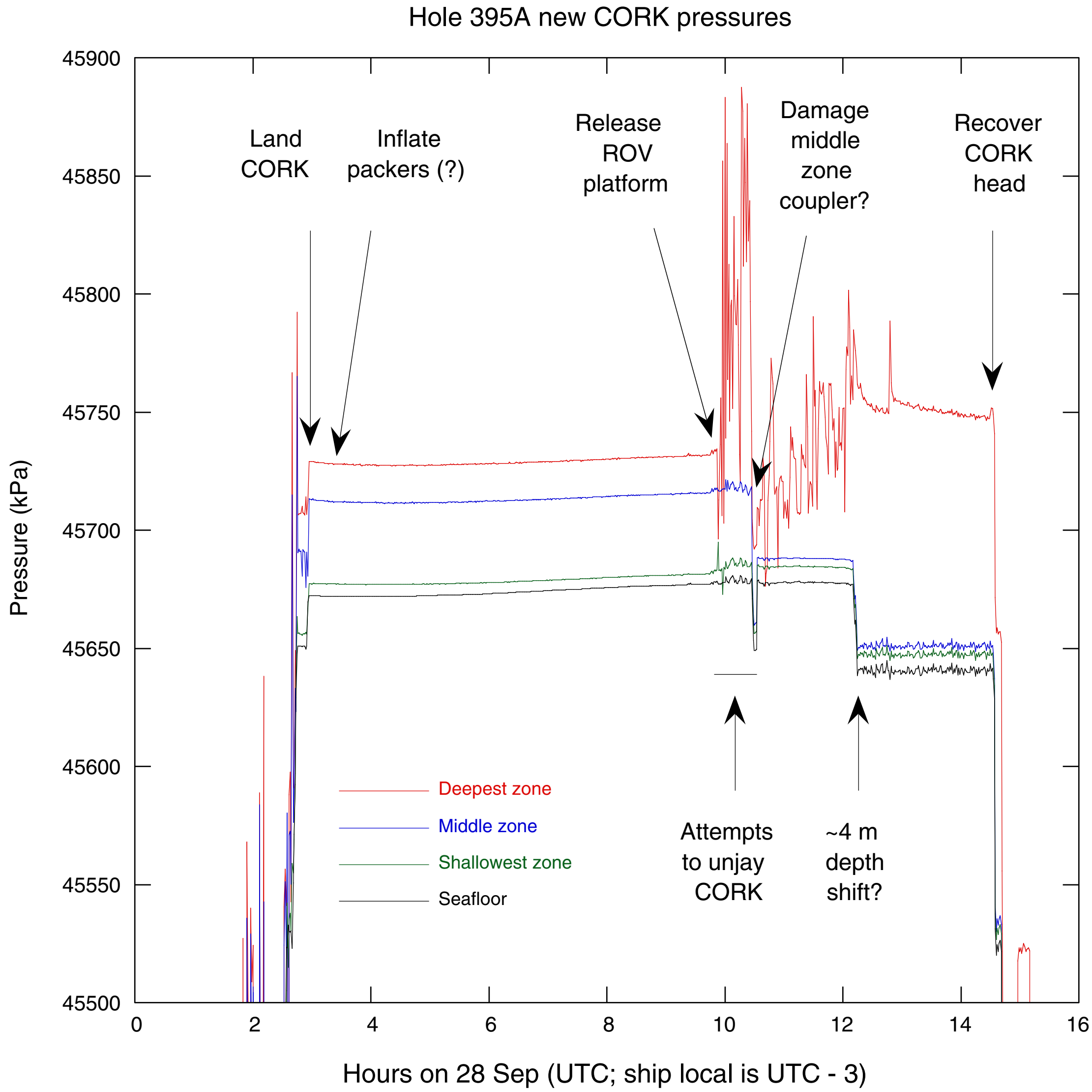

Figure F10. Close-up photograph of deformed stabilizer fins observed on the old Leg 174B subseafloor borehole observatory (CORK) retrieved from Hole 395A.

Figure F11. Plots of caliper, spontaneous potential (SP), and temperature logs from Hole 395A collected during ODP Leg 174A. Yellow bars = locations of CORK packers intended to isolate different hydrologic zones to monitor and sample.

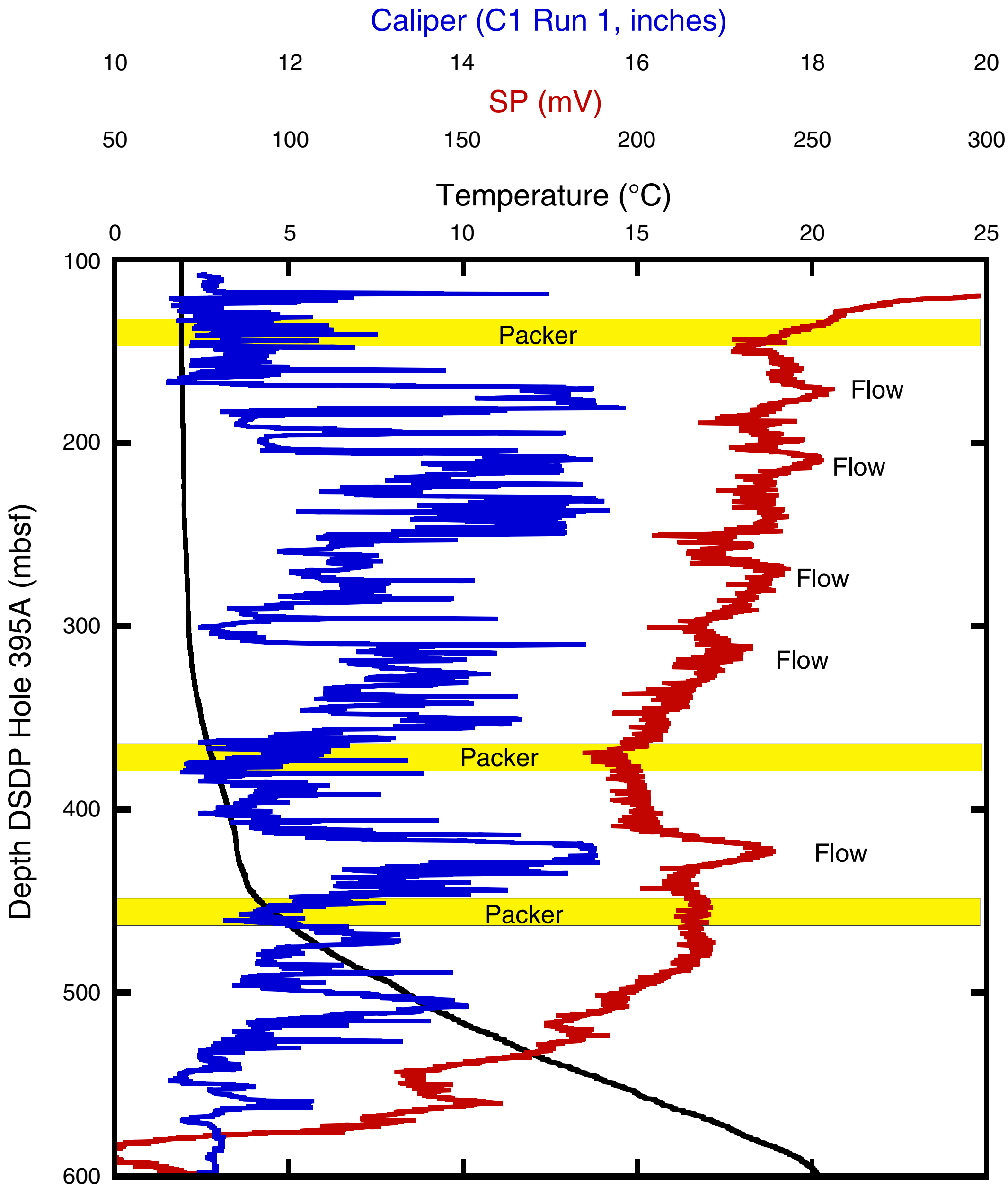

Figure F12. Photographs of rust deposits on the old Hole 395A CORK ROV platform. Left: indication of Areas 1–9 and 12, which were sampled on the CORK. Higher numbered areas on the backside of the ROV platform are not shown. Right: close-up of mineral scale at the base of the ROV platform cone. See Table **T5** for list of samples collected. Photographs by Beth Orcutt.

