Storms, M.A., Batiza, R., et al., 1993
Proceedings of the Ocean Drilling Program, Initial Reports, Vol. 142

1. OPERATIONS REPORT[1]

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EXECUTIVE SUMMARY

Operations during Leg 142 of the Ocean Drilling Program (ODP) took place at Site 864 (EPR-2) on the East Pacific Rise (EPR), located approximately halfway between Valparaiso, Chile, and Honolulu, Hawaii, the respective ports of call (Table 1). This leg was the first attempt at drilling/coring on the EPR since new technologies and systems to combat the hostile drilling environment have been under development. It was determined some time ago that to conduct successful scientific drilling/coring operations at a ridge crest certain advances in drilling technology would be required (Table 2). These included a way to stabilize the unsupported bottom-hole assembly at the seafloor, which would enable boreholes to be initiated on hard, bare rock; a means to isolate upper unstable "rubble" zones allowing deeper drilling/coring objectives to be reached; and an effective way to drill, core, and recover highly fractured volcanic rock while maintaining adequate borehole stability. These developmental systems were put to the test on Leg 142, at a location where the drilling conditions are arguably the most difficult in the world.

Leg 142 was the third sea-trials test of the three-component diamond coring system (DCS) and its integral platform-mounted drilling system (the DCS platform). It was the first sea-trial test of the prototype hex-sided hard-rock guide base (HRB) using a gimballed and counter-balanced 8-ft-diameter reentry cone. It was also the first sea-trial test of the prototype "nested" drill-in bottom-hole assembly (DI-BHA). Although earlier versions of both the HRB and DI-BHA systems had been deployed on Leg 132 with mixed success, neither system had been deployed or tested at sea in its current upgraded and expanded configuration.

Performance of the new HRB system was excellent. Two deployments, one seafloor move, the initiation of three boreholes, and a record 35 reentries into an 8-ft-diameter reentry cone amply demonstrated that the existing HRB technology is now ready for operational use.

The mechanical back-off system for the DI-BHA system also performed well in its "nested" configuration. The system was successfully backed off in three out of three attempts in both 10-3/4-in. and 6-3/4-in. sizes. The 6-3/4-in. drill collars utilized with the second-stage DI-BHA also functioned well, suffering no failures even after many hours of unsupported, above-seafloor rotation were logged. The primary weakness of the DI-BHA system is in bit life, both in hours and footage. Progress in this area is still required before an integral DI-BHA system can be considered operational. Promising test data gathered on both carbonado surface-set and impregnated diamond bits, however, do give hope for the future in this area. Although the related diamond core barrel (DCB) system had problems circulating/reaming to bottom in "rubble" fill, it also showed promise for the future in trimming a short piece of core out of a large block of rubble in Hole 864B while still several meters off the bottom of the hole. The DCB is designed to drill a 7-1/4-in.-diameter hole while recovering a 2.312-in. core with a standard ODP rotary core barrel (RCB) wireline system. It is believed that changes in the junk slot (outside flow area) size and configuration can improve the hole-cleaning ability of the bit and pave the way for this system to become another tool in the ODP arsenal of coring systems.

The DCS platform-mounted drill rig, despite apparently having a functional secondary compensation system on two earlier legs (124E and 132), was not able to successfully cut a core at the EPR. The "improved" software code written for Leg 142 did not work. The Leg 132 version of the code was used throughout the leg with mixed success. By leg's end the DCS compensator appeared to be compensating adequately in "standby" mode using only a velocity signal from an accelerometer installed in the ship's moonpool. When required to go into "approach" mode the system would not function correctly and in fact on many occasions appeared to amplify the heave problem. Three DCS bit runs ended with three destroyed core bits without obtaining a core. It is believed that several problems contributed to the poor performance. A bent-forward feed cylinder caused the introduction of erroneous load-cell data into the computer. This false data led to erratic and erroneous string-weight information. String weight is a key component of the secondary compensation system because it is this starting weight that provides the baseline for the computer to sense and modify weight-on-bit (WOB) for the small, fragile DCS core bits. Without correct load-cell data the system will not function appropriately in the "approach" mode. Leg 142 was operating the DCS in deeper water, and under more severe, albeit moderate, sea-state conditions. The higher string loads and larger heave/swell conditions than those experienced during Leg 132 led to higher inertial loads being imposed on the system. It is not certain at this time whether a properly operating system would have been able to handle these conditions or not. This will require further study. What is known is that the DCS system must be able to operate in weather and sea-state conditions equalling or exceeding those experienced on Leg 142. This may require introducing more hydraulic horsepower into the system or modifying the hydraulic/servo valve design to allow the movement of higher volumes of hydraulic fluid at a faster rate. This, too, will require further study. Finally, the entire approach to DCS secondary compensation—that is, the computer code, the hydraulic system, horsepower, and control theory—should be reviewed by other appropriately qualified vendors and industrial contacts to ensure that the approach taken with the current system is correct and not overly complex, and to see if the system can be made more predictable and reliable for future deployments.

It is true that no core was cut during Leg 142 operations at the East Pacific Rise (Table 3). It is also undeniable that this was a major goal of the leg. It is unfortunate that lack of adequate DCS secondary heave compensation prevented that goal from being obtained. It is important to recognize, however, that it was a nonfunctional secondary compensation system that prevented core from being recovered at the EPR, not the hostile operating environment. Likewise, this incident should not be allowed to overshadow the great strides that have been taken, nor the accomplishments that were made, during this important step toward a comprehensive capability of recovering valuable scientific data from a ridge crest environment.

