Preliminary Cruise Report for R/V *Atlantis*/ROV *Jason-II* Expedition AT26-03: Hydrogeologic, Geochemical, and Microbiological Experiments in Young Ocean Crust of the Northeastern Pacific Ocean Using Subseafloor Observatories

Expedition Dates and Ports 13 July 2013 to 26 July 2013, Astoria, OR to Astoria, OR

Supported by NSF projects: OCE-1031808 (and linked proposals), with a C-DEBI grant in support of EOC and an NSF-RET supplement

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Preliminary Report: 14 August 2013

I. Expedition Overview

A. Summary of Grants and Goals

Expedition AT26-03 was supported by one primary NSF project, an NSF Research Experience for Teachers supplement, and a C-DEBI grant for education, outreach and communication:

(1) OCE-1031808, "Collaborative Research: Completion of single- and cross-hole hydrogeologic experiments on the eastern flank of the Juan de Fuca Ridge using a borehole network"

Project Co-PIs: A. T. Fisher, K. Becker, J. F. Clark, J. Cowen, C. G. Wheat

(2) RET supplement, "Educator participation as outreach specialist on AT26-03"

Project PI: A. T. Fisher

(3) C-DEBI EOC grant, "Linking Transformational Science, Education, Outreach, and Communication (EOC) as part of a C-DEBI "core" project on the Eastern Flank of the Juan de Fuca Ridge"

Project Leaders: S. Cooper, L. Peart

The primary NSF grants supporting this expedition included 14 dive/science days. Work locations during AT26-03 are summarized in **Table 1** and shown in **Figures 1**, **2**, and **3**. Primary tasks completed during AT26-03 are listed in **Table 2**. A listing of AT26-03 participants is included in **Appendix A**.

OCE-1031808 supports multidisciplinary borehole experiments in oceanic crust, to assess hydrogeologic, solute, gas, and colloid transport, and microbiological processes and properties at multiple spatial and temporal scales (meters to kilometers, minutes to years). Results of these experiments will comprise a major advance in our understanding of hydrogeologic properties and fluid processes within the volcanic oceanic crust. This grant supports scientific activities that follow completion of Integrated Ocean Drilling Program Expedition 327, which operated in Summer 2010. This expedition drilled two holes through sediments and into the volcanic crust on 3.5 m.y. old seafloor on the eastern flank of the Juan de Fuca Ridge, HolesU1362A andU1362B (Figures **1**, **2**, and **3**). These holes were drilled, cased, cored, and tested, then instrumented with subseafloor, borehole observatory systems (CORKs) (**Figure 4**). Expedition 327 also included a hydrogeologic, pumping and tracer injection experiment, to assess multi-scale formation properties, including the nature of azimuthal and vertical crustal anisotropy.

The Expedition 327 CORKs augment four additional observatory systems, all located within an area of about 2.5 square kilometers, creating a network of six instrumented sites where researchers are monitoring pressure and temperature at depth, and sampling fluids and microbiological material using autonomous instrumentation (**Figure 3** and **Table 1**). These CORK systems require servicing with a submersible or remotely operated vehicle (ROV) to download data, recover samples, and replace a variety of experimental systems [pressure and temperature data are being collected from the system in Hole 1026B by the Ocean Network Canada (ONC) cabled network]. Servicing these observatories was a primary goal of the Summer 2013 expedition with the R/V *Atlantis* and ROV *Jason*. In addition, we planned to close a large-diameter ball valve and recover a flow meter from the top of one of the CORK observatories (**Figure 4**), ending a two-year, cross-hole flow and pressure perturbation experiment. Fluids flowing from the large diameter ball valve have also provided fluid and microbiological sampling opportunities. Samples recovered from the wellheads will allow assessment of fluid transport rates based on the appearance of tracers pumped into the seafloor at one of the observatory sites in Summer 2010 during IODP Expedition 327. Results of this work will be combined with other studies, including results from past drilling expeditions, to characterize the nature of linked, subseafloor hydrogeologic, geochemical, and microbiological processes, and to provide information needed to constrain coupled models of these processes.

In addition to the overall scientific and technical goals listed above, AT26-03 included a significant education, outreach, and communications (EOC) program. Space was allocated for four dedicated EOC specialists: two school educators, a videographer, and an EOC coordinator and leader. EOC activities during AT26-03 (described in greater detail later) included: (a) blogging, (b) web conferencing with museums, summer camps, and other venues, (c) production of videos, podcasts, and other media, and (d) curriculum development.

B. AT26-03 Operational Objectives

Proposal OCE-1031808 requested support for two oceanographic expeditions, one in Summer 2011 (AT18-07) and one in Summer 2013 (was originally planned for Summer 2012, but delayed because of propulsion problems with the R/V *Thomas G. Thompson*), both focusing on servicing a network of six subseafloor observatories (CORKs) separated by ~40 to 2460 m (**Figure 3**, **Table 3**), collecting fluid and microbiological samples, and completing cross-hole hydrogeologic, geochemical, and microbiological experiments. Because of the close spacing between the primary CORK systems that were the focus of AT26-03 (**Table 3**, **Figure 3**), we often combined operations at multiple wellheads during a single *Jason* dive.

As of the start of AT26-03, pressure measurement and logging systems were installed and running in the CORKs in Holes 1026B, 1027C, U1301A, U1301B, U1362A, and U1362B. Data from Hole 1026B were being downloaded regularly using the Ocean Networks Canada cable, but data from the other CORKs were to be downloaded with *Jason*. Pressure download operations at Sites 1027, U1301 and U1362 included manipulation of valves to check the hydrostatic pressure offset and evaluate gauge drift. During AT18-07 in 2011, the older generation of data logger installed in the top of the wellhead at Hole 1027C was recovered and replaced with a modern system, including a manifold insert that provides access to robust pressure monitoring connectors and valves. An electromagnetic and thermal flowmeter system deployed on Hole U1362B during AT18-07 was also to be recovered during AT26-03, and a second flowmeter was prepared for deployment. The flowmeter was developed so that the rate of discharge from the upper ocean crust, through a large-diameter ball valve, could be monitored for years. In addition, the "chimney" at the end of the flowmeter provides fluid and microbiological sampling opportunities.

As of the start of AT26-03, OsmoSampler systems were installed on wellheads in Holes 1026B, U1301A, and U1362A/B. Existing and new OsmoSampling systems include Teflon coils, copper coils, and microbiological FLOCS incubation chambers. The OsmoSamplers installed on the CORK in Hole U1362B were designed to draw fluids from the discharge from the flowmeter system, rather than from smaller diameter lines on the wellhead. OsmoSampler and FLOCS designed for new CORKs used milk crates and umbilical lines rather than being mounted directly on the wellhead with steel plates, allowing for more flexible configuration and deployment.

Additional fluid samples were planned for collection from wellheads using a variety of techniques. Active pumping systems were to be deployed and recovered on a short-term (single dive) basis, with samples collected on *Jason* or an elevator and returned to the surface for immediate processing. These systems were designed to be attached to dedicated sample ports on wellheads, and to permit in-line monitoring as fluids were collected. These systems also permit pumping of large fluid volumes through filters to assess the nature of fluid particulates. In addition, we planned to recover a long-term fluid sampling and measurement system, the GeoMICROBE sled, deployed during AT18-07 on the wellhead in Hole U1362B. This system was intended to collect fluids at ~3 week intervals and store them until the entire system was recovered. We also planned to use a variety of smaller volume samplers to collect fluids as they flowed from wellheads: gas-tight samplers, major ion samplers, squeeze samplers, and syringe samplers.

If time allowed, we planned to test a new heat flow insertion frame and conduct a brief survey of Zona Bare outcrop, a small area of basement exposure and near exposure located ~50 km north of the primary AT26-03 work area. Additional backup options included surveying other outcrops and/or downloading data from older CORK systems located to the west (**Table 1, Figure 2**).

II. Expedition AT26-03 Narrative

Start of AT26-03

AT26-03 had initial and final ports of call in Astoria, OR. All of our gear was waiting for us when we arrived in port, or arrived soon after, so that we were able to set up labs and be ready for work less after a short transit to our first site. Loading the ship went smoothly. Expedition AT26-03 departed Astoria at 12:00 on 7/13/13 (PDT is used throughout this report) for the 18-hour transit to Site U1362B.

Jason-II dive numbers, dates and times, work sites, and Virtual Van image numbers are listed in **Table 4**. Additional tables list times and locations of pressure downloads (**Table 5**), OsmoSampler recoveries and deployments (**Tables 6 and 7**), syringe and squeeze samplers (**Table 8**), fluid/microbial sampling with pump systems or a Niskin bottle (**Table 9**), samples recovered for viral studies (**Table 10**), and locations and numbers of participants for education, outreach, and communications events (**Table 11**).

Dive 710 (1/9 on AT26-03)

Dive 710 worked on the CORK in Hole U1362B (**Figure 5**). Prior to the dive, we deployed two elevators: one with the Mobile GeoMicrobe (MGM) sampling system, and one with empty cradles to be used for recovery of OsmoSamplers and the flowmeter. Once on the seafloor, *Jason* moved the elevator closer to the wellhead. Shimmering water was observed flowing from the flowmeter chimney, and the interior of the flowmeter bay was covered in precipitate. There was also considerable corrosion around the flowmeter clamp and adapter. Water was sampled from the flowmeter chimney using syringe and squeeze samplers, and the ball valve was closed. The bolt, washer, and clip ring holding the yellow plastic handle on stem of the ball valve were corroded away, but the valve was closed by holding the handle in place while turning. The Umbilosnork was removed from the flowmeter chimney, and old OsmoSamplers were recovered to the basket. Valves for the microbiology sampling were closed, and valves for a hydrostatic pressure check were turned and left open to bottom water. Old OsmoSamplers were moved to the elevator, and new OsmoSamplers were deployed on the wellhead.

A brush was used to clean off corrosion from the flowmeter adapter and ring clamp. The ring clamp was heavily corroded and the mechanism was fouled, so it required about 60 minutes and considerable patience to turn the clamp 90 degrees (CCW, when viewed from above). At this point the flowmeter was not being held securely and it tumbled into *Jason's* basket. It was subsequently moved to the elevator for recovery. Pressure data was downloaded. Images were taken of the GeoMICROBE sled, in preparation for later recovery, and the MGM elevator was moved to theU1362B wellhead for large-volume sampling. These sampling operations occupied the rest of the dive, and then the MGM elevator, OsmoSampler/flowmeter elevator, and *Jason* were recovered.

Dive 711 (2/9 on AT26-03)

Dive 711 worked on CORKs in Holes U1301A/B and U1362A/B (**Figure 6**). Prior to the dive, an elevator was deployed with new OsmoSamplers for Hole U1362A. Work began at Hole U1301A. Pressure valves were opened to hydrostatic, OsmoSampler plates were recovered, and pressure valves were set back to measurement of the borehole. The wellhead and surrounding area were photodocumented, and the brush was used to clean the ODI connector in preparation for pressure download. After the pressure download, we transited to U1301B. At Hole U1301B we switched pressure valves to hydrostatic, then back to measuring the borehole, cleaned the ODI connector, and downloaded data.

We transited to Hole U1362A (past U1362B), stopping along the way to put the U1301A OsmoSampler plates on the elevator, and then to move the elevator close to the U1362A wellhead. There was shimmering water coming from one of the OsmoSampler crates on

U1362A, temperature was measured at ~12-13°C. Both OsmoSampler crates were recovered. A hydrostatic check was started while removing old OsmoSampler crates and deploying new crates to the wellhead. Pressure valves were turned back to borehole, and after some minor maintenance, pressure was downloaded. Fluid and microbiological samples were collected with the Mobile Pumping System (MPS) on *Jason*, and with gas tight, squeeze and syringe samplers. The dive ended with a transit to U1362B, followed by checking with the temperature probe to see if the ball valve was really closed. Temperature measured immediately adjacent to/above the ball valve was ~7.5°C. The MGM elevator and OsmoSampler elevator were released, and the dive was ended.