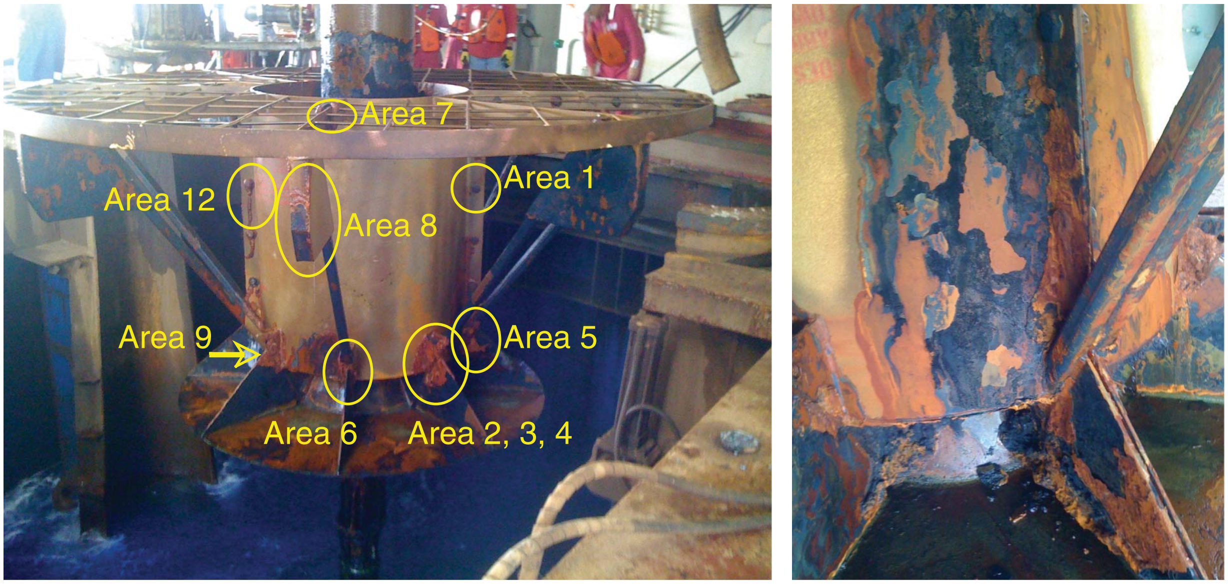

Figure F13. Photograph of sampling of the old Hole 395A CORK packer inflation element. Photograph by Bill Crawford/TAMU.

Figure F14. A. Schematic of microbiology combination tool string. HNGS = Hostile Environment Natural Gamma Ray Sonde, GPIT = General Purpose Inclinometry Tool, MTT = Modular Temperature tool, ELIC = EFTB-Lamont Interface Cartridge, MFTM = Multifunction Telemetry Module, DEBI-t = Deep Exploration Biosphere Investigative tool. **B.** Schematic of Hole 395A logging passes (a downlog through seafloor, an uplog to base of pipe, a downlog from pipe, and a final uplog ending a few meters above seafloor).

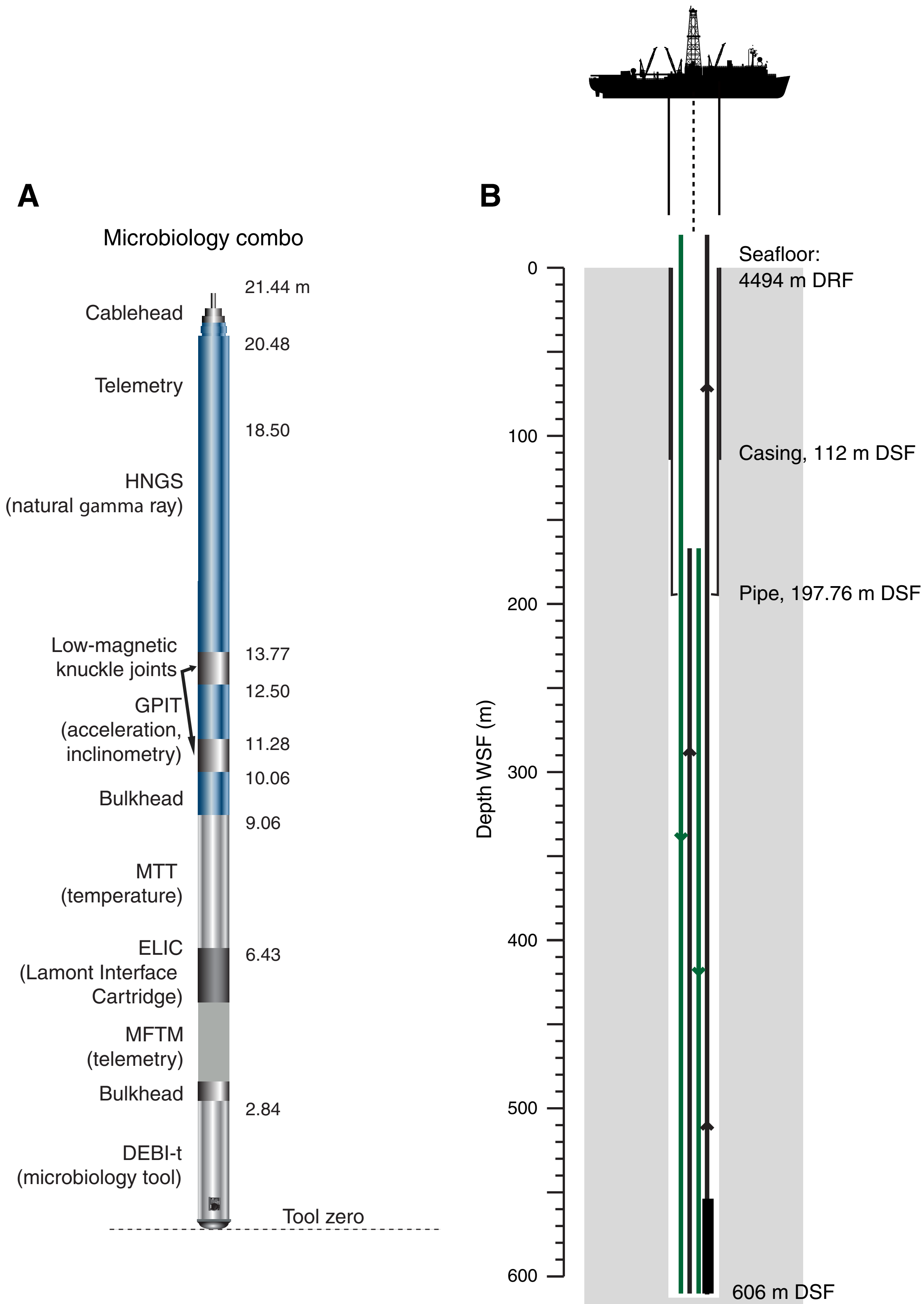

Figure F15. Summary plots of Hole 395A logging results. Blue lines = eruptive unit divisions (after Bartetzko et al., 2001), black lines = limits of casing and pipe for Expedition 336 operations. Arrows mark trends in gamma ray and resistivity. Measurements include borehole diameter (C1, C2 = FMS pass [Leg 174B]), gamma ray (TGR 174B ARI = total gamma ray counts from Azimuthal Resistivity Imager tool string [Leg 174B]; TGR 174B DIT = total gamma ray counts from Dual Induction Sonde tool string [Leg 174B]; TGR 395A 2U2 = total gamma ray counts from microbiology combination tool string Run 2, Uplog 2 [Expedition 336]; TGR 395A 2D1 = total gamma ray counts from the microbiology combination tool string Run 2, Downlog 1 [Expedition 336]), bulk density (Leg 174B), resistivity (174B IMPH = medium induction phasor-processed resistivity, 174B IDPH = deep induction phasor-processed resistivity [both Leg 174B]), and *P*-wave velocity (174B V_P = compressional wave velocity measured with downhole sonic sonde [Leg 174B]). A summary of core recovery and lithologic units is provided at far left (after Shipboard Scientific Party, 1979, fig. 9). DSDP = Deep Sea Drilling Project. Electrofacies (EFA) log after Bartetzko et al. (2001).

