Integrated Ocean Drilling Program
Expedition 321T Scientific Prospectus

Juan de Fuca hydrogeology: cementing operations at the Hole U1301A and Hole U1301B borehole observatories (CORKS)

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Abstract

Integrated Ocean Drilling Program Expedition 321T will cement reentry cones around subseafloor borehole observatories in Holes U1301A and U1301B in order to seal the systems and permit later completion of long-term hydrogeologic, monitoring, and sampling experiments. There is no scientific program during Expedition 321T; only observatory sealing operations will be conducted.

Schedule

Expedition 321T is a continuation of a program initiated during Integrated Ocean Drilling Program (IODP) Expedition 301, working on 3.5 Ma seafloor on the eastern flank of the Juan de Fuca Ridge. This program is based on IODP drilling Proposal 545-Full3 (available at **iodp.tamu.edu/scienceops/expeditions/juan_de_fuca.html**). Expedition 321T will consist of cementing operations only (no sampling, measurement, or other scientific operations) and will be implemented on the R/V *JOIDES Resolution,* operating under contract with the U.S. Implementing Organization (USIO).

At the time of publication of this *Scientific Prospectus,* the expedition is scheduled to start in San Diego, California (USA), on 23 June 2009 and end in Victoria, British Columbia (Canada), on 5 July 2009. Any changes to this schedule will be posted at **iodp.tamu.edu/scienceops/.** Five days are planned for the cementing operations described in this report. Details on the facilities aboard the *JOIDES Resolution* and on the USIO can be found at **www.iodp-usio.org.**

Introduction

IODP Expedition 301 was part of a series of expeditions and experiments to quantify hydrogeologic, lithologic, biogeochemical, and microbiological properties, processes, and linkages on the eastern flank of the Juan de Fuca Ridge (Fig. **F1**). This effort included site surveys to map bathymetric relief, seismic reflection profiles to delineate sediment thickness, sediment cores to allow analysis of pore fluids, and heat flow measurements to determine patterns of lithospheric and hydrothermal heat loss. Operations during Expedition 301 included replacing of one existing subseafloor borehole observatory (CORK), drilling two basement holes and installing two new long-term observatories, coring the upper ~300 m of basement and shallow sediments above basement, and collecting in situ hydrogeologic and geophysical data from basement. Subsequent remotely operated vehicle (ROV) and submersible expeditions have serviced IODP observatories, collecting pressure and temperature data and fluid and microbiological samples and replacing components as needed to maintain these systems for future use. Another drilling expedition (approved by the IODP Science Planning Committee and awaiting scheduling by the Operations Task Force) is planned to emplace three more borehole observatories and initiate crosshole tests, and additional ROV and submersible expeditions will conduct long-term experiments and recover subseafloor data and samples.

Borehole observatories installed during IODP Expedition 301 were designed to seal open holes so that thermal, pressure, and chemical conditions could equilibrate following the dissipation of the drilling disturbance; to facilitate collection of fluid and microbiological samples and temperature and pressure data using autonomous samplers and data logging systems; and to serve as long-term monitoring points for large-scale crustal testing (Fisher et al., 2005b). Unfortunately, the CORKs installed in Holes U1301A and U1301B were not sealed as intended (Fisher et al., 2005a), and data and samples collected during subsequent ROV and submersible servicing operations have shown that both observatory systems are leaking. Operations during Expedition 321T will seal these observatories by putting cement into the reentry cones surrounding the CORK wellheads, allowing the remaining components of the full experimental program to be completed during subsequent drilling and submersible expeditions.

Background

Ocean Drilling Program (ODP) Leg 168 completed a drilling transect of eight sites across 0.9–3.6 Ma seafloor east of the Juan de Fuca Ridge, collected sediment, rock, and fluid samples; determined thermal, geochemical, and hydrogeologic conditions in basement; and installed a series of CORK observatories in the upper crust (Davis, Fisher, Firth, et al., 1997). Two of the Leg 168 observatories were placed in 3.5–3.6 Ma seafloor near the eastern end of the drilling transect, in Holes 1026B and 1027C (Fig. **F1**). Expedition 301 returned to this area and drilled deeper into basement; sampled additional sediment, basalt, and microbiological materials; replaced the borehole observatory in Hole 1026B; and established two multilevel observatories at Site U1301 for use in long-term, three-dimensional hydrogeologic experiments.