Flowmeter calibration following Dive 711

Following completion of Dive 711, we used a small elevator and the hydrowire to calibrate the new electromagnetic flowmeter. This was accomplished by cutting a hole in the elevator grating, and securing the flowmeter so that the bottom adapter penetrated through the hole, near the center of the elevator. Stacks of three *Alvin* weights (48 lbs/stack) were secured to all four corners of the elevator to center the load, and more weight was added next to the flowmeter itself (mounted slightly off center), to help prevent the elevator from kiting in the water column. The elevator was lowered over the side and downward through the water column for periods of 20-40 minutes at a steady rate, across a range of ~10 to 60 m/min, equivalent to about 0.5 to 5 L/s passing through the flowmeter. Unfortunately, the new flowmeter failed during this test after the first 10 minutes of immersion. As a result, it could not be deployed, and a temperature-only flowmeter was rigged for later use.

Dive 712 (3/9 on AT26-03)

Dive 712 was planned to work at Holes 1026B, 1027C and U1362A/B (**Figure 7**). We deployed the MGM elevator before the dive close to U1362A, with intent to recover during a later dive. We dove on 1027C, performed a hydrostatic check, and downloaded pressure data. We transited to 1026B and recovered OsmoSampler plates from the wellhead, then took numerous photos and video of the wellhead. We transited to U1362A and collected samples with the MPS, gas-tight, squeeze and syringe samplers, then moved the MGM elevator to the wellhead and attached the sampling line. When these operations were complete, we used a harness hanging below *Medea* to attach to the GeoMICROBE sled (which lost buoyancy attached by a line during the 2011-13 deployment), and then recovered the sled, *Medea*, and *Jason*.

Dive 713 (4/9 on AT26-03)

Dive 713 completed tasks at Hole U1301A (**Figure 8**). We dove on U1301A, cleaned the OsmoSampler mounting fittings, and installed new OsmoSampler plates on the wellhead. We removed a stack of *Alvin* weights that had been placed on the top plug after replacing it during an earlier expedition. We positioned *Medea* with a harness and top plug recovery tool (Otis) hanging beneath it, then placed the recovery tool in the top plug. *Jason* stood back and filmed while *Medea* began lifting the plug and the cable and instruments hanging beneath it. Unfortunately, the instruments hanging in the CORK at depth became stuck, and it was possible to continue extracting the string only with high upward force on *Medea* (~10,000 to 14,000 lbs). We could see shimmering water exiting the top of the wellhead, so we know that the bottom plug had been pulled above its seat, but progress with removing the string was slow. We continued pulling at 8-12 m/hr for several hours, and were making visible progress, but eventually the cable parted and there was a tension drop. We continued to raise *Medea* slowly until we could be sure we were free of the seafloor, then continued with *Medea* and *Jason* recovery, and with recovery of the (partial) instrument string. We eventually recovered the top plug, cable with three temperature loggers, a center weight, and a short segment of line. Still in the hole is ~165 m of cable, a bottom plug, and OsmoSamplers and microbiological samplers, along with additional temperature loggers. We may try to fish these out during Summer 2014 operations.

Dive 714 (5/9 on AT26-18)

Dive 714 supported activities at Holes U1301A, U1362A/B, 1026B (**Figure 9**). An elevator was deployed prior to the dive with a flowmeter (temperature only) to be deployed on U1362A, new OsmoSamplers to be deployed with the flowmeter, and OsmoSampler plates to be deployed on the CORK in Hole 1026B. We collected fluids from the top of the U1301A wellhead, which was discharging shimmering water, then placed the top plug in the hole using the Otis tool. After this tool was released from the plug, we placed an *Alvin* dive weight on top of the top plug to hold it in place. We transited back to Hole U1362B and looked for shimmering water emanating from the closed ball valve. It did appear that there was some weepage past the valve, and temperatures immediately adjacent to the valve were elevated (10-12 °C). After making a photo survey of the U1362B wellhead, we transited to U1362A, then located and moved the elevator closer to the wellhead.

We opened the clamp above the large diameter ball valve and removed the dust cover, then checked the temperature above the ball valve (it was barely warmed than bottom water). We installed the flowmeter and clamped it in place, then attached the Umbilosnork, and opened the ball valve. The handle on the ball valve was loose (retaining bolt, washer, and clip ring had corroded away, as at U1362B) but with some care the ROV pilot was able to turn the valve stem. We were rewarded by a copious flow of shimmering water.

We closed the valve to the fitting providing water to the MGM elevator, then opened the OsmoSampler valves to collect water from the flowmeter chimney. The first elevator was released to the surface (with OsmoSamplers), and the MGM elevator was moved from the wellhead in anticipation of recovery. We transited to 1026B and installed two OsmoSampler plates on the wellhead, then completed a photo mosaic of the wellhead. We transited back to U1362A and checked the temperature of water discharging from the wellhead – it was up to 61.5°C from 54.5°C right after opening the ball valve (four hours later). We collected fluids with the MPS, gas-tight, syringe and squeeze samplers. Three hours later, the temperature at exit to the flowmeter was 62.0 °C. We ended the dive by releasing the MGM elevator, then surfacing with *Jason*.

Dive 715 (6/9 on AT26-03)

Dive 715 comprised operations at Holes 1027C, U1301B, and U1362A/B (**Figure 10**). Prior to diving, we deployed the MGM elevator near U1362B. We dove on 1027C, in an attempt to reprogram the data logger [to avoid an electronics failure associated with excess drain (short) on the seafloor pressure gauge]. We transited to U1301B and attempted to cut cable to seafloor gauge, in an effort to restore function. This did not work, so we next tried cutting sensor to deepest interval, but this also failed to restore functionality – the logger would need to be retrieved during a subsequent dive.

We transited to U1362A and checked temperature at the chimney above the flowmeter – highest recorded value was 63.4 °C. We collected fluids with the syringe and squeeze samplers.

There appeared to be some leakage also around base of ball valve, but not clear how much – could be conductively heated from water rising in pipe. We transited to U1362B, collecting the MGM elevator while en route. We attached the pump on the MGM elevator to the microbiology valve in the wellhead, then turned on the system. We also collected samples with the MPS on *Jason*, did a fly around photo mosaic, then ended the dive.

Dive 716 (7/9 on AT26-08)

Dive 716 was planned for operations at Holes 1026B, U1301A/B, and U1362A/B (**Figure 11**). Prior to diving we deployed an elevator with the heat flow insertion frame and an empty crate for recovery of the Hole U1301B pressure logger. After dropping the elevator, we began the dive by exploring the seafloor near Hole 1026B in an effort to locate some Ocean Networks Canada instruments, at their request, but this was unsuccessful. We transited to U1362A and measured the temperature of fluid emanating from the flowmeter, recording a high value of 63.7 °C. We recorded some HD video in the hope of estimating the flow rate later from these images. We downloaded pressure data from U1362A, then transited to U1301B to recover the damaged pressure logger. The pressure logger at U1301B was heavily corroded and difficult to remove, so we took a break from that and collected eight push cores.

After stowing the last of the cores, we began tests with the heat flow probe insertion frame, which generally worked well. The clamp around the pressure case on the probe was slightly oversized relative to the guide tube on the insertion frame, so we made note to fix this prior to intended use on a subsequent cruise. The heat flow insertion frame was returned to the elevator for recovery. The U1301B pressure logger was eventually removed from the wellhead after another 45 minutes of effort, then transported to the elevator. A new *Jason* pilot (following shift change) played a bit more with the heat flow insertion frame, to get a sense of how it handled, then put it back on the elevator. The elevator was released to the surface.

We transited to U1301A, connected an umbilical to the microbiology sampling line, and spend the next several hours collecting fluid samples with the MPS. Additional samples were collected with the syringe and squeeze samplers. Then we transited back to U1362B, firing a Niskin bottle along the way. When we reached U1362B, we discovered that one of the glass spheres in the elevator floatation package had imploded, triggering additional floatation implosions and knocking the MGM elevator off the wellhead platform. Amazingly, and thanks to structural reinforcement of sampling line breakpoints directly to the elevator frame, the MGM sampler system was still attached the wellhead and functioning properly, so we did not attempt to change the wellhead configuration, preferring to discuss options and address the damage during the next dive.

Dive 717 (8/9 on AT26-03)

Dive 717 activities were all at Hole U1362B (**Figure 12**). The first step in cleaning up the mess at U1362B was to close the MGM sampling valve, shutting down the pump, filter, and fluid storage system. Next we attempted to straighten up the MGM elevator in anticipation of recovery, and removed debris from the wellhead platform. We made a connection to the U1362B pressure logger, to verify that this system was not damaged by the nearby implosion. We attached a shackle hanging from a harness below *Medea* to the top of the MGM elevator, and also recovered transponders from the elevator that had been blown off into the sediment. Then we ended the dive and recovered the vehicles.

Dive 718 (9/9 on AT26-03)

Having completed all of the highest priority objectives on Expedition AT26-03, we dedicated the final *Jason* dive to exploration of Zona Bare outcrop (**Figure 13**). This feature was discovered by H. Villinger, V. Spiess and other U. Bremen colleagues while swath mapping during transit on the R/V *Sonne* during a site survey expedition in 2000 in preparation for IODP Expeditions 301 and 327. We collected some heat flow data and gravity core samples in 2000, finding a few areas of elevated heat flow and some clams and worm tubules in the weight stand of a gravity corer. A brief ½ dive with *Alvin* in 2009 revealed no significant areas of seepage, but most of the outcrop remained unexplored.

We had acquired relatively high-resolution swath map data across Zona Bare outcrop during AT18-07 in 2011, so that data provided a basemap for our survey. We worked our way back and forth across the outcrop, paying particular attention to steep slopes where basement rocks might be exposed. We found little evidence for seepage, until we realize that the key indicator was a "scorched" appearance running along cracks in the surface sediment. There was often a clustering of macrofauna (stars, sponges, crabs) around these areas, and subsequent measurements with the temperature probe (and later the heat flow probe) revealed that these locations tended to have elevated temperatures and evidence for seepage of altered fluids. In addition to push cores, we also collected squeeze and syringe samples from cracks in the shallow sediment. Eventually we located regions where temperatures at 25-30 cm below the surface were 12-17 °C, and found that there was shimmering water rising from the sediment. We also found small (~1 cm diameter) clams buried just below the surface, and collected these and some hard rock samples for later analyses.

End of AT26-03

After completion of the survey at Zona Bare, we steamed back to Astoria OR for the final port call of AT26-03. We arrived at the dock around 10:00 on 7/26/13, and offloading of equipment was accomplished quickly. One shipment was loaded directly into a rental truck, and other equipment was picked up by various freight companies. Virtually all gear was removed from the ship and labs were cleaned by the end of the day on 7/26/13, making spaces available for the oncoming science party.

III. Summary of CORK Pressure Downloads

A summary of CORK pressure download operations and files retrieved is presented in **Table 5**. Hydrostatic checks were performed at all sites where pressure data was downloaded. Loggers from U1301A and U1362A/B all provided high quality data. The data from 1027C included some errors, most likely due to a seafloor gauge failure, so it could not be read throughout the period of record. The logger at U1301B was in worse shape, also because of a failure of the seafloor gauge, and we were not able to download a readable data file. The logger in Hole U1301B was recovered near the end of AT26-03 and packaged for shipment back to PGC.

IV. Summary of OsmoSampling for Geochemistry and Microbiology

OsmoSampler operations went smoothly during AT26-03. OsmoSamplers were recovered from the wellheads of CORKs installed in Holes 1026B, U1301A, and U1362A/B (**Table 6**). All of these OsmoSampler systems were installed in Summer 2011 during Expedition AT18-07. Hole 1027C is not being used for fluid sampling. Although the manifold insert installed on AT18-07 has two of the new Jannasch connectors (one of which is being used for pressure monitoring), the borehole is underpressured and has a large head space of borehole fluid, so extracting useful fluid samples would be difficult. The CORK in Hole U1301B has never provided high-quality geochemical fluid samples from depth (although some microbiological samples have been useful, comprising a mix of borehole fluids and bottom seawater), and cementing operations during IODP Expedition 321T appear to have caused pressure lines to be crushed (so fluid sampling lines might be crushed as well). No OsmoSamplers were attached to the U1301B wellhead during AT18-07.

New OsmoSamplers were installed on Holes 1026B and U1301A (plates) and Holes U1362A/B (crates) (**Table 6**). Samplers were deployed to monitor both CORK depth intervals in Hole U1362A. FLOCS samplers were deployed on Holes U1301A and U1362A/B, and gas samplers were deployed on all wellheads.