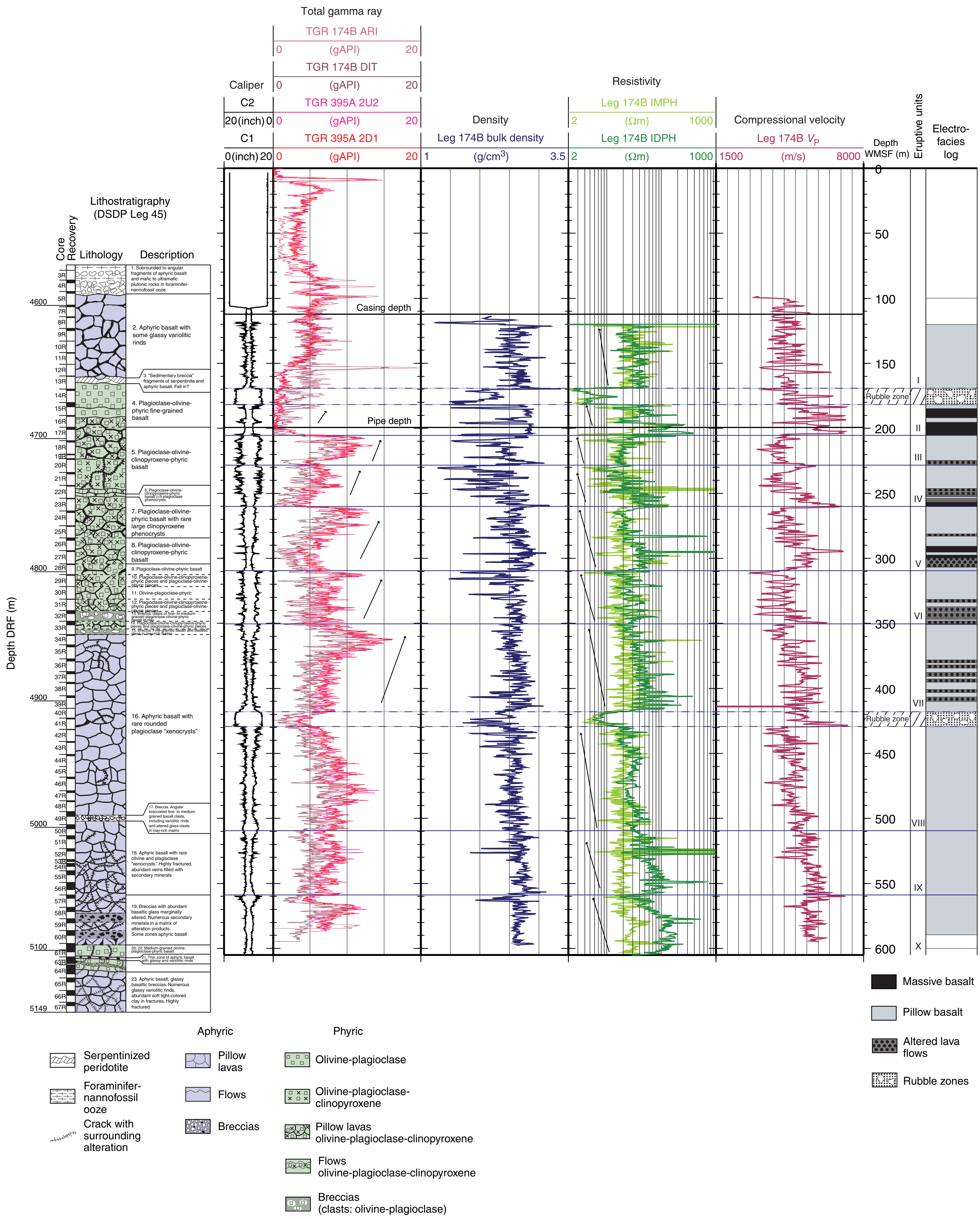

Figure F16. Summary plots of natural gamma ray log measurements, Hole 395A. Note that gamma ray measurements are in gAPI. Measurements include total gamma ray (TGR), potassium abundance, thorium, and uranium. 174B ARI = from the Azimuthal Resistivity Imager tool string (Leg 174B), 174B DIT = from the Dual Induction Sonde tool string (Leg 174B), 395A 2U2 = from the microbiology combo tool string Run 2, Uplog 2 (Expedition 336), 395A 2D1 = from the microbiology combination tool string Run 2, Downlog 1 (Expedition 336).

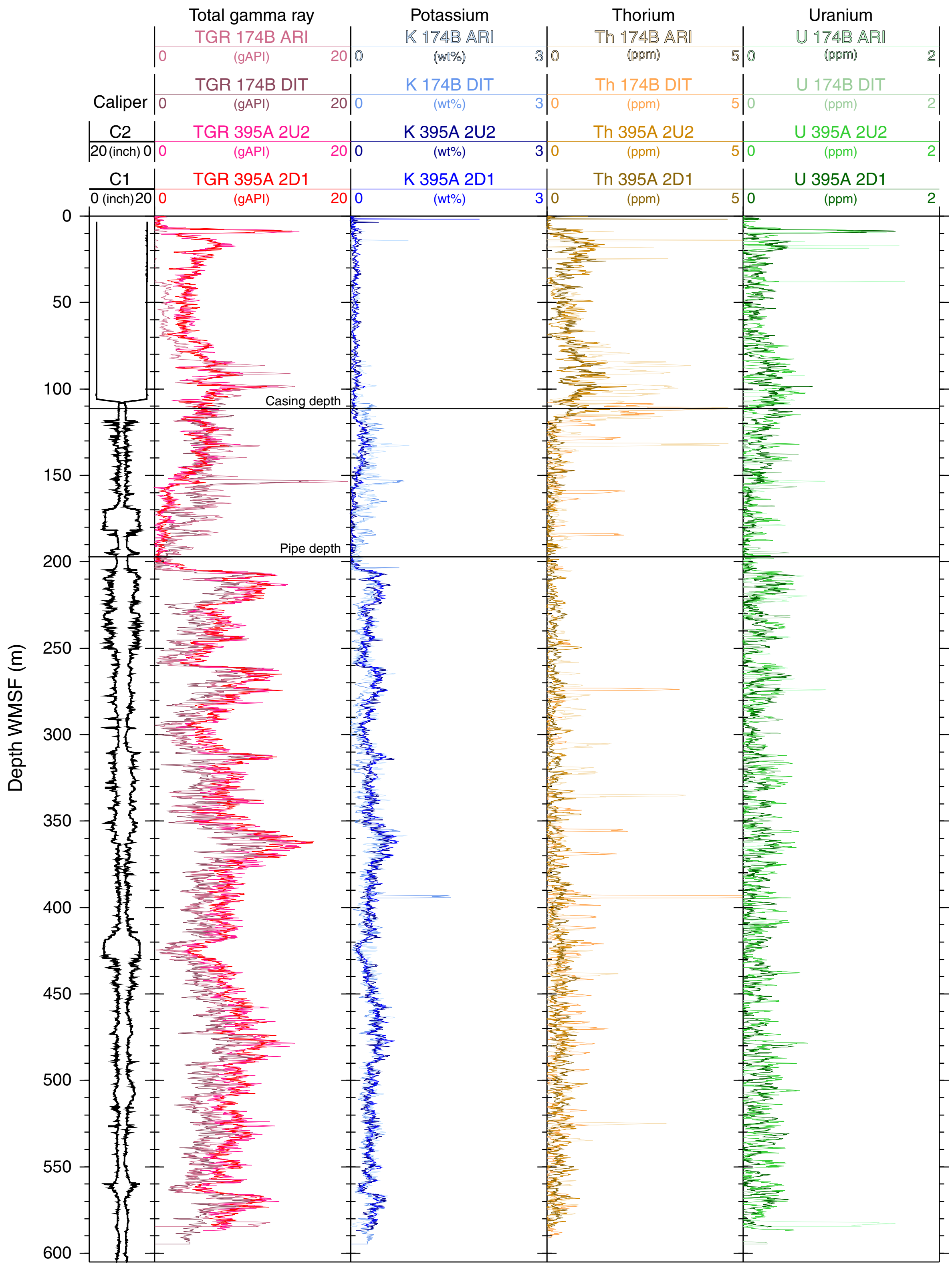

Figure F17. Summary plots of borehole temperature, Hole 395A. Measurements include borehole diameter (C1, C2 [Leg 174B]), temperature measured during Expedition 336 (T-MTT-2up2 = Run 2, Uplog 2; T-MTT-2d2 = Run 2, Downlog 2; T-MTT-2up1 = Run 2, Uplog 1; T-MTT-2d1 = Run 2, Downlog 1), temperature measured during Leg 174B, temperature measured during Leg 109, and temperature measured during Leg 78B. Red dashed line = depth below which temperature is >3°C.