To reiterate, this is one of the toughest areas of the world in which to initiate drilling/coring operations. As referenced in Table 2, the ability to successfully recover scientific cores from this environment requires the development of many new technologies and techniques beyond that of the DCS platform itself. The majority of these are now either proven or well advanced toward operational status. The ability to recover unique scientific data, blaze new ground, and initiate exciting new science has never been closer at hand. If ODP is to

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[1] Storms, M.A., Batiza, R., et al., 1993. *Proc. ODP, Init. Repts.,* 142: College Station, TX (Ocean Drilling Program).

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Table 1. Operations résumé, Leg 142.

Total days (13 January to 18 March 1992)	66.0
Total days in port	6.1
Total days under way	23.4
Total days on site	36.5
Reentry	1.0
Other	0.4
Fishing/remedial	0.2
Development engineering	34.9
HRB deployment	3.2
First-stage drill-in BHA	10.1
Second-stage drill-in BHA	1.5
Bit guide deployment/center bit recovery	3.7
DCS tubing tipping/rigging	2.6
DCS platform rig-up/rig-down	1.9
Drilling joints tripping/stripover	1.1
Platform system testing	2.5
Tensioning	3.8
DCS drilling/coring	3.3
DCB drilling/coring	1.2
Total distance traveled (nmi)	6361
Average speed (kt)	11.4
Number of sites	1
Number of holes	3
Number of reentries	35
Total interval cored (m)	2.0
Total core recovery (m)	0.5
Percent core recovered (%)	25.0
Total interval drilled (m)	27.0
Total penetration (m)	29.1
Maximum penetration (m)	15.0
Maximum water depth (m from drilling datum)	2582.9
Minimum water depth (m from drilling datum)	2581.7

continue being a leader in scientific discovery then it must also pay the developmental price of the technology required.

INTRODUCTION

Previous efforts to conduct scientific drilling and coring operations at young crustal spreading centers have historically been fraught with frustration and failure to achieve the desired goals. These included the loss of multiple bottom-hole assemblies, drill bits that would self-destruct in a matter of hours, and a few meters of hole that would immediately fall in upon removal of the drilling assembly. Undoubtedly, successful drilling and coring at oceanic ridge crests is one of the most difficult technical problems faced by ODP engineers today. The results of Deep Sea Drilling Project (DSDP) Leg 54 and ODP Legs 106/109 demonstrated that new technology and techniques would be required to face and overcome the formidable hurdles encountered in attempting to drill these areas. On the basis of results from earlier legs, the ability to drill and recover core at depth from a ridge crest environment was determined to be dependent upon several developmental capabilities (Table 2). These include the following:

1. Hard-rock guide base—a relatively small, economic, seafloor structure that could be deployed quickly and efficiently. The HRB has the ability to stabilize a drill bit/bottom-hole assembly while attempting to initiate a hole in hard, bare rock exposed at the seafloor; can accept a seafloor slope (or localized surface angle) of up to 25°; allows for the support of one or more casing strings; and preferably incorporates moving or recovery options due to the complexities and time involved in locating an acceptable drill site.
2. Drill-in bottom-hole assembly—a reliable means to propagate a borehole in a hostile drilling environment. It isolates one or more unstable (rubble) formations penetrated; allows separation from the emplaced drilling assembly without requiring the bit to be pulled off bottom or out of the borehole; provides adequate bit/center bit life to achieve the required stability depth; allows multiple (nested) deployment capability in order to combat multiple unstable zones; provides large/small-diameter drill collars/connections capable of surviving rotation above the seafloor without lateral support; and provides a through-bore so that wireline coring systems can ultimately be deployed through the isolation strings, allowing continuous coring to the target depth.
3. Diamond coring system—a wireline coring system capable of drilling and coring through highly fractured, poorly cemented, crystalline rock. It supports wireline systems such as overshots, jars, sinker bars, etc.; provides adequate flexibility in core-catcher selection; provides adequate alternative formation sampling options; determines bit designs able to penetrate and core the desired formations while maintaining an adequate minimum core diameter required for scientific analysis; develops friction reducer and mud programs for diamond drilling in fractured rock; and provides a slimhole drill-rod/tubing string capable of fitting within the ODP drill pipe's inside diameter while maintaining adequate annular flow area, and is capable of holding up to the rigors of high-speed operation with long, 4500-m-plus pipe lengths.

In order to accomplish item 3 above a slimhole diamond coring system is essential. This in turn dictates the development of a diamond drilling rig equipped with a high-speed top drive, closed-loop speed control for constant rpm, fine control of mud pumps for low flow rate requirements, and an active secondary compensation system that allows tagging bottom, drilling through voids, and maintaining constant/low weight-on-bit without destroying the very fragile narrow-kerf diamond core bits employed.

All development work had to be undertaken with very few known facts about the targeted drilling environment. Details on physical properties of the rock, the number of unstable zones, the thickness of unstable zones, and the depth of unstable zones were unknown.