V. Summary of Active Fluid Sampling from CORKs

The University of Hawaii group led efforts in sampling fluid delivery lines from CORK wellheads, using both the MPS coupled to the Medium Volume Bag Sampler (MVBS, mounted in the rear *Jason* basket), Large Volume Bag Sampler (LVBS, mounted in the forward *Jason* basket) and using a MGM elevator with mounted pumps and collection bags (**Table 9**). Additional sampling was completed with Gas Tight samplers, squeeze and syringe samplers (UAF) (**Table 8**), and in the water column with a CTD or Niskin bottle mounted on *Jason*. The MPS and MGM systems worked especially well, collecting hundreds of liters of fluids and passing thousands of liters of fluids through filters.

IV. Summary of Education, Outreach and Communication Activities

The goals of the AT26-03 education, outreach, and communication (EOC) activities were to:

- Increase educational participants' understanding of the science of the expedition and comfort level in communicating science to the public
- Raise awareness among shore-based followers about the nature and process of science and marine science careers
- Increase shore-based understanding of expedition science goals and their value
- Reach at least 500 people

We ran a variety of EOC activities during AT26-03, facilitated by an energetic and talented team of four EOC specialists. In addition to our EOC team leader, one of the team was an elementary/secondary school science teacher, one was a pre-service teacher, and one was a videographer and college instructor. We also participated in an extensive telepresence program operated by the Inner Space Center at the University of Rhode Island, which provided us with live video and audio feeds from the *Jason* cameras and main lab. Collectively, the EOC program focused on the nature and process of science – how researchers ask questions, test ideas, gather data, problem-solve, circle back to new questions and collaborate with both the local, on-board community of participants and the broader science community at large – all in the service of a transformative research agenda.

We ran three main kinds of EOC events during AT26-03:

1) Tele-presence interactions organized by the Inner Space Center to a variety of aquariums and museums nationwide

2) Special events organized by our own team, including educators and scientists

3) Impromptu/informal broadcasting using our 24/7 live stream.

The partnership with Inner Space Center included a high-bandwidth internet connection throughout most of AT26-03. We held 80 real-time video webcasts (**Table 9**), including 72 telepresence interactions of approximately 10 minutes each, and eight longer format programs lasting 30-45 minutes. We reached >2,000 people through these events. For telepresence interactions, EOC team members took turns giving quick overviews of current operations and answering questions from audience. Several scientists also participated in these interactions as guests.

For our special events, we provided shorebased participants with videos and other materials in advance of the web events, so that they could view these materials to become prepared and we could make better use of opportunities to interview expedition participants and show examples of ongoing activities and facilities. Scientists and educators gave tours of the lab and ship, provided brief overviews of the expedition, and answered student questions. We used the telepresence "studio" as a center for these activities, but also used an iPad as a mobile camera transmitting live video from the fantail deck where *Jason* launches. We also broadcasted prerecorded videos. Our special event venues included museums and aquariums, summer science camps, teacher workshops, undergraduate classes, and a professional conference.

For our informal internet events, the team used the live feed to narrate the live *Jason*-feed cameras, explaining what was happening in real time, interviewed scientists, crew (including the captain and mates) and *Jason* engineers, and answered live questions. A telephone line into the telepresence system allowed the team to interact with audiences through audio.

EOC specialists also received training in interviewing and video production, and produced a series of video interviews to use with their students. EOC team members blogged about the expedition on a regular basis, responding to questions and requests from shore. We also had excellent participation in the EOC program by members of the scientific party, and by the ship's officers and crew and members of the *Jason* team, who told their stories and discussed their experiences during voyages of exploration and discovery. Equally important, the EOC team engaged as members of the shipboard party and helped to achieve primary expedition goals, collecting data and samples, standing watch in the *Jason* van, and putting instruments over the rail.

Our videographer produced a series of videos in collaboration with other team members:

- Return to Juan de Fuca 2013: www.vimeo.com/69524899
- What is a CORK?: www.vimeo.com/70307917
- Octopus's Garden in a CORK: www.vimeo.com/70387620
- What is an Elevator?: www.vimeo.com/70600300
- Ask a Jason Pilot: www.vimeo.com/70658674
- Ask the Captain: www.vimeo.com/70829237
- Ask a Large Roundish Purplish Deep Sea Creature: www.vimeo.com/70996604
- Exploring a Land Down Under: www.vimeo.com/71104226

The EOC team developed several curricular pieces. The team provided feedback to Beth Orcutt for incorporation into the new edition of the Adopt-a-Microbe curriculum module. Videos were produced with interviews with scientists and crew, and activities to accompany them. And the EOC team worked on modules for the Junior Ocean Scientist program.

Websites for the expedition included: www.explorationnow.org/atlantis, photo albums were placed here: www.explorationnow.org/atlantis/albums, and blogs were posted here: www.explorationnow.org/atlantis/blog.

Quantitative evaluation of EOC objectives and achievements was completed by the C-DEBI external evaluator, using pre- and post-expedition polls and long-format questionnaires. This information was incorporated into the broader C-DEBI EOC assessment included as part of the 2013 annual report to NSF.

Table 1. Work sites during AT26-03.

Location ID	Latitude	Longitude	Water depth (m)	Year CORK installed	Expedition when CORK was installed
CORK 1026B	47°45.759'N	127°45.552'W	2658	1996/2004	Leg 168/Exp. 301
CORK 1027C	47°45.387'N	127°43.867'W	2656	1996	Leg 168
CORK U1301A	47°45.209'N	127°45.833'W	2658	2004	Exp. 301
CORK U1301B	47°45.229'N	127°45.826'W	2658	2004	Exp. 301
CORK U1362A	47°45.662'N	127°45.674'W	2658	2010	Exp. 327
CORK U1362B	47°45.499'N	127°45.733'W	2658	2010	Exp. 327
CORK 1024C [a]	47°54.531'N	128°45.005'W	2612	1996	Leg 168
Zona Bare [b]	48°11.0'N	127°33.0'W	2580-2500	NA	NA

[a] Downloading pressure data from the CORK in Hole 1024C was a secondary objective of AT26-03. We move the ship to this location prior to dive J2-718, but a delay was caused by a thruster failure. The ship was subsequently moved to Zona Bare outcrop.

[b] Surveying Zona Bare outcrop, including location and sampling of warm springs and collection of heat flow data, was a secondary objective of AT26-03.

Table 2. Summary of tasks completed at each of the CORKs serviced on AT26-03.

Location ID	[1]Exchange OS	[2]Active fluid/MBIO sampling	[3]Deploy/recover flowmeter	[4]Recover GeoM sled	[5]Download P data	[6]Recover sensor string
CORK 1026B	R-3P, D-2P				ONC	
CORK 1027C					√	
CORK U1301A	R-3P, D-3P	√			√	√
CORK U1301B					√	
CORK U1362A	R-3C, D-2C	√	D		√	
CORK U1362B	R-1C, D-1C	√	R	√	√	

[1] OS = OsmoSampler. R = recovered, D = deployed. Several kinds of OsmoSampler systems were deployed on and recovered from CORK wellheads, as described in the text.

[2] Active sampling = using mechanical pumps (in *Jason* and/or on elevator) to draw fluids from wellheads, or sampling flow from overpressured formations with syringe, squeeze, and/or gas tight samplers.

[3] R = recovered from Hole U1362B (deployed on AT18-07 in 2011), D = deployed at U1362A (second instrument).

[4] GeoMicrobe sampling sled was left to draw fluids from CORK in Hole U1362B on AT18-07 (2011).

[5] ONC = Pressure and temperature logging systems installed with CORK in Hole 1026B are being downloaded automatically with the Ocean Network Canada cabled network. All other holes are collecting pressure data autonomously.

[6] The upper part of the Spectra cable was recovered from Hole U1301A, including three temperature sensors. All other string components were left in the hole.

Table 3. Distances between primary CORK systems serviced on AT26-03 (meters).

	Hole 1026B	Hole U1362A	Hole U1362B	Hole 1027C	Hole U1301B	Hole U1301A
Hole 1026B	–	235	532	2199	1039	1076
Hole U1362A	235	–	311	2296	825	861
Hole U1362B	532	311	–	2322	514	550
Hole 1027C	2199	2296	2322	–	2446	2458
Hole U1301B	1039	825	514	2446	–	36
Hole U1301A	1076	861	550	2458	36	–

Table 4. Summary of *Jason* dive numbers, dates/times, dive locations, and Virtual Van image/event numbers from AT26-03.

Dive ID [a]	Date/Time OnB [b]	Date/Time OffB [b]	VV start [c]	VV end [c]	CORK(s)/area serviced [d]
J2-710-1	7/14/13 16:43	7/15/13 6:00	24	1263	1362B
J2-711-2	7/15/13 23:11	7/16/13 16:03	1276	2901	1301A, U1301B, U1362A, U1362B
J2-712-3	7/17/13 8:40	7/18/13 22:27	2918	4414	1027C, 1026B, U1362A, U1362B
J2-713-4	7/18/13 14:55	7/19/13 4:50 [e]	4426	4979 [e]	1301A
J2-714-5	7/19/13 18:02	7/20/13 5:39	5006	6276	1301A, U1362B, U1362A, 1026B, U1362A [f]
J2-715-6	7/20/13 20:43	7/21/13 11:21	6304	7496	1027C, U1301B, U1362A, U1362B
J2-716-7	7/22/13 2:57	7/23/13 17:47	7512	9126	1026B [g],U1362A, U1301B, U1301A, U1362B
J2-717-8	7/23/13 17:47	7/23/13 19:52	9126	9426	1362B
J2-718-9	7/24/13 16:45	7/25/13 22:27	9451	12700	Zona Bare

[a] Dive ID in format J2-XXX-Y; XXX = *Jason* dive number, Y = sequential dive number during expedition AT18-07

[b] OnB = On bottom; OffB = Off bottom. Dates and times are UTC, = local time + 7 hrs.

[c] Virtual Van ID refers to events in the automated logging system. Numbers are approximate, corresponding to days/times listed.

[d] CORKs serviced are listed in order of operations

[e] Final event and time for Dive J2-713-4 is when *Jason* came out of the water, because this dive ended with recovery of the instrument string from Hole U1301A

[f] Second visit to this CORK on this dive

[g] Looking for Neptune Canada components near Hole 1026B

Table 5. Summary of CORK data downloads during AT26-03. All dates and times are UTC.

CORK	Dive	Date/Time [a]	Data start [b]	Data end [b]	H√ [c]	Clock off (s)	Filename
U1362B	710	7/14/13 21:45	7/10/11 9:28	7/14/13 21:34	√	–77.02	13p1362b_1.raw
U1301A	711	7/16/13 0:43	7/3/11 10:56	7/16/13 12:36	√	–490.87	13p1301a_1.raw
U1301B	711	7/16/13 2:19	7/3/11 9:37	9/1/12 0:28[d]	√	+506.39	13p1301b_1.raw
U1362A	711	7/16/13 7:43	7/10/11 7:57	7/16/13 7:47	√	+603.26	13p1362a_1.raw
1027C	712	7/17/13 9:52	6/29/11 11:10	7/17/13 9:35[d]	√	+417.27	13p1027c_1.raw
1027C	715	7/20/13 23:09	7/17/13 10:03	7/20/13 22:43[d]		Not checked	13p1027c_2.raw
U1301B	715	7/21/13 5:30	NA[e]	NA[e]		+316.49	13p1301b_2.raw
U1362A	716	7/22/13 4:51	7/16/13 8:17	7/22/13 4:25		+345.95	13p1362a_2.raw
U1362B	717	7/23/13 18:35	7/14013 23:06	7/23/13 18:12	√	+3501.82	13p1362b_2.raw

[a] Time when download started.

[b] as reported in converted data file

[c] File contains hydrostatic check. Hydrostatic check for U1301A is difficult to see in data because CORK is not sealed.

[d] File includes incomplete/erroneous records because of gauge failure

[e] Data corrupted, could not convert to DAT file to check dates

Table 6. Summary of OsmoSampler recoveries during AT26-03.

CORK	Dive ID	VV# [a]	Interval, location	Type [b]	Contents
U1362B	710	433	Shallow (only), free flow chimney	C-Green, double	FLOCS, Regular, Gas, Enrichment
U1301A	711	1320	Shallow, left bay, lower valve, left nipple	P	FLOCS, Enrichment
U1301A	711	1320	Shallow, center bay, lower valve, left nipple	P	Gas
U1301A	711	1320	Shallow, right bay, upper valve, right nipple	P	Regular
U1362A	711	1930	Shallow, lower valve #3	C-Orange, double	FLOCS, Regular, Gas, Enrichment
U1362A	711	1980	Deep, upper valve #1	C-Red	FLOCS, Enrichment
U1362A	711	1980	Shallow, upper valve #2	C-Green	Regular, Gas
1026B	712	3252	Shallow (only), right bay, lower valve, left nipple	P	FLOCS
1026B	712	3252	Shallow (only), center bay, lower valve, left nipple	P	Gas
1026B	712	3252	Shallow (only), left bay, upper valve, right nipple	P	Regular

[a] Virtual van event corresponding to photograph of system being recovered

[b] P = plate (old style, placed directly on wellhead), C = crate (new style, connected with umbilical)

Table 7. Summary of Osmosampler deployments during AT26-03.