Hole 1026B was drilled to 295 meters below seafloor (mbsf), cased across the sediment/basement interface, and extended to 48 meters subbasement (msb) during Leg

168 (Davis, Fisher, Firth et al., 1997). The original CORK installed in Hole 1026B included a data logger, pressure sensors, thermistors at multiple depths, and a fluid sampler, all of which (except for the fluid sampler, which fell deeper into the hole) were recovered in 1999. The Hole 1026B CORK was never completely sealed after being installed in 1996, and because crustal fluids are overpressured with respect to ambient hydrostatic conditions at Site 1026 (e.g., Davis, Fisher, Firth et al., 1997), this hole discharged fluid for years until it was replaced during Expedition 301. As of the start of Expedition 301, warm (~64°C) altered basement fluid vented freely through the top of the wellhead. The original Leg 168 CORK installed in Hole 1026B was replaced successfully during Expedition 301.

IODP Site U1301 was positioned 1 km south-southwest of ODP Site 1026, where sediment thickness is 260–265 m above a buried basement high (Fig. **F1**). Hole U1301A was drilled without coring to 370 mbsf (107 msb). The casing was extended into the upper 15 m of basement, but poor hole conditions prevented installation of longer casing, coring, or deeper drilling. A depth check prior to CORK deployment in Hole U1301A revealed that much of the lower part of the hole had filled in with rocks from the rubbly formation around the hole.

Hole U1301B was positioned 36 m away and penetrated to a total depth of 583 mbsf (318 msb). Uppermost basement was drilled without coring, and casing was installed to 85 msb. Basement was cored from 86 to 318 msb, with mean recovery of 30%, a value typical for upper basement rocks from young crust. The upper 100 m of the cored interval in Hole U1301B was irregular in diameter, often much larger than the maximum inflation diameter of packers to be used for hydrogeologic testing and CORK observatories. However, the lower 100 m of the hole was stable and to gauge, allowing collection of high-quality wireline logs and providing several horizons suitable for setting drill string and CORK casing packers.

Both of the Site U1301 boreholes contained four nested casing strings: 0.50 m (diameter = 20 inches) casing in the uppermost sediments, 0.41 m (16 inches) casing extending just across the sediment/basement interface, 0.27 m (10-3/4 inches) casing extending into basement, and a 0.11 m (4-1/2 inches) inner CORK casing that houses instrument strings and plugs (Fig. **F2**). The two largest casing strings were sealed by collapse of unconsolidated sediments, and the 0.41 m string was also cemented across the sediment/basement interface. The annulus between 0.41 and 0.27 m casing strings at Site U1301 was supposed to contain a rubber mechanical casing seal near the seafloor, but this component was not available for use during Expedition 301 as planned. An attempt was made to seal the 0.27 m casing strings at depth with cement, but rubbly basement prevented this cement from sealing between the casing and borehole wall. Operations were additionally complicated in Hole U1301B by the separation of the unwelded 0.27 m casing string into two sections, leaving a gap just above the sediment/basement interface (Fig. **F2B**). The CORK installed in Hole U1301A included a casing packer (as part of the 0.11 m inner casing) that was set inside 0.27 m casing. In contrast, the CORK installed in Hole U1301B included two casing packers set in open hole, intended to hydraulically isolate sections of the upper crust (Fig. **F2B**).

Expedition 301 CORKs and the preexisting CORK in Hole 1027C were visited with the ROV *ROPOS* soon after the drilling expedition in September 2004 and again in September 2005 with the submersible *Alvin*. Data recovered during these dives showed that the Hole 1026B observatory was sealed and operating as intended, although the pressure in Hole 1026B was recovering slowly from the thermal perturbation associated with 8 y of upflow of warm formation fluid from the unsealed hole. The CORKs in Holes U1301A and U1301B were incompletely sealed, allowing cold ocean-bottom water to flow into the formation following CORK installation. The flow of cold water into the crust at Site U1301 caused a measurable pressure perturbation at Site 1027, 2.4 km away, comprising an inadvertent crosshole test (Fisher et al., 2008).

Attempts to seal Hole U1301B using a cement delivery system with the submersible *Alvin* in summer 2006 and 2007 were unsuccessful. The submersible could not deliver a sufficient quantity of cement to the cone. Shimmering fluid was observed discharging from Hole U1301A during and after summer 2007 dive operations. No such evidence for upflow from the borehole was observed during earlier visits, suggesting that Hole U1301A must have "turned around" sometime between 2006 and 2007 servicing operations. In fact, downhole temperature loggers recovered from Hole U1301A in summer 2008 provide a detailed record of this flow reversal. Remarkably, Hole U1301B continues to draw fluid rapidly into basement as of summer 2008, even though it is located just 36 m from Hole U1301A, which is vigorously discharging warm formation fluid to the ocean. Understanding of the pressure and thermal interactions between Holes U1301A and U1301B, and implications for local and regional crustal hydrogeology, will require additional investigation. Sealing both observatory systems at the seafloor is important for completing the experimental and monitoring program begun with Expedition 301 (Fisher et al., 2005b).