HARD-ROCK GUIDE BASE DEVELOPMENT

The first bare-rock seafloor structure developed by ODP was deployed during Leg 106 (Mid-Atlantic Ridge) and was successful in stabilizing the BHA well enough to initiate drilling operations. Unfortunately, deepening of Hole 864B was plagued with drilling problems, limiting its penetration to 33.4 meters below seafloor (mbsf) after Leg 106 and a mere 16 m more was added during the Leg 109 drilling effort. A second HRB of this vintage was deployed on Leg 118 (Southwest Indian Ridge) and again led to successful spudding of the borehole. This time drilling operations were very successful, yielding a penetration of 500 m into a significantly more stable, massive, peridotized gabbro. These early model structures, unfortunately, had many drawbacks. In addition to being expensive, they were extremely large, cumbersome, and unwieldy. Only one could be stored on the drillship at a time, and deployment took several days. The base had to be deployed sideways, in two halves, through the moonpool and then rotated for the trip to the seafloor. Delivery was accomplished via cables attached to the lower end of the drill string and was subject to "snap" loading due to vessel heave. The base was ballasted on the seafloor through an intricate system of detachable cementing hoses which also took multiple days/pipe trips to accomplish. It was soon apparent that a smaller, more manageable base would be required for routine, affordable operations.

The first "mini"–hard-rock guide base was developed for Leg 132 and deployed on the Bonin Ridge. This prototype base was considerably cheaper, smaller, and more manageable. This design used a smaller, square-shaped base, made up in four sections. It utilized a standard, full-sized (14-ft) reentry cone and a gimballed casing hanger. The vertical righting moment for the reentry cone was provided by syntactic foam panels mated to the outside of the reentry cone panels. The structure, although a significant improvement over its predecessor, was still unwieldy, and because of the size of the cone was marginally capable of maintaining an upright attitude when placed on the seafloor. Major difficulties with the system were experience during Leg 123 when the flotation package was found inade-

Table 2. Capabilities required for ridge-crest drilling, Leg 142.

Required/desired capability	Leg 54	Leg 106	Leg 109	Leg 124E	Leg 132	Leg 142
Hard-rock guide base		X	X		X	X
Provide seafloor stability		X	X		X	X
Handle 25° slopes					X	X
HRB tilt indicator (mechanical or electric)		X	X		X	X
Small/economical					X	X
Efficient assembly/deployment						X
Multiple casing strings						X
Movable at seafloor					X	X
Recoverable aboard ship					X	X
Drill-in bottom-hole assembly					X	X
Provide 4-in. DCS through bore					X	X
Isolate one unstable zone					X	X
Detach from drill string					X	X
Adequate bit/center bit life						
Multiple unstable zones						X
Option to spud with small-diameter bit						X
Small collars/connections						X
Optional 7-1/4-in. diameter core barrel						X
Diamond coring system				X	X	X
Slimhole coring system				X	X	X
Rugged wireline components					X	X
Drill rod/tubing, 2000 m				X	X	X
Drill rod/tubing, 4500 m					X	X
Optional/multiple core catchers						X
Sampler options for core barrel						X
Friction reducer/drilling mud					X	X
Slimhole bit designs				X	X	X
Diamond drilling rig				X	X	X
High-speed top drive				X	X	X
Constant rpm speed control					X	X
Fine/low flow pump control					X	X
Active secondary compensation				X	X	

Note: The HRB and DI-BHA back-off assemblies were considerably more refined on Leg 142, although the design concepts were proven on Leg 132.

quate on the first deployment. Attempts to bring the cone to an upright attitude resulted in a separation of the reentry cone from the HRB/casing hanger assembly. All told, several weeks of operating time were lost.

The HRB deployed during Leg 142 at the East Pacific Rise was a modified version with several significant changes over the first "mini"-HRB used on Leg 132. The Leg 142 model is a two-piece, three-leg, hexagonal design as opposed to the four-piece, four-leg, square design of earlier vintage. This more stable design was also faster and easier to assemble. The most significant design change employed was the reentry-cone vertical orientation system. The Leg 142 version used a smaller, 8-ft-diameter reentry cone mounted above a gimballed, counter-balanced, casing hanger assembly. This eliminated the need for the syntactic foam buoyancy panels used earlier. The current design is not only simpler and more reliable, but it is also cheaper to fabricate and easier to store aboard ship.

DRILL-IN BOTTOM-HOLE ASSEMBLY DEVELOPMENT

As a result of the repeated drilling and hole-stability problems experienced during operations at the Mid-Atlantic Ridge (Legs 106/109), it was determined that the use of conventional oil-field casing emplaced by traditional oil-field techniques would not be effective. A way to isolate "case-off" unstable formation had to be found that would not require pulling out of the hole. Without this capability, we could not hope to accomplish successful scientific drilling/coring operations to deeper depths.

Leg 132 (Bonin Ridge) was the first leg to deploy the prototype ODP drill-in bottom-hole assembly. This concept employed a special "back-off" capability that allowed the drilling BHA to be left in place when a predetermined depth is reached below the seafloor. The original concept was made to work during the course of Leg 132 operations but not without some difficulty. Problems with the landing-seat attachment to the HRB/casing hanger, and also "fusion" of the back-off nut taper to the taper in the landing seat, plagued the leg early in the operation. Eventually, through some clever onboard modifications, the system was made to work, proving that conceptually the idea was sound. It became apparent through the course of the leg, however, that a single casing string would probably not be effective in isolating multiple bad formations to a depth required for successful scientific drilling/coring to continue.

Conceptually, the prototype DI-BHA used on Leg 142 was similar to the earlier version used on Leg 132. Several key design changes were made, however. The taper on the back-off nut and landing-seat assembly was changed from 7° to 10°. This modification was made as a result of some recent friction clutch studies indicating that fusion or sticking of two surfaces could occur at the lower taper angles. The locking system for the landing seat was fabricated with locking keys that extended through the wall of the casing hanger body and were not simply welded to the inside diameter as was the case on Leg 132. To help prevent premature back-off from occurring, the new version allowed the upper stabilizer to extend down as far as possible over the back-off nut. This served to shroud the back-off portion of the assembly, preventing contact with any other casing hanger or reentry cone surface prior to seating on the landing taper where proper back-off should occur. The final change to the DI-BHA was to make it a "nested" system. The original Leg 132 system used two sizes of drill bits: 11-5/8 and 9-7/8 in. Either system could be deployed and drilled in, but that was the only isolation string available prior to

Table 3. Site summary report, Leg 142.