CORK	Dive ID	VV# [a]	Interval, location	Type [b]	Contents
U1362B	710	460	Shallow (only), Lower valve #1	C-Red, double	FLOCS, Regular, Gas, Enrichment
U1362A	711	2044	Shallow, lower valve #3	C-Blue	FLOCS, Regular
U1362A	711	2044	Deep, upper valve #1	C-Yellow, double	FLOCS, Regular, Gas, Enrichment
U1301A	713	4463	Shallow, left bay, both valves and nipples	P	FLOCS
U1301A	713	4463	Shallow, center bay, both valves and nipples	P	Regular
U1301A	713	4463	Shallow, right bay, upper valve, right nipple	P	Gas
U1362A	714	5521	Deep, free-flow chimney	C-Black	FLOCS, Regular, Gas, BOSS
1026B	714	5736	Shallow (only), left bay, both valves and nipples	P	Regular
1026B	714	5745	Shallow (only), center bay, both valves and nipples	P	Gas

[a] Virtual van event corresponding to photograph of system being recovered

[b] P = plate (old style, placed directly on wellhead), C = crate (new style, connected with umbilical)

Table 8. Summary of syringe and squeeze samples collected during AT26-03.

CORK	Dive ID	VV# [a]	Interval/where	N-Sq [b]	N-Sy [b]	Purpose
U1362B	710	159	Shallow (only), free flow chimney	1	5	Incubations, single cells, DNA, chemistry
U1362A	711	2406	Deep, bioline, via MPS	2	5	Incubations, single cells, chemistry
U1362A	712	3502	Shallow, Osmo valve #1, via MPS	2	9	Incubations, single cells, DNA, chemistry
U1362A	714	5969	Shallow, Osmo valve #1, via MPS	2	1	Single cells, DNA, chemistry
U1362A	715	6982	Deep, free flow chimney	0	9	DNA, chemistry, Gurguis
U1301A	716		Shallow (only), bioline	2	3	Chemistry
Zona Bare	718		Seafloor seeps	1	6	Single cells, DNA, chemistry

[a] Virtual van event corresponding to photograph of system being recovered

[b] Number of squeeze (Sq) and syringe (Sy) samples collected.

Table 9. Summary of fluid and microbiological samples collected with pump systems during AT26-03.

CORK/Location	N [a]	Vol (L) [b]	Purpose
Hole U1301A	2	40	DNA analysis
	2	2	Filtrate
	9	NA	Cryopreserved
	4	NA	Microscopy
Hole U1362A	20	217	DNA analysis
	3	3	Filtrate
	80	NA	Cryopreserved
	65	NA	Microscopy
Hole U1362B	25	206	DNA analysis
	2	2	Filtrate
	56	NA	Cryopreserved
	33	NA	Microscopy
Site U1362 (CTD)	7	34	DNA analysis
	1	1	Filtrate
	6	NA	Microscopy
Site U1362 (*Jason*/Niskin)	4	18	DNA analysis
	8	NA	Microscopy

[a] Number of samples collected of this type in this location

[b] Total volume of samples collected.

Table 10. Summary of sample volumes (L) processed or archived for analyses of viral abundance, diversity and ecology.

DIVE#	1	2	3	4	5	6	7	23 July
DIVE	J2-710	J2-711	J2-712	J2-713	J2-714	J2-715	J2-716	CTD
CORK	U1362B	U1362A	U1362A	U1301A	U1362A	U1362B	U1301A	Cast
LINE	Bioline	Deep Bioline	Deep Stainless	N.A.	Shallow Stainless	Bioline	Stainless	N.A.
SUBSURFACE FLUIDS								
Viral Concentrate (TFF)	27	35	46			120		
Viral Concentrate (NanoCeram *In Situ*)			4330			5470		
Viral Concentrate (NanoCeram)					17		22	
Microbial Concentrate (NanoCeram)								
Whole water Fixed (Electron Microscopy)		0.5	0.5		0.5	0.05		
Fixed 0.2 µm Filtrate (counts)	0.05		0.05		0.05		0.1	
Fixed NanoCeram Filtrate (counts)			0.05		0.1		0.2	
Induction Experiment								
Fixed whole water (Time Zero)					600			
Fixed whole water (Controls)					600			
Fixed whole Water (Induced)					600			
SEAWATER								
Viral Concentrate (NanoCeram)	5.5	5						15
Whole Water Fixed (Microscopy)		0.5			0.5			0.1
Fixed 0.2 µm Filtrate (Microscopy)	0.05	0.05			0.1			0.1
Fixed NanoCeram Filtrate (Microscopy)		0.05						0.05
Microbial Concentrate (NanoCeram)				5.5				20

Table 11. Summary of education, outreach, and communication "events" during AT26-03

Date	Venue/audience	Type	Location	N part
7/14/14	Mystic Aquarium	museum	CT	36
	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Mystic Aquarium	museum	CA	36
	Texas State Aquarium	museum	TX	15
	Long Beach Aquarium	museum	CA	20
	Houston Museum	museum	TX	25*
	Mystic Aquarium	museum	CT	36
	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Houston Museum	museum	TX	25*
	Mystic Aquarium	museum	CT	36
	Greg Mulder - ROV workshop	teacher workshop	OR	15
7/15/14	Mystic Aquarium	museum	CT	36
	Mystic Aquarium	museum	CT	36
7/16/14	Stamford Boys and Girls Club	club	CT	25*
	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Mystic Aquarium	museum	CT	36
	Texas State Aquarium	museum	TX	15
	Long Beach Aquarium	museum	CA	20
	Houston	museum	TX	25*
	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Mystic Aquarium	museum	CT	36
	Texas State Aquarium	museum	TX	15
	Long Beach Aquarium	museum	CA	20
	Houston Museum	museum	TX	25*
	Mystic Aquarium	museum	CT	36
	University of Houston	school/teachers	TX	30

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		(4-8th grades)		
7/17/14	Mystic Aquarium	museum	CT	36
	Mystic Aquarium	museum	CT	36
	Texas State Aquarium	museum	TX	15
	Long Beach Aquarium	museum	CA	20
	Houston Museum	museum	TX	25*
	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Houston Museum	museum	TX	25*
7/18/14	Mystic Aquarium	museum	CT	36
	Bechtel Engineers	engineering group	CT	15*
	Mystic Aquarium	museum	CT	36
	North Museum - Lancaster	museum	PA	35
	Long Beach Aquarium	museum	CA	20
	Mystic Aquarium	museum	CT	36
7/19/14	National Youth Science Camp	summer camp	WV	120
	C-DEBI GEM class	undergraduates	CA	16
7/20/14	Oceans 2020 Conference	professional conference	CA	100*
7/21/14	Seymour Discovery Center	museum audience	CA	75
7/22/14	Mystic Aquarium	museum	CT	36
	Mystic Aquarium	museum	CT	36
7/23/14	Mystic Aquarium	museum	CT	36
	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Houston Museum	museum	TX	25*
	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Mystic Aquarium	museum	CT	36
	Texas State Aquarium	museum	TX	15

	Long Beach Aquarium	museum	CA	20
	Houston Museum	museum	TX	25*
	Mystic Aquarium	museum	CT	36
7/24/14	Hawaii Academy of Arts & Sciences	school	HI	55
7/25/14	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Mystic Aquarium	museum	CT	36
	Texas State Aquarium	museum	TX	15
	Long Beach Aquarium	museum	CA	20
	Houston Museum	museum	TX	25*
	Mystic Aquarium	museum	CT	36
	Long Beach Aquarium	museum	CA	20
	Mystic Aquarium	museum	CT	36
	Texas State Aquarium	museum	TX	15
	Long Beach Aquarium	museum	CA	20
	Houston Museum	museum	TX	25*
	Mystic Aquarium	museum	CT	36
7/26/14	Long Beach Aquarium	museum	CA	20
	Long Beach Aquarium	museum	CA	20
	Mystic Aquarium	museum	CT	36
			AT26-03 Total:	2429

* Exact number of participants unknown; estimate based on report from shore-based facilitator.

Figure 1. Overview of cruise track for AT26-03 expedition with R/V *Atlantis*/ROV *Jason* in Summer 2013. Initial and final port was Astoria OR. Primary ship track is shown with solid line. Most expedition activities focused on sites where long-term, subseafloor observatory systems (CORKs) were installed as part of Ocean Drilling Program and Integrated Ocean Drilling Program expeditions. Red box indicates area of **Figure 2**, showing primary work sites in greater detail.

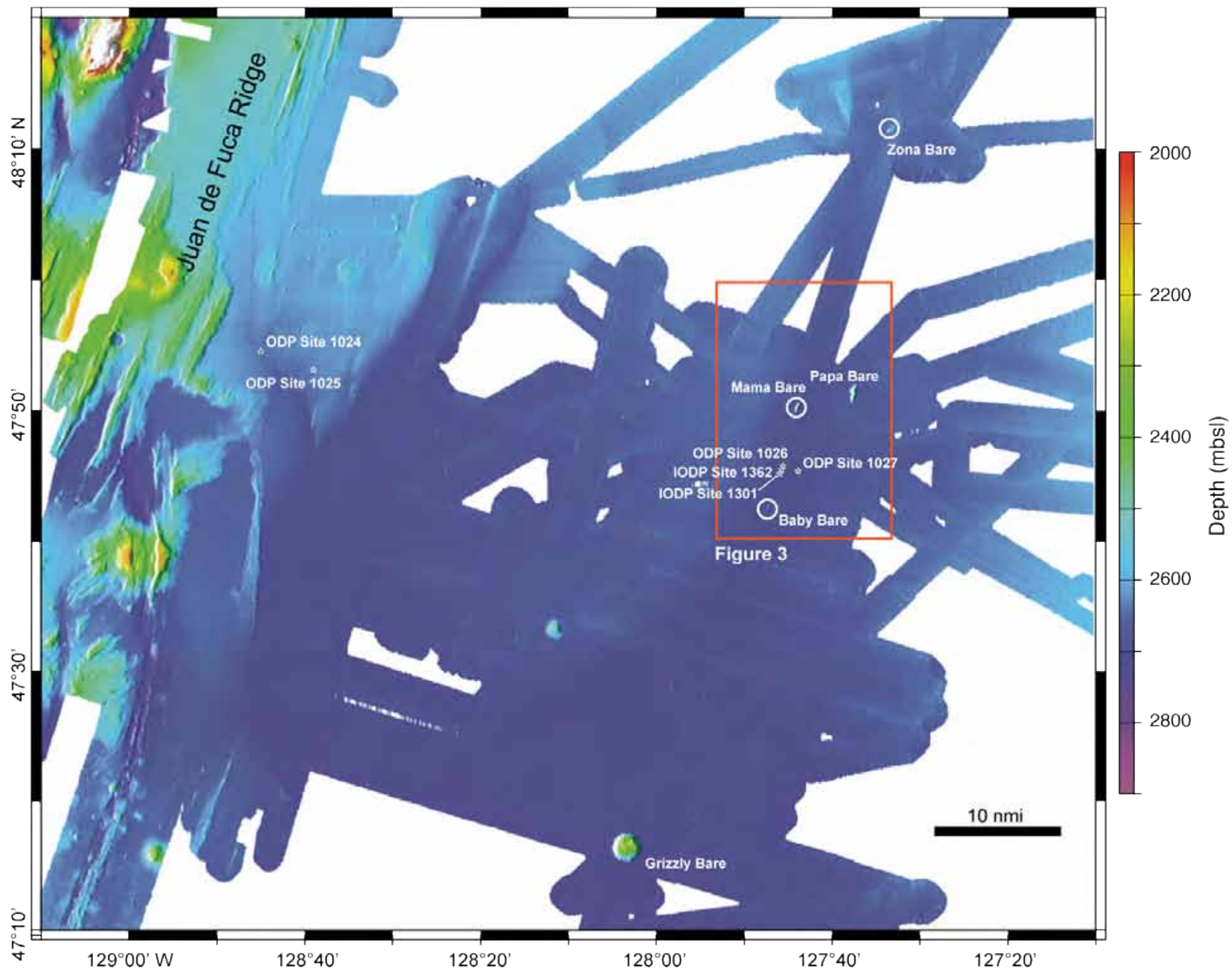

Figure 2. Bathymetric map showing work area for AT26-03. The work sites for most CORK servicing are located within the red box (shown in greater detail in **Figure 3**). Additional CORK Sites 1024 and 1025 are located closer to the Juan de Fuca Ridge, to the west. All sites are location east of the Juan de Fuca Ridge, where volcanic rocks are covered by relatively thick accumulations of marine sediments. Also shown on this map are locations where volcanic rock outcrops penetrate sediment and are exposed at the seafloor. Several of these features were cleared as secondary work sites prior to AT26-03, including Zona Bare outcrop, which was surveyed for the first time by ROV on the last dive of the expedition.

