July 26, 2004

IODP EXPEDITION 301: JUAN DE FUCA HYDROGEOLOGY
WEEK 4 REPORT

OPERATIONS

HOLE 1301A: 47° 45.2095‘ N, 127° 45.8329’ W, Seafloor depth 2667.3 mbrf:
Return to Hole 1301A to conduct hydrologic testing and CORK: Prior to reentering Hole 1301A, we needed to accurately verify the depths of the seafloor, top of the cuttings pile, and top of the reentry cone at both Holes 1301A and 1301B. These CORK installations are intended to be long-term observatories and will require easy ROV/submersible access. Based on measured depths, we will extend the Hole 1301B CORK two meters before installation.

We then reentered Hole 1301A (7th time), drilled out the cement at the base of the 10-3/4 inch casing, and lowered the bit without rotation or circulation to determine how deep we might install the CORK (262.2 mbsf; 34.0 m into basement). By 0315 hr 18 July, the bit was back on board and we began assembling the packer bottom-hole assembly for the hydrologic testing.

After reentering the hole (0901 hr 18 July), we positioned the packer inside the base of the casing and conducted the hydrologic testing of upper oceanic crust. For a description of the tests, see the SCIENTIFIC RESULTS section below. The testing was completed at 2330 hr 18 July, the packer assembly was back on board by 0730 hr 19 July.

Our next operation was to install the CORK. It took about 12 hrs to assemble the CORK parts consisting of (1) 18 m of slotted 4-1/2 inch casing, (2) three sampling mini-screens attached to the outside of the casing ~10 m below a casing packer, (3) four screens immediately below the packer, (5) umbilical tubing strapped to the casing connecting the screens and packer to the CORK head, (6) 4-1/2 casing, and (7) the CORK head. After the CORK head was attached, we lowered the entire CORK assembly to the seafloor, reentered Hole 1301A at 0045 hr 20 July, and lowered nearly all the way into the hole. Just before landing the CORK head in the reentry cone, we deployed the ~294 m-long, downhole geochemical (OsmoSamplers), microbiologic, and thermal sensors down through the 4-1/2 inch casing so that they would land in the slotted casing at the bottom of the CORK casing. Once this sensor string was landed inside the CORK, we landed the CORK and inflated the 4-1/2 inch casing packer. We then deployed the ROV/submersible platform using our new mechanical release system (LULA). We then used the camera/sonar system to view the release of the CORK running tool. The installation appeared to fine and the CORK running tool was quickly released and we recovered the drill string. During the pipe trip, we moved 36 meters back to Hole 1301B and the drill string was back on board at 2400 hr 20 July ending operations for Hole 1301A. The entire CORK deployment took 1.7 days.

HOLE 1301B: 47° 45.2286‘ N, 127° 45.8262’ W (final); Water depth: 2667.8 mbrf
Return to Hole 1301B to RCB Core basement, collect downhole logs, conduct hydrologic testing, and CORK: We reentered Hole 1301B (0525 hr 21 July), drilled out the cement at the base of the 10-3/4 inch casing, cleaned out the rathole below the casing, and drilled 1.0 m of new hole to provide 9-7/8 inch pilot hole for the RCB coring bit. The bit was recovered at1530 hr 21 July.

RCB Coring in Basement: We reentered Hole 1301B (2215 hr 21 July) and started coring at 0300 hr 22 July. The first IODP core, Core U301-1301B-1R, was recovered at 0535 hr 22 July (5.9 m advance; 1.5 m recovered). On this first bit run, we have cut Cores 1R to 15R from 351.2 to 453.2 mbsf (86.04 to 191.04 m below the top of basement) coring 102 m and recovering 31.41 m (31%). Except for a few thin intervals, the drilling conditions have been good. Since we want to core this hole deeply into basement, we decided to change the bit after 53 hr of rotating time. Before retrieving the drill string, we made a wiper trip back up to the 10-3/4 inch casing encountering 7 m of soft fill that was easily circulated out of the hole.

SCIENTIFIC RESULTS

During this week we (1) conducted hydrologic (packer) tests at Hole 1301A, (2) completed installation of a CORK at Hole 1301A, and (3) obtained cores from Hole 1301B.

Hydrologic formation testing in Hole 1301A: We inflated the drillstring packer at 267 mbsf, 10 m above the casing shoe, and conducted a series of constant-rate injection tests to assess the permeability of a 92.6 m-long section of upper basement. Five tests were conducted using different pump rates and duration (15 strokes per minute [spm] for 30 min, 30 spm for 45 min, 50 spm for 1 hr, 75 spm for 2 hr, 100 spm for 1 hr). Following each test, we monitored pressure for the same duration as pumping duration. Our last three injection tests are of longer duration than any previously attempted in upper oceanic basement and should investigate a greater radial distance into the formation.