Hole	Latitude (N)	Longitude (W)	Water depth (m)	Number of cores	Interval cored (m)	Core recovered (m)	Core recovered (%)	Interval drilled (m)	Total penetration (m)	Time on hole (days)	Cumulative time on site (days)
864A	9°30.85′	104°14.66′	2581.7	4	2.00	0.50	25.00	13.00	15.00	27.69	27.69
864B	9°30.85′	104°14.66′	2582.9	1	0.10	0.00	0.00	7.20	7.30	6.31	34.00
864C	9°30.85′	104°14.66′	2582.9	0	0.00	0.00	0.00	6.80	6.80	2.52	36.52

initiating DCS operations. Because of the nature of the hostile "rubble" environments present at ridge crests, it was felt that more than one casing string would likely be required before a stable-enough zone could be reached and coring initiated. With the DI-BHA "back-off" concept proven on Leg 132, work began immediately on a "nested" version of the tool using the same concepts but allowing two separate casing strings (BHAs) to be deployed and backed off individually, one inside the other. The Leg 142 DI-BHA system has much more flexibility than the earlier version. A primary or first-stage DI-BHA can be drilled in and backed off using 10-3/4-in. drill collars, 10-3/4-in. back-off assembly, and either a 12-1/2 × 7-3/8-in. 6-cone bit or an 11-1/2 × 7-3/8-in. diamond (carbonado surface-set or impregnated) bit. Inside the throat of the primary bit is a 7-1/4-in., C-7/1-cone or an M89TF/2-cone center bit. This center bit is driven by a casing advancer latch locked into the bit sub. Once the center bit is removed, DCS coring can begin or coring with the diamond core barrel can be initiated. The DCB system uses 6-3/4-in. drill collars, core barrel, and a 7-1/4 × 2.31-in. diamond (carbonado surface-set or impregnated) core bit. This system utilizes standard ODP rotary core barrel (RCB) wireline components and is potentially an effective coring option prior to deployment of the DCS. Should the formation remain unstable or intersect a second unstable zone requiring an additional casing string, the secondary or second-stage DI-BHA can be drilled in and backed off using the same 6-3/4-in. drill collars, a smaller, 6-3/4-in. back-off assembly, and a 7-1/4 × 4.05-in. diamond (carbonado surface-set or impregnated) bit. Inside the throat of the this bit is a 4.0-in. C-7/1-cone or an H100F/2-cone center bit held down and rotated by the same modified extended core barrel (XCB) latch as mentioned above. The Achilles' heel of all DI-BHA systems is bit life. If the bearings/cutting structure or diamond bit life cannot be extended to a reasonable depth, then all that is gained with an automatic downhole back-off system is lost. If the bits fail to penetrate to the required depth only one option remains, which is to pull out of the hole, change bits, reenter the hole, and hope that the previously drilled interval can be regained and extended. Development of extended-life bits for use in drilling ridge crest environments is therefore of paramount importance to a successful future scientific drilling/coring program.

DEVELOPMENT OF THE DCS CORING SYSTEM

The initial deployment of a slimhole diamond coring system took place on Leg 124E, the first sea-trials test of the DCS concept. For this leg a conventional, off-the-shelf, mining-type "HQ" coring system was used. Mining coring systems are designed to "nest" inside one another; thus, when hole trouble occurs the previously used drill rod becomes the casing for the next system without withdrawing it from the borehole. Each system is identified with a letter, the "Q" indicating that it is a wireline rather than a conventional system. The system used by ODP on Leg 124E was a slightly modified "HQ" system in that the bit/core size (3.96 × 2.20 in.) was somewhat nonstandard. In a typical mining application the "H"-size bit/drill rods would follow the "P" size. Should it become necessary to leave the "H"-size rods in the hole, an "N"-size bit/drill rod could then be deployed through the "H" size. Other than the bit, core size, and the use of a landing ring, the initial ODP slimhole coring system was standard. Many other systems had to be developed and brought on-line for the first DCS trial and it was felt that spending time on a functionally proven mining coring system should be of a lower priority.

Many problems and shortcomings of this initial system were identified during the Leg 124E deployment. In general, the mining system was just not robust enough to withstand the rigors of offshore deep-water drilling. Many mechanical failures were experienced with the wireline components, including the jars and overshot assemblies. In addition, because a standard HQ core-barrel landing ring would not fit through the DCS tubing's inside diameter (ID) (2.99 in.), the recommendation was to turn down the landing shoulder and land the core barrels on the bit crown. This was also not an acceptable design, as proven by early field results.

Among the wireline core barrel refinements made for Leg 132 were the total redesign of the HQ mining core barrel into an ODP HQ offshore slimhole coring system. The inner tubes were made smaller, allowing the landing ring to be reinstated and eliminating the need to land the core barrel on the bit crown. The jars, overshots, and most other wireline components were redesigned and significantly strengthened for deep-water offshore use. This completely redesigned wireline coring system performed well during Leg 132 in the coring of a 79-m hole on the Bonin backarc basin. Although all weaknesses experienced with the wireline components used on Leg 124E were rectified, two other limitations were identified. Core recovery through the highly fractured basalt was a respectable 64% until a zone of extremely friable volcanic tuff was encountered. Recovery through this interval was a disappointing 0%. One obvious problem was that the only available collet core catcher was not designed to catch this type of loose material.