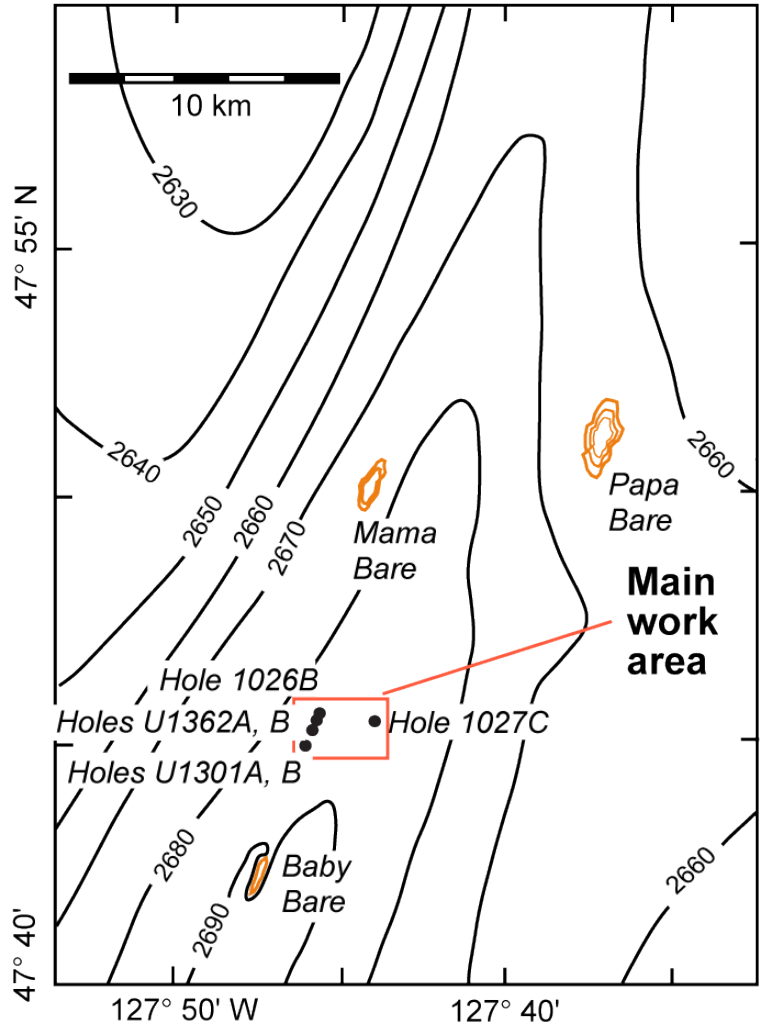

Figure 3. Detailed contour chart showing primary work area during AT26-03. All of these work sites are located within a few kilometers of each other, where the seafloor is relatively flat and comprises thick marine sediments over basement volcanic rocks. Gold contours show locations of small volcanic rock outcrops, as labeled. Two additional CORK sites are located to the west (**Figure 2**).

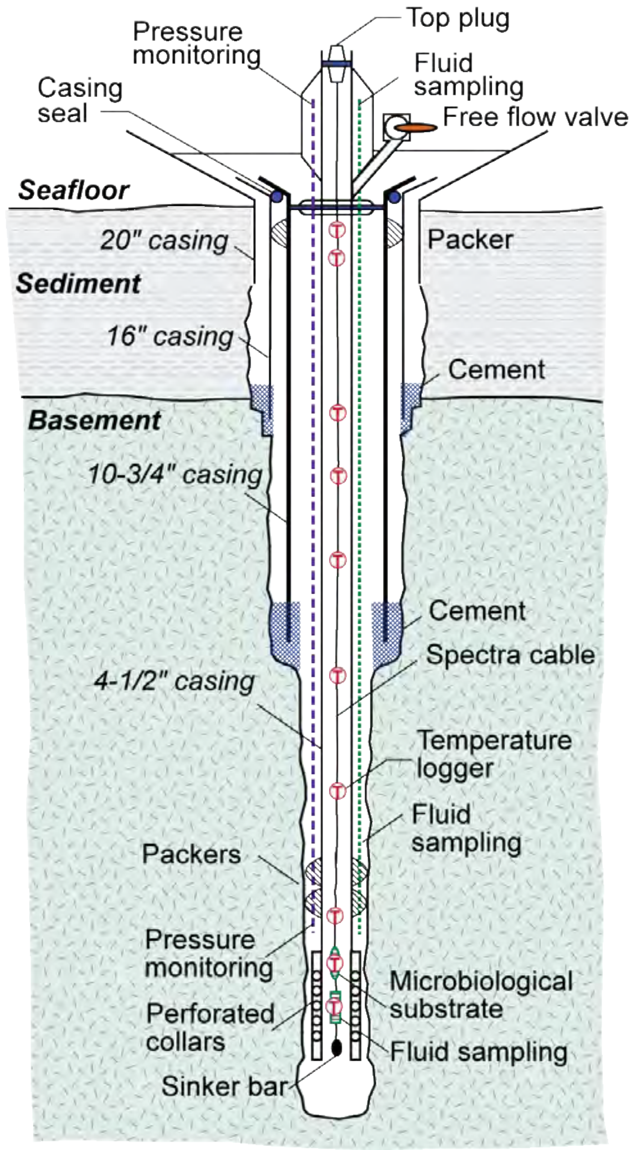

Figure 4. Cartoon showing features of CORK systems deployed during IODP Expedition 327. Earlier CORKs have some of these characteristics, but Exp. 327 CORKs have additional features including: perforated and coated drill collars and casing at depth, two kinds of CORK and casing packers (inflatable and swellable), a casing seal between 10-3/4 inch and 16 inch casing strings, a tapered gravity plug for a top seal, and a free flow valve in the L-CORK wellhead. Additional features that Exp. 327 CORKs have in common with the last generation of CORKs deployed on IODP Expedition 301 include: main CORK seal in the throat of the reentry cone within 10¾ inch casing, primary CORK casing diameter of 4½ inches, up to eight fluid, microbiological, and pressure sampling lines, with ports and screens at various depths, and a mixture of fluid and microbiological sampling systems suspended on Spectra cable at depth. Temperatures are recorded with autonomous sensor and logging instruments incorporated into the fluid and microbiological samplers or hung independently from the Spectra cable. The CORK in Hole 1027C is from an earlier generation and lacks casing that extends into basement.

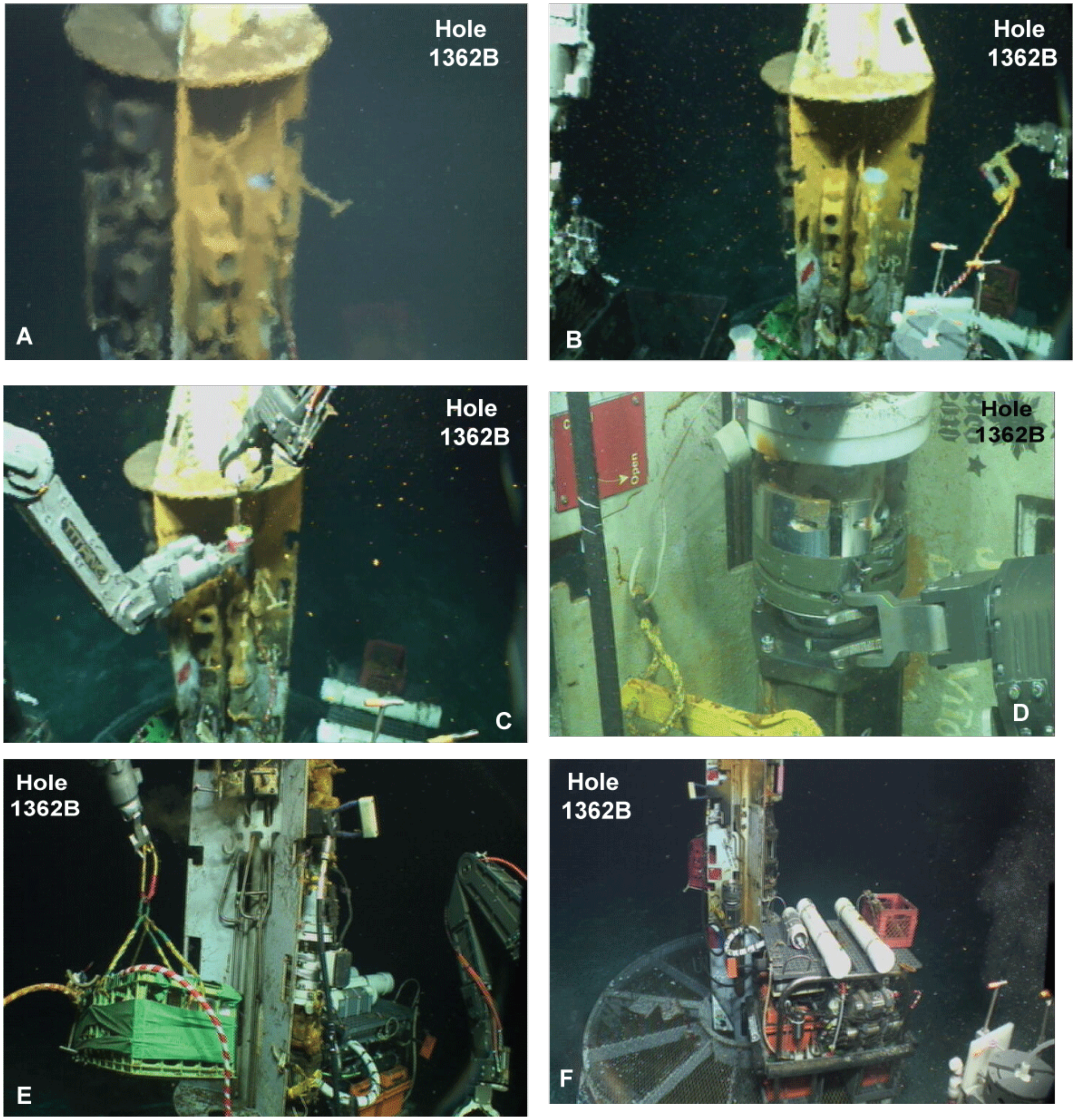

Figure 5. Images of CORK in Hole U1362B during dive 710, first dive of AT26-03. A. Initial view of CORK, with shimmering water discharging from the flowmeter. B. Removing "umbilosnork" sampling inlet from the top of the flowmeter chimney. C. Deploying squeeze sampler in top of discharging flowmeter chimney. D. *Jason* manipulator attempting to release the ring clamp above the large diameter ball valve on Hole U1362B, after closing the ball valve and ending discharge. E. Recover Osmosampler crate from well head prior to removal of flowmeter from top of ball valve. F. GeoMICROBE sled as it appeared at the start of AT26-03, prior to recovery – floatation that had been attached to the bail on top of the sled was missing.

