Storms, M. A., Natland, J. H., et al., 1991
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5. OPERATIONS REPORT[1]

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OVERVIEW AND ACCOMPLISHMENTS

During Leg 132, a second-generation mining-type diamond coring system (DCS) designed for deep-water drilling, was field-tested in young, fractured basalts at an unsedimented spreading ridge. This is an environment where previous rotary coring on earlier legs had proven inadequate. In addition, two new types of DCS seafloor structures were tested. One for bare, fractured rock applications and the other for use in sedimentary formations. A new drill-in bottom hole assembly (BHA) concept was deployed and tested for the first time. This system was used to successfully isolate unstable zones in the upper section of the formation and enabled the DCS to be successfully deployed in a coring mode.

Although the secondary scientific goals for the leg were not fully met, virtually all of the engineering goals were satisfied. In this context Leg 132 can be considered to be a complete success.

The problems identified and subsequently solved on the leg will result in more reliable, field-tested systems being available for future scientific legs.

All DCS Phase II (4500 m) subsystems are now considered 100% operational. These include such systems as the electric top drive and new silicon control rectifier (SCR) controls, the secondary heave compensator system, the coring winch and controls, the hydraulic system and controls, the feed cylinders, the main and auxiliary hydraulic pumps, platform auxiliary systems such as tongs, tuggers, etc., the SCR mud pump control system, and the mud circulation standpipe system. Some limited modifications to these systems are desired, however, future deployment of the DCS is not tied to these refinements or enhancements. Desired modifications include the addition of a proper piloted winch control for improved low speed operation, the addition of high-pressure return line filters on the hydraulic system, high-pressure/dual seals to be installed on the compensation/feed cylinders, and better/more versatile tugger controls allowing safer low speed control.

The initial deployment of the new mini-hard rock base (HRB) met with disaster when the floatation righting system for the reentry cone funnel proved to be inadequate. This was overcome, however, and the guide base has been proven to be a very versatile structure. The new HRB is field-recoverable and/or can be deployed operationally on several holes at the same site. This new capability has vast operational planning and economic ramifications.

The drill-in BHA concept is also one which has now been proven viable. There were a few surprises on Leg 132 and a few operational techniques found to be unrealistic, however, the basic concept remains solid. The technique is vastly superior to the conventional techniques used in the past such as pre-drilling a hole and then emplacing casing. What is required now is to evaluate the friction taper on the back-off nut so as to avoid the fusion/jamming problem identified this leg. Secondly, to redesign the C-ring gland allowing more clearance for drilling-in the BHA and a larger latching surface for the C-ring to ultimately shoulder on.

The wireline core barrel components used on Leg 132 were a tougher version of those evaluated on Leg 124E but remained an adaption of the systems typically used in the mining industry. This upgraded wireline coring and retrieval system performed nearly flawlessly throughout the leg. The only major shortcoming of the system was in the core catchers where more versatility is needed. In coring the highly friable volcanic tuffs and brecciated basalts the single-collet-style core catcher used universally in the mining industry proved to be inadequate. All other features of the system performed as designed, and no failures were experienced with the core barrel latches, swivels, jars, overshots, or any of the other components.

Specially designed 11-5/8 in. and 9-7/8 in. tungsten carbide insert (TCI) roller cone bits were built for use on Leg 132. These bits were made to withstand the rigors of drilling in fractured rock for emplacing the drill-in BHA. Special 4 in. dual-TCI roller cone center bits were used in the throat of the primary bit during the drill-in process. This center bit was unlatched and recovered prior to deployment of the DCS tubing string. All primary bits, center bits, and latching systems worked nearly flawlessly. Only one partial failure was experienced and that was a washout on one center bit cone with 21 rotating hr.

Bare-rock spudding operations took place on Leg 132 using the same positive displacement coring motor (PDCM) used on earlier legs. Experience using this system has now shown this technique to be not only operationally viable but routine. A new technique was used with the motors on this leg. Locking balls were pumped down the drill string, locking the motor rotor and stator together. This locking mechanism allows a drilling torque of up to 25,000 ft-lb to be transmitted through the motor when the 6,000 ft-lb motor torque is found inadequate. This technique has now been tested and proven operational for use when necessary.

Other than more actual on-bottom coring time in the originally planned variety of formations, only one engineering objective went untested, that of deploying a slimhole logging tool into a nominal 4 in. diameter DCS hole. Proving the viability of offshore slimhole logging will have to wait for another day.

In addition to the hardware testing and evaluation that took place on the leg, an unprecedented amount of field training was accomplished. The Leg 132 SEDCO/FOREX drill crew and several ODP drilling engineers are now much more experienced at coring fractured rock with diamond coring systems; deploying, moving, and recovering hard rock guide bases; drilling-in, releasing, and recovering bottom hole assemblies; and spudding zero age crustal formations using positive displacement mud motors. This training will manifest itself in the form of more efficient and problem-free operations on future scientific legs.

INTRODUCTION

Leg 132 was the second of an anticipated sequence of cruises designed to allow the testing and refinement of the hardware and techniques necessary for establishing, maintaining, and successfully coring to completion a scientific bore hole on a young,

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[1] Storms, M. A., Natland, J. H., et al., 1991. *Proc. ODP, Init. Repts.,* 132: College Station, TX (Ocean Drilling Program).

[2] Ocean Drilling Program, 1000 Discovery Drive, College Station, TX 77845-9547, U.S.A.

unsedimented spreading ridge. Two other secondary drilling objectives, the chert-chalk sequences at Shatsky Rise and the shallow-water reefal carbonates at M.I.T. Guyot unfortunately had to be abandoned when leg operating time expired (Fig. 1, Table 1).

As the technical complexity of these high-priority scientific problems continues to grow, so too does the demand for dedicated ship time enabling the required technology to be developed, tested, and refined to an operational level. Although the Ocean Drilling Program continues to emphasize comprehensive shore-based testing of developmental equipment, these tests cannot adequately simulate the offshore marine environment in which the tools will ultimately have to operate. Engineering legs are therefore essential to the successful attainment and refinement of the required technology.

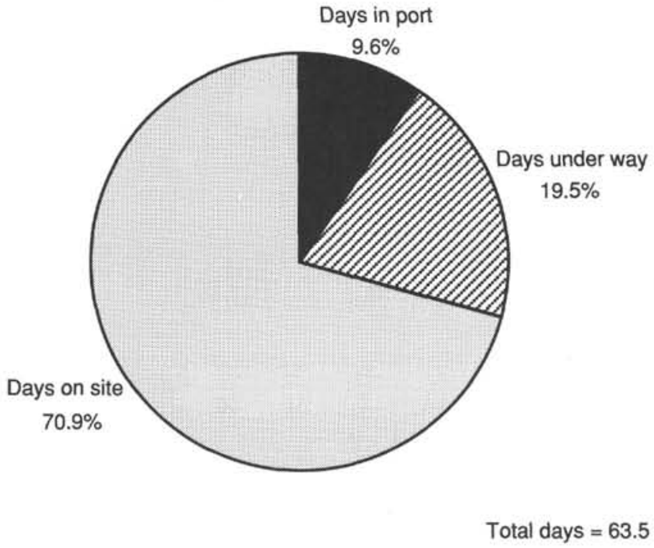

Figure 1. Leg 132 total time distribution.

Table 1. Operations resume, Leg 132.

Total days (2 June–4 August 1990)	63.5
Total days in port	6.1
Total days under way	12.4
Total days on site	45.0
Trip time	12.3
Coring time	.3
Drilling time	1.7
Logging/downhole science time	1.4
Reentry time	2.6
Repair time (contractor)	.2
Fishing	1.1
Other	3.4
Development engineering time	22.0
Total distance traveled (nmi)	3252
Average speed (kt)	10.9
Number of sites	3
Number of holes	11
Number of reentries	28
Total interval cored (m)	204.6
Total core recovery (m)	164.7
Percent core recovered	80.5
Total interval drilled (m)	120.3
Total penetration (m)	324.9
Maximum penetration (m)	136.1
Maximum water depth (m from drilling datum)	4682.4
Minimum water depth (m from drilling datum)	1799.6

Drilling in fractured basalt was a particular impetus to the development of the DCS. Two full legs of the Ocean Drilling Program, 106 and 109, had been devoted to an unsuccessful attempt to establish a deep hole in the axial rift of the Mid-Atlantic Ridge. Although a hole was spudded into bare rock for the first time using a hard-rock guide base, only 50.5 m of basalt were penetrated using rotary coring, recovery was very low, sidewall stability was a continual problem, and the hole ultimately was abandoned. This simply confirmed previous experience with rotary coring in very young ocean crust at thinly sedimented ridges during Deep Sea Drilling Project Legs 34, 49, and 54.

For engineering details pertaining to the deployment and operation of the DCS platform/mast assembly, diamond coring system, minihard rock guide base, and drill-in-BHA systems please refer to the engineering reports prepared on these systems.

PUSAN, SOUTH KOREA, PORT CALL

Operations Port Call Activities

Two activities dominated the Pusan, Korea, port call. One centered on loading the enormous amount of hardware and supplies necessary to support the DCS deployment. In addition to the DCS system itself, this effort also included all seafloor hardware/equipment required for bare fractured rock spudding at the Bonin Rift/M.I.T. Guyot sites, as well as reentry hardware for Shatsky Rise operations. A total of 499,334 lb of ODP surface freight equipment and supplies were loaded during the course of the 6 day port call, not including expendable mud supplies. An additional 8641 lb of air freight came aboard. Receipt of some critical engineering A/F components was expedited through customs with the help of Chang-Shik Lee, a Korean ODP/TAMU graduate student sailing on Leg 132.

In addition to the above-mentioned freight, 120 drums (55 gal) of pig iron ingots, at approximately 1600 lb each, were purchased locally and loaded aboard ship. This material was to be used for ballasting the two hard rock guide bases.

Loading of all bulk products, 100 metric tons of barite and 90 metric tons of bentonite gel was completed swiftly and efficiently, as was the loading of potable/drill water (1540 metric tons) and refueling (198,260 US gal).

Additional mud products included 8,000 lb (160 sacks at 50 lb each, 40 sacks per pallet) of Baravis and 45 drums (55 gal each) of EP Mudlube friction reducer taken aboard.

The second port call activity consisted of rigging, modifying, and testing the DCS platform/mast assembly itself. Of primary concern was the repair of the hydraulic feed cylinders on the mast assembly and testing of the DCS secondary heave compensation system. Other activities included the installation of the DCS umbilical cables and the new racking boards for the DCS tubing.

All of the carefully planned loading activities were disrupted when it was found that the entire shipment was unloaded from the shipping containers at the customs yard in Pusan. This created major problems for the agent and ODP in receiving hardware dockside in the order that it was needed. Nothing was left untouched by customs personnel except the flat containing the DCS mast/top drive assembly. It was theorized that this item (all 49,000 lb) would also have been unloaded had customs had access to a large-enough crane. The piecemeal delivery of hardware and supplies disrupted the efficiency of an already work-intensive port call, but this hurdle was eventually overcome.

The limiting item of the port call for UDI was the repair of T-1 thruster. This was completed on schedule. UDI also loaded a replacement drill line for changing out after Leg 132.

All scheduled activities were completed early on the 6th day. Port call operations officially ended at 0800 hr on 8 June 1990 with the last line off the dock at central pier 2, Pusan harbor.

Engineering Port Call Activities

During the port call, many of the DCS electrical and mechanical components were assembled and function-tested. The DCS mast/platform assembly was fit-tested in the derrick. The DCS handling dolly was skidded back and forth across the rig floor with the DCS mast/ platform in place. The DCS hydraulic equipment was function-tested, and the secondary heave compensator was tested using the built-in test cylinders on the mast to induce artificial heave motion into the primary feed cylinders and top drive assembly.

DCS Mast/Platform Hardware

Upon arrival of the DCS mast dockside, work was begun immediately on repairs of the DCS feed cylinder lower seal gland nuts. A total of 96 man-hr was required to complete the repair job on the cylinders. A tremendous amount of time and effort was required to hand-grind the galled threads on the cylinder rods. Upon completing repairs to the DCS feed cylinders, assembly of the system on the rig floor began.

The DCS handling dolly tracks were installed on the rig floor. Part of the track assembly was new, so it was necessary to modify the aft starboard track to clear a support beam for the roof located on the starboard side of the rig floor. Eight hours was required to initially install the DCS handling dolly tracks. Upon completing the track installation, the DCS platform dolly was assembled and installed on the tracks, which required 2 hr. Several of the dolly track wheels were found to be frozen up due to corrosion. One wheel was freed but one remained frozen. Because of the considerable amount of time required to free the wheels, it was decided to go ahead and install the mast and platform on the rig floor and free the wheels as necessary while underway to the first site.

The platform was installed on the guide dolly without incident, and the mast was slung and moved into place on the rig floor.

The mast lift sequence was first to use the number one crane to lift the mast horizontally to the rig floor, using a four-part sling arrangement. Two loose 20 ft slings were then attached to the 500 ton elevator bails, and the mast was slowly handled from horizontal to vertical using the draw works. The platform was then rolled into place on well center, and the mast was stabbed into the platform guide roller assembly without any difficulty. Four hours was required to assemble the mast and platform on the rig floor.

The DCS guide dollies were attached to the DCS mast and test-fit in the derrick guide track. It was discovered that the guide dolly arm counterweight contacted the side of the mast strong-back preventing the dolly roller assembly from clearing the track. The counterbalance weights were trimmed to provide the appropriate clearance. The rollers were attached in the track, and the mast was raised up and down in the derrick to check for proper operation. No interference problems were found. Eight hours was required to initially fit and modify the guide dollies in the derrick with the DCS mast. With additional handling experience by the rig crew, this operation will become more efficient.

The DCS platform/mast assembly was skidded back and forth on the dolly tracks with ease. The one port-aft handling dolly wheel that was frozen did not appear to hamper the movement of the dolly. Therefore, no further effort to free the dolly wheels was made. The dolly track was greased to enhance movement of the dolly wheels on the tracks.

The wireline winch and lebus fleet angle compensator were installed on the DCS mast strong-back. No problems were encountered with the installation, which took a total of 4 hr.

DCS Electrical System and Controls

Both the control panels (top drive and heave compensator) were unpacked and checked in preparation for installation. An air-purge system was installed on the heave compensator panel that, along with the space heater already mounted in the box, would effectively eliminate any infiltration of moisture within the panel. Once this was done, both panels were installed in and bolted to the steel frame that mounts to the main hydraulic console. The entire assembly was then lifted and bolted in place. Sensor and control cables were connected and preliminary checks performed.

The new throttle and summing amplifier boards were installed in the two SCR bays for the top drive. Checks of all the previously installed control and power wiring revealed only one minor mistake which was quickly corrected.

The data acquisition system (DAS) cable for monitoring heave compensator computer data, which had previously been run to the downhole measurements laboratory, was terminated and checked. This cable was later used to monitor the computer during function-testing of the system. In the downhole laboratory, a computer was connected to log and analyze data for troubleshooting and to help measure the effectiveness of heave compensation under actual field conditions.

DCS Hydraulic Systems

Two DRECO service representatives attending the port call connected the hydraulic umbilical between the mast and platform in a 6 hr period without incident. Upon completion of installation of the hydraulic hoses, all primary and ancillary hydraulic equipment was tested. All systems functioned properly. The main feed cylinder and test cylinder system were carefully bled to remove all air from the system.

All of the primary and secondary hydraulic controls on the driller's console were tested and found to be in good working order. The control console was designed to hinge down and lay on the platform, to protect the controls and gages from damage during shipment. No damage to the console was incurred either during shipment or assembly on the rig floor.

Tubing Racking Board Installation In Derrick

Thirty six hours was required to install the forward and aft racking boards for the tubing in the derrick. No major difficulties were encountered with the installations. Safety chains were welded to all of the hinged fingers at both the 90 ft and the 45 ft levels in the derrick. The 90 ft tubing racking board was designed to pin into the existing pad eyes that supported the drill pipe racking boards.

DCS Secondary Heave Compensator

Test cylinders within the main feed cylinders on the platform allow artificial heave to be induced for testing. This was done repeatedly during the port call once the DCS was assembled in the storage location on the drill floor. Of particular interest was testing the system in drilling mode since the tests in Utah had been cut short in order to ship the system to Pusan. The system appeared to function normally in that it compensated against the artificial heave.

PUSAN TO SITE 808 (NKT-2, ONDO)

The transit to Site 808 was uneventful other than for weather. Some minor gale conditions were encountered the first day underway from port resulting in a slightly reduced speed of 10.1 kt. Conditions continued to moderate, however, and the vessel eventually made good time to the location averaging nearly 13.0 kt. Since this was a reoccupation of a Leg 131 site, arrival was simplified by slowing down and picking up the positioning beacon deployed on Leg 131 (Fig. 2). This was easily accomplished and at 0330 hr on 10 June, the thrusters and hydrophones were lowered officially starting Leg 132 at Hole 808E.