The ROV platform installed at Hole U1301A was based on an older design, with a solid surface that is perforated by eight, 12 inch diameter holes (Fig. **F3A**). Screens were welded below these holes prior to installation of the platform by the drillship so that instrumentation later deployed or manipulated by a submersible or ROV could not fall through the holes. In contrast, the ROV platform at Hole U1301B is a new design and has a series of radial support arms covered by the same screen material as was welded to the bottom of the platform at Hole U1301A (Fig. **F3B**). By the time the ROV platform was deployed at Hole U1301B, Expedition 301 participants realized that it would likely be necessary to cement the cone to achieve a hydraulic seal around the CORK, and a slot was cut through the screen to facilitate this operation. Several barrels of cement were pumped into the cone near the end of Expedition 301, after passing the end of the drill string through the slot in the ROV platform, but the quantity of cement available at that time was insufficient to achieve a seal. There will be sufficient cement available during Expedition 321T so that each of the two cones can be filled twice, in case some cement drains away before it can set, and so that excess cement can collect outside and around the base of the cones to assist with sealing.

Operations

Overview

The operational objective of Expedition 321T is to conduct cementing operations, which will entail pumping cement into the reentry cones of Holes U1301A and U1301B in an attempt to achieve a hydraulic seal around the observatories.

Port call and transit to Hole U1301B

After a 1 day port call in San Diego, the ship will transit for an estimated 5.3 days (~1134 nmi) before arriving at Hole U1301B (Table **T1**). Since this transit will be heading into the southward-flowing California Current and into the prevailing wind direction, we have assumed a transit speed of 9 nmi/h.

Operations in Hole U1301B

Once we arrive at the coordinates for Hole U1301B, we will prepare the drill string for cementing operations and lower it to just above the seafloor. Once we locate the seafloor observatory we will lower the end of the drill string with a 5-1/2 ft cementing stinger attached to it through the ROV platform. The ROV platform at Hole U1301B has a sector that was cut out before it was deployed on Expedition 301 (Fig. **F3B**). The cementing stinger has two to three 3 inch diameter holes in the side within the lower 6 ft of the sub and has a mule shoe–style cutoff at the bottom angled at ~45° for penetration. Cement will be pumped into the reentry cone through the cutout in the ROV platform. Lowering the drill string through the cutout has to be done with care to ensure the drill string does not strike the CORK head situated above the ROV platform that contains sensors and data loggers. After the cement has been deployed, we will raise the drill string out of the reentry cone and offset the drillship to the Hole U1301A observatory without retrieving the drill string.

Operations in Hole U1301A

The operations in Hole U1301A will be very similar to those at Hole U1301B. One difference is that the ROV platform has no cutout (Fig. **F3A**). The ROV platform is mostly solid metal with 12 inch circular penetrations with a metal mesh welded beneath. Once the drill string has been stabilized over the ROV platform, one of the 12 inch holes will be penetrated using the cementing stinger and some of the weight of the bottom-hole assembly (BHA), and cement will be pumped into the reentry cone. After the cement has been pumped, the drill string will be pulled clear of the seafloor and the ship will offset away from Site U1301 to flush any remaining cement from the drill string. Once this is completed, we will return, inspect the cement job at both Holes U1301A and U1301B using the subsea camera, and then retrieve the drill string.

Transit to Victoria

Once the drill string is secured, we will transit to Victoria. The transit from Site U1301 to Victoria is ~0.7 days (181 nmi) at 10.5 nmi/h.

Cement mix

Based on the cement mix test results provided by BJ Services Company, both seawater and freshwater formed good slurry rheology and mixability. For cementing operations at Holes U1301A and U1301B we intend to use the seawater mix as it thickens slightly faster (6.5 h) than freshwater (7.5 h) and will result in a higher compressive strength for the hardened cement (513 versus 125 psi at 40°C). Cement will be mixed to the optimum 15.9 ppg slurry density using seawater (freshwater would give 15.8 ppg).