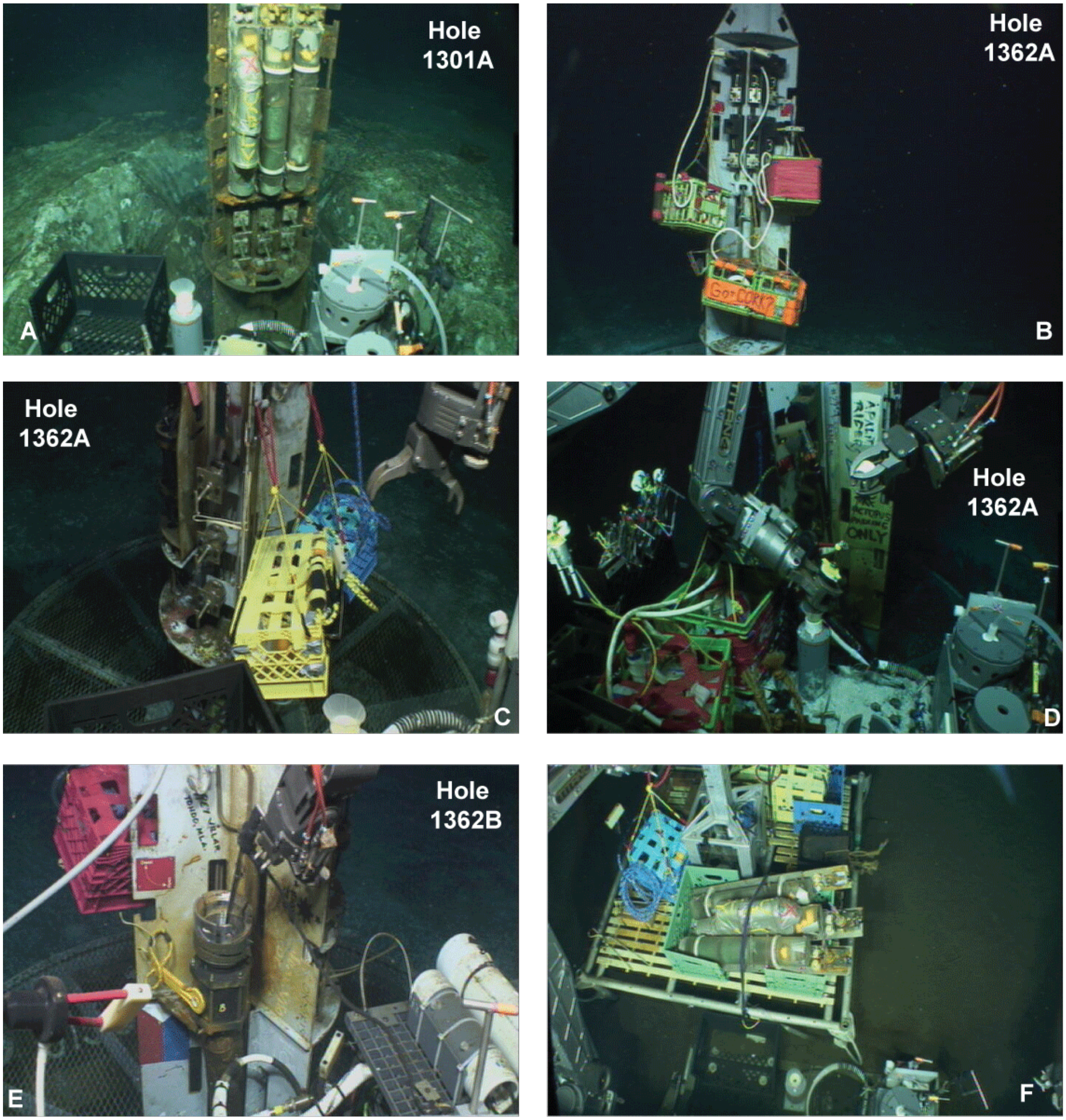

Figure 6. Images from Dive 711, which visited Holes U1301A/B and U1362A/B. A. Hole U1301A as it appeared upon arrival. All of the OsmoSampler plates were subsequently recovered. B. CORK in Hole U1362A as it appeared upon arrival – all of the OsmoSampler crates were subsequently recovered. C. New OsmoSampler crates deployed at Hole U1362A. D. Deploying a squeeze sampler using the MVBS at Hole U1362A. E. Checking for leaks around the ball valve at Hole U1362B, one day after closing the valve. F. OsmoSamplers removed from Hole U1301A, on the elevator prior to recovery.

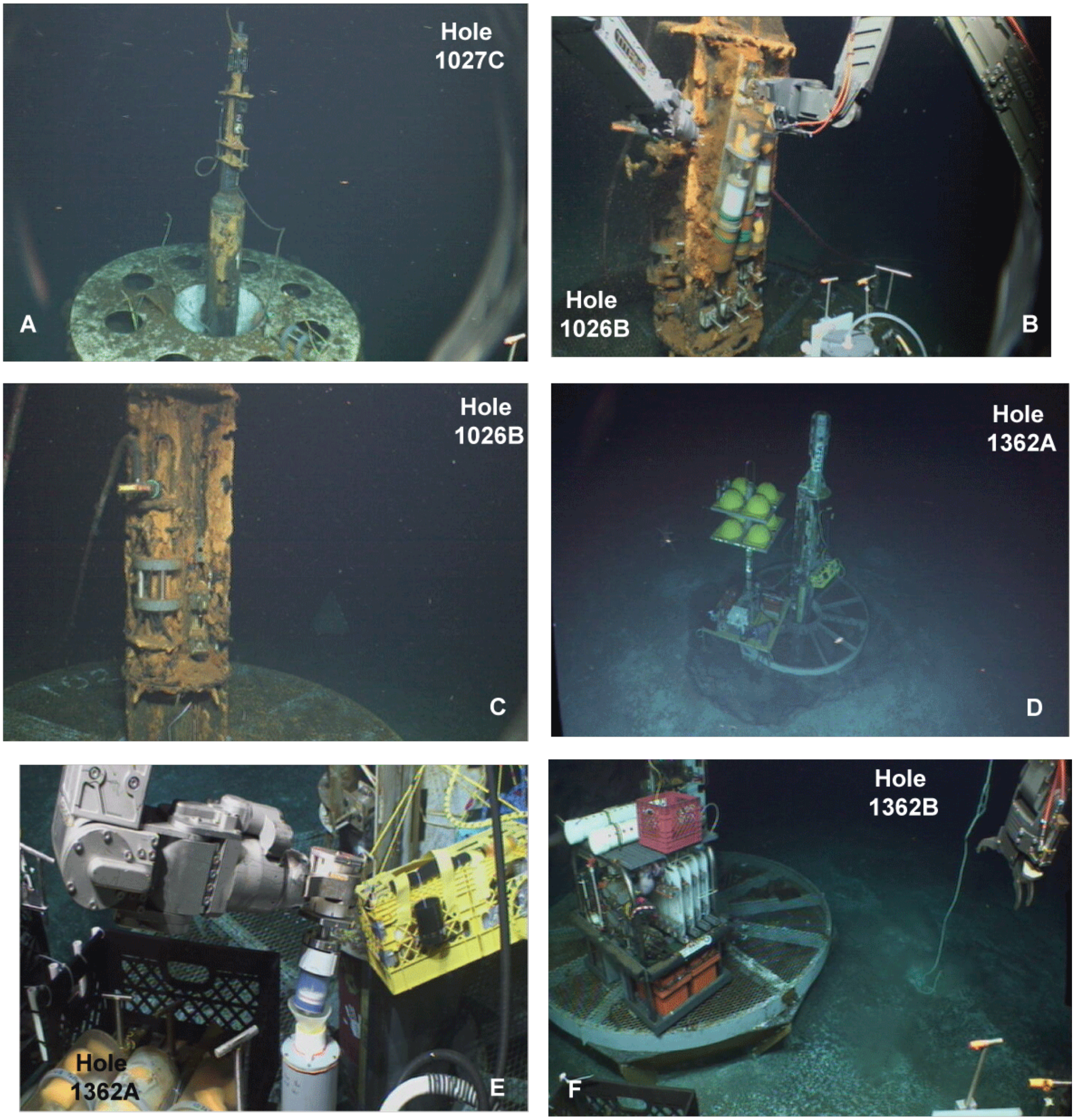

Figure 7. Images from Dive 712, which visited Holes 1026B, 1027C, and U1362A/B. A. Hole 1027C as it appeared upon arrival, before data download. B. Recovering OsmoSampler plates from Hole 1026B. C. Pressure bay on CORK in Hole 1026B. Notice cable extending from top of wellhead, connecting the thermistor string to ONC cabled observatory system. D. MGM elevator positioned near wellhead in Hole U1362A. E. Collecting a squeeze sample during MVBS operations at Hole U1362A. F. Positioning harness for recovery of GeoMICROBE sled from platform at Hole U1362B.

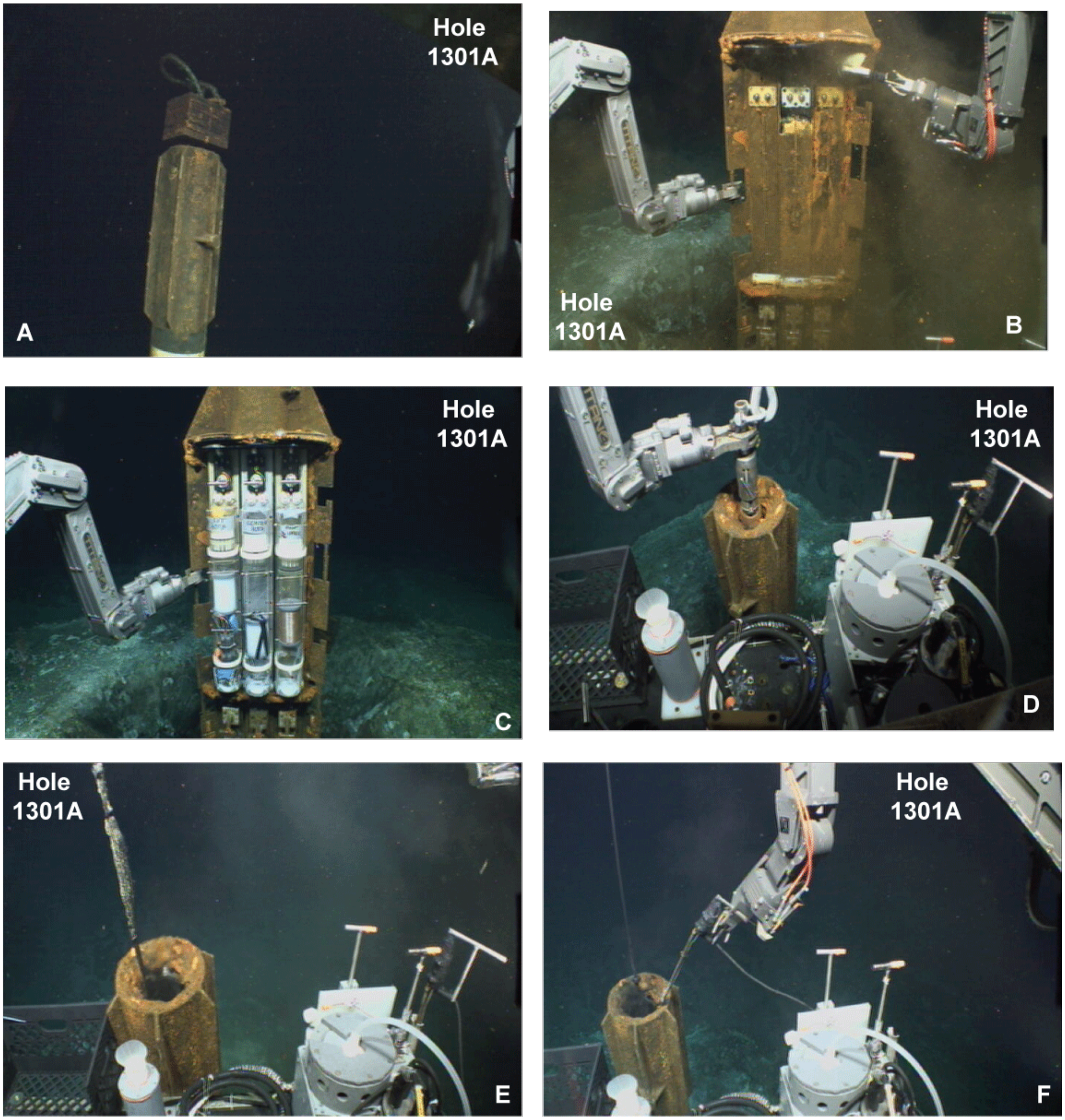

Figure 8. Photographs from Dive 713, which operated at Hole U1301A. A. Weight stack at top of Hole U1301A wellhead, added in 2009 to prevent loss of pressure if cementing was successful. B. Cleaning wellhead prior to attachment of new OsmoSamplers. C. New OsmoSamplers attached to Hole U1301A. D. Pulling plug from top of Hole U1301A using harness hanging below *Medea*. E. Thermistor bundle exposed as cable is pulled from wellhead. F. Measuring temperature at the top of the Hole U1301A wellhead.