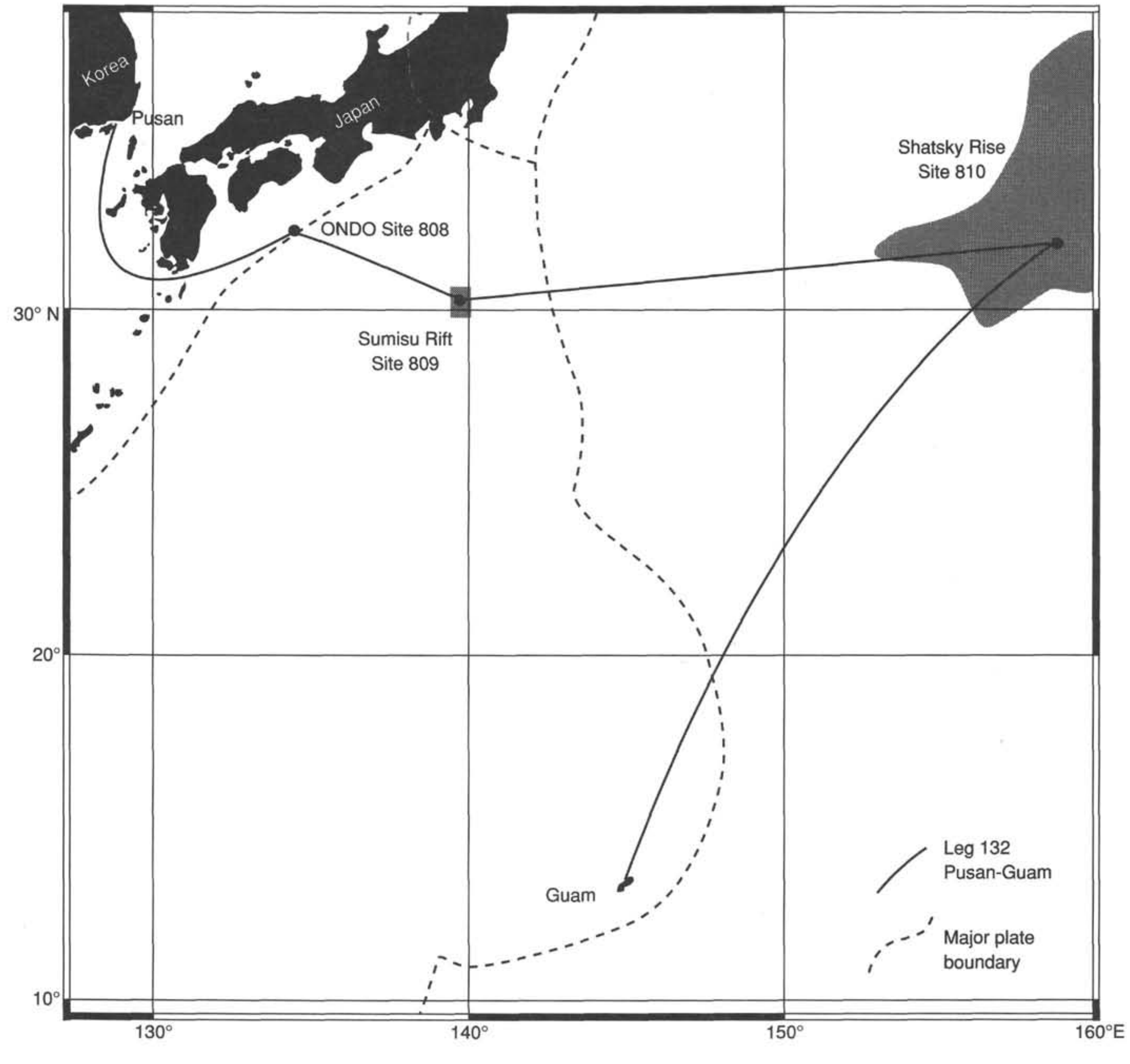

Figure 2. Leg 132 drill sites.

HOLE 808E OPERATIONS

Operations at Hole 808E were added onto the Leg 132 itinerary in an effort to redeem the money and effort that had gone into developing the ODP Nankai Downhole Observatory (ONDO) temperature measurement tool. Attempts to emplace the tool in the cased Hole 808E had been unsuccessful on Leg 131 but the supposed cause had been identified. Modifications were made to the landing pads on the ONDO assembly during the Pusan port call, and personnel on Leg 132 were requested to attempt another emplacement. To assist in the endeavor three members of the Leg 131 staff remained aboard for operations at this first site. They consisted of Asaiko Taira (Leg 131 Co-chief Scientist), Hiroshi Matsuoka (ODP visiting engineer), and Hideyuki Murakami (ONDO technician).

Since it was deemed hazardous to deploy the vibration-isolated televiewer (VIT) frame on the coaxial reentry cable in the strong Kuroshio Current, down-the-pipe sonar reentry was used for the emplacement of the ONDO instrument array. Four attempts were made before an operating Mesotech sonar tool reached reentry depth. The first tool became firmly stuck in the new circulating head when the 4 in. landing shoulder would not pass through the bore of the head. When extricated, the tool was nonfunctional. The second (new) sonar tool was then deployed, but the pipe bladder side plate from the motor section came off during the wireline trip, and the tool malfunctioned at about 4200 m. The original tool had been repaired, but it was stopped by an obstruction (the side plate?) at 1680 m. The obstruction was cleared and a sonar reentry eventually was made after 2-1/4 hr of scanning and maneuvering. The cone target was cluttered and difficult to discern at close range, probably because of a combination of sediment accumulation around the cone and gain-control problems with the tool.

The shortened ONDO array (Fig. 3) was then emplaced essentially as per the original plan. It was necessary to relocate the winch onto the pipe racker catwalk (with I-beams to distribute the weight) because of interference from the DCS rig. The ONDO landing tool set down at the proper depth. The Schlumberger electrical releasing head was actuated on the first attempt and gave electrical indication of "shooting." However, the entire weight of the array was picked up 1 or 2 m before the weight was suddenly lost.

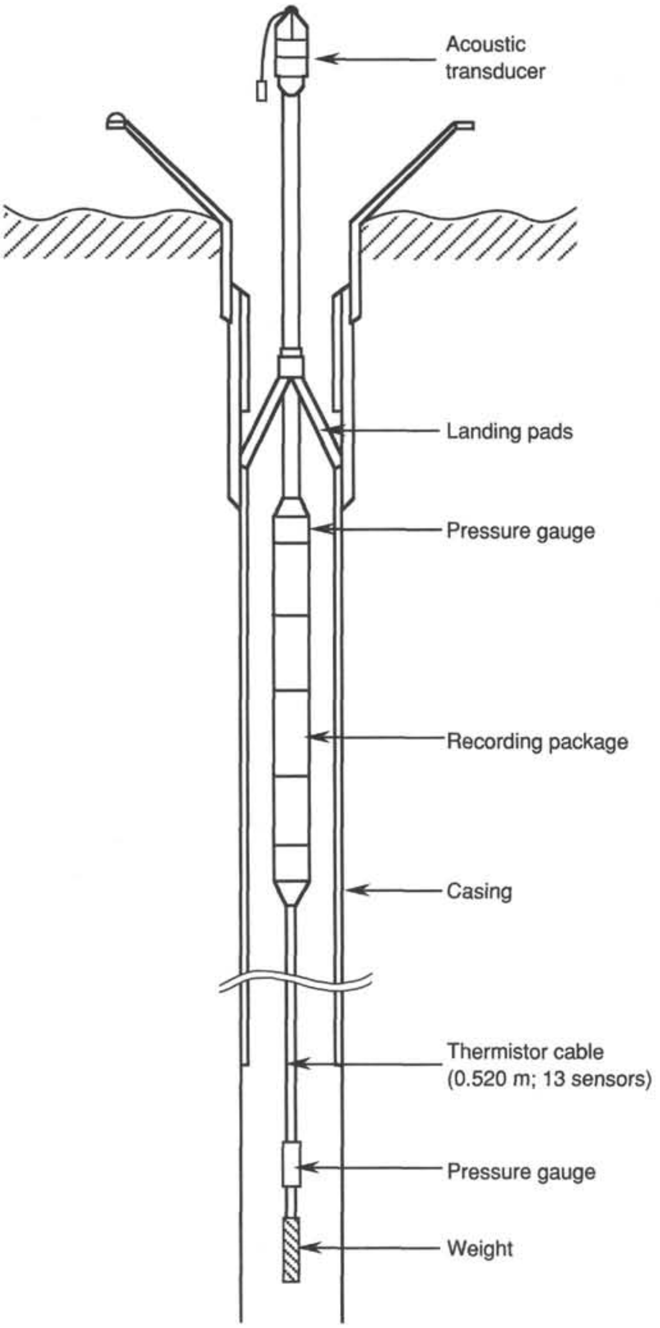

Figure 3. Shortened ONDO array (see text for discussion).

At 1045 hr on 12 June 1990 all thrusters were shut down and the vessel was allowed to drift over the site while the ONDO technician attempted to communicate with the seafloor installation. This test was unsuccessful, possibly due to the noise of the drill ship complicated by the inability to lower the ONDO transducer lower than 15 m into the water. At 1130 hr the test was abandoned, and the vessel got underway for Site 809, the first Leg 132 drill site.

Additional details of the ONDO deployment are given in an unpublished report by Hiroshi Matsuoka.[3]

SITE 808 TO SITE 809 (ENG-5, BONIN)

The transit to Site 809 was brief, less than a day, with no operational problems encountered. A positioning beacon was dropped at 1045 hr on 13 June 1990, establishing Hole 809A.

While underway and prior to deployment of the DCS at ENG-5, the first scheduled drill site for the diamond coring system, a considerable amount of both electrical and mechanical work was performed. All of the auxiliary DCS drilling equipment was installed including the hydraulic rig tongs, pipe handling sling assembly for 10 ft drill joints, rotary plug, and slip bowl. The pipe basket was loaded with 10 ft drilling joints. The safety harnesses were installed with tension-reel safety lines. The kelly hose and standpipe were installed on the DCS platform. Handling pad eyes were welded on the upper wireline sheave assembly arm to aid in telescoping the assembly up and down when standing the platform back in the derrick. The Cavins oil saver was installed on top of the swivel. Flooring was installed on the platform over the existing grating consisting of 1/8 in. steel plate underlying a 1/4 in. thick rubber mat and a top layer of cocoa matting. The DCS core barrel shucks were modified for handling the 10 ft core barrels.

Electrical tasks consisted of function-testing the top drive and controls. When the system was first energized, rotation was incorrect (the shaft turned in reverse when it should have turned in the forward direction). Also, it was found that the motor quickly accelerated at an uncontrolled rate of speed, and came close to overspeeding several times. The motor direction problem was due to the fact that the SCR system on the ship was configured to effect rotation reversal by changing polarity of the motor armature, not the field circuit as has been previously assumed (all motors on board are configured as series motors). The solution was to swap field and armature leads on the platform. It was necessary to correct the problem in this manner because the motor current measuring device on the platform was installed within the armature circuit. This meant that if the cables had been left connected as they were, current measurement would have been possible in only one direction. Because torque is proportional to motor current, it thus would have been impossible to measure torque in one direction—inconvenient when trying to break-out or make-up connections within accurate torque limits. The overspeeding was corrected by changing the throttle and summing amplifier board. The same board that was removed was later used in another SCR card rack and, after adjustment, worked satisfactorily.

Once the above two problems were solved, the motor was observed to be operating erratically. It tended to run rough, and a clanking noise indicated that the motor was being driven with bursts of voltage at a rate of roughly 1 Hz. Examination of the control voltage from the board revealed a square-wave response, as opposed to a smooth DC control voltage. After many hours of investigative work, it was determined that the feedback/control section of the board was oscillating at high frequency. SEDCO/FOREX personnel were able to remedy the oscillations

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[3] Copies of the "ONDO Deployment Report" by Hiroshi Matsuoka are available from Engineering and Drilling Operations, Ocean Drilling Program, 1000 Discovery Drive, College Station, TX 77845-9547, U.S.A.

by judicious placement of a few capacitors on the board. Also, a zener diode and a resistor were used to limit the control voltage switching so as not to drive the SCR bridge quite so hard. All of this resulted in satisfactory operation and smooth motor response to both throttle and current limit signals. Once running smoothly, adjustments of the various current limits were completed within the control panel. Make-up torque for the 3-1/2 in. tubing connections was set at 2500–3000 ft-lb, and break-out to 4500 ft-lb, after calibration of the current measuring transducer on the platform. A complete running sequence was successfully performed with tests of make-up, break-out, and high rotation operation. All of this troubleshooting took several days as operation of the DCS top drive was subject to availability of the top drive SCR bay. Since the main Varco top drive uses the same bay(s), no work could be done while drilling operations were in progress.

The electronic depthometer was installed in the console and quickly found to be inoperative. A substantial amount of water was found inside the enclosure although the unit was supposed to waterproof. Although the water was easily removed and the electronic components dried, the keyboard was also discovered to be flooded and all efforts to dry it were fruitless. As there were two other identical depthometers in use on board, one was quickly pressed into service for DCS.

Various components critical to the proper operation of the heave compensator were checked during this time as well. The bleed valve, controlled by the computer, had not been checked during the test phase in Utah. This valve is used during the approach sequence and during "AUTO WOB/AUTO" feed rate modes of control. The function of this valve is to bleed fluid from the piston side of the feed cylinders so that the trapped fluid does not build pressure to the point of stalling servo operation on the rod side. If fluid was not bled off at a controlled rate, the rod side pressure would quickly reach a maximum at which point the rod- and piston-side forces would be equal, and the system would no longer be able to make progress in the downward direction. When checked, the valve was found not to function correctly one time, then function correctly the next time. The valve was disassembled and checked. Function tests with the valve out of the circuit showed that the return side of the valve was incorrectly plumbed. Once this problem was corrected, the valve seemed to function every time.

Numerous heave compensator software changes and checks were in process during this time. The main problem was the velocity signal to the servo. This control signal is present in all modes except "MANUAL" and it serves to compensate for vessel heave (as opposed to the other servo control variables which control weight on bottom (WOB), feed rate, approach, retract, etc.). The problem was that the signal lacked long term stability and tended to drift with time longer than several minutes. This was not a new problem, as it was also experienced in Utah during the testing. The velocity signal is calculated based on an accelerometer sensor input, using an integration technique. The accelerometer sensor, however, is not temperature-stable and the signal must be continuously checked for drift. As originally conceived, the software computes what are called zero crossings, and corrects the measured accelerometer voltage such that the signal is centered about zero, which it must be long term. Work on this algorithm did in fact continue during most of the drilling on the first site. A totally different method of velocity signal calculation would eventually be used.

Mud pump operation was checked with the now modified throttle and summing amplifier boards. Further slight modifications had to be made along with slightly different adjustments, but in the end, very smooth low-speed operation at rates of 10 strokes per minute (SPM) and less was confirmed. Once all adjustments were made, the panel-mounted SPM gauge was calibrated. The full range of pump speeds was available, i.e., 3–120 SPM.

Many hours of effort went into function-testing the components of the DCS prior to shipment. However, as can be seen by the above list of tasks performed, a considerable amount of time and manpower was required to ready the DCS for deployment. In the future, consideration should be given to installing the DCS on a leg or near the end of a leg that precedes the cruise during which the system is to be used. There is a considerable amount of system testing and troubleshooting that would otherwise use up a significant portion of a regular science leg. At least 2 weeks should be allowed for testing and making all systems operational after the initial assembly in a 5–7 day port call.

APPROACH TO SITE 809

Site 809 was approached from the north on the morning of 13 June 1990, using GPS navigation to stay as closely as possible along an existing survey line. A profile was obtained of four volcanic peaks along the western fissure of Central Ridge establishing precisely the latitude of the target site at the saddle between the third and fourth peaks encountered. Turning east, the vessel was slowed and all profiling gear was retrieved. The vessel then proceeded north to that same latitude.

Turning west, the 3.5 kHz echo sounder and GPS navigation was used to establish the precise longitude of the saddle at its maximum elevation along this line of latitude. Geometrically, this represented the most level place possible to place the HRB. Once past the ridge crest, the ship turned 180° degrees to 090° using a modified Oonk turn, returning precisely to a reciprocal track. Proceeding at 4 kt back to the saddle, the beacon was dropped at 1045 hr at the precise maximum elevation established earlier with the 3.5 kHz echo sounder. The ship hove to and thrusters were lowered. From where it was dropped, the beacon was carried by currents about 100 m to the southeast before reaching the seafloor.

HOLE 809A OPERATIONS

Hole 809A was the first of several bare-rock spud attempts designed to determine the optimum amount of drill-in-BHA (DI-BHA) hardware to deploy through the mini-HRB and to evaluate one of two bit sizes. Prior to running in the hole (RIH) with the drilling assembly, a test of the center bit latching system was conducted. A minor space-out problem was corrected and the system was ready for deployment.