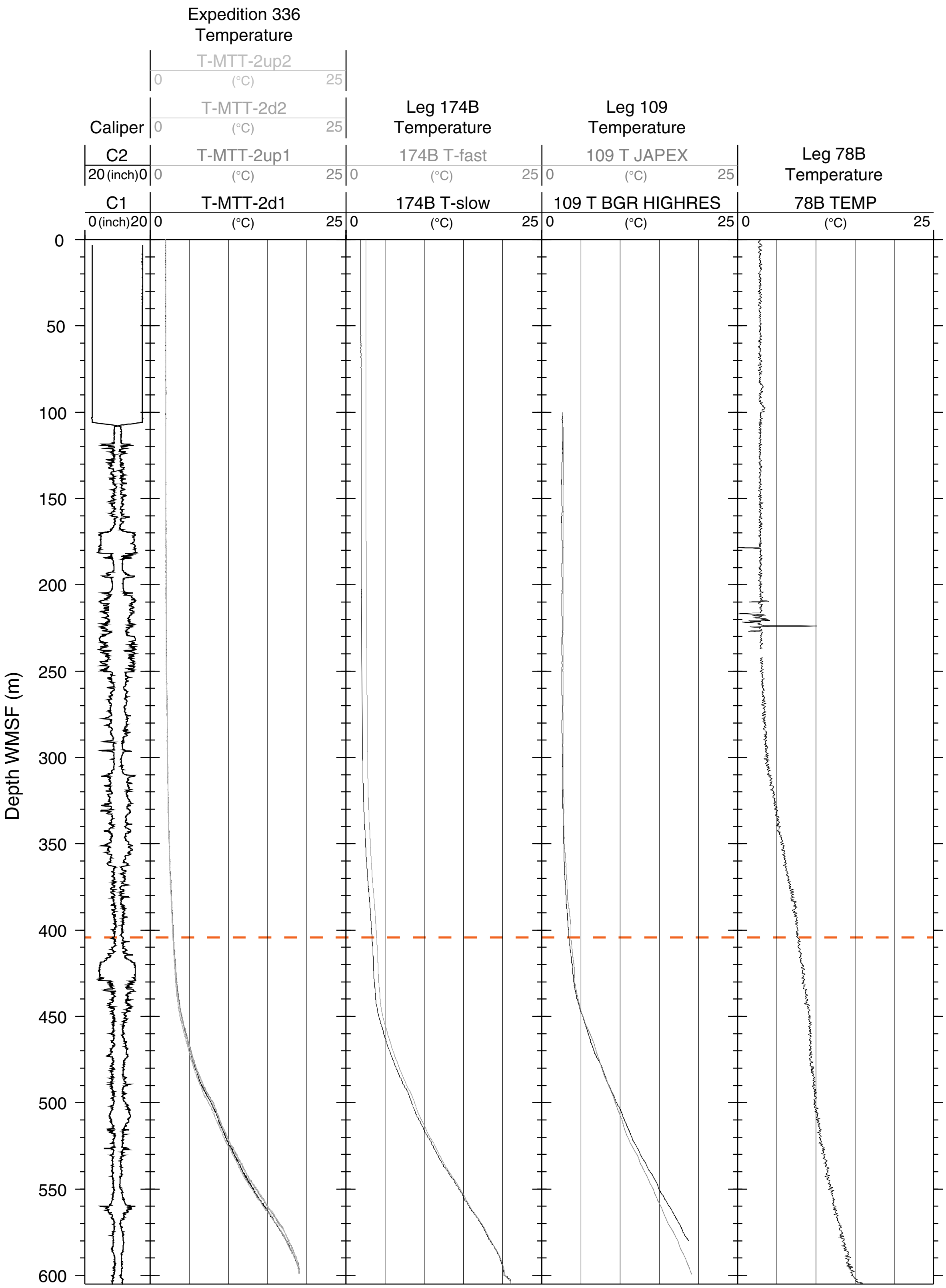

Figure F18. Photon intensity plots from Hole 395A (Run 2, downlog Pass 1). Photon counts indicate high concentrations of organics in the borehole fluids. The 320 and 340 nm bands, which are used for assessment of microbial bioload, are uniform throughout the borehole. The 360, 380, and 455 nm bands change as a function of depth and correlate with the temperature gradient in Hole 395A. These bands are representative of higher weight molecular organics.

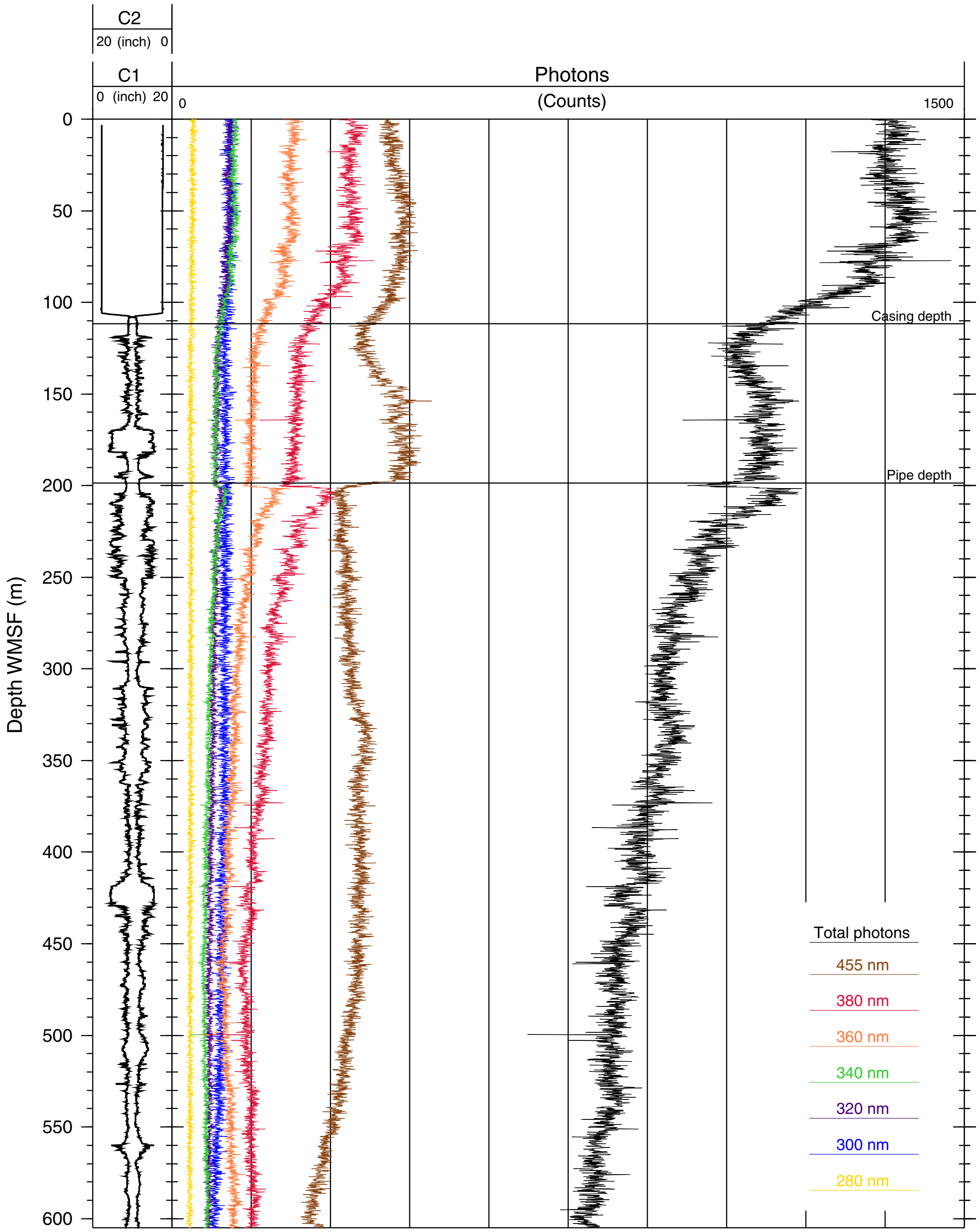

Table T1. Summary of operations, Hole 395A. Operations included (A) retrieving existing Hole 395A CORK and 600 m long thermistor string installed in 1997, (B) downhole logging with the microbiology tool string (Deep Exploration Biosphere Investigative tool [DEBI-t]), and (C) installing a new multilevel subseafloor borehole observatory (CORK). (Continued on next two pages.)