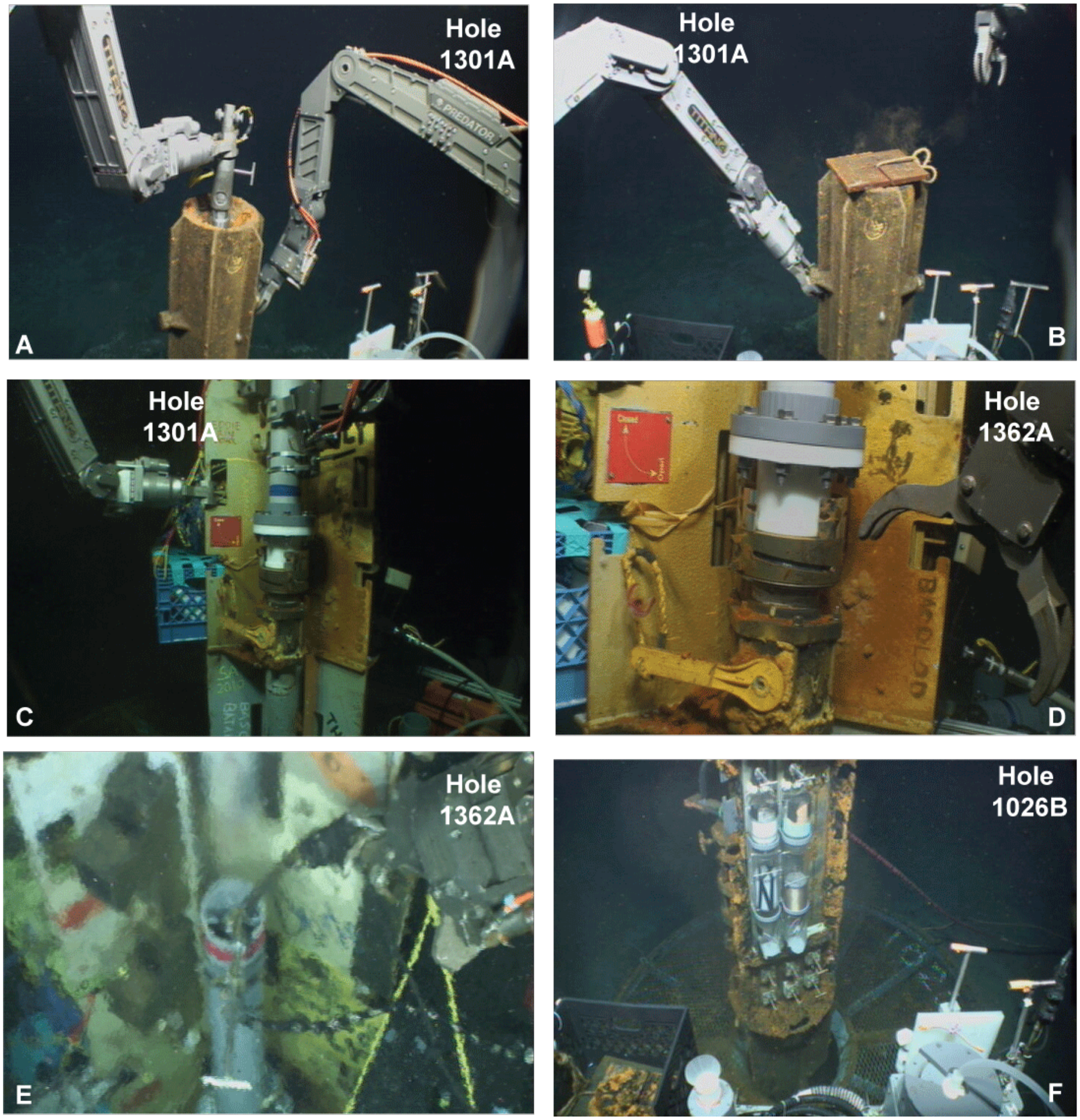

Figure 9. Photos from Dive 714, which visited Holes U1301A, U1362A/B and 1026B. A. Positioning top plug in Hole U1301A. B. *Alvin* dive weight added to top of U1301A wellhead. C. Deploying flowmeter on Hole U1362A. D. Preparing to move handle on ball valve, allowing water to discharge from flowmeter chimney. E. Measuring temperature of shimmering discharge from flowmeter. F. New OsmoSamplers deploying on CORK in Hole 1026B

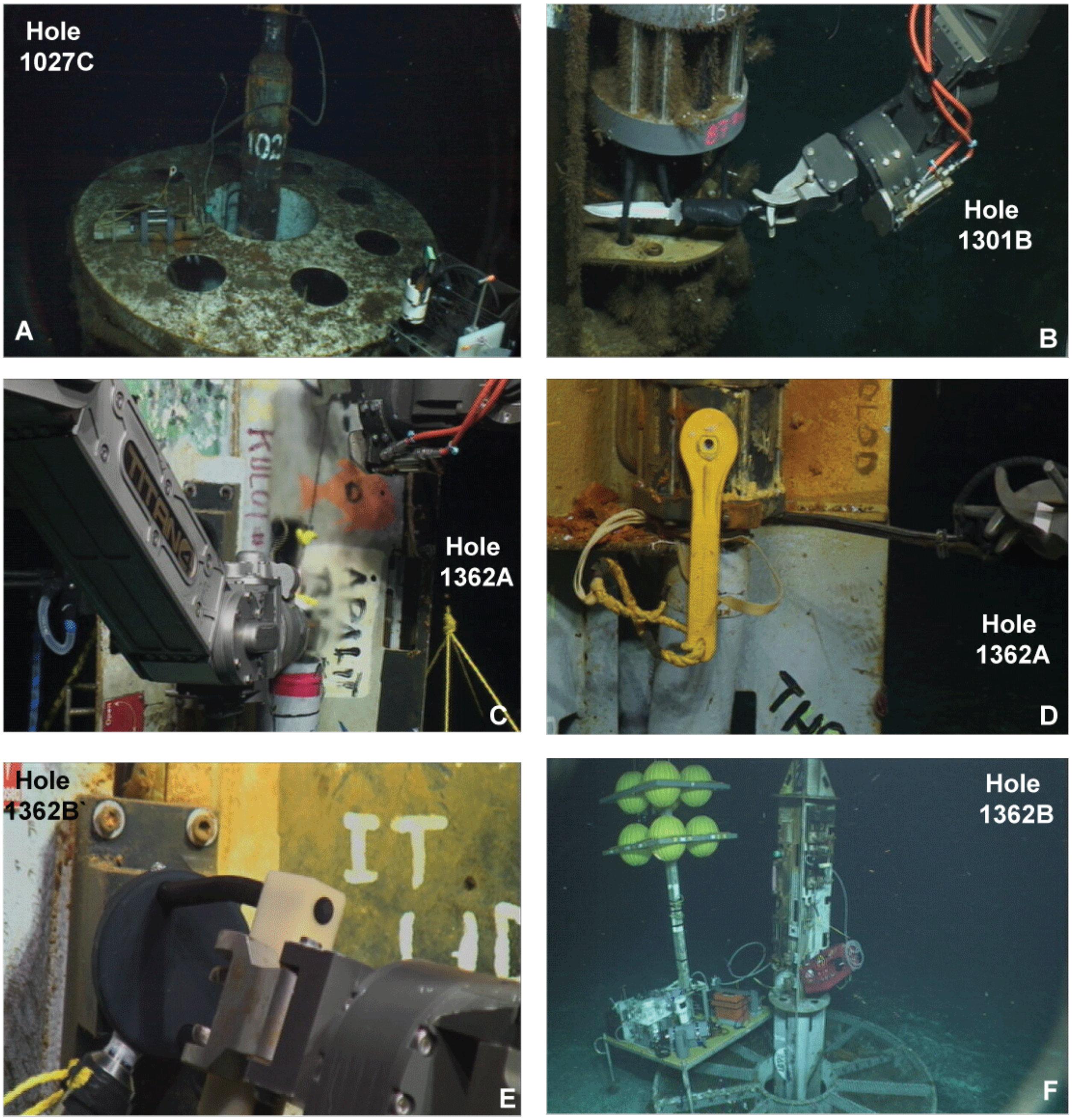

Figure 10. Images from Dive 715 to Holes 1027C, U1301B, and U1362A/B. A. Arriving at Hole 1027C to reprogram data logger. B. Cutting pressure transducer cables at Hole U1301B in an effort to avoid collection of bad data with corroded sensors. C. Deploying syringe sampler at Hole U1362A. D. Detail of ball valve handle below flowmeter, showing that nut has corroded away. E. Making connection for microbiology sampling at Hole U1362B. F. MGM sled deployed at Hole U1362B.

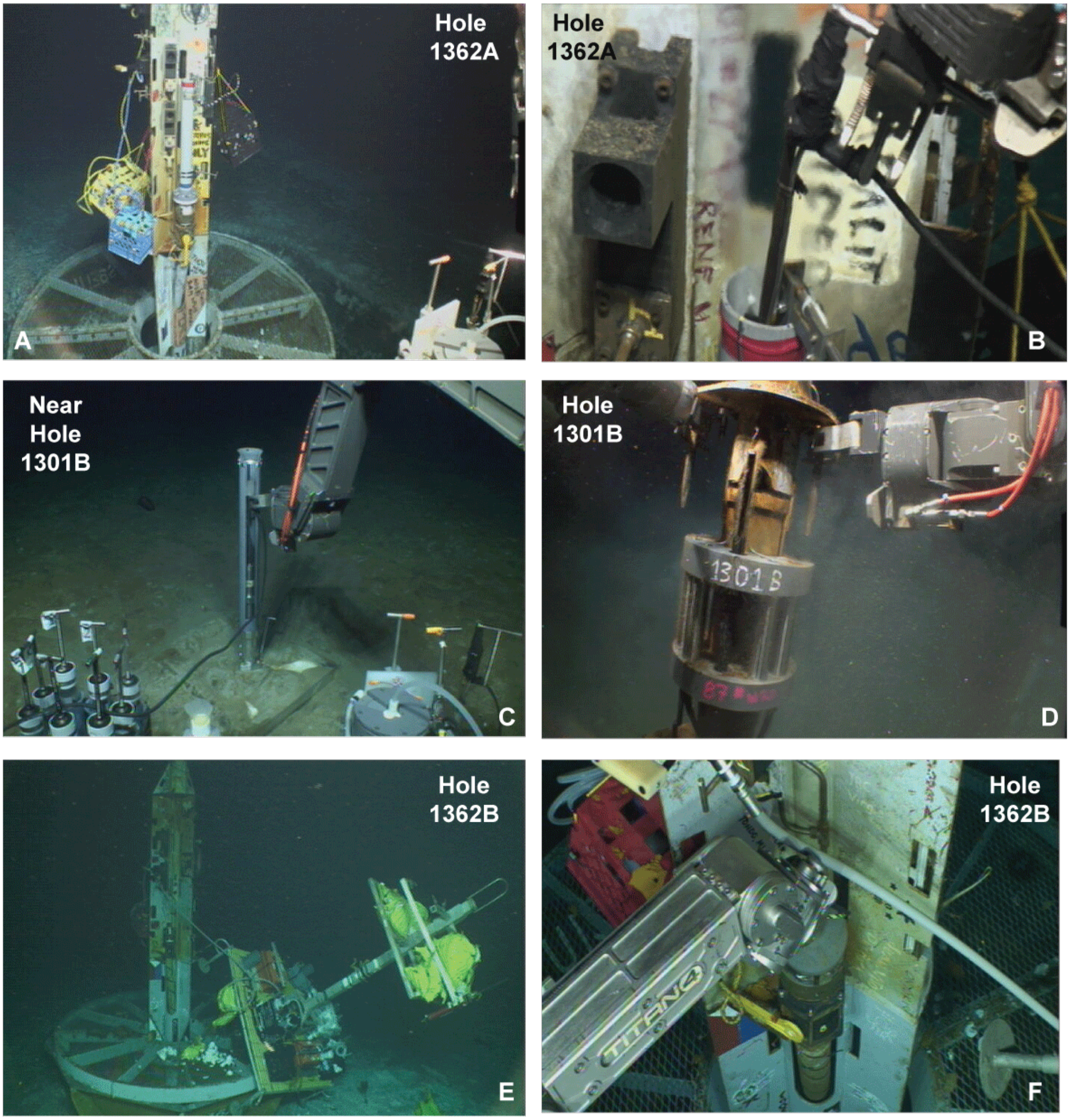

Figure 11. Images from Dive 715, which visited Holes U1301A/B and U1362A/B. A. Arriving at U1362A to measure discharge temperature and collect more fluid samples. B. Measuring the discharge temperature next to Umbilosnork. C. Testing heat flow insertion frame adjacent to Hole U1301B. Recovering Hole U1301B pressure logging system. E. Elevator carnage at Hole U1362B, as a result of glass ball implosion. F. Placing dust cover on large diameter ball valve at Hole U1362B.