Two additional changes were made to the wireline coring system for Leg 142. An optional leaf-spring finger-type core catcher for recovering soft, friable formations was designed. Secondly, the core-lifter case design was modified to allow the use of either the collet or spring-type core catchers individually or in tandem.

In addition to the changes made to the primary coring system itself, other optional sampling systems were added to the complement of wireline tools. New for Leg 142 was a split-spoon sampler option, a hydraulic piston sampler option, and a push sampler option. All of these alternate sampling systems were designed as options to the DCS core barrel for drilling in friable or very unconsolidated formations. All sampling systems are interchangeable within the same outer tube, so a round trip of the DCS tubing string is not necessary. All that is required is a wireline trip to change to the type of coring or sampling system that is appropriate for the formation.

DEVELOPMENT OF THE DCS PLATFORM-MOUNTED DRILL RIG

The initial platform drilling system deployed on Leg 124E as a test of the DCS concept was a limited-capability system designed strictly to allow DCS concept viability to be established. This system was limited to a total drill-string depth of 1900 m. It utilized a leased hydraulic top drive with adequate rpm capability but limited total load-carrying capacity. No mud pump control, a critical operation in slimhole diamond coring, was available. Separate mud pits, pumps, etc., had to be placed on the rig floor and were operated via hand signals from the DCS driller on the platform to an assistant on the main rig floor. The secondary compensation system concept proved workable with an accelerometer mounted on the DCS mast assembly but the reliability and flexibility of the control system left much to be desired. When changes to electronic gains or constants had to be made, or when new E-PROM computer boards had to be installed, the control console box had to be opened up and the contents exposed to the weather/inclement elements, etc. This yielded many problems when routine or not-so-routine adjustments to the system had to be made. Moisture inside the control console became a major problem, causing unnecessary electronic component failure/malfunction.

A major complaint from the SEDCO drillers was the vast difference in the drilling controls' operation and location compared to what they were used to in the rig-floor drill shack. They also expressed annoyance over the inexpensive "poor boy" platform-mounted coring winch and its lack of redundant breaking systems.

Improvements to the system for Leg 132 were many, as this was the first real operational prototype system to be fielded. The leased hydraulic top drive was replaced with a purchased electric top drive. This top drive was capable of 640 maximum rpm (520 rpm with 8000 ft-lb of rotational torque) and nearly 12,000 ft-lb of torque. In addition, it has an API-rated bearing-load capacity of over 650 tons. Design improvements to the top-drive control system enabled the system to be operated at constant rpm independent of torque. This technique has ramifications far and above the DCS system itself. It is quite likely that this same closed-loop control system will eventually be incorporated into the rig's standard Varco top drive for use during other non-DCS drilling/coring operations. The ability to maintain constant rpm is critical to good coring system performance, thus enhancing core recovery and optimizing core quality.

Another design improvement for Leg 132 was the addition of a mud-pump control system that not only allowed control of the mud pumps from the DCS platform but also eliminated the need for separate rig-floor pumps, pits, and operator. The mud-pump control-system design enhancements, coupled with the use of smaller (4-in.) liners in the primary National 1900 triplex rig pumps, allowed flow rates as low as 6 gal/min to be achieved. Low, smooth, well-controlled circulation is also critical to effective slimhole diamond coring. This advanced control system is another that quite likely will be used in the future for other ODP applications such as packer/permeability experiments, and/or other downhole tools research requiring extremely accurate and controlled flow rates.

For Leg 132, the coring winch was completely redesigned with a state-of-the-art level wind system and a total of three redundant braking systems. In addition, the tugger placement was repositioned and the drilling control console was significantly modified. All drilling controls, where possible, were made to conform to those that the SEDCO drillers were used to, including location. The control console for the secondary compensation system was redesigned to allow external keypad entry for changes in gains, constants, etc. The box was also equipped with a heater/dryer system to help reduce moisture-related electronic problems. As a result, the platform-mounted systems together enabled the drilling of a 79-m hole into highly fractured crustal basalt. In addition, hole stability was maintained to total depth with no pipe sticking and little fill between core runs. The secondary compensator system experienced no electronic component failures; however, the concept itself had to be redesigned aboard ship when it was discovered that the Leg 124E hardware/software would not work with seafloor hardware emplaced and tied back to the DCS platform. The platform-mounted accelerometer signal (saturated with noise) was eventually replaced with a signal coming from the LDGO/BRG wireline compensator accelerometer located in the ship's moonpool area. The only caveat to the systems Leg 132 performance is that it worked in a relatively benign sea state and in relatively shallow water (depth less than 1900 m).

Despite the relatively good performance of the platform-mounted systems on Leg 132, several areas of improvement were identified. The shipboard "poor boy" software/hardware needed to be refined into a final secondary compensation capability (i.e., clean up what was done as a stopgap measure on Leg 132). The low-pressure hydraulic filter system was marked for replacement with a high-pressure system to eliminate the filter "blowouts" and resultant hydraulic oil spills experienced on the leg. The seals on the hydraulic feed cylinders generated high frictional drag, tended to leak, and were a major problem to change in the field. The cylinder end-cap design was slated for redesign, and the cylinder seals were to be replaced with a low-friction variety. Concern had been expressed about the overly sensitive winch and tugger controls that were difficult to control safely at low speed, such as when a core barrel was about to be stopped at the platform working deck. A low-speed winch/tugger control system was therefore considered as a design refinement. A solid windwall/roof unit was added for more protection of the DCS drill crew during inclement weather. An improved fire retardant floor and automated extinguisher system were added, and increased-capacity shock cylinders were added to the platform structure. Finally, a full-scale "slingshot" and "drop" test was conducted on the platform shock system to verify that the analytical design predictions were correct and to aid in establishing proper pressure-relief valve settings. All work on the platform systems was geared toward building on and improving what were already considered to be functional systems.