Operational task	Start Date (2011)	Start Time (h)	End Date (2011)	End Time (h)	Task time Hours	Task time Days
(A) Retrieve existing Hole 395A CORK						
End sea voyage/lower thrusters and hydrophones	20 Sep	2330	21 Sep	0030	1.00	0.04
Clear riser hatch, remove crossover sub, make up to CORK pulling tool	21 Sep	0030	21 Sep	0200	1.50	0.06
Remove and lay out upper guide horn	21 Sep	0200	21 Sep	0300	1.00	0.04
Pick up and make up CORK pulling tool, replace bushings, hang in slips	21 Sep	0300	21 Sep	0330	0.50	0.02
Install mousehole, assemble stabber, install bales and elevators	21 Sep	0330	21 Sep	0415	0.75	0.03
Pick up single drill collar	21 Sep	0415	21 Sep	0430	0.25	0.01
Open moonpool doors; blown hydraulic hose	21 Sep	0430	21 Sep	0515	0.75	0.03
Pick up drill collars	21 Sep	0515	21 Sep	0630	1.25	0.05
Handle bottom-hole assembly	21 Sep	0630	21 Sep	0630	0.00	0.00
Trip: surface to mudline, plus 0 h in 4481 m of water	21 Sep	0630	21 Sep	1530	9.00	0.38
Trip: drift tubulars/strap (measure) drill pipe, plus 3 h in 4481 m of water	21 Sep	1530	21 Sep	1530	0.00	0.00
Pick up top drive and space out drill pipe	21 Sep	1530	21 Sep	1600	0.50	0.02
Repair VIT camera system winch hydraulics	21 Sep	1600	22 Sep	1645	24.75	1.03
Deploy VIT camera system to seafloor	22 Sep	1645	22 Sep	1900	2.25	0.09
Space out drill pipe/install sinker bars	22 Sep	1900	22 Sep	2000	1.00	0.04
Maneuver ship for reentry	22 Sep	2000	22 Sep	2045	0.75	0.03
Verify CORK engagement/pick up drill pipe 5 m	22 Sep	2045	22 Sep	2100	0.25	0.01
Run in hole with sinker bars/engage and recover thermistor string	22 Sep	2100	22 Sep	2200	1.00	0.04
Apparent 200 lb weight gain; however, no thermistor string recovered at surface on first attempt						
Run in hole with sinker bars/engage and recover thermistor string	22 Sep	2200	22 Sep	2315	1.25	0.05
Again apparent weight gain; however, no thermistor string on second attempt; overshot latch fingers not engaging—likely because of detritus over pulling neck						
Handle VIT camera system	22 Sep	2315	22 Sep	2330	0.25	0.01
Run in hole with sinker bars/engage and recover thermistor string	22 Sep	2330	23 Sep	0100	1.50	0.06
Still no CORK recovery despite circulation and heavier jar force; abandon attempt to recover thermistor string with wireline						
Lay out sinker bars	23 Sep	0100	23 Sep	0115	0.25	0.01
Set back top drive	23 Sep	0115	23 Sep	0145	0.50	0.02
Lay out knobbies/drill pipe and space out for max reentry cone clearance	23 Sep	0145	23 Sep	0200	0.25	0.01
Trip: mudline to surface, plus 0 h in 4481 m of water	23 Sep	0200	23 Sep	0930	7.50	0.31
Handle bottom-hole assembly	23 Sep	0930	23 Sep	1030	1.00	0.04
Remove ROV platform in moonpool	23 Sep	1030	23 Sep	1130	1.00	0.04
Remove long recovery tool	23 Sep	1130	23 Sep	1215	0.75	0.03
Retrieve data logger at surface	23 Sep	1215	23 Sep	1530	3.25	0.14
Lay out Hole 395A CORK and stinger	23 Sep	1530	23 Sep	1700	1.50	0.06
(B) Downhole microbiology logging (DEBI-t)						
Handle bottom-hole assembly	23 Sep	1700	23 Sep	1800	1.00	0.04
Trip: depth to depth, from (mudline) 0 to 2000 mbsf, plus 0 h in 4481 m of water	23 Sep	1800	23 Sep	2045	2.75	0.11
Handle VIT camera system	23 Sep	2045	23 Sep	2100	0.25	0.01
Trip: depth to mudline, from 2000 mbsf to mudline, ±0.5 h	23 Sep	2100	24 Sep	0100	4.00	0.17
Check pipe tally and space out for reentry	24 Sep	0100	24 Sep	0115	0.25	0.01
Maneuver ship for reentry	24 Sep	0115	24 Sep	0130	0.25	0.01
Trip: mudline to depth (4550 mbrf; 56 mbsf), from 0 to 56 mbsf, plus 0 h; including space out for logging and spotting log tool pallet	24 Sep	0130	24 Sep	0200	0.50	0.02
Handle VIT camera system	24 Sep	0200	24 Sep	0200	0.00	0.00
Rig up special triple combo tool string for temperature and DEBI-t microbiological scanning						
Rig up	24 Sep	0200	24 Sep	0500	3.00	0.13
Triple combo: log from 56 to 110 mbsf at 200 m/h	24 Sep	0500	24 Sep	1500	10.00	0.42
POOH with logging line to clean hole	24 Sep	1500	24 Sep	1430	–0.50	–0.02
Bridge at 4670 mbrf would not pass logging tool string; POOH						
Run in hole with logging bit to clear bridge	24 Sep	1430	24 Sep	1530	1.00	0.04
Rig up	24 Sep	1530	24 Sep	1615	0.75	0.03
Triple combo: log from 56 to 590 mbsf at 200 m/h (up, down, plus double passes)	24 Sep	1615	25 Sep	0300	10.75	0.45
Rig down	25 Sep	0300	25 Sep	0400	1.00	0.04
Hole 395A depth check (without circulation or rotation)						
Move bit from 56 to 196 mbsf, which will take 0 h	25 Sep	0400	25 Sep	0400	0.00	0.00
Trip: log depth to depth, from logging depth of 196 mbsf to 600 mbsf; no problem running drill pipe to 600 m without circulation or rotation	25 Sep	0400	25 Sep	0500	1.00	0.04
Trip: depth to mudline, from 600 mbsf to mudline, plus 0.5 h	25 Sep	0500	25 Sep	0615	1.25	0.05
Trip: mudline to surface, plus 0 h in 4481 m of water	25 Sep	0615	25 Sep	1200	5.75	0.24
Handle bottom-hole assembly	25 Sep	1200	25 Sep	1230	0.50	0.02
Slip/Cut drill line	25 Sep	1230	25 Sep	1345	1.25	0.05
Repair iron roughneck hydraulic hose	25 Sep	1345	25 Sep	1415	0.50	0.02