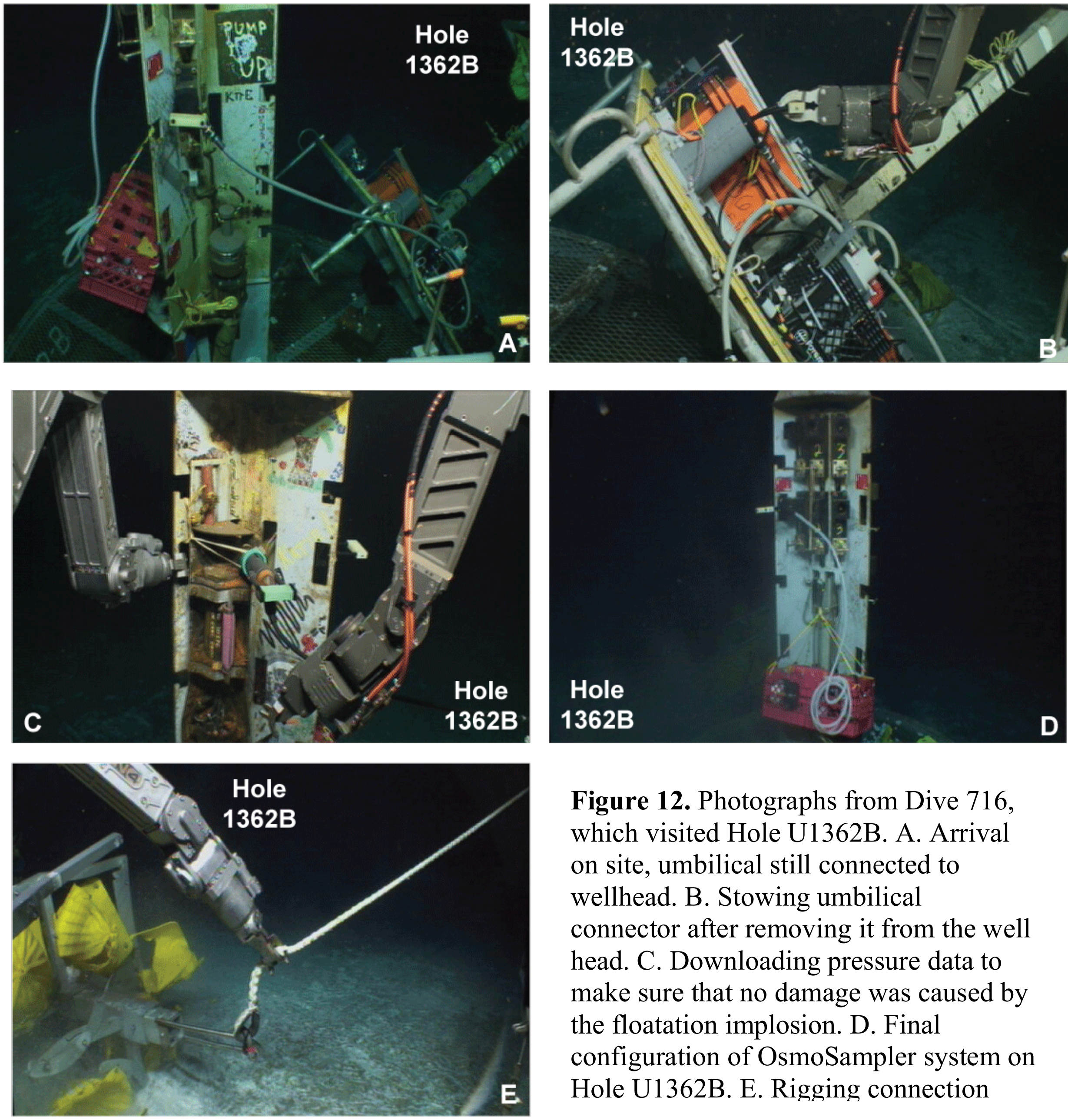

Figure 12. Photographs from Dive 716, which visited Hole U1362B. A. Arrival on site, umbilical still connected to wellhead. B. Stowing umbilical connector after removing it from the well head. C. Downloading pressure data to make sure that no damage was caused by the floatation implosion. D. Final configuration of OsmoSampler system on Hole U1362B. E. Rigging connection between the MGM elevator and harness below *Medea* prior to recovery.

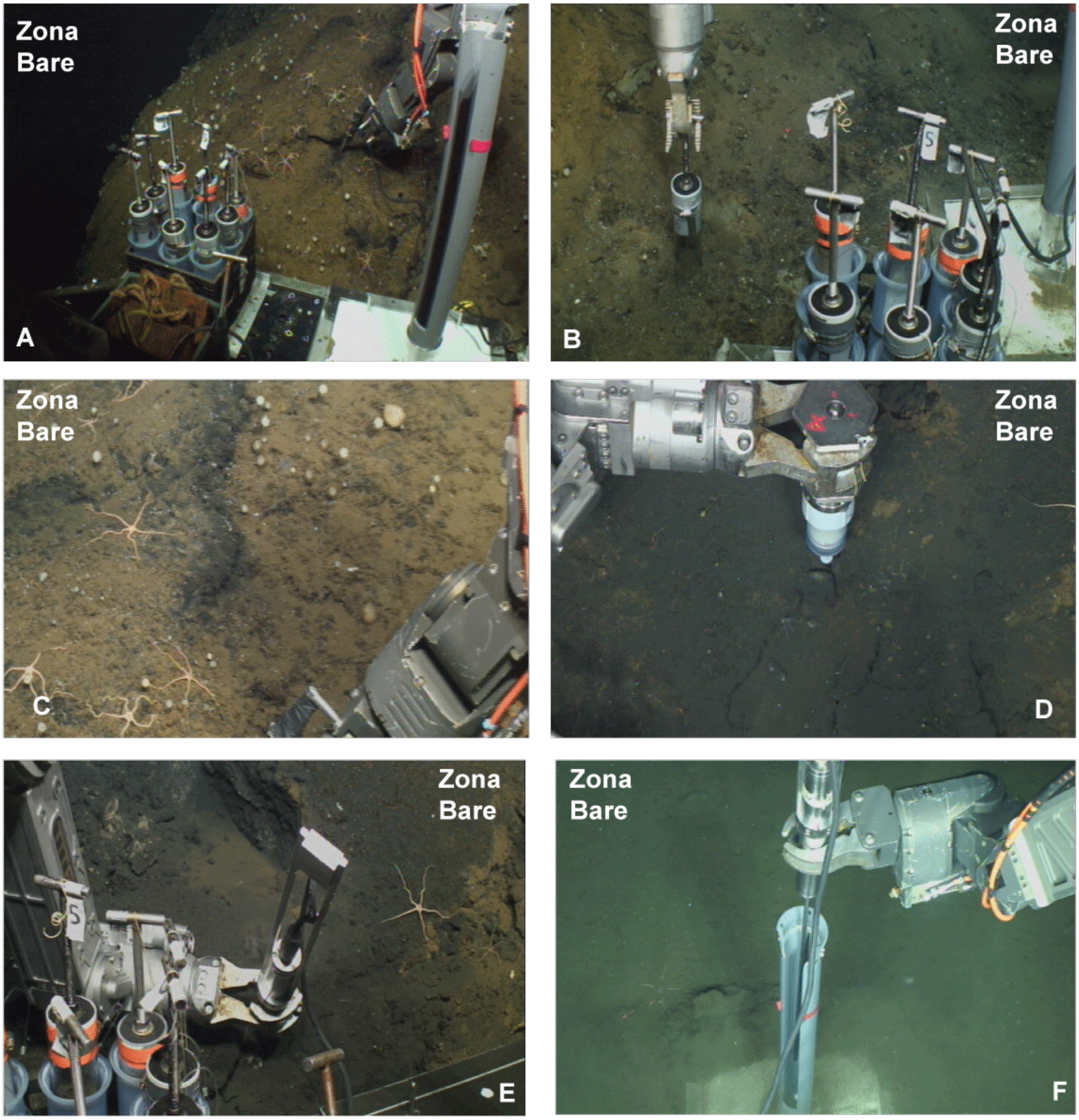

Figure 13. Operations during Dive 718, final dive of AT26-03, which explored Zona Bare outcrop. A. Measuring the shallow temperature in an area of dark sediment. B. Collecting a push core. C. Typical "scorched" appearance that tended to be associated with fluid seepage. D. Collecting sedimentary fluids with a squeeze sampler in an area of suspected seepage. E. Making a heat flow measurement without the insertion frame. F. Making a heat flow measurement with the insertion frame.

Appendix A. Expedition AT26-03 Participants

Table 1. Science and EOC Specialists

Name	Affiliation	email
Baquiran, Jean-Paul (JP)	USC	baquiran@usc.edu
Bowers, Robert	U Hawaii	rmbowers@ifa.hawaii.edu
Cooper, Sharon	Ocean Leadership	scooper@oceanleadership.org
Fisher, Andrew	UCSC	afisher@ucsc.edu
Fournier, Trevor	UAF	tfournier@csumb.edu
Hsieh, Chih-Chiang (Oliver)	U Hawaii	oliver.hakka@gmail.com
Inderbitzen, Katie	UAF	kinderbitzen@alaska.edu
Jungbluth, Sean	U Hawaii	seanpj@hawaii.edu
Lauer, Rachel	UCSC	rlauer@ucsc.edu
Lopez, Jackie	UCSC	lopez.jackie89@gmail.com
Neira, Nicole	UCSB	nneira@umail.ucsb.edu
Nigro, Olivia	U Hawaii	onigro@hawaii.edu
Omori, Everett	U Hawaii	everetto@hawaii.edu
Orcutt, Beth	Bigelow	borcutt@bigelow.org
Skutnik, John	Bigelow	johnskutnik@gmail.com
Smith, Shannon	UCSC/HAAS	sklsmith@ucla.edu
Steward, Grieg	U Hawaii	grieg@hawaii.edu
Strong, Lisa	Ocean Leadership	lisa@strongmountain.com
Sturm, Arne	U Hawaii	arsturm51@gmail.com
Wheat, C. Geoffrey	UAF	wheat@mbari.org
Winslow, Dustin	UCSC	dwinslow@ucsc.edu
Yafuso, Jannai	U Hawaii	jannai@hawaii.edu

Table 2. Atlantis Officers, Crew and Technicians

Name	Position
Lunt, Allan	Captain
Crane, Mitzi	First mate
Johnsen, Logan	Second mate
Bean, Rick	Third mate
n.a.	ComET
Popowitz, Ed (Catfish)	Bos'n
Martinez, Raul	AB
Wills, Lance	AB
Newman, Patrick	AB
Barnes, Richard	OS
Singleton, Mike	OS
Little, Jeff	Chief engineer
Walsh, Steve	First asst. engineer
Brennan, Phil	Second asst. engineer
Stairs, Richard	Third asst. engineer
Oliver, Brandon	Oiler
Taylor, Alex	Oiler
Harris, Matt	Oiler
Walcott, Leroy	Wiper
Jackson, Larry	Steward
Nossiter, Mark	Cook
Hall, Cecile	Mess attendant
Sims, David	SSSG
Hagg, Robb	SSSG
Johns, Arianna	MATE/SSSG

Table 3. *Jason* Group

Name	Position
Kevis-Sterling, Akel	Expedition leader, pilot
Varnum, James (Jimmy)	Pilot
Hansen, Scott	Pilot
Agee, Casey	Technician, navigator
Dow, Edward	Technician, navigator
Collasius, Don	Technician
Hutchinson, Baxter	Technician, navigator
Erick, Joshua	Technician
Pelowski, James	Technician, IT specialist