While making up the PDCM, developed by Eastman Christensen (EC) in conjunction with ODP development engineering, it was determined that EC had provided crossover subs with the wrong thread for ODP operations. This problem was corrected by some industrious work by the UDI machinist onboard who fabricated the correct thread on a crossover sub supplied by ODP. The motor-bearing gap was measured and a flow test at the rig floor showed rotation to begin at approximately 20 gpm.

The first of what ultimately was to be three rendezvous during the leg occurred while the rig floor PDCM testing was in progress. The deep-sea tug *No. 21 Chitose Maru* came alongside at 1630 hr on 14 June 1990. A transfer of the three "ONDO" personnel was made to the vessel which then departed for Yokosuko, Japan, at 1700 hr.

After a brief VIT survey to locate a likely HRB landing spot, test Hole 809A was spudded using a special DCS 11-5/8 in. TCI bit and a special dual roller cone center bit combination. It was drilled in using the PDCM to a depth of 1828 m. The seafloor was located at 1819.7 m giving a total depth below seafloor of 8.3 m. The VIT frame with TV camera was pulled above the motor during rotation. periodically rotation was stopped to evaluate progress at the seafloor. The lateral instability of the drilling assembly led to the creation of a large crater around the hole (estimated at several meters across), however, penetration did progress. Drilling parameters for this first hole consisted of 0–5,000 lb WOB, 175–330 gpm, 30–70 rpm, and pump pressures of 300–550 psi.

Hole 809A was successfully terminated at 1700 hr on 14 June 1990 when the bit arrived on deck. Both the primary and center bits were in excellent condition after 7.0 hr rotating time. Retrieval of the center bit/latch assembly at the rig floor was accomplished without incident.

Problems with degraded stranding of the coax cable during retrieval of the VIT frame were experienced on this deployment and on each deployment thereafter. The cable armor was in poor shape in many areas as a result of the high current experienced on Site 808E during Leg 131.

HOLE 809B OPERATIONS

After another brief TV survey, Hole 809B was spudded. This time a 9-7/8 in. TCI roller cone bit was used with a dual cone center bit powered by the same PDCM. Spud time was 2315 hr on 14 June 1990.

Hole 809B was drilled to a depth of 1813 m total depth from a seafloor of 1799.6 m. The resultant penetration achieved was 13.4 mbsf after a total rotating time of 8.25 hr. This time some minor torquing occurred beginning at 3.5 mbsf. Spotting 10 bbl pills of high-viscosity bentonite gel mud seemed to alleviate the problem. Hole conditions improved and the motor torque smoothed out. Drilling was eventually terminated at 0830 hr on 15 June after getting stuck and then free with 55,000 lb overpull.

The VIT was used to survey the second bare-rock spud, and it was obvious that the smaller bit minimized the amount of wallowing and resulted in a smaller crater (less than 1 m across).

Prior to pulling out of the hole (POOH) with the drill string, a small offset (10 m south) was made to look for an appropriate HRB landing site. This was done since it would not be possible to see under the guide base at the time of actual deployment. Bottom was tagged with the bit and recorded as 1799.8 m. The site looked good with what appeared to be minimal relief pillows.

The drill string was recovered and the bit was on deck at 1400 hr, 15 June, officially ending Hole 809B. The primary and center bits again were in excellent condition and judged reusable. The center bit latch was released and the center bit recovered at the rig floor without incident.

HOLE 809C OPERATIONS

Operations at Hole 809C began with preparations for completing the assembly of the mini-HRB, gimbal, and reentry cone assemblies (Fig. 4). The landing sleeve for the back-off nut on the DI-BHA assembly was installed in the gimbaled casing hanger. The HRB sections were positioned on the moon pool doors and assembly was begun. The HRB was aligned, pinned, bolted, and then welding of several seams was begun.

During HRB assembly in the moon pool area, the rig floor was rigged up for making-up the 3-1/2 in. DCS tubing string. After make-up the tubing was then racked in the derrick using the starboard side forward racking boards installed during the Pusan port call. A total of 51 stands of the new S-130 tubing, 3.868 in. OD connections, were made up (average length 26.87 m), 39 stands of N-80 tubing (average length 28.66 m), and 10 stands of N-80 tubing with connections turned down to 3.750 in. OD. These joints are used in open hole for added annular clearance. A total 2775 m of DCS tubing was racked in the derrick.

Upon completion of the tubing make-up operation, the spinning wrench was rigged down, the double-jay tool was made-up and stood back in the derrick, and pick-up slings were rigged for maneuvering the HRB. The guide base was picked-up, the legs dropped into position and welded out, and the entire assembly was then lowered onto the I-beams straddling the open moon pool doors. After tack-welding the beams and HRB to the doors, the gimbaled casing hanger was lowered into place on the trunnion blocks and made-up to the HRB assembly. The trunnion blocks were welded out and the reentry cone was attached to the gimbaled hanger. After attaching the turnbuckle support straps to the HRB/reentry cone, the cone/casing hanger was welded out.

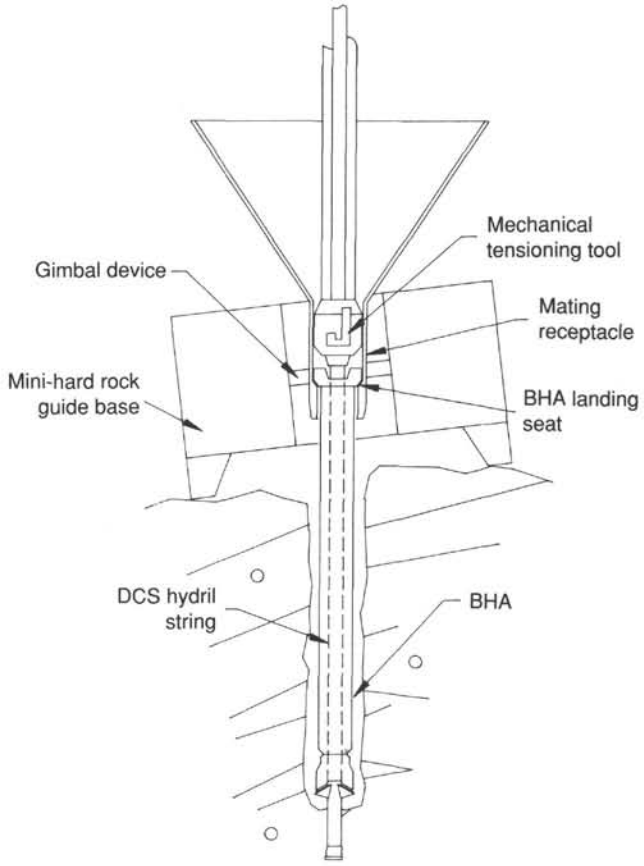


Figure 4. Weighted mini-guide base for bare-rock operations using backed-off BHA for upper hole stabilization.

The next operation consisted of ballast material loading. The favored steel shot ballast material was not available in Pusan and the cost to ship the amount required was prohibitive. For this reason, a local supply of pig iron ingots was procured. A total of 60 drums of pig iron was desired for ballast in the guide base structure. An all-hands effort of SEDCO crew, ODP engineers, scientists, visiting industry personnel, etc. required 4 hr to load, by hand, the pig iron into the HRB. Once completed, a slurry of 16 ppg barite mud was washed into the tanks to maximize the weight of the structure as much as possible. The resultant weight was 129,000 lb or 98.5% of the desired weight.

After jaying into the gimbaled casing hanger, the HRB was picked up and then RIH on 5 in. drill pipe. The base was landed on the seafloor at 1100 hr, 17 June, after a pipe trip of 4.75 hr. After some time trying to determine the attitude of the base, the decision was made to un-jay. At 1215 hr, as the jay-tool pulled clear of the cone throat, the cone appeared to fall over and rest in the corner of the guide base. Much speculation followed, as all concerned tried to piece together the various pieces of information and determine if the cone buoyancy was inadequate or if the guide base was on too great of a slope to right itself. The VIT camera parallax made it extremely difficult to determine the attitude of the cone. Finally, after reviewing the video tape, it was decided that the base was reasonably level but that the cone had fallen over due to inadequate floatation. At that point it was decided to attempt reentering the cone to determine if it could be righted using the drill string. If so, it may be possible to reenter and bring the cone to an upright (vertical) attitude. The cone could then be supported with the DI-BHA, and operations could continue normally. After less than 1 hr, the cone was entered and moved using the drill pipe. It was decided that the plan was feasible and would, in fact, be easier since the diameter of the DI-BHA was less than the double-jay tool. The drill string was then recovered and the double-jay tool was on deck at 1830 hr, 17 June 1990.

The DI-BHA was then made-up using a new 11-5/8 in. DCS bit, center bit, and 11-1/2 in. stabilized bit sub and back-off sub assembly. It was decided to attempt drilling in the minimum BHA to minimize the risk of getting stuck and failing to land the back-off sub on the proper landing seat. Also at this time all BHA connections involved in the bare rock spudding on the "A" and "B" holes were magnaflux inspected along with the PDCM connections. The shipboard-fabricated "Mercier" PDCM crossover sub was broken out and inspected. The sub passed inspection and was put back into service.

To speed up operations the VIT frame was started down the drill pipe before the DI-BHA reached the seafloor. While running in with the frame, the winch operator narrowly avoided collision with a fishing line wrapped on the drill pipe trending toward the stern. The VIT frame was retrieved and an attempt was made to contact fishing boats in the immediate vicinity. The boats were contacted in English, Japanese, and Korean, with no response. Judging from the markings they all appeared to be from the same fleet—possibly from Taiwan or mainland China.

To solve the immediate problem, the spare VIT sleeve was rigged up with a cutting edge on the lower end. The sleeve was lowered with the coring line to 900 m without sign of contact. The sleeve was pulled and the VIT frame was lowered again. The pipe appeared clear but the frame had to be retrieved once more because of what appeared to be a long line with floats drifting down on us. The fear was of getting line wrapped around the pipe with the VIT frame lowered and running into it on the way up. The zodiac boat was launched with a small search team, and some of the floats were recovered. It was decided that no fishing line was attached, and that the floats were apparently jettisoned as trash from a fishing vessel in the area. While in the water, the zodiac was used to inspect all thruster pods as much as possible. They appeared clear. The rudder post on the stern was also inspected and found to have line wrapped on it. This was tied off on the rear rail and eventually broke free. The problem with fishing boats continued to be serious as the boats would come extremely close (in violation of international maritime law) and drop drift lines close to our location. They generally would show up around dusk and leave the area again around dawn, apparently using our stationary position as a reference point while fishing the area. Never were any of our requests to stand clear acknowledged or heeded. The next day the boats were gone. Perhaps they were full or perhaps they were tired of getting fouled and losing gear. In any event future operations at the sight still had fishing boats in the vicinity but they stayed well clear of our position, and as far as we could determine posed no immediate threat to our operations.

With the zodiac safely back aboard, operations continued, and the HRB cone was reentered at 1100 hr on 18 June. The ship was maneuvered in an attempt to straighten the cone. At one point it appeared to right itself. Rotation of the PDCM was used to help ease the bit into the transition pipe, and the bit apparently tagged bottom at 1215 hr. After spudding Hole 809C, rotation was continued for 5 min, and then the seafloor structure was checked. All hardware appeared to be OK. Drilling continued with 2,000–5,000 lb WOB, 42–82 SPM, pump pressure 300–500 psi with stall pressures of 700–800 psi. After no apparent penetration after 30 min, the hardware was again checked. The back-off sub appeared to be inside the cone throat, but there was some uncertainty as to whether correct back-off depth was reached. After picking-up on the drill string, the upper portion of the back-off assembly came clear leaving the DI-BHA in place. Several concerns remained in that the separation occurred without any back-off torque seen. Also, placement of the nut in the cone throat appeared to be too high.

While pulling out of the hole with the drill pipe, the pipe trip was halted for 1 hr while the draw works pivot post for the transmission shift was repaired. The trip was then resumed and the drill string with back-off hardware was recovered and on deck at 2000 hr on 18 June 1990. All DI-BHA hardware appeared to have functioned as designed.

The tensioning sub was then made up to the tapered stress joint with properly torqued shear (actually tension) bolts and prepared for RIH. The dog cages were tack-welded as added insurance against downhole failure as they appeared weak.

The tensioning assembly was then RIH and hung off while picking up the required knobby joints for DCS platform spaceout. The sinker bars were inserted for retrieval of the DI-BHA center bit, and the ship was maneuvered for reentry. The cone was reentered at 0430 on 19 June, however, there appeared to be an obstruction in the throat of the cone preventing proper jay-in. The fear that the DI-BHA had not been drilled in far enough was apparently true. The drill string was tripped out of the hole while modifying the BHA fishing sub with a centralizing sleeve.

By 0200 hr on 20 June, the fishing BHA was ready to RIH. Another breakdown occurred while tripping. The current amplifier on the draw works traction motor required replacement. After 2.25 hr repairs were completed and the trip in the hole was resumed. At 1000 hr on 20 June 1990, the cone was again reentered and the fish (BHA) was successfully engaged. The DI-BHA assembly was back on deck by 1500 hr that same day.

It was decided at that time to drill a "rathole" through the HRB/cone for inserting the DI-BHA. This would maximize the chances of proper emplacement of the BHA and achieve DCS test status as quickly as possible with the least amount of risk. While RIH with the rathole drilling BHA, a pipe union on the iron roughneck failed shutting down operations for an additional hour. The trip was subsequently completed and maneuvering for reentry commenced.

While stabbing the reentry cone at 0015 hr on 21 June, the cone parted at the gusset ring transition to the gimbaled casing hanger. Several looks with the VIT camera were made while discussing the next plan of attack. Because the cone was only partially separated from the casing hanger it was deemed too risky to attempt reentry. Instead it was decided to attempt further weakening the cone to move it more out of the way and allow reentry directly into the throat of the casing hanger. This was satisfactorily accomplished and a reentry was then made into the hanger at 0300 hr. Attempts to right the gimbaled hanger with the cone hanging on the side provided futile, and eventually the bit heaved out of the hanger. At this point the decision was made to attempt total separation of the cone from the hanger. The bit was set down gingerly on the outer edge of the reentry cone funnel, and the cone toppled over to one side of the HRB coming to rest upside down. There was relief among those present as there was some concern over whether the cone would float once separated from the gimbaled hanger. This proved not to be the case.

With the cone funnel now separated, attention was turned to reentering the hanger and working the bit down to bottom. Unfortunately, this too was not possible. The bit cones repeatedly hung up in the hanger jay-slots until the activity was abandoned. The pipe was recovered and then run back in the hole with a "slick" drilling assembly. That assembly has no stabilized bit sub and has the 9-7/8 in. bit rather than the 11-5/8 in. bit used on earlier attempts.

At 0115 hr on 22 June, after only 6 min of maneuvering time, the hanger was reentered with the "slick" drilling assembly. This proved no better, however, and after repeated attempts to work the bit down to bottom, the effort was abandoned. While pulling out of the hole, a fishing tool for recovering the upside-down reentry cone funnel was fabricated. At 1630 hr the bit was on deck but the fishing tool was still under fabrication. It was not until 0600 hr the following morning that the tool was completed, and sufficiently cooled down from welding to allow RIH. In addition to the fishing tool, a jet sub was fabricated by drilling a 1 in. diameter hole in the side of a crossover sub and then plugging the bottom of the assembly. This tool proved to be a real asset and at 1015 hr on 23 June 1990 a "jet-assisted" reentry was made into the upside-down reentry cone. The fishing tool, fabricated much like a sheet rock molly bolt with articulating arms, recovered the funnel without incident and the structure was on deck at 1545 hr that same day.

While efforts were begun to repair the recovered cone and mount the second set of floatation panels, thoughts turned to the feasibility of recovering the guide base as well. When faced with the time-consuming prospect of assembling the second HRB, plus the potential loss of the M.I.T. Guyot site, the idea caught on fast.

An "ultra flexible" fishing BHA made up of drill pipe, jet sub, and bull nose pilot sub was assembled and RIH. At 0230 hr on 24 June, the casing hanger was reentered. Thirty minutes later positive confirmation of jay-in was determined, and the HRB was lifted off bottom. At 0700 hr the HRB was just below the ships keel. It required about 45 min to carefully manipulate the massive structure through the moon pool, and it finally was set down on the moon pool doors. The first-ever, recoverable hard rock guide base had just landed back aboard ship! The saga of Hole 809C had ended.

HOLE 809D OPERATIONS

It required some 28 hr to then refurbish the HRB, mount the new cone with doubled floatation panels, remove sections from the top of the metal cone panel (to lighten the structure as much as possible), and prepare for the second deployment. During this time a makeshift electronic tilt beacon was fabricated from a commandable positioning beacon. The beacon was modified with a pendulum-activated circuit. In theory, if the HRB-mounted beacon was to tilt more than 20° the pendulum made contact with a conducting ring, closing the circuit, and changing the repetition rate on the beacon.