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

Operational task	Start Date (2011)	Start Time (h)	End Date (2011)	End Time (h)	Task time Hours	Task time Days
(C) Install new multilevel CORK						
Make up 3 stands of perforated 6.75 inch drill collars, plus 1 joint of perforated steel 5.5 inch casing	25 Sep	1415	25 Sep	1800	3.75	0.16
Rig up umbilicals, attach miniscreens, prep for make up 4.5 inch casing	25 Sep	1800	25 Sep	1915	1.25	0.05
Deploy 2 joints of 4.5 inch fiberglass casing	25 Sep	1915	25 Sep	2015	1.00	0.04
Lost 1.5 h grinding 4.5 inch casing elevators to fit fiberglass pipe	25 Sep	2015	25 Sep	2245	2.50	0.10
Deploy 2 joints of 4.5 inch fiberglass casing	25 Sep	2245	25 Sep	2330	0.75	0.03
Make up packer assembly No. 1						
Make up fiberglass to steel crossover	25 Sep	2330	25 Sep	2345	0.25	0.01
Make up landing sub No. 1	25 Sep	2345	26 Sep	0000	0.25	0.01
Make up packer No. 1 (B-1)	26 Sep	0000	26 Sep	0015	0.25	0.01
Make up steel to fiberglass casing crossover	26 Sep	0015	26 Sep	0030	0.25	0.01
Make up 1 joint of 4.5 inch fiberglass casing and lower packer to moonpool	26 Sep	0030	26 Sep	0045	0.25	0.01
Connect umbilicals to upper and lower ends of packer	26 Sep	0045	26 Sep	0215	1.50	0.06
Make up 2.96 m 4.5 inch fiberglass casing pup	26 Sep	0215	26 Sep	0230	0.25	0.01
Make up and deploy 4.5 inch fiberglass casing						
Make up 4 joints of 4.5 inch fiberglass casing	26 Sep	0230	26 Sep	0330	1.00	0.04
Install 3(?) miniscreens	26 Sep	0330	26 Sep	0445	1.25	0.05
Make up 1 joint of 4.5 inch fiberglass casing plus one 2.96 m casing pup	26 Sep	0445	26 Sep	0515	0.50	0.02
Make up 29 joints of 4.5 inch fiberglass casing	26 Sep	0515	26 Sep	0930	4.25	0.18
Make up packer assembly No. 2						
Make up fiberglass to steel crossover	26 Sep	0930	26 Sep	0945	0.25	0.01
Make up landing sub No. 2	26 Sep	0945	26 Sep	1000	0.25	0.01
Make up packer No. 2 (B-2)	26 Sep	1000	26 Sep	1015	0.25	0.01
Make up steel to fiberglass casing crossover	26 Sep	1015	26 Sep	1030	0.25	0.01
Make up 1 joint of 4.5 inch fiberglass casing and lower packer to moonpool	26 Sep	1030	26 Sep	1030	0.00	0.00
Connect umbilicals to upper and lower ends of packer	26 Sep	1030	26 Sep	1245	2.25	0.09
Make up and deploy 4.5 inch fiberglass casing						
Make up 1.74 m fiberglass pup	26 Sep	1245	26 Sep	1245	0.00	0.00
Make up 3 joints of 4.5 inch fiberglass casing	26 Sep	1245	26 Sep	1315	0.50	0.02
Make up 1.74 m fiberglass pup	26 Sep	1315	26 Sep	1330	0.25	0.01
4.5 inch elevator fit up for steel casing elevators	26 Sep	1330	26 Sep	1400	0.50	0.02
Makeup packer assembly No. 3						
Make up fiberglass to steel crossover	26 Sep	1400	26 Sep	1415	0.25	0.01
Make up landing sub No. 3	26 Sep	1415	26 Sep	1430	0.25	0.01
Make up packer No. 3 (C-1)	26 Sep	1430	26 Sep	1445	0.25	0.01
Make up 1 pup joint of 3 m steel casing	26 Sep	1445	26 Sep	1500	0.25	0.01
Make up 1 joint of 4.5 inch steel casing	26 Sep	1500	26 Sep	1500	0.00	0.00
Lower packer No. 3 into moonpool	26 Sep	1500	26 Sep	1500	0.00	0.00
Connect umbilicals to upper and lower ends of packer	26 Sep	1500	26 Sep	1730	2.50	0.10
Make up and deploy 4.5 inch steel casing						
Make up 6 joints of 4.5 inch steel casing	26 Sep	1730	26 Sep	1845	1.25	0.05
Make up L-CORK head and running tool						
Make up running tool to L-CORK head	26 Sep	1845	26 Sep	1930	0.75	0.03
Make-up L-CORK head to top of 4.5 inch steel casing string and lower into moonpool	26 Sep	1930	26 Sep	2000	0.50	0.02
Cut umbilicals to length and make up final connections to L-CORK head	26 Sep	2000	26 Sep	2100	1.00	0.04
Rig down moonpool work area/open doors/pull bushings	26 Sep	2100	26 Sep	2130	0.50	0.02
Attach packer/inflate hose and safety line from running tool to CORK head/lower to moonpool	26 Sep	2130	26 Sep	2145	0.25	0.01
Install bushings at rig floor	26 Sep	2145	26 Sep	2200	0.25	0.01
Pickup first stand of drill collars	26 Sep	2200	26 Sep	2215	0.25	0.01
Lower/Raise CORK below keel to purge air from all lines	26 Sep	2215	26 Sep	2245	0.50	0.02
Install osmo pump/check all valve positions and secure with rubber bands	26 Sep	2245	26 Sep	2330	0.75	0.03
Remove moonpool work platform and open moonpool doors	26 Sep	2330	27 Sep	0000	0.50	0.02
Test-fit VIT camera system sleeve over CORK	27 Sep	0000	27 Sep	0030	0.50	0.02
Make up remainder of bottom-hole assembly and run in hole with 2 stands of 5.5 inch transition pipe	27 Sep	0030	27 Sep	0100	0.50	0.02
Make up and deploy instrument string						
Make up instrument string and top plug	27 Sep	0100	27 Sep	0400	3.00	0.13
Deploy instrument string (attempt to land top plug was unsuccessful)	27 Sep	0400	27 Sep	0500	1.00	0.04
Inspect latch (all appeared okay, except for significant pipe dope), rezero line counter						
Deploy instrument string for second time and attempt to land top plug; shear overshot pin on 2nd attempt	27 Sep	0500	27 Sep	0545	0.75	0.03
Replace pin/redeploy overshot and engage latch assembly/test latch engagement	27 Sep	0545	27 Sep	0645	1.00	0.04
Run in, attempt to latch, shear off, repair CORK, POOH (note that trip was shorter for reentry because of 530 m casing below running tool)	27 Sep	0645	27 Sep	1145	5.00	0.21
Trip: surface to mudline (3/4 speed), plus 0 h in 4481 m of water; fill pipe every 30 stands (15–20 min per fill)	27 Sep	1145	27 Sep	1915	7.50	0.31
Handle VIT camera system	27 Sep	1915	27 Sep	1945	0.50	0.02
Maneuver ship for reentry	27 Sep	1945	27 Sep	2000	0.25	0.01
Reenter Hole 395A with L-CORK at 2003 h						

Table T1 (continued).

Operational task	Start		End		Task time	
	Date (2011)	Time (h)	Date (2011)	Time (h)	Hours	Days
Run in hole with CORK stinger assembly and L-CORK to 5000 m	27 Sep	2000	27 Sep	2245	2.75	0.11
Pick up top drive	27 Sep	2245	27 Sep	2315	0.50	0.02
Run in hole with CORK stinger assembly, open compensator, and land L-CORK	27 Sep	2315	28 Sep	0000	0.75	0.03
Pressure up drill string and inflate CORK packers	28 Sep	0000	28 Sep	0030	0.50	0.02
Recover VIT camera system from seafloor	28 Sep	0030	28 Sep	0200	1.50	0.06
Assemble and deploy ROV platform						
Assemble ROV platform on moonpool and install "lunar lander" platform deployment tool/rig VIT camera system slings	28 Sep	0200	28 Sep	0400	2.00	0.08
Handle VIT camera system	28 Sep	0400	28 Sep	0430	0.50	0.02
Deploy VIT camera system to seafloor	28 Sep	0430	28 Sep	0630	2.00	0.08
Land and release ROV platform; attempt to release CORK running tool from CORK head from 0644 to 0734 h	28 Sep	0630	28 Sep	0734	1.07	0.04
Recover VIT camera system from seafloor	28 Sep	0734	28 Sep	0930	1.93	0.08
Remove ROV platform deployment slings and run in hole with VIT camera system	28 Sep	0930	28 Sep	1130	2.00	0.08
Inspect L-CORK installation (found CORK broken)	28 Sep	1130	28 Sep	1145	0.25	0.01
Trip: mudline to surface, plus 0 h in 4481 m of water	28 Sep	1145	28 Sep	1930	7.75	0.32
Handle VIT camera system	28 Sep	1930	28 Sep	1830	–1.00	–0.04
Handle bottom-hole assembly	28 Sep	1830	28 Sep	1845	0.25	0.01
Inspect CORK, remove OsmoSamplers, lay out to core technician shop roof	28 Sep	1845	28 Sep	2015	1.50	0.06
Rig down CORK running tool and close stabber	28 Sep	2015	28 Sep	2030	0.25	0.01
Install upper guide horn and secure moonpool	28 Sep	2030	28 Sep	2245	2.25	0.09
Lay out drill collars	28 Sep	2245	29 Sep	0000	1.25	0.05
Review 2400 h weather report/make decision on when and where to move because of Tropical Storm Philippe	29 Sep	0000	29 Sep	0000	0.00	0.00
Secure for transit	29 Sep	0000	29 Sep	0130	1.50	0.06
Pull thrusters and hydrophone; begin sea voyage at 0218 h 29 September 2011	29 Sep	0130	29 Sep	0215	0.75	0.03
Hole 395A totals:	20 Sep	2330	29 Sep	0215	194.75	8.11

Times are given in local ship time, which is Universal Time Coordinated (UTC) – 3 h for all on-site operations. VIT = vibration-isolated television, ROV = remotely operated vehicle, triple combo = triple combination, POOH = pull out of hole, L-CORK = lateral CORK.

Table T2. Configuration of new subseafloor borehole observatory (CORK) completion hardware deployed in Hole 395A. (Continued on next page.)