We plan to take 1300 sacks (61 short tons) of cement preblended with ¼ lb per sack of Cello-Flake (cellophane) flakes lost circulation material (LCM). In addition, ~1660 sacks (78 short tons) of Class G neat cement will also be available onboard. This cement will not be combined with LCM because we do not have the recommended mixing capabilities. We also plan to take aboard six 55 gallon drums of sodium silicate liquid "extender." This additive can be used to develop the same volume of cement slurry while using lower quantities of neat cement. The lowest recommended density using the extender would be 11.3 ppg and this would require 68 gallons of extender for every 100 sacks of cement. The preference is to not use the extender unless we are running short on cement.

Risks and contingencies

There are a number of risks to achieving the objectives of this program.

Poor weather/sea state: Cementing operations using the drill string in very close lateral proximity to the observatory as well as having to lower through the ROV platforms into the reentry cone will require reasonably good environmental conditions (weather, sea state, currents, etc.). The opening in the Hole U1301B ROV platform was successfully entered once during Expedition 301 with nearly the exact same systems. One difference is that our Expedition 321T work will be done without active heave compensation. The passive heave compensator was completely refurbished and is expected to allow us to accomplish this operation.

Inability to reenter small targets in Hole U1301A ROV platform (12 inch screened hole): Being able to stabilize the end of the drill string over and/or penetrating the much smaller (12 inch) circular penetrations in the Hole U1301A ROV platform is clearly going to be a challenge. In addition, the wellhead at Hole U1301A was determined to be loose ("wobbly") during 2007 submersible operations, but it is not known if this will present additional challenges.

Damaging the wellhead: Care must be taken to avoid damaging the wellhead as part of planned operations. There will be particular risks when the BHA is positioned close to the wellhead, either immediately before or immediately after reentry. The ship will need to be offset slightly away from the wellhead just prior to removing the BHA from the cone, so that it does not "swing" into the wellhead when it is free of the cone. It may be difficult to see the platform and wellhead clearly during these operations. In addition, it may be challenging to avoid having the BHA shift toward the wellhead when weight is put down on it against the (sloped) base of the cone. We will have to watch these operations carefully with the subsea camera system.

Cement deployed but does not seal holes: If this occurs, extra cement is available for deployment. There should be enough cement onboard to fill each reentry cone at least twice. Approximately 24 h of contingency time has been allocated at each site to allow for the risks listed above or other problems that arise.

The expedition could end early if operations go exceptionally smoothly or if there are difficulties that make completion of planned operations impossible. Researchers will return to Holes U1301A and U1301B in August 2009 with the submersible *Alvin* to download data and exchange sampler systems, and we should be able to assess the quality of the cement seals around the borehole observatories at that time.

References

Davis, E.E., Fisher, A.T., Firth, J.V., et al., 1997. *Proc. ODP, Init. Repts.,* 168: College Station, TX (Ocean Drilling Program). **doi:10.2973/odp.proc.ir.168.1997**

Fisher, A.T., Davis, E.E., and Becker, K., 2008. Borehole-to-borehole hydrologic response across 2.4 km in the upper oceanic crust: implications for crustal-scale properties. *J. Geophys. Res.*, 113(B7):B07106. **doi:10.1029/2007JB005447**

Fisher, A.T., Urabe, T., Klaus, A., and the IODP Expedition 301 Scientists, 2005a. IODP Expedition 301 installs three borehole crustal observatories, prepares for three-dimensional, cross-hole experiments in the northeastern Pacific Ocean. *Sci. Drill.,* 1:6–11. **doi:10.2204/iodp.sd.1.01.2005**

Fisher, A.T., Wheat, C.G., Becker, K., Davis, E.E., Jannasch, H., Schroeder, D., Dixon, R., Pettigrew, T.L., Meldrum, R., McDonald, R., Nielsen, M., Fisk, M., Cowen, J., Bach, W., and Edwards, K., 2005b. Scientific and technical design and deployment of long-term, subseafloor observatories for hydrogeologic and related experiments, IODP Expedition 301, eastern flank of Juan de Fuca Ridge. *In* Fisher, A.T., Urabe, T., Klaus, A., and the Expedition 301 Scientists, *Proc. IODP,* 301: College Station, TX (Integrated Ocean Drilling Program Management International, Inc.). **doi:10.2204/iodp.proc.301.103.2005**

Zühlsdorff, L., Hutnak, M., Fisher, A.T., Spiess, V., Davis, E.E., Nedimovic, M., Carbotte, S., Villinger, H., and Becker, K., 2005. Site surveys related to IODP Expedition 301: ImageFlux (SO149) and RetroFlux (TN116) expeditions and earlier studies. *In* Fisher, A.T., Urabe, T., Klaus, A., and the Expedition 301 Scientists, *Proc. IODP,* 301: College Station, TX (Integrated Ocean Drilling Program Management International, Inc.). **doi:10.2204/iodp.proc.301.102.2005**

Table T1. Planned drill site details.