At 1200 hr on 25 June 1990, the HRB was RIH for the second time. The seafloor was tagged with the guide base legs at 1600 hr. The cone appeared to lean over, the "Weingarth/Comier" tilt beacon signal died completely, and one corner of the HRB became visible. These were all interpreted to be bad signs, or at any rate indicated a slope higher than desired. The base was picked up off bottom, and the tilt beacon signal was again received at its normal rate. After a few minutes, the HRB was again set down and this time the tilt beacon signal remained normal. The jay-tool could be seen stroking in the slots of the casing hanger. The jay-tool was un-jayed at 1630 hr and the drill pipe was withdrawn from the casing hanger. This time the cone remained in a vertical orientation as designed.

After recovering the drill string, the BHA was NDT inspected and then the 11-5/8 in. bit and drill-in-BHA was RIH. At 0600 hr on 26 July, the guide base was reentered, the seafloor was established at 1802.0 m, and drilling was initiated. The DI-BHA system performed perfectly achieving a depth of 1808.3 m (6.3 mbsf). The back-off system functioned as designed leaving the lower portion of the DI-BHA in the hole. The anticipated pressure spike was seen as the nut seated causing increased torque on the PDCM. The pressure then immediately dropped off to below the previous operating level indicating a reduction of torque since the BHA was no longer attached. The PDCM ran exceptionally well giving no problem whatsoever.

The drill string was again tripped out of the hole and the tensioning sub plus tapered stress joint were made up. The string was RIH, sinker bars stabbed (to recover the center bit after jay-in), and the vessel was maneuvered for reentry. At 1615 hr on 26 June, the cone was reentered and the tensioning sub was jayed-in. At this point 35,000–40,000 lb tension was applied to the drill string.

After apparently latching onto the center bit (overpull of 700 lb), the tensioning sub was un-jayed in preparation for retrieving the sinker bars from the pipe, and setting up for tripping in the DCS tubing. As the tension jay-tool was retrieved from the cone throat, what appeared to be a jay-latch dog was observed falling into the hole. When the sinker bars arrived on deck it was found that the center bit had not been recovered.

The drill pipe was tripped out of the hole, and everyone's worst fears were confirmed. Not only had a jay-dog been left in the hole but a rib from one of the dog cages was also missing. The shear bolts in the dogs were also all sheared. In retrospect, the tool was obviously too weak in torsion to take the abuse of normal jay-in/jay-out operations. For the next deployment it was decided to negate the redundant shear-out feature of the tension sub, and all dogs on the back-up tool were welded solid.

After a series of discussions it was decided to jay-in to the hanger again and attempt another retrieval of the center bit/latch assembly. If successfully retrieved, then operations would continue as planned. If not, then it would be assumed that the junk in hole was preventing access to the pulling neck, and the HRB would have to be moved.

At 1530 hr on 27 June, after RIH with the modified tension jay-tool, the drill pipe was successfully jayed-in. Further attempts at recovering the center bit, however, were unsuccessful. It was assumed at that point that the latch dog or cage rib were lying across the top of the backed-off BHA preventing access. The decision at that point was to jay-back into the hanger, pick up the HRB, and strip over, leaving the drilled in BHA in place. At 1830 hr on that same day the HRB was successfully moved and landed 10 m from the original landing spot, ending Hole 809D. After moving the HRB, the jay-dog was observed resting on top of what appeared to be a perfectly straight DI-BHA. There was negligible washout or wallowing evident around the drilled in BHA. The guide base had been very effective at containing the bit/BHA during spudding.

HOLE 809E OPERATIONS

After tripping out of the hole, another DI-BHA was made-up using the same 11-5/8 in. bit used on Hole 809A. The pipe/BHA was run to bottom and the HRB reentry cone was reentered at 0645 hr on 28 June 1990. This time drilling was tough. Intentions were to drill-in the BHA to 9.0 mbsf, however, after reaching a depth of 8.0 m, the motor indicated increased torque, and the pipe would intermittently get stuck. At one point the "formation" chased the bit to within 2 m of the seafloor. Each time the motor stalled and the bit was picked up off bottom, more hole was lost. After drilling down to approximately 7 or 8 mbsf, the penetration rate slowed to near zero. After several more hours of attempting to drill down the last couple of meters, the VIT system was lowered and the seafloor operation was observed. The DI-BHA back-off nut was obviously 1–2 m from seating. Since rotating time on the bit was now up to 21 hr, it was decided to recover the drill string and inspect the bit/BHA assembly rather than risk leaving a bit cone in the hole or be unable to recover a jammed center bit assembly. At 2130 hr the top drive was set back. and preparations were made to begin pulling out of the hole. During the trip out a hydraulic hose on the pipe racker system failed shutting down operations for 1.0 hr. During this time efforts turned to gathering up subs which would allow shortening the 9.0 m DI-BHA to about 8.0 m. It was feared that the assembly may never achieve that last 1–2 m of penetration, and yet care had to be taken not to run too short a follow-on BHA. This would result in a rathole down the hole which could act as a cuttings trap during DCS coring operations and cause hole-cleaning problems.

At 0345 hr on 29 June, the bit and DI-BHA were on deck. All hardware was extensively scarred and metal shards were found distributed on the bit, stabilizer, and other BHA components. It appeared that the BHA had been in a severe bind during drilling. The stabilizer ring directly below the back-off nut was severely worn, and it was evident that had the assembly penetrated another 6–12 in. the nut would have contacted the cone transition pipe and most assuredly would have backed-off prematurely, well above the appropriate landing sleeve.

The center bit was recovered intact and the latch released as designed, however, one of the two cones had locked-up and broken a tooth. The center bit was also washed-out.

Based on the observed damage it was suspected that the hole was being drilled at a severe angle. At this point it was deemed wise to RIH and inspect the HRB. After tripping in the drill string, the VIT frame with TV camera was lowered. The HRB had obviously changed attitude drastically from where it was at the inception of drilling. Apparently the circulation and/or vibration associated with drilling in the BHA had caused two of the four HRB legs to penetrate the pillow basalts causing the guide base to tilt beyond the working angle of the gimbaled reentry cone/hanger assembly. Inclinometers on the side of the cone indicated that the northwest side of the base was now tilting > 25° to the west. The northeast side of the base appeared to be tilting > 22° to the east. The result was contact between the gimbaled cone/hanger assembly and the guide base putting the DI-BHA in a bind. This is also what led us to believe that the hole was deviated or unstable and explains why the drilling was going so smoothly and then suddenly increased torque, stuck pipe, and zero penetration problems arose. The tilt beacon had not been turned on so as to conserve the unknown battery life, but when turned on, the tilt beacon, mounted in the lowermost corner of the base, was not functioning and appeared to be covered up with cuttings.

Given this new bit of information, the guide base was reentered, jayed-in, and lifted from the seafloor at 1230 hr on 29 June 1990. Hole 809E was terminated at this point and Hole 809F was begun.

HOLE 809F OPERATIONS

With the HRB lifted off bottom, the ship was offset 20 m to the west. During the move the signal from the tilt beacon returned, probably as a result of cuttings being washed from above. The HRB was landed once again on the seafloor at 1300 hr. Upon touchdown, the camera frame swung as if the pipe was bowing, a corner of the base became visible from beneath the cone funnel, and the tilt beacon changed repetition rate. All of these signs indicated that the guide base was sitting at an excessive angle. The base was picked up for the second time and the pipe was allowed to swing free for a few minutes. When the base was landed again, approximately 5 min later, all indications were that the base was at an acceptable attitude. When the pipe was un-jayed, the dogs could be seen freely sliding in the jay-slots, and the cone appeared vertical.

After the un-jaying operation was completed, 45 min was taken to maneuver around the guide base and attempt to determine its attitude. The northwest side appeared to be dipping 4°–5° to the west, and the northeast side appeared to be dipping 12° to the east. While we were viewing the northeast side, the north leg appeared to punch through a basalt pillow. The resultant dip changed from 12° to 9°–10°, still to the east.

After a round trip of the drill string, the pipe was run back to bottom with the DI-BHA. A TV reentry was made at 2215 hr on 29 June 1990, Hole 809F was spudded 5 min later, and the DI-BHA was drilled in and released by 2250 hr (Fig. 5). Thirty minutes was required to drill-in the assembly 5.9 m using the PDCM.

After pulling out of the cone, 15 min was taken to check the attitude of the cone. The dip angles were found to be the same as before drilling, and the drill string was then tripped back to the rig floor.

The tensioning sub/tapered stress joint assembly was made up (Fig. 6), and the drill string was run in the hole. The cone was reentered at 0815 hr on 30 June, the tension sub was then jayed in, and 35,000–40,000 lb tension was applied. Since this was the first attempt to put the drill pipe in tension, measurements were made to determine the final space-out of the DCS platform when hung in the derrick. This was done while running in the hole with the sinker-bar assembly to recover the center bit and latch assembly from the DI-BHA. Upon recovery of the center bit, the string was un-jayed from the guide base and the top drive was set back. Prior to pulling out of the hole with the drill pipe, the VIT frame was recovered and the drill line was cut and slipped. By 1230 hr the pipe was on deck and preparations for DCS drilling were begun.

Before picking up the DCS platform, several operations had to be performed. These included removing the iron roughneck "bigfoot" and dual-elevator handler from the drill floor, installing the platform dolly tracks on the rig floor, skidding the DCS platform over well center, and installing the guide dolly arms on the derrick guide rails.

Because this was the first time the platform was picked up, several other "first time" tests were run. The platform was picked up as far as possible until the traveling block was at the crown. No interferences were discovered although we found that tiebacks would have to be adjusted on the primary heave compensator hoses. Some secondary (safety) stops were fitted and welded onto the platform. The shock-cylinder relief valves were set, and the DCS standpipe hoses were installed. In addition, a DCS wireline winch test was conducted while the platform was over well center.

After completing all required preliminary DCS testing and installations, the platform was racked back to the starboard side, and preparations were made for tripping the DCS tubing string. With the drill pipe positioned above the seafloor, the 90 ft stands of 3 1/2 in. tubing were tripped into the hole. By 1530 hr the tubing was tripped down to the top of the stress joint and hung off at 1791 m. The tubing running tools and staging were then rigged down.

The DCS platform was rolled into place over well center and the guide-dolly roller assemblies were installed onto the derrick guide rails. The 500 ton links were attached between the heave compensator and the DCS mast. The platform was picked up in the derrick and the lower set of 500 ton links were pinned into the lower end of the mast. The DCS platform was raised high enough in the derrick to allow the Varco top drive to be picked up and attached to the links below the DCS platform (Fig. 7).

With the DCS platform positioned approximately 45 ft above the rig floor, the laborious, time-consuming strip-over operation was begun. By 1700 hr on 2 July 1990, the stage was set for the 21st reentry of the site.

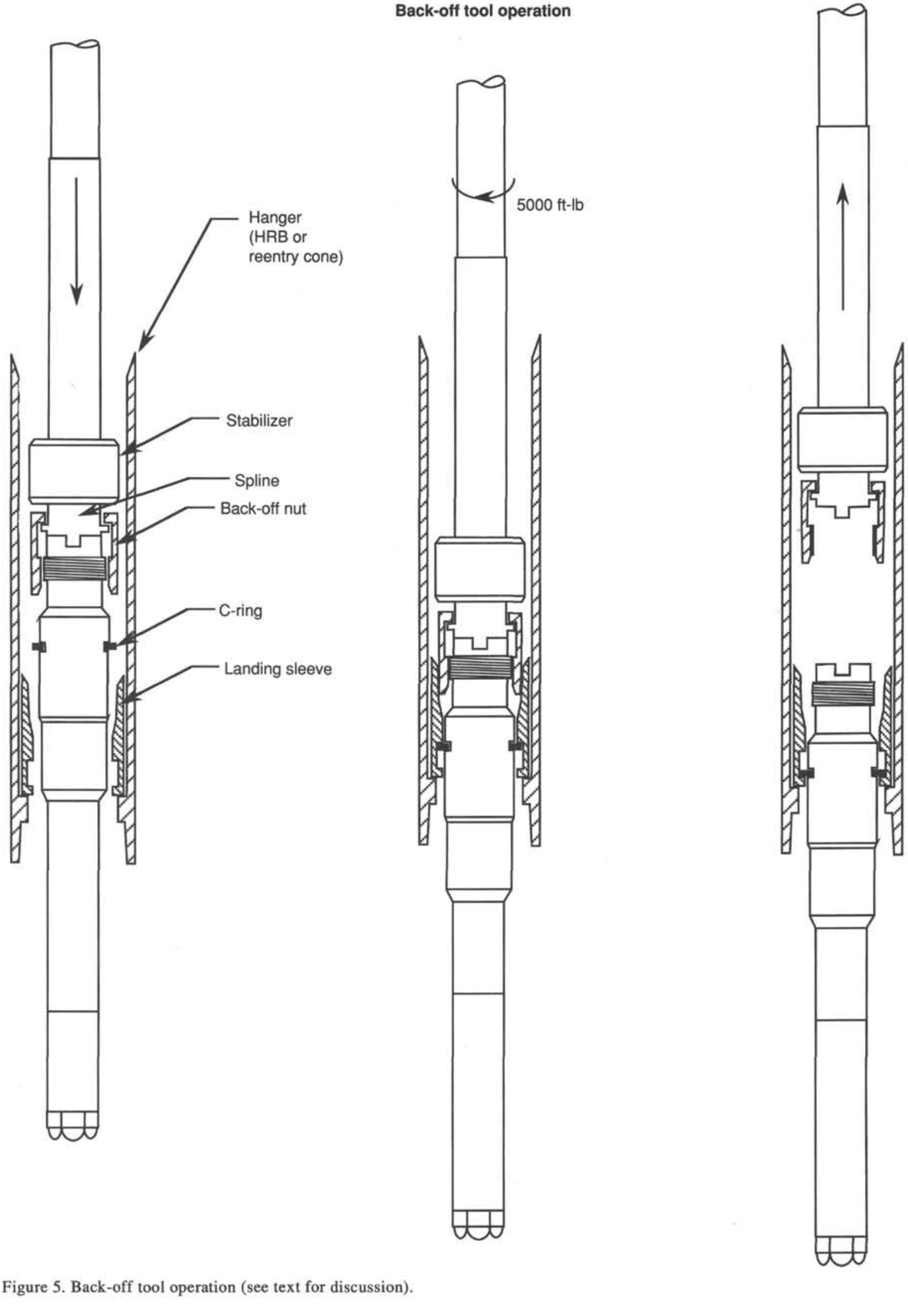


Figure 5. Back-off tool operation (see text for discussion).

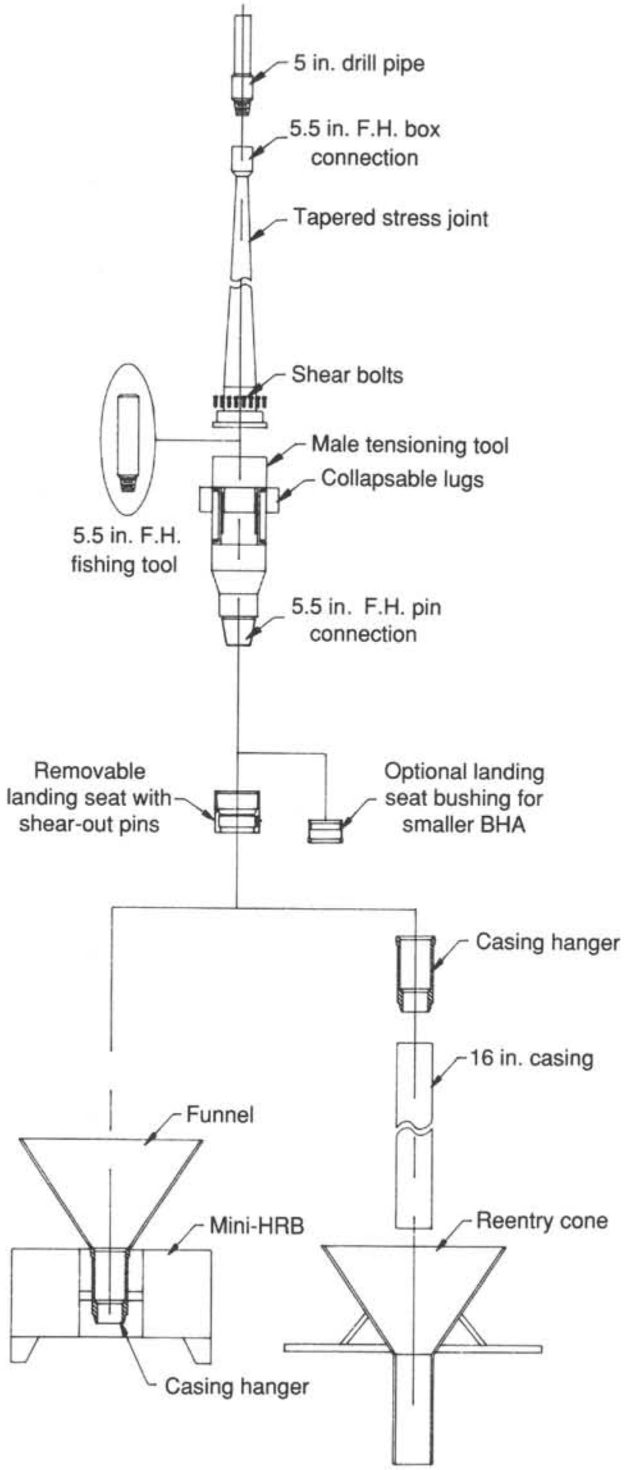


Figure 6. Seafloor hardware options (see text for discussion).