The preceding discussion on the developmental aspects of the DCS and related ridge crest drilling systems was included in this report so that a proper perspective can be maintained in judging the results of Leg 142 relative to the past DSDP/ODP capability to drill and core in these hostile environments.

The following detailed engineering reports are provided in subsequent chapters to this operationally oriented report:

"Diamond Coring System Phase IIB: Engineering and Operations Report," by J.E. Briggs, R.P. Lawrence, and D.H. Reudelhuber;
"Design and Performance of Subsea Hardware," by G.L. Holloway;
"Design and Performance of Diamond and Roller Cone Bits," by G.L. Holloway; and
"Design Improvements to DCS Core Barrel and Sampling Systems," by G.L. Holloway.

VALPARAISO PORT CALL

Leg 142 began in Valparaiso, Chile, at 1730 hr Local (L) on 12 January 1992. The ship was not due in until early the following morning and the early arrival allowed customs and immigration formalities to be dispensed with ahead of schedule. Major logistical activities, however, did not begin until the following morning.

As is customary, activities commenced with the loading of Catermar food supplies, crew change, and technical crossover between key personnel. As Leg 142 was a diamond coring system (DCS) engineering leg, a larger-than-average amount of hardware had to be loaded aboard ship. Of particular importance were the expeditious preparations for the loading of the DCS dolly, platform, and mast hardware. Once the dolly tracks were installed across the rig floor, the platform assembly was lifted aboard, followed by the mast assembly.

Prior to the loading of engineering, technical, and operational supplies, the forward drill collar rack had to be emptied and the contents transferred primarily aft to the riser hold. Only those collars and knobby drilling joints required for Leg 142 operations were left in the rack.

Once the rack was emptied of all standard operational hardware, loading of the developmental hard-rock guide base (HRB) and drill-in bottom-hole assembly (DI-BHA) hardware began. Loading of the DCS tubing string and HRB ballast was left until last.

Because of the magnitude of engineering hardware to be loaded, all SEDCO and ODP technical loading requirements were deferred and loaded during windows of opportunity.

Other port call activities included the installation of the derrick and mini-DCS-platform umbilicals, refueling, and routine offloading of cores/reefer samples, etc. In addition, an on-site review of the newly instituted ODP Technology Safeguards Security procedures was conducted by Karen Dibenedetto and Jim Truske from the U.S. Department of Commerce. Results of the review were favorable.

Despite the heavy loading requirements for the port call, all activities were accomplished ahead of schedule and the vessel was ready to depart the dock by midday on 17 January except for one minor problem. An E-PROM burning card (personal computer board), hand-carried to the vessel, was faulty and could not be made to operate correctly. This computer card was required for making adjustments to the DCS secondary compensation system and without it the ship could not sail. Two additional cards were sent out immediately and the vessel departed the dock at 1230 hr for anchorage in order to await arrival of the critical parts. Upon arrival of the E-PROM cards, clearance papers were signed and the anchor weighed. The vessel officially got underway for Site 864 (EPR-2) at 1930 hr on 18 January 1992.

TRANSIT TO SITE 864 (EPR-2)

Excellent weather, and a following sea, courtesy of the Peruvian Current, contributed to the good time made during the transit from Valparaiso, Chile, to the drill site. The vessel covered the 3168 nautical miles (nmi) in 11.4 days, averaging a respectable 11.6 knots (kt) for the voyage (Fig. 1).

The transit time was well utilized in rigging up the multitude of DCS platform systems; sorting, strapping, and staging the DCS tubing; and readying all of the seafloor hardware/drilling systems to be deployed once on site.

Much effort went into readying the DCS tubing for expedited make-up once on site. A directive from Underseas Drilling, Inc. (UDI), received before the leg, prohibited transiting with the tubing made up into stands and racked in the derrick. Therefore, this work had to be done after arrival on site and early during site operations. While the DCS tubing was at Baker-Hughes in Houston getting inspected, cleaned, and externally coated, the various types and sizes became jumbled. One of the first operations undertaken aboard ship was to strap (measure the length of) each joint and rebundle the tubing appropriately for expedited make-up when running in the hole. The S-130 tubing joints were kept together and would ultimately go at the top of the tubing string. The N-80 joints were to go below the S-130 joints. One batch of N-80 joints had the pin connections turned down to 3.750-in., allowing greater annular area in the 3.960-in. diamond borehole. These joints (N-80T) were identified and bundled together so as to be located on the bottom of the string when the stands were ultimately made up. For reference, the DCS tubing and drilling joint tally for Leg 142 is as follows:

Quantity	Description	Tool joint outside diameter	Total length (m)	Length per joint (m)	Total length (ft)	Length per joint (ft)
Hydril 500-series tubing with wedge-lock connections:						
28	N-80T	3.750	266.6	9.52	874.28	31.22
215	N-80S	3.868	2044.6	9.51	6708.00	31.20
217	S-130	3.868	2050.7	9.45	6729.20	31.01
Total tubing string: 460 joints					4361.9 m 14,311.5 ft	
DCS drilling joints with Hydril wedge-lock connections:						
11	S-130	3.868	16.8	1.52	55.0	5.0
94	S-130	3.868	286.6	3.48	940.0	10.0
Total drilling joints: 105			303.4 m		995.0 ft	
Total approximate string length:					4660 m (15,300 ft)	

Fortunately, the weather continued to cooperate right up until arrival on site. Because of the good conditions, the UDI drilling superintendent agreed that there would be no problem transiting the final 3 days with the upper guide horn (UGH) removed. This allowed the hard-rock guide base to be positioned and fully assembled on the moonpool doors prior to arrival on site. Assembly of the HRB consisted of (1) moving the HRB halves onto two 12-in. I-beams set port to starboard across the moonpool doors (in the closed position), (2) bolting the halves together, (3) installing the landing seat for the 10-3/4-in. back-off nut inside the hanger body, (4) setting the trunnions of the gimballed casing hanger assembly onto the lower pivot plate and installing the upper pivot plate, (5) mounting the 8-ft-diameter reentry cone onto the casing hanger, (6) mounting two, glycerin-filled, bull's-eye tilt indicators on opposite sides of the HRB, and (7) installing a single electronic tilt beacon and bracket. The tilt beacon used was a Datasonics Model 359 non-commandable unit set with a frequency of 18.0 kHz (serial no. 841). Once assembled, the base was welded out for additional strength even though it is designed to require only bolting. Both ODP tensioning "J"- (or jay-) tools and the SEDCO double jay-tool were fit-tested inside the hanger jay-slots to ensure that proper engagement was possible. One tensioning tool required grinding on the dogs to allow full engagement into the jay-slots. *Note that the casing hanger installed at Hole 864A was fabricated with a backward "jay."* This casing hanger was left over from last year's pre–Leg 132 procurement and was erroneously fabricated with a left-hand "jay." This hanger requires right hand torque to jay-in (on deck) and left-hand torque to jay-out (downhole), which is backward from the normal casing hangers deployed by ODP. The final step in the HRB preparations consisted of art work. The HRB was identified with different markings on five of the six sides. The markings (Aggie gig-'em hand, ATM symbol, NSF/JOI, SEDCO/BP 471, and Leg 142) are useful in determining the orientation of the base and assist in maneuvering for reentry operations. The reentry funnel itself was painted with black concentric circles, labeled with a "T" adjacent to the tilt beacon, and labeled with a "1" and a "2" next to the first and second bull's-eye brackets, respectively. Finally the jay-slots were marked with black paint. Most HRB assembly activities were completed prior to arrival on site. The SEDCO double-jay deployment tool was jayed-in, making the base ready for deployment once the legs were dropped and welded out. This last operation could not be completed until after arrival. The moonpool doors could then be fully opened providing room for the HRB legs to drop down into position.

The approach to Site 864 was somewhat unorthodox. Only a magnetometer was towed while underway. No air or water guns or other conventional profiling gear were deployed since there was no sediment cover overlying the basaltic crust of the axial summit caldera. An extraordinary amount of site survey work had been done prior to this leg and the drilling target was to be located primarily by global positional system (GPS) navigation and a subsea television survey of the area.

The chief scientist laid out an approach plan and reviewed it with both the UDI captain and ODP operations superintendent. This plan had the vessel approach the East Pacific Rise at full speed on a course of 321° en route to the first way point located over a distinctive seamount (8°49.0′N, 103°53.2′W). The course was then changed to 349°, putting us on a track toward the second way point (9°36.0′N, 104°02.8′W). The course was again changed to 239°, putting us on a course to the drilling target located at a latitude of 9°30.85′ and a longitude of 104°14.66′W. During this last leg of approach the ship's speed was reduced to 6 kt at approximately 8 nmi from the site and the magnetometer was recovered aboard ship.

The drilling target for Leg 142 (Site EPR-2) was a small, ponded lava lake some 30 to 40 m wide and 70 to 80 m long, running roughly parallel to the north/south-trending walls of the axial summit caldera (ASC). This young volcanic flow unit was located within the walls of the ASC during one of several submarine dives made by Woods Hole