Full interpretation of these tests will require correction for the thermal perturbations to borehole fluid densities and pressures due to (a) the transient establishment of an uphole flow thermal profile and (b) the cooling effect of pumping during the injection tests. Preliminary interpretation of the longest injection test (using Glover's formula for the nearly steady-state pressure increase) indicates a permeability of ~4 x 10^{-11} m^2 when averaged over open-hole section of basement tested. This value is between (a) lower permeability measured at over shorter length scales from shorter-duration Leg 168 packer experiments and (b) higher permeabilty measured at much larger scales from earlier CORK observations and thermal modeling. This is consistent with previous reports of a spatial scale effect on permeabilty of uppermost basement on the flank of the Juan de Fuca Ridge.

CORK installation in Hole 1301A: Hole 1301A is located on eastern flank of the Juan de Fuca Ridge where the crustal age is 3.5 m.y. We drilled and cased the hole to 277.1 mbsf through 262.2 m of sediment and 14.9 m into basement. We then drilled to 369.66 mbsf (107.5 m into basement), but poor hole conditions prevented installing the CORK to this total depth. Below the cased hole, we installed a suite of instruments within slotted 4-1/2 inch casing in a 19 m-long, open-hole section of upper oceanic crust 14.9 to 34.0 m below the top of basaltic crust (277.1 to 296.2 mbsf). The monitoring zone is isolated by the CORK-head seal at the seafloor and by a 4-1/2 inch casing packer inflated inside the 10-3/4 inch casing ~7.6 m from its base. Long-term (>5 year) experiments deployed in this zone include pressure and temperature monitoring, chemical (water, gas) sampling, and microbiologic colonization. We have now completed our first step toward creating a three-dimensional observational network in upper oceanic basement.

RCB-coring in Hole 1301B: Cores 1301B-1R to 10R: 351.2 to 424.4 mbsf (86.04 to 159.24 m below the top of basement). Cored 73.2 m and recovered 21.03 m (29%). A thin hyloclastite overlying a series of pillow lavas with glassy margins and an assortment of veins (some with oxidation halos). Disseminated pyrite starts to appear in Core 5R. Compressional velocities 5.2-5.8 km/sec (avg. 5.4 km/sec); Thermal conductivity 1.2 to 1.8 w/(m-k). Samples taken but not yet analyzed for thin section, porosity, density, paleomagnetics and geochemistry. For microbiologic analyses, basalt samples were collected immediately after core recovery (to minimize exposure of anaerobic bacteria to oxygen) and incubations were intiated.

EDUCATION

The fourth weekly installment of the Teacher-at-Sea's daily journal (text and photo) has been sent to shore. The first lab brief (microbiology lab) has been transmitted to shore where it is undergoing final editing and formatting for web distribution. Paleomagnetism lab brief has been submitted to shore for review. Initiating Chemistry lab brief.

TECHNICAL SUPPORT AND HSE ACTIVITIES

IODP technical staff concentrated on assisting with the CORK assembly by assisting with the installation of the centralizers and securing the umbilical to the CORK casing as well as with the deployment of the sensor string (OsmoSamplers and temperature sensors) lowered into the CORK.

Lab activities: Final preparation for coring. The PFT tracer pump for microbiologic contamination testing was activated prior to coring to ensure the drill pipe would be filled and properly delivered to the bit. We are evaluating impact of higher pump rates used for hard rock drilling on PFT usage. We will take advantage of planned helicopter transfer to secure more tracers.

The entire technical staff, and curator in particular, have focused on initiating core archiving, processing, and sampling. The curator has worked out a plan with the scientists to obtain substantial time-critical microbiologic samples in critical hard rock sections of limited recovery. Due to the importance of the hard rock core description and as the microbiology samples are destructively sampled, a method for digitally imaging the samples before they are taken has been implemented. We have also implemented fo the first time use of an anaerobic, high-concentration hydrogen gas mix to nurture sample cultures. A multitude of other small but essential repairs were conducted to facilitate core processing and science needs.

The Electronic Specialists finalized repairs to the weigh-on-bit filter and drawworks block position encoders, calibrated PFT pump and enabled communications to control it from the drillers shack, resolved communication problem of packer pressure gauges, and spent a little time to troubleshoot a problem with the cryogenic magnetomoter.

Computer System Managers are now into routine operational status but continue to fine-tune the many workstations. Implemented and documented system-wide network time synchronization, investigating limited communication between TSF and IODP network, installed digital color management software for Digital Imaging Specialist, setting up basic UNIX system printing, broad spectrum of system administration and troubleshooting (e.g., resolved macDiff problems, implemented SQL scripts for curation).

Programmer Specialist has (1) fine-tuned Digital Imaging System workflow and automation for providing to scientists and staff, (2) developing same functionality for close-up photographs as well as for close-ups taken of hard rock microbiology samples that are destructively sampled prior to routine core curation, description and imaging, and (3) developed temporary solutions for curation and sampling needs.

HSE: Due to the extensive support required by TSF staff, IODP staff, and scientists, a scheduled fire drill had to be postponed. IODP technical staff viewed a number of safety instructional videos.

Core recovery:	21.03 m
Samples collected:	108 (although many have been subdivided for multiple analyses)