Part number	Description	Diameter (inch)		Connection		Measured length (m)	Cumulative bottom depth (mbsf)	Cumulative bottom depth corrected for stretch (mbsf)	Comments
		Outside	Inside	Up	Down				
	CORK	5.00	4.05		4.50 8RD STC pin	5.40	5.4	5.4	2.4 m CORK + 3 mbsf
34	Casing, 4.5 inch, 10.5 lb	5.00	4.05	4.50 8RD cplg box	4.50 8RD STC pin	11.47	16.9	16.9	
35	Casing, 4.5 inch, 10.5 lb	5.00	4.05	4.50 8RD cplg box	4.50 8RD STC pin	13.74	30.6	30.6	
36	Casing, 4.5 inch, 10.5 lb	5.00	4.05	4.50 8RD cplg box	4.50 8RD STC pin	13.74	44.4	44.4	
37	Casing, 4.5 inch, 10.5 lb	5.00	4.05	4.50 8RD cplg box	4.50 8RD STC pin	13.69	58.0	58.1	
38	Casing, 4.5 inch, 10.5 lb	5.00	4.05	4.50 8RD cplg box	4.50 8RD STC pin	13.73	71.8	71.8	
39	Casing, 4.5 inch, 10.5 lb	5.00	4.05	4.50 8RD cplg box	4.50 8RD STC pin	13.74	85.5	85.5	
40	Casing, 4.5 inch, 10.5 lb	5.00	4.05	4.50 8RD cplg box	4.50 8RD STC pin	13.74	99.3	99.3	
	Casing pup, 4.5 inch, 10.5 lb	5.00	4.05	4.50 8RD cplg box	4.50 8RD STC pin	3.00	102.3	102.3	
C1	Packer, combo, 4.5 inch, coated	10.50	4.05	4.50 8RD cplg box	4.50 8RD STC pin	9.07	111.3	111.3	Hole 395A 11.75 inch 54 lb casing to 112 mbsf
OJ3221	Landing seat, 3.375 inch, coated	5.00	3.375	4.50 8RD STC box	4.50 8RD STC pin	0.19	111.5	111.5	
OJ3225	Crossover, 4-1/2 inch LTC × 4-1/2 inch EUE	5.00	4.00	4.50 8RD LTC box	4.50 8RD EUE pin	0.18	111.7	111.7	
	Casing pup, 4.5 inch, fiberglass	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	1.74	113.4	113.5	Strength transition
128	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.90	122.3	122.4	Zone 3 miniscreens; target 120 mbsf*
129	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.85	131.2	131.2	
130	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.85	140.0	140.1	
	Casing pup, 4.5, fiberglass	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	1.74	141.8	141.8	
OJ3226	Crossover, 4-1/2 inch EUE × 4-1/2 inch STC	5.50	4.00	4.50 8RD EUE box	4.50 8RD STC pin	0.19	142.0	142.0	
B2	Packer, Inflate, 4.5 inch, coated	8.08	4.052	4.50 8RD cplg box	4.50 8RD STC pin	6.60	148.6	148.6	Top of packer target 145 mbsf
OJ3222	Landing Seat, 3.125 inch, coated	5.00	3.125	4.50 8RD STC box	4.50 8RD STC pin	0.19	148.8	148.8	
OJ3225	Crossover, 4-1/2 inch LTC × 4-1/2 inch EUE	5.00	4.00	4.50 8RD LTC box	4.50 8RD EUE pin	0.18	148.9	149.0	
81	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.84	157.8	157.8	
82	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.87	166.6	166.7	
83	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.85	175.5	175.6	
84	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.89	184.4	184.5	
85	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.85	193.2	193.3	
86	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.85	202.1	202.2	
87	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.84	210.9	211.0	
131	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	219.8	219.9	Target slotted casing 210–280 mbsf
132	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	228.7	228.8	
133	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.89	237.6	237.7	
134	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	246.5	246.6	
135	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	255.3	255.5	
136	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	264.2	264.4	
137	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.86	273.1	273.2	
138	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.85	281.9	282.1	
88	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	290.8	291.0	
89	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.84	299.6	299.8	
90	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.85	308.5	308.7	
91	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.83	317.3	317.5	
92	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.90	326.2	326.4	
93	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	335.1	335.3	
94	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	344.0	344.2	
95	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	352.9	353.1	
96	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	361.7	362.0	
97	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.86	370.6	370.9	
98	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.85	379.5	379.7	
99	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.73	388.2	388.5	

Table T2 (continued).

Part number	Description	Diameter (inch) Outside	Diameter (inch) Inside	Connection Up	Connection Down	Measured length (m)	Cumulative bottom depth (mbsf)	Cumulative bottom depth corrected for stretch (mbsf)	Comments
100	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.83	397.0	397.3	
101	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.87	405.9	406.2	
	Casing pup, 4.5, fiberglass	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	2.96	408.8	409.1	
139	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.87	417.7	418.0	Target slotted casing 410–435 mbsf
140	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	426.6	426.9	
141	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.90	435.5	435.8	Zone 2 miniscreens target 430 mbsf†
102	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	444.4	444.7	
103	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.84	453.2	453.5	
	Casing pup, 4.5, fiberglass	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	2.96	456.2	456.5	
OJ3226	Crossover, 4-1/2 inch EUE × 4-1/2 STC inch	5.50	4.00	4.50 8RD EUE box	4.50 8RD STC pin	0.19	456.4	456.7	
B1	Packer, inflate, 4.5 inch, coated	8.08	4.052	4.50 8RD cplg box	4.50 8RD STC pin	6.60	463.0	463.3	Top of packer target 460 mbsf
OJ3223	Landing seat, 2.875 inch, coated	5.00	2.875	4.50 8RD STC box	4.50 8RD STC pin	0.19	463.2	463.5	
OJ3225	Crossover, 4-1/2 inch LTC × 4-1/2 inch EUE	5.00	4.00	4.50 8RD LTC box	4.50 8RD EUE pin	0.18	463.3	463.7	
104	Casing, 4.5 inch, fiberglass - red	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	472.2	472.6	
142	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.86	481.1	481.4	
143	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.86	489.9	490.3	
144	Casing, 4.5 inch, fiberglass, slotted - blue	5.00	3.91	4.50 8RD EUE box	4.50 8RD EUE pin	8.88	498.8	499.2	
OJ3226	Crossover, 4-1/2 inch EUE × 4-1/2 inch STC	5.50	4.00	4.50 8RD EUE box	4.50 8RD STC pin	0.19	499.0	499.4	
OJ3282	Crossover, 4.5 inch × 5.5 inch, coated	5.50	4.05	4.50 8RD LTC box	5.50 8RD LTC pin	0.19	499.2	499.5	
OJ3284	Casing, 5.5 inch, perforated, coated, 14 lb	6.05	5.01	5.50 8RD LTC cplg	5.50 8RD STC pin	6.12	505.3	505.7	Zone 1 miniscreens‡
OJ3281	Crossover, 5.5 inch × 6.75 inch, coated	6.75	4.13	5.50 8RD LTC box	5.5 FH pin	0.48	505.8	506.1	
OJ3285	Drill collar, 6.75 inch, perforated, coated	6.75	4.13	5.50 FHM box	5.5 FHM pin	4.29	510.1	510.4	
OJ3285	Drill collar, 6.75 inch, perforated, coated	6.75	4.13	5.50 FHM box	5.5 FHM pin	4.29	514.4	514.7	
OJ3285	Drill collar, 6.75 inch, perforated, coated	6.75	4.13	5.50 FHM box	5.5 FHM pin	4.29	518.7	519.0	
OJ3285	Drill collar, 6.75 inch, perforated, coated	6.75	4.13	5.50 FHM box	5.5 FHM pin	4.29	523.0	523.3	
OJ3285	Drill collar, 6.75 inch, perforated, coated	6.75	4.13	5.50 FHM box	5.5 FHM pin	4.29	527.3	527.6	
OJ3285	Drill collar, 6.75 inch, perforated, coated	6.75	4.13	5.50 FHM box	5.5 FHM pin	4.29	531.6	531.9	
OJ3286	Bullnose, coated	6.75	4.13	5.50 FHM box	Bullnose	0.91	532.5	532.8	

* = 122.4 m microbiology umbilical (0.5 inch ID Tefzel), spool A. † = 435.8 m microbiology umbilical (0.5 inch ID Tefzel), spool B. ‡ = 505.7 m microbiology umbilical (0.5 inch ID Tefzel), spool C, 505.7 m each, stainless steel pressure and packer inflation umbilicals (1 × 0.5 inch OD and 3 × 0.25 inch OD) and stainless steel geochemistry umbilicals (3 × 0.5 inch OD and 3 × 0.25 inch OD). Part numbers beginning with “OJ” designate USIO engineering part numbers; numbers 34–144 are identification numbers assigned when casing was loaded and measured; B1, B2, and B3 identify the three packers used. ID = inside diameter, OD = outside diameter. 8RD = size of threaded tubing connection, STC = short thread coupling, cplg = coupling, LTC = long thread coupling, EUE = external upset ends connection, FH = full hole threaded tool joint, FHM = full hole modified tool joint, box = female threaded connection, pin = male threaded connection.

Table T3. Downhole instrument string deployed in Hole 395A.