At 1715 hr the cone was reentered, the jay-tool attached, and 35,000 lb of tension was pulled on the tapered stress joint (Fig. 8). Prior to beginning continuous DCS platform operations, a safety meeting was held with all ODP and SEDCO/FOREX crew members involved to discuss emergency procedures to be followed in case a drive-off or platform fire should occur.

With all safety procedures in place, the DCS rig crew began conducting off-bottom tests of the secondary heave compensator. A leak in the DCS standpipe manifold was repaired, and pump tests were conducted with and without the DCS core barrel in place. These were done to establish baseline pressures at various flow rates to aid in deciphering potential core blocks or other downhole problems once coring was initiated. After adjusting the lebus-winch counterbalance weights on the DCS wireline winch and conducting a series of other compensator tests, the first attempts at coring began.

At 1930 hr on 6 July 1990 the formation was tagged with the DCS bit for the first coring attempt. A Longyear Series-2 impregnated bit (3.960 in. OD x 2.2 in. ID) was used for bit run 1. The 10 ft drilling joints were tripped to the bottom of the DI-BHA rathole at 5.9 mbsf using the secondary heave compensator to slowly feed the drilling assembly through the void between the bottom of the tensioning tool and the top of the back-off sub. No difficulty was encountered lowering the bit through this section. The 10 ft joints were advanced to the casing shoe and the secondary compensator was engaged. However, the computer repeatedly would instruct the bit to touch bottom, then retract it. An increase in pump pressure occurred, indicating a core jam. The core barrel was recovered and found to have 13 cm of vesicular basalt rubble in the barrel. Repeated indications of core jams were reflected by pump pressures. The second core barrel was pulled, but was empty. We suspected that the rubber core-block washers were in some way causing false indications of core jams so they were replaced with steel washers. (It was recognized that without the rubber washers it would be more difficult to see the core blocks.) The next core barrel run resulted in the recovery of 0.85 m of fractured basalt. Baravis polymer drilling fluid was circulated continuously during the coring cycle. Typical coring parameters were 20 gpm circulation, WOB from 1000 to 2000 lb, bit rotational speed from 80 to 100 rpm, and pump pressure from 80 to 280 psi.

After limited recovery on the first two coring runs, no additional core was recovered for the next four coring runs. It was initially thought that the core barrels were not latching in. The space-out on the inner tube was shortened by 0.625 in. in an attempt to correct the erratic pump pressures observed. During coring runs 3 through 6, pump pressures varied from 200 to 750 psi. Numerous center-bit runs were made to clear any obstruction that might be in the bit. The core barrel latch dogs, landing shoulder, and core catcher were painted prior to dropping the barrel. This gave a positive indication when the barrel seated properly. On coring run 6, difficulty was encountered latching onto the core barrel with the overshot. Apparently there was a significant amount of fill on top of the core barrel. Two wireline runs were made in an attempt to pull the core barrel. We decided to swab the pipe using a core barrel latch-head assembly in an attempt to clear the fill above the core barrel. The swabbing attempt worked and the core barrel was recovered. Coring operations were resumed and four more cores were recovered with recovery ranging from 0.2 to 2.0 m. Again pump pressures were very erratic. Coring parameters were as follows: flow rates varied from 20 to 70 gpm, bit rotational speeds ranged from 80 to 200 rpm, pump pressures ranged from 150 to 750 psi. The drilling rate fell off significantly during the last three coring runs for this bit. On the last run, Core 9Z, the bit advanced only 0.3 m in 45 min, whereas only 15–20 min was required to advance the bit 1–2 m earlier in the bit run. Core 9Z recovered 0.13 m of massive basalt. We decided to pull the bit at the end of that run since bit failure was suspected.

The first DCS bit arrived on deck at 2400 hr on 10 July. About 70% of the usable bit matrix was worn away, limiting the flow paths across the face of the bit. This explained the high pump pressures that occurred at the end of the bit run.

All core-barrel components were checked and space-out was reverified. A new impregnated bit was installed and the tubing

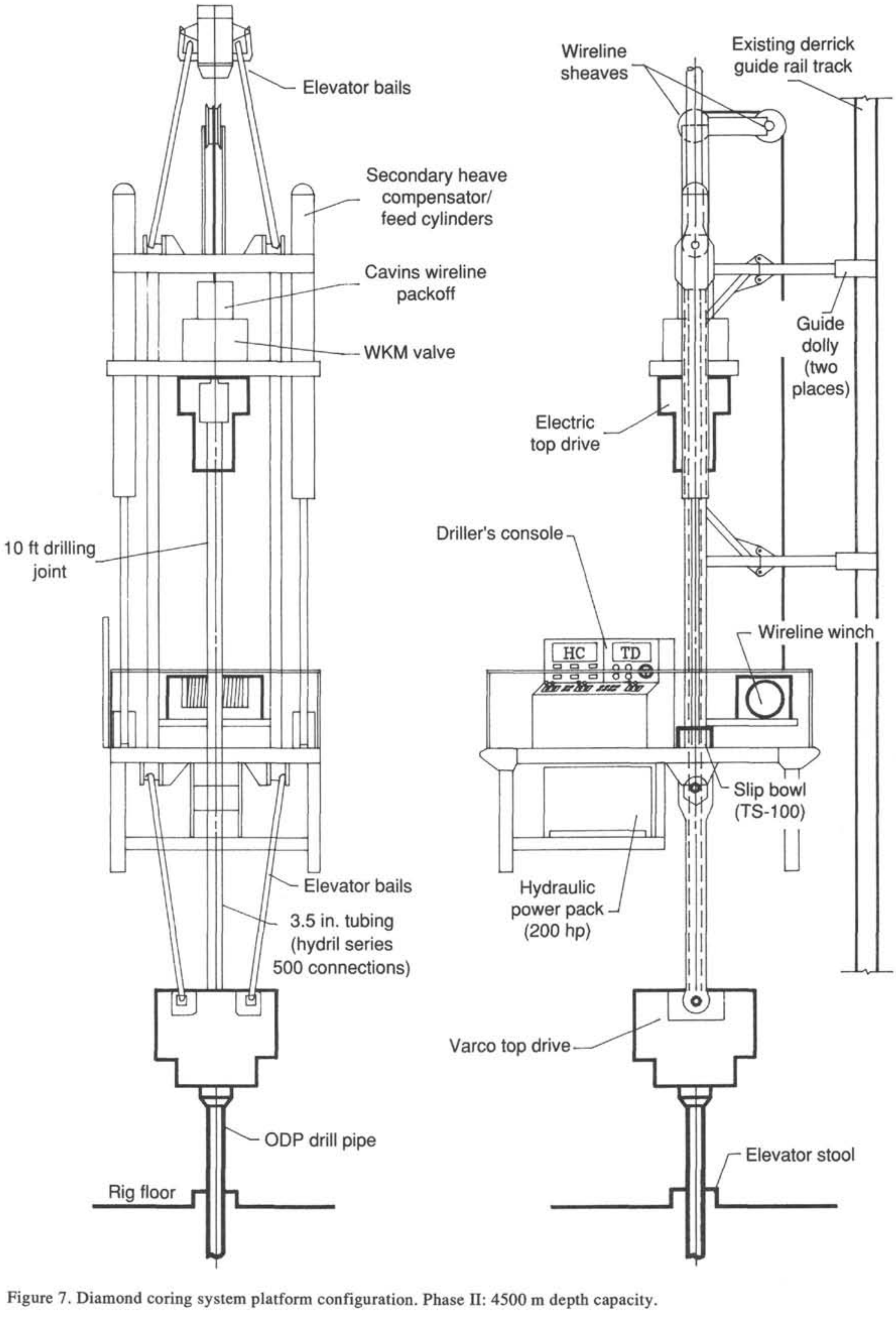


Figure 7. Diamond coring system platform configuration. Phase II: 4500 m depth capacity.

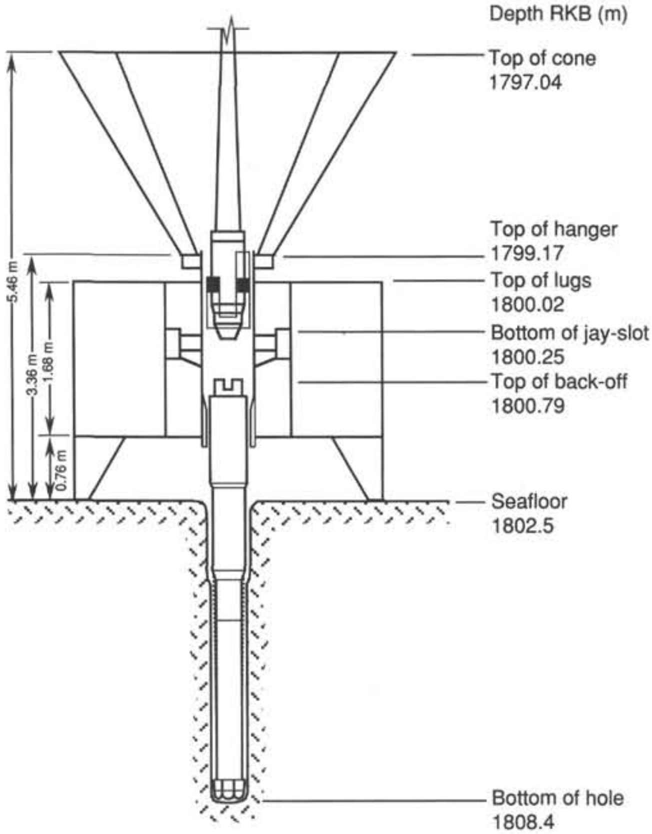


Figure 8. Seafloor stackup, Hole 809F (see text for discussion).

was tripped back in the hole. At 0500 hr on 11 July 1990, the tubing was down and the DCS platform was again ready to be picked up. At 1630 hr that same day the cone was reentered, the jay-tool was engaged, and tension of 35,000 lb was pulled.

After another round of mud-pump flow tests, heave-compensator tests, and trouble-shooting of the top-drive control system, DCS coring with the second bit was ready to begin.

The second bit run was made with a Longyear Series-2 impregnated bit identical to that used in the first bit run. There was nothing unusual about the wear noted on the first bit which would necessitate a change in the bit matrix or crown design. Once outside the casing shoe, the computer for the secondary heave compensator was used to lower the bit to bottom while rotating at 100 rpm. A center bit was in place for this operation. While rotating through the casing shoe and down to the bottom of the hole, up to 2000 ft-lb of torque occurred. The high torque was attributed to the absence of lubrication in the annulus between the tubing and drill pipe. This may have been accentuated by ocean currents of 1.5–2.0 kt bending the drill string. After pumping EP Mudlube mixed with Baravis polymer into the annulus, the high torque dissipated. When bottom was tagged, 3.0 m of fill was encountered. Once on bottom the center bit was retrieved and coring operations were resumed at 0600 hr on 12 July 1990. Nine consecutive cores were cut beginning with Core 10Z. Drilling parameters were as follows: WOB 500–2000 lb., flow rate 30–50 gpm, bit speed 100–300 rpm, and pump pressures from 100 to 300 psi. Core recovery ranged from 0.14 to 1.87 m of highly fractured and vesicular basalt in each 3 m core.

After advancing the hole 32 m beyond the casing shoe, core recovery suddenly dropped to zero. Apparently a zone of highly friable volcanic tuft and unconsolidated basalt breccia was encountered.

Beginning at 1630 hr on 13 July, intermittent DCS coring was resumed alternating with testing of the new secondary heave compensator. During this period, numerous attempts were made (including dropping the bit deplugger and center bit) to clear any possible obstruction that might have prevented the core barrels from latching. The thinking was that this might be the cause of the nil core recovery. Many variations of bit speed, flow rate, and weight on bit were also used, all to no avail. Some intervals were drilled ahead with a center bit, others drilled ahead with core barrels in place. At one point a push sampler was deployed; then a modified bit deplugger with a hole bored in the bottom was used. Several makeshift core catchers were tried, all with little or no success. The only common thread throughout this period was an extremely high penetration rate and indications of voids ranging in size from a few tens of centimeters up to nearly a meter. Penetration rates were so excessive that selected weight on bit could not be maintained even with controlled full DCS hydraulic power advancing the bit.

A drift profile of the hole at 60 mbsf was attempted, but the results were inconclusive because of a bubble in the angle unit. The best interpretation is that the hole deviated from the vertical by about 1.5°.

Finally, out of desperation, the flow rates were continually decreased on the last few cores in an attempt to recover the elusive material. Cores 29Z through 33Z were cut with minimal (10.0 gpm) to below minimum (6.0 gpm) flow rates as recommended by the bit manufacturer. All that was accomplished was that the penetration rate went to zero and the bit stopped drilling nearly entirely. The second-to-last core recovered a chunk of vesicular basalt jammed in the core catcher with impressions of the center-bit surface-set diamonds imbedded in it. The center bit had been run just prior to that core. The last core recovered a few pebbles of vesicular basalt. Apparently, the DCS bit had finally penetrated the friable volcanic breccia back into more massive vesicular basalt, just as the flow rates were cut back. Due to indications that the bit was plugged after Core 33Z, and a suspicion that bit failure had also occurred based on penetration rates, the bit run was ended. All coring operations were suspended at 2015 hr on 16 July.

Upon completion of coring operations, several attempts were made to run the caliper/gamma slimhole logging tool through the DCS bit. All attempts to get out of the bit were unsuccessful. Because of the obstruction in the pipe all but 37 stands of DCS tubing were then wet-tripped out of the hole. At that point the obstruction cleared itself, and the remainder of the trip was dry.

Examination of the bit, which arrived on deck at 0400 hr on 18 July, revealed that all of the diamond-impregnated matrix was gone. A piece of basalt 0.34 m long was found trapped inside the bit throat. It is not known at what point the bit actually failed. It is possible that it failed prior to passing through the unconsolidated zone as evidenced by the extremely long drilling times that were required to advance the bit for the last two cores. A total of 13.4 hr rotating time were logged during the bit run. It is also possible that coring the breccia zone may have prematurely eroded the matrix of the bit to the point that, when competent basalt formation was finally encountered near the bottom of the hole, the bit had little or no drilling life remaining. The mode of failure also may have been abrupt separation or loss of the bit crown due to drilling without adequate flow rate to clean and cool the bit matrix.