Hole	Latitude, Longitude	Seafloor depth	Operations description	Transit (days)	Drilling/ Coring (days)	Logging (days)
San Diego, California			Begin Expedition 1 day port call			
			Transit ~1134 nmi to Hole U1301B @ 9.0 kt	5.3		
U1301B	47.7538° N, 127.7638° W	2667	Hole U1301B - Lower end of pipe to/into reentry cone and pump cement into reentry cone - Flush drill pipe and offset to Hole 1301A		2.5	
U1301A	47.7535°, N, 127.7639°W	2671	Hole U1301A - Lower end of pipe to/into reentry cone and pump cement into reentry cone - Flush drill pipe and inspect cement job at both holes; recover drill string		2.5	
			Subtotal days onsite: 5.0			
			Transit ~181 nmi to Victoria, B.C. Canada @ 10.5 kt	0.7		
Victoria, B.C., Canada			End Expedition	6.0	5.0	0.0
			Subtotal onsite time:	5.0		
			Total operating days:	11.0		
			Total Expedition (including 1 port call day):	12.0		

Notes: Seafloor depth is prospectus water depth plus 11.0 m adjustment from water line to rig floor (i.e., drillers depth). San Diego port call is assumed to be 1.0 day. Cementing includes ~24 h of contingency time split evenly between the two holes. Transit speed from San Diego to Hole U1301B is assumed to be 9.0 kt due to opposing current. All other transits assume 10.5 kt.

Figure F1. Maps showing the IODP Expedition 301 and 321T field area. **A.** Index map showing locations of ODP Leg 168 drilling transect (thick black line), IODP Expedition 301 work area (gold star), the Juan de Fuca Ridge, and nearby continental areas. Inset profile shows locations of ODP Leg 168 sites. **B.** Regional bathymetric map showing locations of ODP Holes 1026B and 1027C and IODP Site U1301. **C.** Map of basement relief created from bathymetric and seismic data, showing locations of ODP and IODP drill sites. Areas marked in white are present-day basement outcrops. Figure modified from Zühlsdorff et al. (2005).