Item	Length (m)	Connector length (m)*	Bottom depth (mbsf)	FLOCS or O_2 probe ID	Temperature probe†
Bottom of plug**			–5.84		
Spectra‡**	58.25 (59.12)				
Sinker bar - 100 lb	1.52		54.8		
Spectra	58.66 (59.54)				
Landing seat, 3.375	111.5	0.16	111.66		
MBIO	5.73	0.16	117.55	88/89	A 1857001
Enrichment	5.2	0.16	122.91	78/79	
Standard	2.63	0.16	125.7		
Acid addition	5.2	0.16	131.06		
BOSS	5.2	0.16	136.42		
Oxygen probe	0.58	0.16	137.16	49	
Copper - Gas	2.63	0.16	139.95		O 9913815
Spectra	10.02 (10.17)				
Landing seat, 3.125	148.8	0.16	148.96		
Spectra rope	83.00 (84.25)	0.16	233.37		
MBIO	5.73	0.16	239.26	80/81	
Enrichment	5.2	0.16	244.62	86/87	
Standard	2.63	0.16	247.41		
Acid addition	5.2	0.16	252.77		
BOSS	5.2	0.16	258.13		
Copper - Gas	2.63	0.16	260.92		O 9413814
Spectra rope	146.00 (148.19)	0.16	409.27		
MBIO	5.73	0.16	415.16	84/85	A 1857002
Enrichment	5.2	0.16	420.52	74/75	
Standard	2.63	0.16	423.31		
Acid addition	5.2	0.16	428.67		
BOSS	5.2	0.16	434.03		
Oxygen probe	0.58	0.16	434.77	77	
Copper - Gas	2.63	0.16	437.56		O 9913816
Spectra rope	31.25 (31.72)				
Landing seat, 2.875	463.5	0.16	463.66		
Spectra rope	27.00 (27.41)	0.16	491.23		
MBIO	7.61	0.16	499	76/77	A 1857003
Enrichment	6.8	0.16	505.96	82/83	
Standard	3.43	0.16	509.55		
Acid addition	6.8	0.16	516.51		
BOSS	6.8	0.16	523.47		
Copper - Gas	3.43	0.16	527.06		O 9913813
Sinker bar - 150 lb	3.19	0.16	530.41		

* = a stainless steel coupler was used to join two packages and join packages to landing seats. † = temperature probes were purchased from Onset (O) and Antares (A); probes are located 53 cm from the top of the 2.875 inch diameter OsmoSampler packages and 60 cm from the top of 2.5 inch diameter packages. ‡ = Spectra lengths are given in measured units and expected lengths based on stretch within the hole (in parentheses); some downhole depths for Spectra are not given because additional line was used to ensure that the plugs could seat at the correct depths. ** = these depths refer to predeployment configuration; depths and lengths are not accurate considering that the CORK wellhead severed during deployment. Lifting loops were weaved every 12.5 m from the top plug. FLOCS = Flow-through Osmo Colonization System. MBIO = microbiology, BOSS = BioOsmoSampling System.

Table T4. Estimate of umbilical lines remaining in hole above the top of the broken off 5 inch casing remaining in the hole. These are best-guess estimates derived from recovered parts.

Line	No.	Position* (ft)	Comment
1/2 inch SS inflate line	NA	–2.5	Separated at lower landing ring
1/2 inch Ti microbiology	1	+2	
1/2 inch Ti microbiology	2	+2	
1/2 inch Ti microbiology	3	–2.5	Separated at lower landing ring
1/4 inch SS pressure	1	+2.5	With union on
1/4 inch SS pressure	2	+2	
1/4 inch SS pressure	3	–2.5	At lower landing ring
1/4 inch SS geochemistry	1	+2	
1/4 inch SS geochemistry	2	+2	
1/4 inch SS geochemistry	3	+1	With union on
1/8 inch SS geochemistry	1	+2.5	With union on
1/8 inch SS geochemistry	2	+2.5	With union on
1/8 inch SS geochemistry	3	+2.5	With union on

* = relative to failure point (top of 5 inch fish). SS = stainless steel, Ti = titanium. NA = not applicable.

Table T5. Sample log for microbiology sampling of the remotely operated vehicle (ROV) platform recovered from the old Hole 395A CORK.

Sample ID	Description	Container	Used by/for
Area 1	Rust around upper nut on ROV platform cone; light brown/orange	50 mL conical	Mills/RNA (–80°C)
Area 2	Base of platform arm; black to orange layer cake	50 mL conical	Mills/RNA (–80°C)
Area 3	Same as Area 2	Whirl-pak bag	Edwards/DNA (–80°C)
Area 4	Same as Area 2; underlying black rust	50 mL conical	Mills/RNA (–80°C)
Area 5	Base of 2nd arm; black to red-orange layer cake	50 mL conical	Mills/RNA (–80°C)
Area 6	Base of 3rd arm; similar to Area 3	Whirl-Pak bag	Mills/RNA (–80°C)
Area 7A	ROV platform shackle; nicely scaled rusticle formations: some rusticles, some bulk, very wet	Whirl-Pak bag	Edwards/DNA (–80°C)
Area 7B	ROV platform shackle; nicely scaled rusticle formations: outside layer of rusticle	50 mL conical	Mills/RNA (–80°C)
Area 7C	ROV platform shackle; nicely scaled rusticle formations: inside of rusticle	50 mL conical	Mills/RNA (–80°C)
Area 7D	ROV platform shackle; nicely scaled rusticle formations: outside layer of rusticle	50 mL conical	Mills/RNA (–80°C)
Area 7E	ROV platform shackle; nicely scaled rusticle formations: rusticle	50 mL conical	Edwards/DNA (–80°C)
Area 8	Top of Arm 3, black rust	50 mL conical	Edwards/DNA (–80°C)
Area 9A	Base of Arm 4, black to orange layers; rusticle	1.5 mL eppi	Edwards/FISH (–20°C)
Area 9B	Base of Arm 4, black to orange layers; rusticle	1.5 mL eppi	Edwards/FISH (–20°C)
Area 9C	Base of Arm 4, black to orange layers; rusticle plus seawater	1.5 mL eppi	Edwards/FISH (–20°C)
Area 9D	Base of Arm 4, black to orange layers; big chunk of rusticle	Whirl-Pak bag	Edwards/DNA (–80°C); Russell and Wang/ culturing; archive (–80°C)
Area 10	Base of cone, rusticle	50 mL conical	Edwards/DNA (–80°C)
Area 11	Base of cone, large chunk by nut, mostly black interior	Whirl-Pak bag	Mills/RNA (–80°C)
Area 12A–12E	Rust around nut on ROV platform cone	1.5 mL eppis	Edwards/DNA (–80°C)
Area 13	Second ROV platform shackle, rusticles	2× 50 mL conical	Edwards/DNA (–80°C)
Area 14	Rust around nut on ROV platform cone	50 mL conical	Edwards/DNA (–80°C)
Area 15	Base of Arm 5, rusticle	50 mL conical	Edwards/DNA (–80°C)
Area 16	Base of cone, rusticles	2× 50 mL conical	Edwards/DNA (–80°C)

Sample locations are illustrated in Figure **F12.** FISH = fluorescent in situ hybridization.

Table T6. Sample log for microbiology (MBIO) sampling of the thermistor cable recovered from the old Hole 395A CORK.

MBIO sample ID	Becker thermistor ID	Approximate depth (mbsf)
ThermStr-1	10	98.95
ThermStr-2	9	173.1
ThermStr-3	8	249
ThermStr-4	7	299
ThermStr-5	6	349
ThermStr-6	5	399
ThermStr-7	4	449
ThermStr-8	3	499
ThermStr-9	2	549
ThermStr-10	1	599

From every cut section, samples were collected for the following analyses: (A) archive (–80°C), (B) Mills (RNA/–80°C), (C) Wang (culturing), (D) Russell (culturing), (E) Edwards 1 (FISH/–20°C, in conical), or (F) Edwards 2 (DNA/–80°C).

Table T7. Sample log for microbiology (MBIO) sampling of the thermistor cable sinker bar, packer inflation element, and stinger recovered from the old Hole 395A CORK.

MBIO sample ID	Used by/for
Packer-1	Russell and Wang/culturing
Packer-2–6	Edwards/DNA
Packer-7–11	Mills/RNA
SinkerBar-1–4	Edwards/DNA
SinkerBar-5–8	Mills/RNA
Stinger-1–3	Edwards/DNA

Table T8. Logging operations summary, Hole 395A.

Date (2011)	Time (h)	Activity
24 Sep	0335	Downhole logging operations start
24 Sep	0532	Winch spooling mechanism fails
24 Sep	0628	Winch fixed; continue running tool into Hole 395A
24 Sep	0952	Logging aborted because of impassable ledge at 4670 m wireline log depth below rig floor (WRF)
24 Sep	1410	Microbiology combo back to the surface and rigged down
24 Sep	1610	Tool string run back into hole following the logging bit run down past the obstruction; pipe set at 4691.76 mbrf
24 Sep	1635	Begin downlog at 4448 m WRF (275 m/h)
24 Sep	2046	Reach total depth 5094 m WRF
24 Sep	2046	Start first uplog (275 m/h)
24 Sep	2216	Start second downlog at 4687.1 m WRF (366 m/h)
24 Sep	2322	Start second uplog at 5094.1 m WRF (549 m/h); uplog ended just beyond where the tool crossed the seafloor at 4496 m WRF
25 Sep	0330	Logging tool string rigged down and operations complete

Time is reported as ship local (UTC – 3 h).