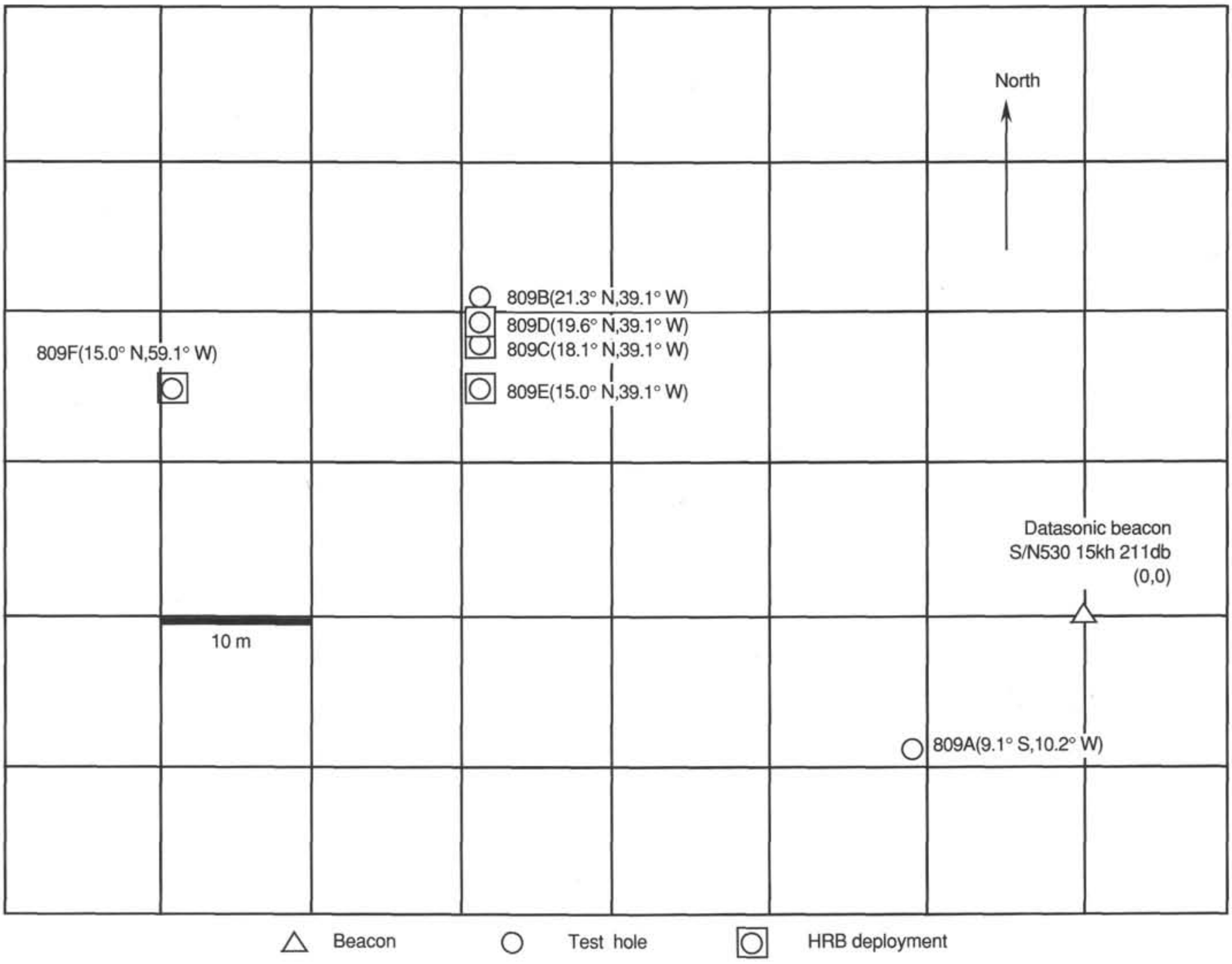
In all, 33 DCS cores were taken on Hole 809F. A total penetration of 79.2 m was achieved with 59.0 m cored, 11.13 m recovered, and 14.3 m drilled. All but 32 m of the hole was drilled through the elusive unrecoverable volcanic breccia.

Repeated attempts to break through the obstruction at the bit with the logging tool led to 75 m of kinked logging cable. This had to be removed and the seven-conductor logging line reheaded. Beginning at 0400 hr on 18 July 1990, several attempts were made to run the logging tool down the drill pipe string into open hole. However, a bridge was encountered at the top of the hole. Lowering the logging tool onto the bridge only succeeded in lowering it by a few meters, but no farther. With this, logging was abandoned at Hole 809F.

The third and final rendezvous of the leg occurred on July 15, 1990, when the *No. 21 Chitose Maru* returned to Site 809 for the second time. The vessel brought fresh fruit and vegetables to the SEDCO/BP 471 and received two disembarking passengers, Messrs McKinnon and Dominguez. Dr. McKinnon was returning to WESTECH having completed his work on the DCS secondary compensation system. Mr. Dominguez, a SEDCO oiler, was encouraged to leave by the ship's doctor due to the possible recurrence of a serious medical condition. There was no medical emergency at the time.

After pulling out of the hole with the tensioning sub and tapered stress joint, the drill collars racked in the derrick were laid out, and the upper guide horn was installed. By 1845 hr on 18 July 1990, the DCS platform had been set back, and the vessel got underway for Site ENG-6, ending operations at Hole 809F (Fig. 9).

Throughout both DCS bit runs, hole stability was not a problem. Very little fill was encountered, and the DCS tubing string was never subject to excessive torque or pipe sticking. As mentioned above, when drilling with the 11-5/8 in. drilling assembly in Holes 809A and 809B, both hole sloughing and stuck pipe occurred within 9 m penetration below the seafloor. During Legs



Position of holes

809A: 31° 3.439′ N 139° 52.721′ E
809B: 31° 3.48′ N 139° 52.66′ E
809C: 31° 3.50′ N 139° 52.63′ E
809D: 31° 3.49′ N 139° 52.67′ E
809E: 31° 3.41′ N 139° 52.64′ E
809E: 31° 3.50′ N 139° 52.64′ E

Figure 9. Site 809, relative positions of holes. Holes all located with GPS.

106 and 109, we found that, when drilling fractured basalt formations, a smaller hole size enhances hole stability. If reducing the hole size from 14-3/4 in. to 9-7/8 in. enhances hole stability, a further reduction from 9-7/8 in. diameter to 4 in. might create hole conditions that would allow significant penetration into fractured basalt. This premise was borne out by the results of drilling with the diamond coring system at Site 809.

SITE 809 TO SITE 810 (ENG-6, SHATSKY RISE)

The transit to ENG-6, Shatsky Rise, was uneventful. The vessel made good time averaging 11.7 kt for the 889 nmi distance prior to slowing down for surveying. An additional 64 nmi were steamed over an altered course so as to pass over DSDP Sites 306 and 305. The chert layer to be cored was picked up on seismic reflections and traced to the prospectus coordinates for Site 810. Unfortunately, as the vessel passed over location, the target reflector was over 200 mbsf. The chief scientist elected to continue on course and the reflector eventually pinched out to a depth of about 115 mbsf. This depth closely approximated that originally sought after and was deemed achievable in the remaining time. The beacon was dropped at 0600 hr on 22 July 1990, establishing Site 810 on the Shatsky Rise.

APPROACH TO SITE 810

The Shatsky Rise Site ENG-6 (810) was approached on 21 July 1990 beginning seismic coverage just prior to passing over DSDP Site 306 on the south side of the Rise. The course was then changed so as to pass over Site 305, tracing basement and chert horizons beneath a pelagic sediment cap thickening to the north. An earlier profile record was paralleled on this course which showed that the pelagic cap first thickens and then thins to a point where the upper "chert reflector" can be reached with only 150 m of drilling.

GPS navigation indicated that the desired track was being closely adhered to, however, when actually passing over the preliminary target (ENG-6), the pelagic cap proved to be considerably thicker than anticipated (about 250 m).

The decision was made to continue north on the anticipation that the pelagic cap would thin still more, following an uppermost "chert reflector" using the 3.5 kHz echo sounder until the overlying sediments were thinner. This occurred beneath a flat area between possible channel structures in the pelagic cap. Here, the beacon was dropped establishing Site 810 at 0600 hr on 22 July 1990. Based on the 3.5 kHz record, the top of the "chert" was estimated to be between 115 and 125 mbsf.

SITE 810 OPERATIONS

Prior to setting a modified reentry cone (Fig. 10) at Site 810, three holes were spudded. One (Hole 810A) was to recover a mud-line piston core for an ongoing ODP geriatric core study. The second (Hole 810B) was a jet-in test to provide information required for washing in the 16 in. diameter casing (conductor pipe) to be attached to the bottom of the reentry cone. A third hole was cored using the ODP Advanced Piston Corer (APC) and Extended Core Barrel (XCB) coring systems. This hole was necessary to locate the uppermost chert horizon in the section, and also to provide physical properties data on the calcareous ooze overlying the chert. These data were to be used in accessing what magnitude of skin friction could be expected against the casing and DI-BHA assemblies. This in turn would help to determine what degree of tensioning could ultimately be used with the tensioning jay-tool and tapered stress joint assemblies.

HOLE 810A

Hole 810A was spudded at 1400 hr with the APC coring assembly. When recovered, the core barrel was filled with 9.74 m of calcareous ooze, with oxidized mud-line sediment at the top. Since this core was to be donated to the ODP geriatric core study, the hole was not respudded for a more accurate mud-line measurement. The bit cleared the mud line at 1415 hr ending Hole 810A.

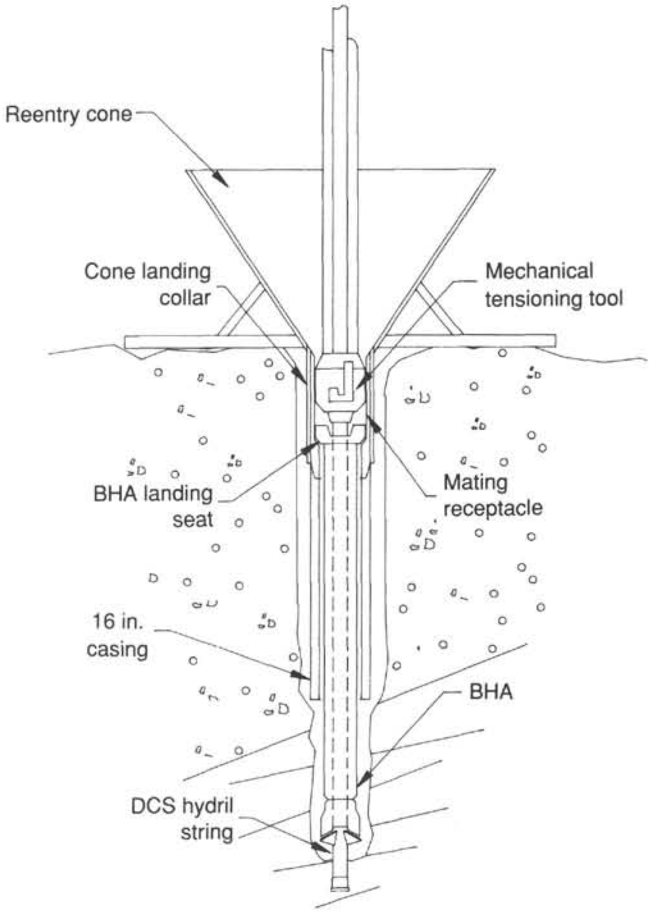


Figure 10. Reentry cone with casing for sediment overlying hard rock using backed-off BHA for upper hole stabilization.

HOLE 810B

Hole 810B was a simple jet-in test to verify that an adequate amount of 16 in. casing could be washed in for tensioning the modified reentry cone. The jet-in test was done prior to piston coring the section because of the potential risk in contacting a chert horizon with the APC. Such an impact might bend a core barrel, necessitating a pipe round-trip. A few minutes were taken to monitor pump pressure vs. flow rate prior to initiating the jetting procedure. An XCB core barrel with a center bit was dropped and at 1545 hr on 22 July 1990, Hole 810B was spudded. For jetting purposes the mud line was assumed to be at approximately 2633 m from the dual-elevator stool (DES) at the rig floor. The bit was washed to 2693 m or 60 mbsf at gradually increasing flow rates from 20 to 77 SPM. No rotation was used but up to 10,000 lb WOB was ultimately required. Hole 810B was terminated at 1645 hr on 22 July 1990 when the bit cleared the mud line.

HOLE 810C

Hole 810C was spudded at 1800 hr on 22 July 1990 using the APC. The intentions were to core with the APC and/or XCB, as required, down to the chert reflector in the section. Knowing the exact location of the chert horizon would help to expedite the DCS cored interval by allowing accurate placement of the DI-BHA bit. Some overlap with APC/XCB cores would also be beneficial in interpreting the effectiveness of the DCS. Thirdly, knowing what the formation properties were like prior to coring with the DCS would help in bit selection and refinement of coring parameters such as weight-on-bit, bit rotational speed, flow rate, rate of penetration (for controlled feed rate operations), etc.

After spudding, the recovery in Core 1H was used to establish an accurate mud line at 2634.1 m. The section was cored from that point down to 2761.2 m or 127.1 mbsf with the APC. The last piston core, 15H, did not bleed off indicating incomplete stroke. The barrel was pulled from the sediment using the sand line with no sign of overpull which had been running up to 10,000 lb on previous cores. Upon recovery, the APC shoe was found to be severely damaged on one side. This was firm evidence that the barrel had contacted a chert horizon. Although recovery was a respectable 9.88 m, we felt that the barrel most likely did not actually penetrate that far. That belief was later supported by the scientific party which verified that the majority of the core was highly disturbed flow-in material.

Core 16X was cut using the XCB system with a polycrystalline diamond compact (PDC) cutting shoe. While washing down the rathole from the previous APC core, a hard surface was encountered after 1.1 m. It was assumed that this was indeed the chert layer and that the APC barrel probably had not penetrated beyond that point. Coring on XCB Core 16X continued from that point down an additional 9.0 m where we stopped coring. Total depth achieved was 2770.2 m or 136.1 mbsf. Recovery, thanks to a flawlessly performing piston corer system, was 105.7% for the entire calcareous ooze section. The last core cut, using the XCB, recovered 2.92 m of milky white calcareous ooze with some fragmental chert. This core required 40 min of rotating time to cut and at times required up to 18,000 lb WOB. Hole 810C was officially terminated at 1200 hr on 23 July when the bit arrived on deck.

HOLE 810D

The first order of business for Hole 810D was to prepare the modified reentry cone for deployment. Modifications to the cone included the addition of cuttings diverter pipes and a special cone transition/casing hanger for compatibility with the DI-BHA hardware.

The reentry cone, which had been pre-assembled as much as possible, was moved into position over the moon-pool doors. A total of 48.79 m of 16 in., 75 lb per ft, casing was made-up. That would allow 52 m of casing to be emplaced into the seabed, approximately 10 m less than what was verified as jet-able at Hole 810B. The lower end was terminated with a "Texas" weld-on casing shoe. The 16 in. casing hanger was made-up and tightened to 7500 ft-lb of torque. The joint was then tack-welded in four places at 90°. Some difficulty was encountered in landing the casing hanger inside the throat of the reentry cone, and the problem was believed to be caused by some welded-on dogs at the base of the hanger. These dogs were meant to engage slots in the cone and provide torsional resistance during the un-jaying operation. After several hours of raising, lowering, and rotating the casing attempting to align the slots, we decided that some misalignment of the dogs must be preventing the hanger from landing properly. Since they were judged unnecessary given the weight of the structure and the sticky nature of the sediments, the dogs were torch-cut off. After this operation was completed, the hanger was lowered back into the cone and again it would not seat properly. There was continual binding during this process between the casing hanger and the cone transition pipe. The C-ring did not engage so the hanger was picked-up, rotated, and relanded several times in an attempt to get it all the way down on the landing shoulder. After one such landing attempt, a splash was heard. When the hanger was retrieved, the casing was missing. The casing box thread appeared to be machined correctly, and there was no visible sign of damage. Grease marks clearly indicated that adequate thread make-up had been achieved. The only answer to the mystery at this time is that the tack welds broke, allowing the casing to rotate and unscrew during the repeated attempts to seat the casing hanger.

While a new casing-string space-out was underway, attention was turned to the problem of why the hanger was not seating properly. The C-ring was removed to eliminate it as a source of the problem. Subsequent to removal of the C-ring, the hanger was lowered into the cone transition and a loud report was heard as the hanger dropped down slightly. The hanger appeared to be correctly shouldered and now in proper position. When picked-up, however, the cone was firmly attached to the hanger, even though no C-ring was installed. Several hours were spent welding the cone and support beams down to the moon-pool doors so a good pull could be made to try and unseat the hanger. All efforts proved futile, however, and the exercise was abandoned at 0300 hr on 24 July 1990. It was surmised at that time that welds on the outer diameter of the casing hanger body coupled with welds or eccentricity in the bore of the cone transition-pipe were responsible for the problem. Since time was critical at this stage, we decided to weld the casing hanger into the cone throat, load up the cone base with as many drums of pig-iron ingots as possible (14 eventually were loaded), and run the cone in the hole without casing. We felt the cone/ingot weight (35,000 lb in water) plus the weight of a 115 m long DI-BHA (45,000 lb in water) would be enough tension against which to manipulate the drill string. Without any skin friction factor applied to the BHA a safety factor of 2:1 was achievable.

