August 16, 2004

IODP EXPEDITION 301: JUAN DE FUCA HYDROGEOLOGY WEEK 7 REPORT

OPERATIONS

HOLE 1301B: 47° 45.2286' N, 127° 45.8262' W; Water depth: 2667.8 mbrf

This week we have returned to Hole 1301B to conduct hydrologic tests and install a CORK-II.

Drill out remedial cementing of 10-3/4 inch casing and check open hole depth in Hole 1301B: We planned to drill out the cement that we pumped to align and secure the backed-off 10-3/4 inch casing. We reentered the hole and encountered resistance at the top of the lower section of 10-3/4" casing at the depth as before (2926.0 mbrf). We were able to rotate slowly through this location, into the top of the lower casing section, and were able to lower the bit into open hole. The bit was easily lowered to the depth of the planned CORK installation. We did not encounter any cement and retrieved the drill string at 0730 hr on 9 August.

Hydrologic (Packer) testing: We assembled a packer bottom-hole assembly, tested the surface circulation equipment, and reentered Hole 1301B at 1310 hr 9 August. As before, we had to rotate through the top of the lower piece of 10-3/4 inch casing (at 2926.0 mbrf), but after that the pipe was lowered with no problem to 3152.0 mbrf. Three packer tests were conducted at three different depths from 1745 hr 9 August until 1200 hr 10 August. We then raised the packer to 3047.0 mbrf to test a potential CORK packer location. By 1400 hr 10 August all packer work was completed and at 2100 hr all packer components were on the rig floor.

Deployment of the Cork "Test" Casing String in Hole 1301B: Due to the problem with the 10-3/4 inch casing, we decided that before assembling the entire Cork-II casing string we should run a test string to ensure it could pass through. After testing the new bow-spring centralizers on the rig floor, we assembled the test string and reentered Hole 1301B for the 15th time at 0435 hr 11 August. This string had to be rotated slowly through the troublesome 10-3/4 inch casing. After advancing to 3002 mbrf, we retrieved the string back on the rig floor at 1315 hr 11 August.

First attempt to install a CORK-II in Hole 1301B: The CORK for Hole 1301B was the most complex planned for this expedition. It included 3 packer elements (to isolate 4 zones), numerous miniscreens, two ubmilicals (one with Teflon coated interior for microbiology), as well as the capability to have an OsmoSampler/temperature/microbiologic string deployed through the middle of the 4-1/2 inch casing. The CORK running tool was modified so that it could withstand minimal rotation without disengaging. It took 22.25 hours to assemble the CORK (~3 times longer than anticipated). We reentered Hole 1301B at 1630 hr 12 August and we visually observed the lowering of the CORK into the hole until the lowermost packer had reentered the hole; we then raised the camera to above the CORK head per standard protocol so as to not risk loosing the TV system should a failure occur in the casing string being deployed. It appeared that the CORK was passing easily into the hole and we continued lowering it until the CORK head was ~12 m from landing in the reentry cone.

We decided to conduct a depth check with the coring line and a sinker bar to ensure the OsmoSampler-thermistor string could be installed into the open hole. At this time, we realized something was not right, when the sinker bars would not pass 2665 mbrf, which was just at the seafloor depth. When we lowered the camera over the CORK head we found that the CORK 4-1/2 inch casing had failed. Casing was piled up around the reentry cone and one end of the 4-1/2" casing string was extending out from the throat of the reentry cone. Another piece of casing was sticking up out of the seafloor. We retrieved the drill string and the CORK wellhead, but that was all that was recovered as the casing had failed at its connection to the bottom of the wellhead.

We then made up a short bottom-hole assembly to perform a camera inspection of the broken casing and reentry cone. At 1015 hr 13 August we began the survey to determine what could be done to fix the situation. During this survey we also moved the 36 m back over to Hole 1301A to make sure that we had not damaged the CORK installed there earlier in the cruise. Our best analysis of the failure at this time is that a bow spring stabilizer either hung up momentarily in the throat of the reentry cone/casing hanger area or there was a build up of friction from the multiple bow spring stabilizers deployed causing the 4-1/2 inch casing to buckle above the seafloor. We recovered the BHA and started fabricating a specially designed fishing tool to try to snag the 4-1/2 inch casing to clear the hole and reentry cone area of the broken casing.

We lowered the fishing tool to the seafloor and hooked the casing in ~30 minutes. Our best estimates of the length of casing inside the hole was 200-250 m, so we raised the fishing tool >300 meters above the seafloor and offset 300 m to the west of the hole. We released the casing on the seafloor as we could not safely retrieve it. We moved back over Hole 1301B and there was only a single joint of casing remaining sticking out of the seafloor beside the cone. The reentry cone and opening of the hole appeared to be free of any obstacles.

Our next step was to lower a bit into the hole to verify that all the broken 4-1/2 inch casing had been removed. We reentered Hole 1301B for the 18th time at 1030 hr 14 August with a 9-7/8 inch drill bit. Other than encountering the same problem zone of 10-3/4 inch casing (at 2926 mbrf), the bit easily passed to the total planned depth of the CORK installation. The bit was back on board at 1800 hr 14 August and we began to prepare for a second attempt at installing a CORK at Hole 1301B.

We are fortunate to have been able to recover from the failure of the first CORK. We are now assembling a CORK using parts that were originally to be used for the Hole 1027 CORK.

SCIENTIFIC RESULTS

During this week we returned to Hole 1301B (1) to determine the results of our attempt to align and cement the backed-off 10-3/4 inch casing, (2) to determine how much open hole in basement is accessible for subsequent experiments, (3) conduct hydrologic (packer) testing, and (4) attempted to install a new CORK installation. We also present the initial scientific results from APC-coring at Hole 1301C that was completed last week.