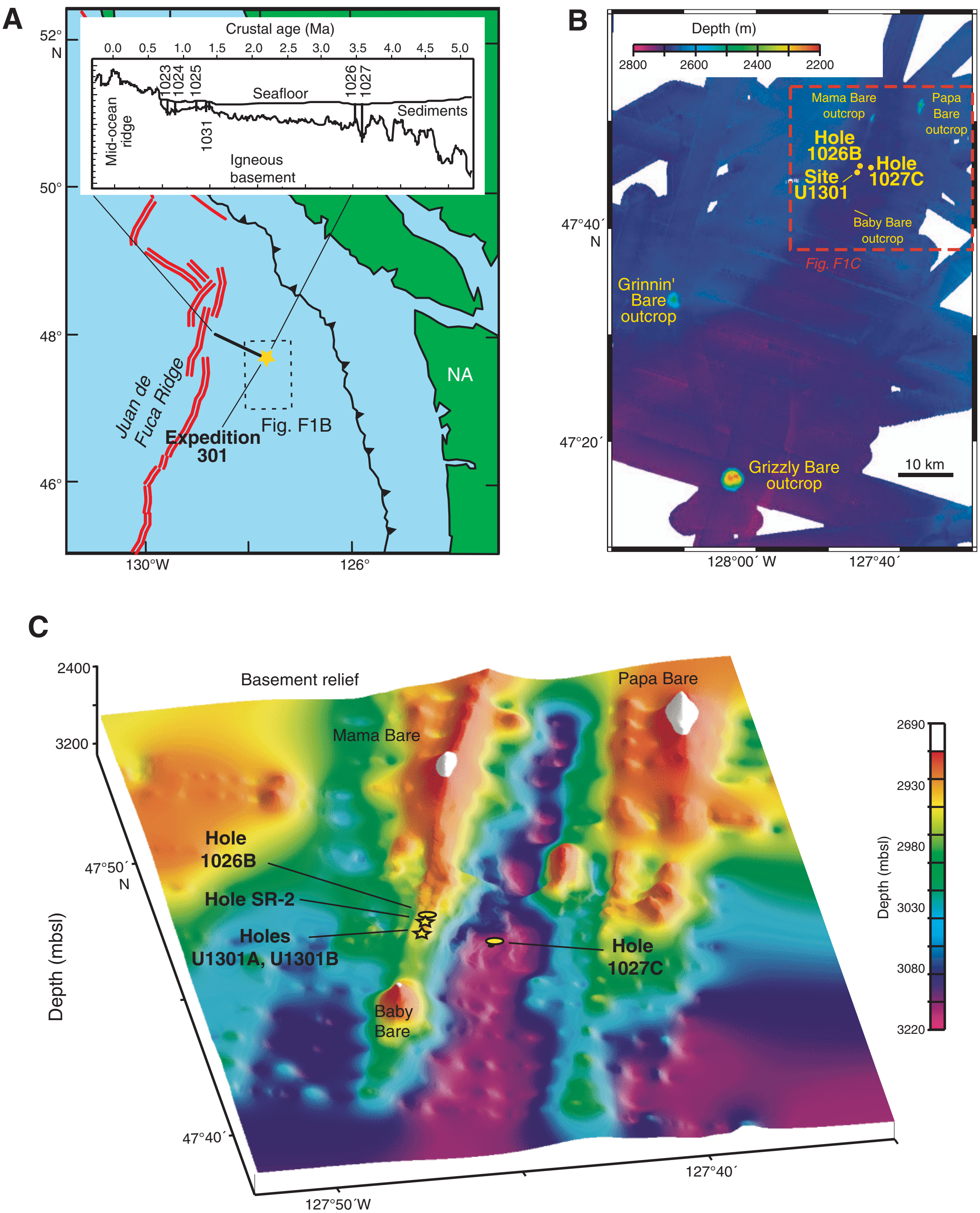


Figure F2. Summary of basement and borehole observatory characteristics in Holes U1301B and U1301A (modified from Fisher et al., 2008). **A.** Basement recovery, primary lithology, borehole size, and bulk density from Hole U1301B (Fisher et al., 2005a). Basement cores were collected from ~355 to 575 mbsf (~100 to 320 msb), with recovery indicated by black intervals next to depth column. Borehole diameter was measured with wireline caliper tool. Bulk density log (line) and analyses of pieces of rock (diamonds) show evidence for considerable porosity in uppermost basement and a layered basement structure, especially below 470 mbsf (220 msb), with alternating more and less dense intervals. Horizontal bands indicate depths where subseafloor borehole observatory (CORK) casing packers and the drill string packer used for hydrogeologic testing were set against the borehole wall. **B.** Casing and CORK configurations in Holes U1301B and U1301A. Observatories in both holes lack a critical seal between 0.27 m and 0.41 m casing, which is needed to prevent the flow of cold bottom water into shallow basement or the flow of warm formation fluid out into the ocean. More information on CORK and hole configurations is available in Fisher et al. (2005a, 2005b). TD = total depth. (**Figure shown on next page.**)

Figure F2 (continued). (Caption shown on previous page.)