The modified, ingot-laden, and casing-less reentry cone was deployed and landed on the seafloor at 1300 hr on 24 July 1990 (Fig. 11), officially spudding Hole 810D. The cone was released

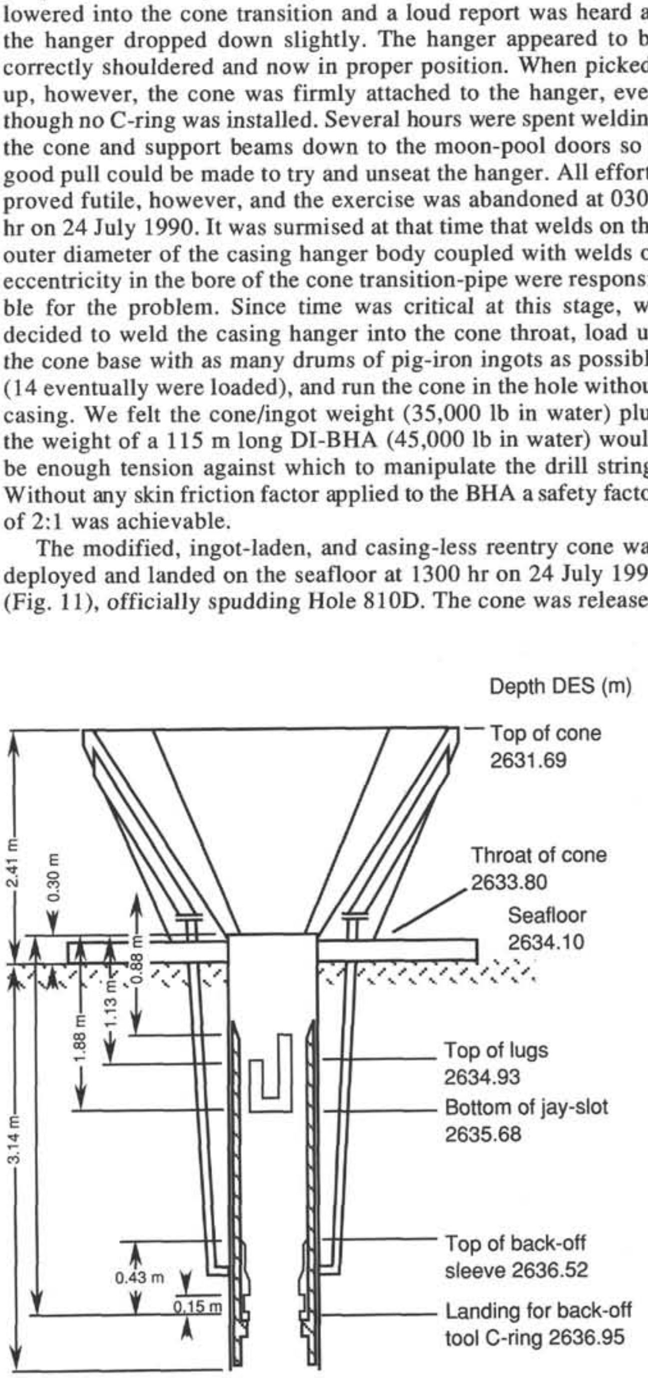


Figure 11. Seafloor stackup, Hole 810D (see text for discussion).

from the jay-tool and the drill string was then tripped back to the rig floor.

A DI-BHA was made-up with a 9-7/8 in. DCS-H87F bit, a stabilized bit sub, latched-in center bit, 11-5/8 in. back-off sub assembly, and four stands of 8-1/4 in. drill collars and run in the hole.

In less than 1 hr the vessel was maneuvered over the cone and reentry achieved. The stage was now set for drilling-in and releasing the BHA.

After a straightforward washing operation the BHA apparently landed but no evidence of successful back-off was indicated. It appeared that although seated, the two back-off tapers were not contacting each other. Since a C-ring was deployed this time and was not used on the earlier successful back-off sub deployments on Site 809, it was considered a suspect in preventing proper shoulder contact. Additional weight was applied, up to 25,000 lb, to attempt forcing the C-ring down into the landing seat bore but this only resulted in causing the PDCM to stall out. The locking balls, described in "Site 809" chapter, "Operations" section (this volume), were dropped, locking the mud motor. A top-drive torque of up to 20,000 ft-lb was applied, but still no success was achieved at backing-off the nut. We decided at that point to trip the drill string and inspect the downhole hardware. During the trip a spare C-ring was modified with a small bevel to eliminate the square edge which must pass into the landing sleeve bore. This was done to save ship's time when all hardware was recovered on deck, on the presumption that the C-ring was causing the downhole problem.

At 1630 hr on 25 July 1990, the back-off hardware was recovered on deck. The C-ring was found to be properly latched into the groove in the landing seat, as designed. However, the shear pins in the landing seat had sheared when the BHA was retrieved because the back-off nut had not released. The keys welded into the casing hanger to prevent rotation of the landing seat had also sheared, allowing the entire landing seat to spin, thus not letting the back-off nut unscrew.

Because the hole was pre-drilled at this point it was elected to break the make-up torque on the back-off nut and run in the hole with an un-torqued assembly. The nut broke out on deck as designed at around 5,000–6,000 ft-lb of torque and was unscrewed three-fourths of a turn to ensure that the threads were not damaged. No problems were anticipated with the "loose" assembly since no rotation would be required to get back to the bottom of the hole.

To allow transmission of torque for unscrewing the back-off nut, the landing sleeve had to be modified. The SEDCO welder put beads of hard-facing on the outside diameter of the sleeve and on the bottom of the landing shoulder. It was felt that this would jam the sleeve into its landing spot tightly enough to allow unscrewing the un-torqued back-off nut. This modified DI-BHA assembly was deployed and reentered into the cone at 0100 hr on 26 July 1990.

After landing the assembly, all attempts at back-off were again fruitless. All variations of low and high weight (2,000–40,000 lb), low and high rotational speed (35–100 rpm) were tried, all in vain. Several times the pipe become stuck in the process allowing rotation to take place but not allowing the pipe to be picked up.

Ultimately, after having the pipe stuck for over an hour, the assembly was freed and it was decided again to recover the drill string and inspect the hardware. At 1200 hr on 26 July 1990, the back-off assembly was once again at the rig floor. Inspection of the hardware indicated that the C-ring had again latched properly into its groove. The hard-facing on the landing seat had done its job and allowed the back-off nut to fully unscrew. The only thing holding the 45,000 lb BHA was fusion or jamming between the two tapers on the landing sleeve and back-off nut. Except for this problem, the system had worked as designed. There was no apparent reason for the pipe-sticking problem, although later we believed this to be the result of the landing sleeve flaring due to excessive heat and load being applied to the taper. Eventually the outside diameter wore down allowing retrieval from the casing hanger.

Operations at Site 810 were further hampered on this date by a Japanese tuna boat. Buoys supporting fishing lines from this boat were seen off both starboard and port sides aft. The buoys were not drifting free but were obviously fouled on something beneath the ship. We feared that line would get sucked into or fouled on the thruster pods or hydrophones. The captain systematically had these structures raised one at a time. The buoys and attached line ultimately became freed when the BHA was recovered aboard ship.

The third DI-BHA run in the hole had a new landing sleeve, with appropriate hard-facing build-up, and the new beveled C-ring. This was done to conserve rapidly-diminishing operating time and save the time it would take to rebuild the other assembly. The beveled C-ring was not anticipated to be a problem because this time the BHA was to be drilled down to just above the top of the chert reflector, thus supporting the BHA if it should release from the reentry cone. Since some amount of new hole was to be drilled this time the back-off nut was left torqued.

The DI-BHA was made up once again, this time with an additional 13.7 m added to space the casing shoe (DI-BHA bit) to within 0.8 m of the chert layer. Reentry was made at 2145 hr on 27 July 1990.

As the back-off assembly landed, a momentary jump in rotary torque to 18,000 ft-lb was witnessed, followed by a drop in torque below normal and a subsequent loss of 50,000 lb of BHA weight. The pipe at the rig floor also over-spun as the torque was released. All of these events indicated that the BHA had released this time as designed.

Before tripping the drill string it was decided to recover the center bit, thus saving a reentry operation prior to tripping the DCS tubing string. Initial attempts at getting the sinker bar assembly to bottom were to no avail, however, and it was feared that the BHA had parted or backed-off about 25 m below the casing shoe. Eventually the tools were worked to bottom but did not recover the center bit. Upon recovery, the overshot was found to be heavily damaged, providing further evidence of a downhole problem. The drill string was then tripped out of the hole.

On deck, the back-off nut was again discovered to be fused or wedged into the landing sleeve. The nut had indeed backed-off as designed. However, the BHA had fallen out the bottom of the casing hanger when the beveled C-ring failed to shoulder properly in the landing groove. This particular landing sleeve had been modified during operations at Site 809 to open up the clearance through the inside diameter. This was done when it appeared that the tight, 1/8 in. clearance was causing the DI-BHA assembly to bind up while being drilled in. As a result, the BHA fell 25 m into the formation when released from the back-off assembly, the anticipated multiple chert layers doing little or nothing to impede the fall. Damage to the overshot was obviously the result of setting down on the splined top of the DI-BHA lower back-off assembly.

It was now too late to continue with operations for ultimate DCS deployment, but a back-up site, conventionally cored, could still be drilled. First, additional drill collars were brought up from the riser hold for the contingency site. Then all efforts turned to laying out the DCS tubing string and storing it on top of the riser hold hatch, before the weather, which was threatening, became too rough to handle the joints safely.

Ultimately, because of the approach of Typhoon Steve, and the time required both to lay out and stack all of the DCS tubing, and then rig down all heavy DCS hardware (requiring crane operations), the contingency site was canceled, and it was decided to spend the remaining time attempting to recover the BHA and 12 drill collars left in Hole 810D.

A pilot modification to the 5-1/2 in. FH DI-BHA fishing tool was made, and at 1315 hr on 28 July 1990, the entire remaining DI-BHA was successfully recovered from the hole. By 1420 hr on 29 July, all collars had been laid down, and the ship got underway. Since, this was still early for departure to Guam, even with deteriorating weather, a short box survey of the Shatsky Rise area was conducted (Table 2).

SHATSKY RISE SEISMIC SURVEY

Once underway, the vessel steamed south at 4 kt, streamed gear, and turned back over Site 810, increasing speed to 6.5 kt. At this speed, a seismic survey of the region was carried out around a fairly substantial seamount exposing basement at its summit, a few kilometers north of Site 810. The seamount was crossed on a west-to-east course, then turning first south, and then southwest, to link back to Site 810. Shatsky Rise was departed on a course of 210°, steaming at 6.5 kt to obtain a line over the tapering sediment prism on the southwest side of Shatsky Rise, to a depth of 3400 m. It was intended to carry this line somewhat further to the southwest, but rapidly deteriorating weather conditions persuaded the captain that the area should be left with all possible speed.

SITE 810 TO GUAM

Our transit to Guam started out with a rather exciting night on 31 July 1990, when tropical cyclone Steve made its closest point of approach. The storm eventually passed harmlessly to the northwest of us leaving us with 50 kt winds and 25 ft seas. The remainder of the transit was uneventful. Arrival at the pilot station in Guam was slightly ahead of schedule, and Leg 132 officially ended at 1900 hr on 4 August 1990, with the first line on the dock at Victor pier 6.

LEG 132 DEVELOPMENT ENGINEERING

The following are summaries of the various engineering design reports relating to the development and operational testing of the DCS. When completed these reports will be available upon request from ODP.

DIAMOND CORING SYSTEM—PHASE II (4500 M)

Leg 132 deployment and use of the DCS platform/mast assembly was a resounding success. This was due to the tremendous and diligent efforts of all parties concerned both before and during Leg 132. Although some limited equipment problems were experienced, the problems were solved and the system was made fully operational before the end of the first coring site. Equipment reliability was very good, and the improvements made to the system as a result of previous experience on Leg 124E proved to be useful and effective in accomplishing the goal of coring fractured basalt.

The new electric top drive and SCR controls worked as designed and proved the concept of using an electric motor for high-speed mining style coring. The capability to make and break connections with the top drive greatly improved efficiency. The closed-loop method of motor speed control worked flawlessly. These two aspects of electric top drive control are unique to the DCS coring system, and their successful first-time-ever use during Leg 132 sets a new standard for top drive controls with potential application to drilling units worldwide. Top drive operation at both low and high speeds and torques was smooth at all times. Application of the same control techniques for low-speed control of the mud pumps was successful and allowed smooth operation of the large 1600 HP rig pumps at speeds as low as 3 SPM (3 SPM = 6 gpm!).

The main hydraulic power system and controls worked quite well, as did all auxiliary systems. There is room for improvement in areas such as feed cylinder rod seals, wireline winch control, and the low pressure return filter systems, and these areas will be improved upon at the first opportunity.

Leg 132 was blessed with good weather. For this reason, DCS operations were never hampered by excessive heave motion. It should be noted that the DCS operating window is limited in this regard, and it was chance that operations were never curtailed by the environment. Any future plans for DCS legs must take into account the possibility of bad weather. The operating limits are considerably more restrictive than normal coring operations due to the location of the platform, which results in amplified roll and pitch motions. The heave motion limit is defined as a limit of primary heave compensator rod travel for safe operations, approximately 15 ft double amplitude. If roll and pitch motions hamper safe operations on the platform, operations may have to be terminated before the 15 ft limit is reached.

Heave compensation and controls, although off to a shaky start, eventually were operational, and this system provided effective secondary compensation. A problem with servo velocity signal quality was resolved by taking a completely different approach to acceleration measurement. Control electronics were reliable and the extra steps taken to protect the electronics from the environment were successful. WOB control was good and

Table 2. Site summary report, Leg 132.

Hole	Latitude (N)	Lontitude (E)	Seafloor depth (m)	Number of cores	Interval cored (m)	Core recovered (m)	Core recovered (%)	Interval drilled (m)	Total penetration (m)	Time (hr)
809A	31°03.44′	139°52.72′	1819.7	0	0.0	0.0	0.0	8.3	8.3	30.25
809B	31°03.48′	139°52.66′	1799.6	0	0.0	0.0	0.0	13.4	13.4	21.00
809C	31°03.50′	139°52.63′	1801.5	0	0.0	0.0	0.0	4.1	4.1	209.75
809D	31°03.49′	139°52.67′	1802.0	0	0.0	0.0	0.0	6.3	6.3	82.75
809E	31°03.51′	139°52.64′	1803.0	0	0.0	0.0	0.0	8.0	8.0	33.25
809F	31°03.50′	139°52.64′	1802.5	33	59.0	11.1	18.8	20.2	79.2	471.00
Site totals:				33	59.0	11.1	18.8	60.3	119.3	848.00
810A	32°25.37′	157°50.74′	2633.0	1	9.5	9.8	103.2	0.0	9.5	8.25
810B	32°25.37′	157°50.75′	2633.0	0	0.0	0.0	0.0	60.0	60.0	2.50
810C	32°25.40′	157°50.74′	2634.1	16	136.1	143.8	105.7	0.0	136.1	19.25
810D	32°25.36′	157°50.73′	2634.1	0	0.0	0.0	0.0	0.0	0.0	146.50
Site totals:				17	145.6	153.6	105.5	60.0	205.6	176.50
808E	32°21.09′	134°56.60′	4682.4	0	0.0	0.0	0.0	0.0	0.0	56.00
Site totals:				0	0.0	0.0	0.0	0.0	0.0	56.00
Leg totals:				50	204.6	164.7	80.5	120.3	324.9	1080.50

allowed coring with measured WOB variations of ± 200–500 lb. Feed rate control mode was tested and worked quite well. A load cell accuracy problem will have to be solved so that load measurement can be corrected.

The new heavy duty hydraulic wireline winch and 3/8 in. sandline system made the retrieval of cores and downhole tools easy, efficient, and safe. The addition of two types of brakes (hydraulic fail-safe and disc-type) assured that total braking control of the wireline was possible in all situations. Slow speed control of the winch was poor, but this was quickly solved by adding another hydraulic control valve to the console. A permanent solution will require changing the joy-stick control to an alternate type.

Throughout the construction, deployment, and use of the DCS, special effort was devoted to maximizing the safety of the equipment and the operation. No system was ignored in the continual search for ways to improve safety. There were no injuries during the course of drilling. However, the main hazard remains that the platform is located 45 ft above the rig floor, and personnel must work while standing on a work platform attached to the primary heave compensator; this must be changed. Now that the DCS system is proved, efforts should be redirected to finding an alternative approach, the crux of which will be to eliminate the work platform in the derrick along with the associated hazards and inefficiencies.

Leg 124E was the first attempt ever at applying mining-style coring and drilling techniques to the offshore environment on a floating rig. The lessons learned during this first attempt laid the groundwork for optimizing and fine-tuning the drilling, coring, and handling equipment necessary to meet the challenges of coring in lithologies where rotary methods had repeatedly failed. ODP, SEDCO/FOREX, and a host of companies met this challenge and succeeded in building and proving the diamond coring system on Leg 132.

DCS—Seafloor Hardware

Engineering Leg 132 was used to test out and further refine the DCS seafloor spudding equipment and drilling hardware. Information learned from Leg 124E with the prototype DCS revealed that it was imperative to establish a seabed platform from which to begin coring operations. Therefore, a complete and separate set of equipment was designed for the seafloor to complement the vessel-mounted drilling hardware. Two types of seafloor templates or structures were designed for operations on both hard rock and soft sediments. Knowledge from past legs where hard-rock spudding was performed was combined with requirements from the DCS in order to develop a new HRB. This new mini-HRB was much smaller than those used in the past primarily due to a different design philosophy used in establishing the hole. Previous attempts used a more conventional oilfield approach of drilling a larger hole and setting surface casing strings, whereas a drill-in type BHA was used on Leg 132. The DI-BHA was implanted into the formation and then left through the use of a back-off sub specially developed for hard rock and DCS operations. This required only one trip for the BHA to be drilled in and backed-off, whereas conventional practice required possibly several trips before establishing the hole. This concept eliminated any redrilling or reaming of the hole that might be necessary due to instability of the formation or the size of the hole that had to be drilled in order to set 16 in. diameter or larger casing.