APC coring at Hole 1301C: We cored the sediment section at Hole 1301C to collect high-quality APC-core samples for geochemical and microbiologic studies. We cored continuously from the seafloor to 119 .1 mbsf and then alternately cored and drilled

ahead without coring to ensure we had sufficient time to obtain the deepest sediments. The cores were extensively sampled for microbiological and geochemical studies on the catwalk. The sedimentary succession consists of two units: a ~200-230 m thick turbidite sequence overlying a 40-50 m-thick hemipelagic mud unit with carbonate nodules; the boundary between the units was not recovered due to discontinuous coring.

For geochemical analyses, we collected 38 headspace, 28 porewater (20-40 cm-long whole-round), and 30 solid phase samples. Methane concentrations are low in the upper part of the section but increase sharply between 60-70 mbsf reaching a high at ~100 mbsf. Methane concentrations are low below 178 mbsf. No higher hydrocarbon gases were detected.

The porewater samples were analyzed for pH, alkalinity, sulfate, calcium, magnesium, potassium, sodium, chloride, dissolved phosphate and ammonium, selected major, minor and trace elements (barium, boron, iron, lithium, manganese, silica, and strontium), total carbon (TC), inorganic carbon (IC). The majority of profiles are similar to those observed at nearby ODP Site 1026. The carbon content of the porewater increases from the seafloor down to a maximum of 520 ppm at 43 mbsf. From 178 to 265 mbsf, TC and IC concentrations are very low from 21 to 6 ppm and 9 to 0.1 ppm respectively.

Sediment samples show relatively low organic carbon, nitrogen, and hydrogen contents. Organic carbon contents are highest close to the sediment/water interface (0.9 wt%) and decrease rapidly. Total nitrogen averages ~0.04 wt% and shows a similar trend. C/N ratios fluctuate around ~7.7, indicating marine organic matter. Inorganic carbon contents are uniformly low and $CaCO_3$ values are from 0.75 to 5.7 wt%.

We collected 195 whole-round core (WRC) samples for microbiological analyses and aseptically sampled them for culture and molecular experiments. Fluid tracers in the drilling fluid indicate that the inner part of nearly all WRC's provide uncontaminated samples. Microscopic observation of cell densities shows a general downhole decrease, except for a slight increase near the sediment-basement contact. We inoculated sediment slurries into seven types of media for anaerobic cultivation experiments. These are incubating at 5 different temperatures (20, 37, 55, 70, 85ºC) and after 5 days of incubation, we have not yet observed any cell growth.

Three good formation temperature measurements were obtained (43.1, 82.2, and 247.4 mbsf). Combined with bottom water temperature, these indicate a gradient of 0.228°/m, heat flow of 280nW/m^2, and an extrapolated temperature at the top of basement of 62°C.

The average thermal conductivity in clay and sand layers is 1.1 and 1.5 W/m - K, respectively with an increase with depth over the upper 100 mbsf. P-wave velocities range from 1.5 to 1.8 km/s over the 265-meter drilled interval and exhibit a ~3 to 6% increase in the upper 50 mbsf but show no significant trend below. Bulk density of clay samples increased from 1.4 g/cm^3 at the seafloor to ~2 g/cm^3 at 100 mbsf with no significant trend below that. Clay porosity showed a corresponding decrease with depth from 80% at the seafloor to ~50% at depths ≥ 100 mbsf. Grain density is remarkably consistent with a value of 2.8 g/cm^3 regardless of depth or lithology.

Sediments are virtually all magnetized with a normal polarity, as expected from the young age of the section. Natural remanent magnetization values are almost as high as igneous rock, apparently because the sediment source regions are rich in igneous clastic debris and ash.

Hydrologic (packer) testing: The drill string packer was successfully inflated at three positions in open hole (472 mbsf, 442 mbsf, and 417 mbsf), to assess the permeability of the section of upper basement deeper than the shallowest section tested in Hole 1301A. Two or three constant-rate injection tests were conducted at each inflation depth, and the quality of the records is excellent. Preliminary processing suggests permeabilities on the order of 10^{-11} m^2 for the tested section (152-318 m below the top of basement), slightly lower than the initial value for the shallowest basement section in Hole 1301A but still very permeable.

EDUCATION

The sixth weekly installment of the Teacher-at-Sea's daily journal (text and photo) has been sent to shore. The Chemistry Lab brief is undergoing final shipboard editing and will be sent to the shore this week. The Physical Property lab brief will be accomplished next. The Teacher-at-Sea has been observing all of the labs, and especially sediment core processing and squeezing/analysis of interstitial waters. The Teacher-at-Sea has also been assisting with sediment core description.

TECHNICAL SUPPORT AND HSE ACTIVITIES

Lab activities: Two full technical shifts contributed to assembly of the Hole 1301B. The second and third helicopter deliveries at the helideck were sorted, hauled to the lab stack, inventoried and dispersed. The labs were busy finishing processing, analyzing, and sampling of sediment cores. We also conducted two days of sampling the basalts recovered from the base of Hole 1301B. The digitizing boards supporting the MST p-wave logger failed. The logger was repaired and replacement boards have been ordered. The non-contact resistivity instrument was working and was repaired after coring was completed. Nearly all analyses from hard rock and sediment sections cored have been completed. End-of-Leg schedules have been posted, EOL technical reports are in progress and lab documentation is being updated. Preparation for offgoing shipment of equipment and samples has been initiated. The technical group is now helping with the second Hole 1301B CORK attempt.

HSE: The weekly fire and boat drill was focused on verifying proper functioning of all fire alarms and bells. So most of the day shift technical staff remained in the lab stack and science areas to verify their functioning.