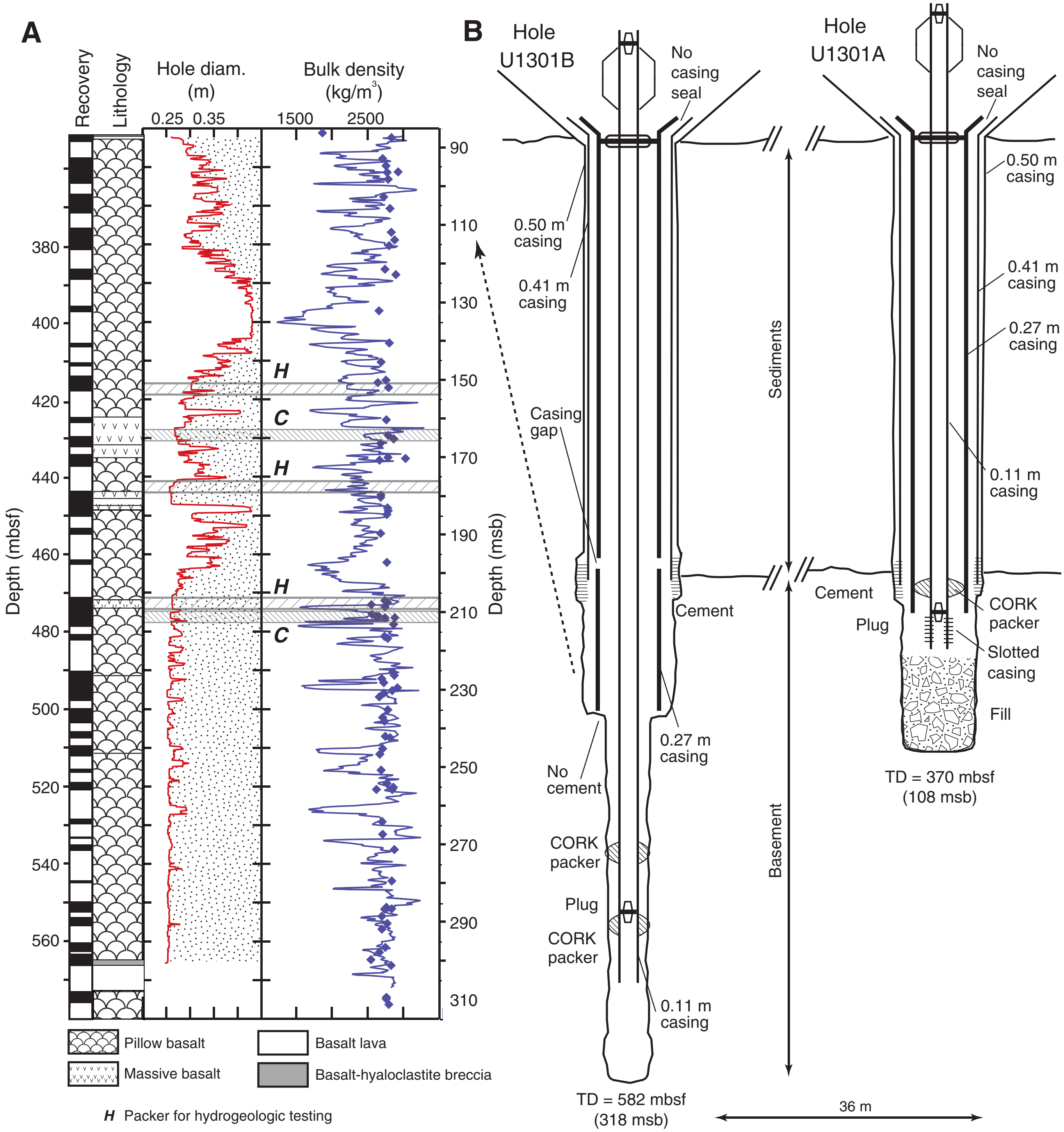
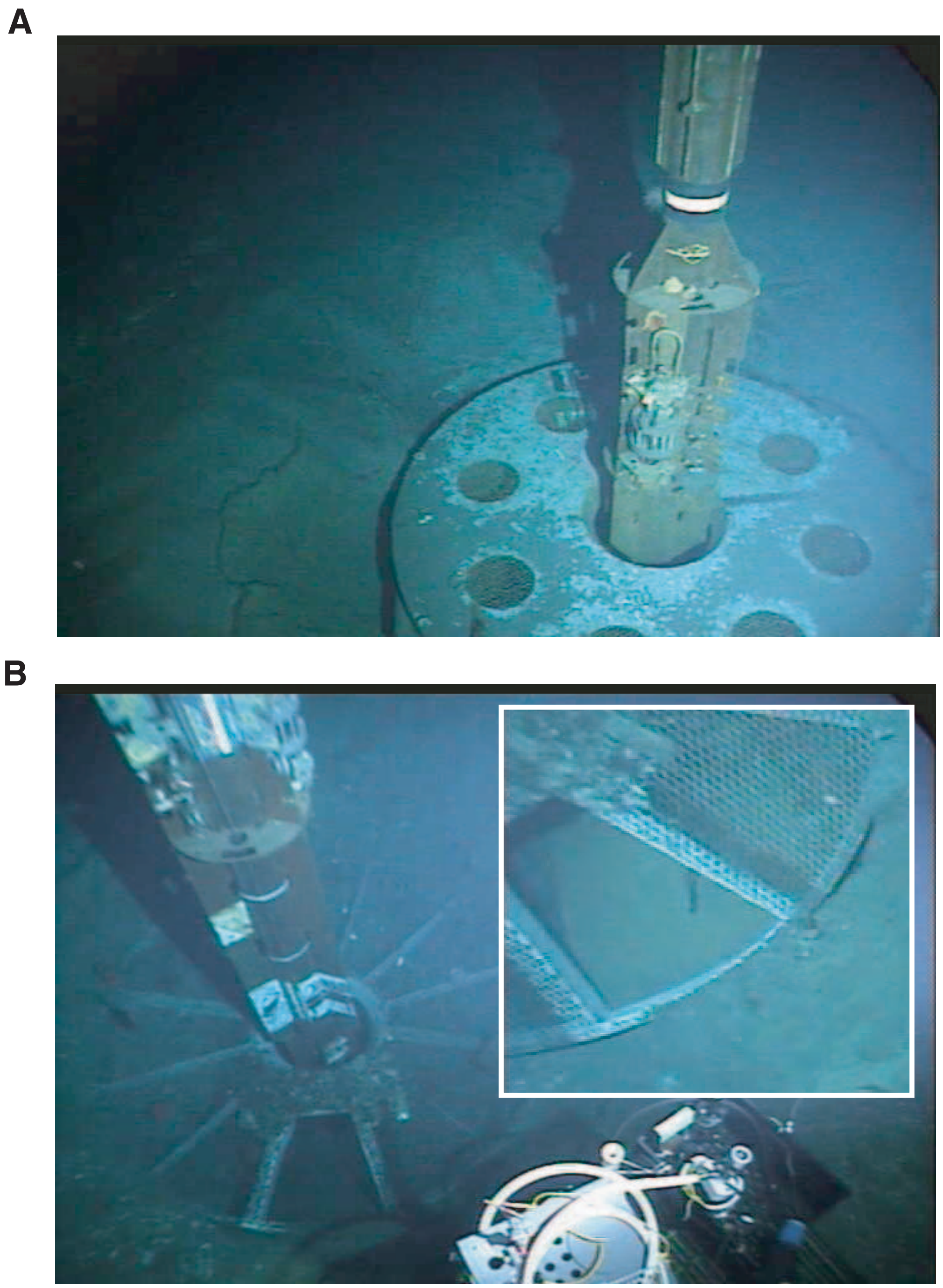