The other type of seafloor template deployed with the DCS was a modified reentry cone. Modifications to the standard ODP reentry cone included the addition of discharge tubes to divert the cuttings and a specially designed casing hanger compatible with the drill-in BHA. This reentry cone concept was designed for locations where a considerable amount of soft sediments overlie the formation of interest. Components of each type seafloor structure were fabricated using as much existing ODP hardware as possible.

The concept of using the conventional ODP drill string as a mini-riser also was incorporated into the DCS seafloor hardware. Although circulation was not attempted, the drill string was held in tension throughout the drilling process. This was accomplished with a specially designed tensioning tool fashioned after the double-jay running tool. The tensioning tool utilized the same jay-slots that were used to lower the mini-HRB and reentry cone to the seafloor. Connected to the tensioning tool was a tapered stress joint which provided a smooth transition from the mini-riser to the seafloor structure.

A considerable amount of information was learned pertaining to the strengths and weaknesses of both systems along with the individual hardware components deployed with them. It was further demonstrated that the HRB could be redeployed and repositioned on the seafloor for performing multiple holes. The back-off sub concept was valid but required additional testing of the mating receptacle tapers, and it was learned that retractable lugs on the tensioning tool were most likely underdesigned for the torsional loading conditions that it was subjected to. The majority of the engineering objectives were accomplished, however, not without some redesign of equipment which failed. It was demonstrated, however, that all of the concepts tested for establishing and maintaining holes in bare fractured rock or soft sediment were valid and suitable for continued refinement.

Much of the whole deployment scheme required or depended upon progressive success of each seafloor component in order for coring to be initiated with the DCS. Many of the problems encountered on Leg 132 were a direct result of either inadequate floatation for the cone on the HRB or poor welding practice. The inadequate welding on the casing hanger used in the reentry cone resulted in shearing both the restraints for holding the landing seat from turning when attempting to unscrew the back-off sub.

DCS—Roller Cone Bits And Associated Hardware

Design changes were made to conventional ODP rotary core barrel bits to allow deployment with the DCS. Two significant changes were made to the bits so that a latch in center bit could be run. These included: (1) enlarging the throat diameter and (2) removing the core guide while still maintaining the same size roller cones. The center bit was a completely new design using two small TCI cones. The position within the primary bit was adjustable so that the center bit could be run ahead of or behind the larger cones. This was accomplished by placing spacers between the latch and the center bit. The center bit was held in place by a modified XCB latch which allowed recovery via a wire line.

The bits held up remarkably well for the fractured basalt encountered at the Bonin back-arc location (Table 3). Though not as hard and abrasive as some locations investigated on previous hard rock legs, it still produced a challenge for the bits to penetrate and endure. All the holes were spudded with a PDCM. Several holes had the additional benefit of being confined within the diameter of a casing hanger and run in conjunction with spiral bladed stabilizers. There was no excessive wear or damage reported to any of the larger bits. Several of the bits were rerun at the same location. One washout occurred on a center bit after 21 hr of rotation. Overall the bit performance and quality was rated extremely high.

DCS—Modified Core Barrel System

A modified coring system was developed for use with the DCS drilling equipment. This system integrated both mining and oilfield technology to produce a coring system that would withstand

Table 3. Bit summary report, Leg 132.

Hole	Manufacturer	Size (in.)	Type	Serial number	Depth cored (m)	Depth drilled (m)	Total penetration (m)	Cumulative total meters (m)	Time on this hole (hr)	Total time (m)	Conditions[a]	Remarks
809A	Security	11-5/8	M84F	489656		8.3	8.3	8.3	7.0	7.0	O,0,NO,A,E,I	#14 jets (4)
809A	Security	4	H100F	489713		8.3	8.3	8.3	7.0	7.0	O,0,NO,A,E,I	7/16 jets (2)
809B	Security	9-7/8	M84F	489668		13.4	13.4	13.4	9.0	9.0	O,0,NO,A,E,I	#14 jets (4)
809B	Security	4	H100F	489712		13.4	13.4	13.4	9.0	9.0	O,0,NO,A,E,I	7/16 jets (2)
809C	Security	11-5/8	M84F	489657		4.1	4.1	4.1	1.8	1.8	O,0,NO,A,E,I	#14
809C	Security	4	H100F	489711		4.1	4.1	4.1	1.8	1.8	O,0,NO,A,E,I	2 @ 7/16, center bit inside
809D	Security	11-5/8	M84F	489658		6.3	6.3	6.3	0.8	0.8		Left in hole
809D	Security	4	H100F	489709		6.3	6.3	6.3	0.8	0.8		Left in hole
809E	Security	11-5/8	M84F	489656		8.0	8.0	16.3	14.0	21.0	O,0,NO,A,E,I	Wedged F/HRB
809E	Security	4	H100F	489713		8.0	8.0	16.3	14.0	21.0	O,0BT-LT,8F,I,WO,BHA	Wedged F/HRB
809F	Security	11-5/8	H87F	489662		5.9	5.9	5.9	0.5	0.5		Left in hole
809F	Security	4	H100F	489711		5.9	5.9	10.0	0.5	2.3	O,0,NO,A,E,I,NO,BHA	
810A	Security	11-7/16	S86F	469668	9.5		9.5	262.5		19.5		APC
810B	Security	11-7/16	S86F	469668		60.0	60.0	320.5		19.5		Jet-in test
[b]810C	Security	11-7/16	S86F	469668	136.1		136.1	456.6	0.7	20.2	T1,B1,I	
810D	Security	9-7/8	H87F	489665		151.3	151.3	151.3	2.8	2.8		
810D	Security	4	H100F	489711		151.3	151.3	161.3	5.0	7.3	O,4,CD,H,4,I,FC	Good condition

[a] Numerical values are on a linear scale of 0–8, with 0 being no loss, wear, or reduction and 8 being total loss, wear, or reduction of teeth or bearings; O = outer one-third of bit; NO = no dull/no other wear; A = all rows; E = bearing seals effective; I = in gauge; BT = broken teeth/cutters; LT = lost teeth/cutters; F = bearing seals failed; WO = wash out on bit; BHA = change bottom-hole assembly; CD = cone dragged; H = heel rows; FC = flat crested wear.

[b] All bit runs except Hole 810C were with special DCS bits brought aboard for Leg 132.

the rigors of offshore drilling. The coring string was run through the conventional API drill string used aboard the *JOIDES Resolution* and could be deployed with either type of seafloor structure designed for the DCS. The bit size cut a nominal 4 in. hole while producing a 2.20 in. diameter core. Both 1.5 and 3 m (5 and 10 ft) core barrels were available to be run. The inner core barrel was deployed by free-falling it inside the tubing string and retrieving it on a wire line after the interval was drilled.

The core barrel hardware performed almost flawlessly through the entire program even though core recovery was low. Different drilling parameters were adjusted in attempts to increase core recovery. However, due to a highly fractured volcanic tuff encountered at the Bonin location recovery remained low. This was primarily due to the lack of proper core catchers for this type of formation. Cores taken when actual fractured or vesicular basalt was encountered were cut to gauge and produced recovery of over 60%. Over 79 m was drilled and cored with the new core barrel system. This amounted to 20 hr of actual coring time for the 33 times it was deployed in 1800 m of water. Total recovery for the hole amounted to slightly over 11 m of core with recovery near 19%. A latch-in center bit was also used on several occasions to drill ahead and clean out the bottom of the hole. A total of three 10 ft core barrels was used throughout the drilling program. These barrels were run both with and without core liners.

The core barrel retrieval system was also upgraded over that used during Leg 124. The latching mechanism provided positive trouble-free operation throughout the leg. A bit deplugger was also used on several occasions to clear the throat of the diamond bit when a core jam prevented the inner barrels from latching in.

Based on experience from the leg, several upgrades to the coring equipment are under consideration to increase its flexibility in different soil or formation types. These include other types of core catchers, introduction of a piston sampler for soft formations, and possibly adding a float valve to eliminate swabbing of the tubing during core barrel retrieval.

SHIP'S SYSTEMS AND HARDWARE

TV Reentry System Performance

Many runs were made with the VIT frame this leg. Aside from a few encounters with fishing line and continued deterioration of the coax cable, the system worked well.

Some problems were experienced with the subsea lights burning out; the fuse for the light banks located inside the telemetry pod burned out also. The electronic technicians suspected that this problem was associated with turning the lights off or on while on bottom. This is a natural course of action when trying to minimize glare and maximize picture clarity. Perhaps using a dimmer switch would be a better way to solve the problem.

All in all, the external frame TV system worked exceptionally well, considering that over 29 VIT deployments were made during the leg leading to 27 TV reentries. Only one through-the-pipe sonar reentry was made, and the tool never worked again for the remainder of the leg.

Coax Cable

The coax cable used on the external reentry system continued to deteriorate by losing some of its outer armor. It was sometimes impossible, due to current, to eliminate rubbing on the aft end of the moon pool. Eventually the grip had to be moved up about 50 ft and coiled and/or secured below the grip to the frame. This cable is scheduled for replacement at the beginning of Leg 134.

Mesotech Sonar

At the beginning of the leg the old 3-3/4 in. Mesotech sonar tool was in good electronic shape but had a few mechanical problems. These problems were carryovers from the previous leg and believed to be the result of drill pipe vibration at Site 808 in the Nankai Trough. Inspection of the lower section revealed that the upper flexible coupling was broken, and the tool was having problems with seawater entering the lower section. It was decided to fix the coupling using epoxy but this lasted for only one or two runs before it failed again. A new 3/4 Mesotech tool was eventually deployed.

The first attempt to reenter at the ONDO site was with the old tool. The tool barely made it past the drill floor before it failed. A quick check revealed that one of the leads for one of the capacitors was loose and once corrected the tool was ready to run again.

The second run managed to get the tool down to 4200 m before communications failed. Once the tool was back on deck it was discovered that both of the plates that cover the bladders were off, along with the transducer and its cover. We also discovered later that the Gearhardt Owens cable head had been rotating and most of the leads were either open or had shorted to the case.

The old tool was eventually put back together. This tool made it through the first reentry, but communications were lost on the way up and a bench check revealed that the flexible coupling had broken again and the lower section had seawater in it again. In addition, the Gearhardt Owens cable head was once again damaged. This was the only through-the-pipe reentry required or made on this leg.

Automatic Station Keeping System (ASK)

The automated station keeping system was really not challenged on this leg. It performed well in all required facets of operation including some delicate reentry maneuvers into some extremely small targets. Beacons, both from Datasonics and Benthos, performed well except for a minor problem with the weight attachment design on the Benthos beacon (Table 4). This attachment, which failed during a moving deployment of a beacon on Leg 130, also failed during a stationary deployment on Leg 132. The problem is centered around the bolts for the attachment flange pulling through the plastic case. To correct the problem a thin ring was fabricated out of 1/4 in. plywood to distribute the load on the internal side of the case. With the bolts extending through the support ring we experienced no further failures.

Engine Room And Ship's Machinery

The engine room and other ship's machinery all performed up to par with routine preventive maintenance services work ongoing throughout the leg in most departments. Several minor breakdowns occurred with rig floor equipment, including repairing the draw works pivot post for transmission shifting, replacing a current amplifier on the draw works traction motor, and repairing a failed hydraulic hose on the pipe racker. All in all, only 5.25 hr of mechanical breakdown time was charged to the leg. The T-1 thruster which underwent bearing replacement during the Pusan port call functioned well, however, there is a questionable hub on the T-11 thruster which was scheduled for inspection in Guam.

Weather And Currents

Weather for the better part of the leg was not an operational factor. The sea state conditions throughout operations at the ENG-5 Bonin site ranged from mild to millpond and were virtually ideal for DCS platform operations. This was not to be the case later in the leg. While operating on the last site, ENG-6 Shatsky Rise, operations began to get a taste of the tropical depressions which can begin forming at this time of the year. Toward the latter days at this site, sea state conditions began to have an effect on planning. The vessel was sitting under a progressively deepening tropical depression and had several separate tropical cyclones (Steve, Vernon, and Natasha) identified to the southwest moving in a northerly direction. The cyclones were still over 1000 nmi away but were still to be watched closely. The seas, swells, and wind were progressively building to the point that it became paramount to get the DCS tubing string out of the derrick and safely stowed on top of the riser hatch. It was also necessary to break down the drill collars racked in the derrick and lay them out before handling became dangerous for rig personnel. It was originally planned to rig down the DCS hardware while underway to Guam but because of the progressive line of fronts extending between the Marshall Islands and our location it was decided that all heavy lifts should be made prior to getting underway. As such the DCS winch and AC/DC umbilicals were rigged down on location.

The weather continued to deteriorate as the vessel was conducting a post-site survey on the Shatsky Rise. Eventually the captain became concerned enough about the weather that the survey was terminated and the vessel headed directly to Guam at full speed. This speed was not to be maintained for long as the rotation on the primary propulsion shafts had to be reduced to 120 rpm to keep the props from racing as they came out of the water in heavy seas. Most of the weather was from the tropical depression we were in and an approaching cyclone "Steve."

According to updated weather reports from the Naval Oceanographic Command in Guam, Typhoon Steve's closest point of approach was to be about 150 nmi. In actuality, based on barometric readings, wind speed, and direction, the storm was placed about 50 nmi crossing to the north and west of the vessel's position. As the ship proceeded toward Guam in heavy weather, the separation was increased between it and "Steve."

The worst of the weather brought sustained winds of 40–50 kt with gusts to 60 kt and seas of 20–25 ft. As the ship continued south, the weather progressively improved, and it eventually became possible to predict an on-time or possibly somewhat early arrival in Guam.

For future planning, it should be noted that the severe tropical depressions and typhoons encountered all tended to track directly over sites ENG-6 and ENG-7. If any future operations are conducted in the Shatsky Rise or M.I.T. Guyot areas, then it would be wise to have the leg end no later than the middle of July.

Personnel

Leg 132 was the second in a series of "engineering legs" dedicated to the development of hardware and techniques that will be required in future rigorous scientific coring programs. The success of these legs and the continued demonstrated success of the program is highly dependent on the professionalism and skill of the crew of the SEDCO/BP471.

Table 4. Beacon summary report, Leg 132.

Hole	Make	Frequency (kHz)	Serial number	Total time on site (days)	Water depth (m)	Remarks
808E	Benthos, 210-HP	14.5	43463	12	4684	Dropped during Leg 131 at 1000 hr 30 May; died 1455 hr 10 June.
808E	Datasonics	17.5	606	55	4684	Dropped during Leg 131 at 0900 hr 9 May; still strong signal on departure 12 July.
809A	Datasonics	15.0	530	725	1820	
809D	Data. 352 DCR	14	451		1803	Deploy on hard rock base 1200 hr 25 June; modify tilt beacon; left 18 July, still strong.
809F						Beacon eventually degraded to one-half power; dropped new beacon.
809F	Benthos 210-HP	16.0	43474		1803	Drop 1650 hr 13 July; weight attachment failed; recover floating beacon with load basket 1704 hr.
809F	Benthos 210-HP	16.0	43476		1803	Drop 1708 hr 13 July; left 1845 hr 18 July; beacon still strong.
810A	Benthos 210-HP	16.0	43474	84	2634	Repair weight attachment, drop 0600 hr 22 July; left 1430 hr 29 July; strong signal.

This talent was demonstrated over and over on Leg 132. While operating in 1800 m of water, on site ENG-5 (Bonin back-arc basin) the crew of the 471 exhibited exemplary teamwork in recovering not only a failed prototype reentry cone but then proceeded to recover a 130,000 lb hard rock guide base crucial to the engineering and scientific objectives of the leg. This latest feat was accomplished by jay-ing back into a casing hanger lying at a near-horizontal slope. Other outstanding jobs have been performed as well, including the fabrication of a critical crossover sub, and the fishing from the hole of two separate DI-BHA systems by threading into a 5-1/2 in. FH box connection, one of these at a near-horizontal angle. They have been exposed to some exceptionally complex tasks when the wiring and mechanical installation of necessary DCS components were being integrated into the ship's systems. Over a grueling 2 month period the crew was challenged to the maximum. Time and time again they came through when the chips were down.

The support from the ship's electrical supervisor, electricians, and electronics technician is certainly worth mentioning. Without their steadfast support and untiring energy, the multitude of DCS-related engineering tasks could not have been accomplished

By exhibiting a rare combination of technical know-how, patience, teamwork, and just plain old-fashioned perseverance, the Leg 132 ODP/SEDCO team continued to get the job done. The entire crew is to be commended for a job well done. It was a pleasure to sail with all of them.

Ms 132A-105