Figure F3. Photographs of Hole U1301A and U1301B CORK configurations taken with the submersible *Alvin* in summer 2008. **A.** Hole U1301A has an older generation of ROV platform, which is solid metal perforated by eight 12 inch diameter holes. Screens were welded behind the holes during Expedition 301 prior to platform deployment. **B.** Hole U1301B has a screen platform with one radial section cut out. Inset shows detail of platform cutout.



Site summaries

Hole U1301A

Priority:	Primary
Position:	47°45.210′N, 127°45.833′W
Water depth (mbrf)	2667.3
Target drilling depth (mbsf):	Not applicable; reoccupy existing borehole location; no new penetration
Approved maximum penetration (mbsf):	Not applicable; reoccupy existing borehole location; no new penetration
Survey coverage (track map, seismic profile); sediment cores:	See Fisher et al. (2005a) and Zühlsdorff et al. (2005).
Objective (see text for complete details):	Observatory is not completely sealed. Seal subseafloor borehole observatory by pumping cement into the observatory's reentry cone.
Drilling/coring program:	Lower end of drill string to ROV platform on reentry cone; deploy cement through 12 inch circular holes in ROV platform (Fig. **F3A**)
Anticipated lithology:	Not applicable; reoccupy existing borehole location; no new penetration

Site summaries (continued)

Hole U1301B

Priority:	Primary
Position:	47°45.228′N, 127°45.827′W
Water depth (mbrf)	2667.8
Target drilling depth (mbsf):	Not applicable; reoccupy existing borehole location; no new penetration
Approved maximum penetration (mbsf):	Not applicable; reoccupy existing borehole location; no new penetration
Survey coverage (track map, seismic profile); sediment cores:	See Fisher et al. (2005a) and Zühlsdorff et al. (2005).
Objective (see text for complete details):	Observatory is not completely sealed. Seal subseafloor borehole observatory by pumping cement into the observatory's reentry cone.
Drilling/coring program:	Lower end of drill string to ROV platform on reentry cone; deploy cement through sector cut out of surface mesh of ROV platform (Fig. **F3B**)
Anticipated lithology:	Not applicable; reoccupy existing borehole location; no new penetration

Expedition scientists and scientific participants

The current list of participants for Expedition 321T can be found at **iodp.tamu.edu/scienceops/precruise/juandefuca/participants.html.**