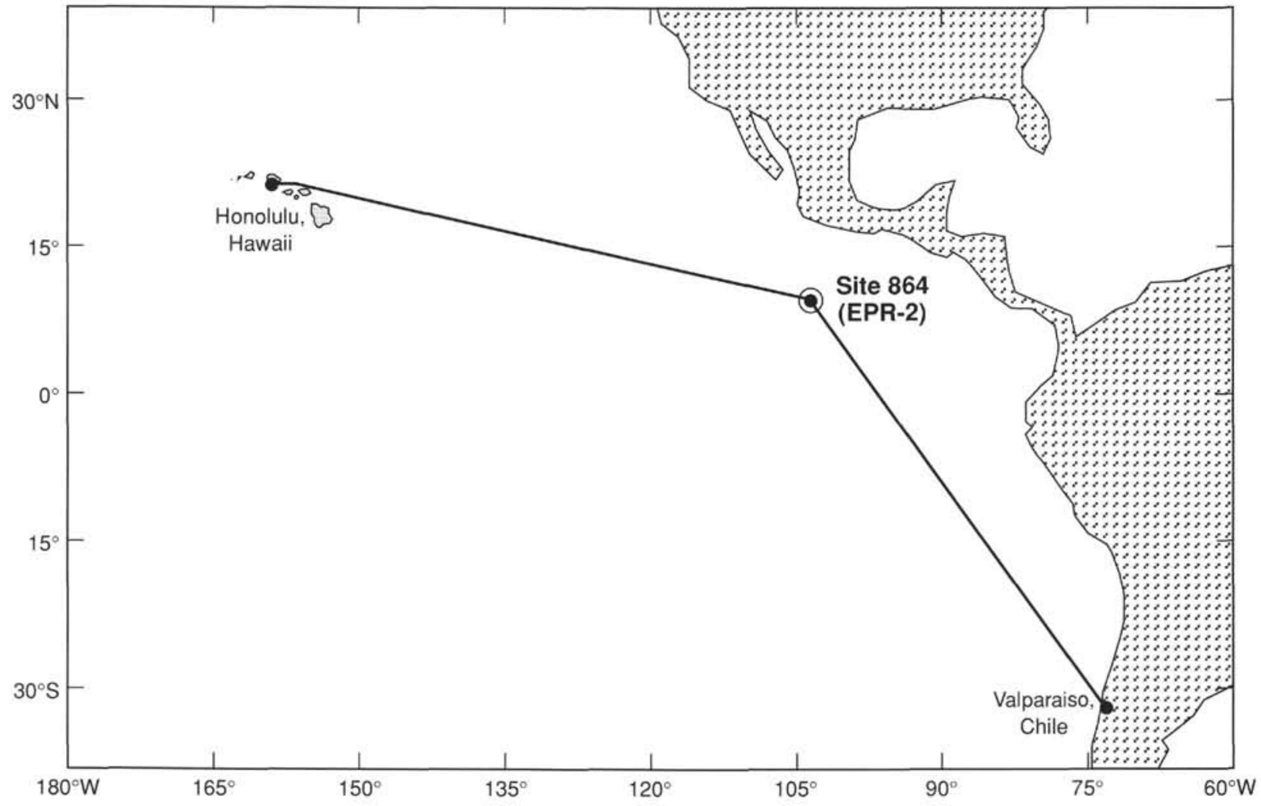

Figure 1. Leg 142 transit map from Valparaiso, Chile, to Honolulu, Hawaii, via Site 864 (EPR-2).

Oceanographic Institution's *Alvin* as part of a larger EPR site survey program. An ODP engineer, Dan Reudelhuber, was present on the particular dive that selected and marked the drilling target. This particular site was selected and marked (with a tethered white plastic trash-can lid) because of its virtually flat terrain and the massive nature of the flow unit, and because it constituted a relatively wide, fracture/fissure-free area on which to land an ODP hard-rock guide base (Fig. 2).

LEG 142 ON-SITE OPERATIONS (HOLES 864A, 864B, AND 864C)

All on-site operations pertaining to the hard-rock guide base, drill-in BHA system, diamond coring system (DCS), and diamond core barrel (DCB) for Holes 864A, 864B, and 864C are described below. A special development engineering time distribution chart is included in this report (Table 4), in addition to the total time distribution (Fig. 3) and the standard operations time distribution (Table 5). Included are time breakdowns for operations relating to deployment of the hard-rock guide base, first- and second-stage drill-in bottom-hole assembly systems, bit guide deployment and center bit recovery, DCS tubing rig-up/rig-down and tripping, DCS platform rig-up/rig-down, DCS drilling joint tripping and stripover operations, DCS platform systems testing/trouble shooting, jay-in/jay-out and tensioning operations, DCS drilling/coring and wireline time, and, finally, DCB drilling/coring and wireline time.

Hole 864A

First HRB Emplacement

Two HRB assemblies were deployed during Leg 142 (Table 6). These two structures were used to initiate three boreholes into the

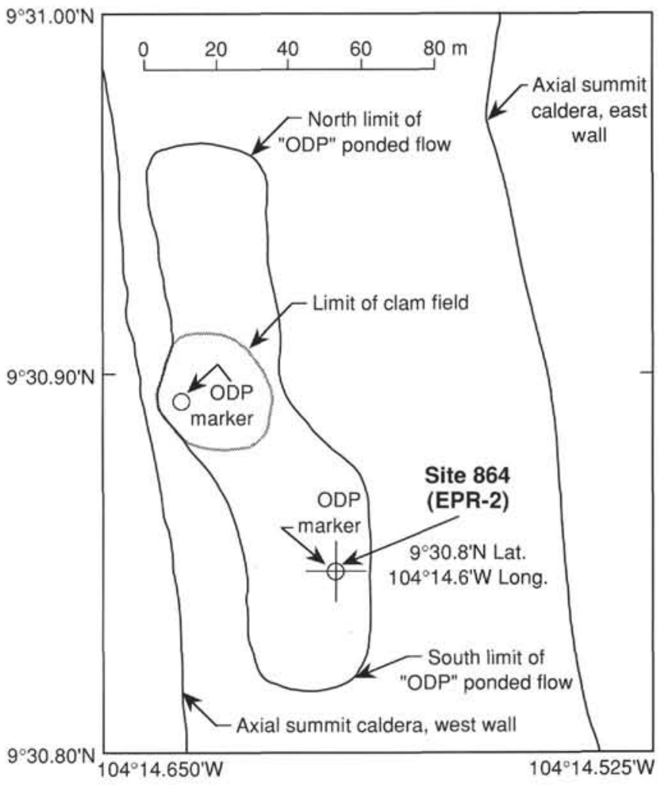

Figure 2. Site location map for operations at Site 864 (EPR-2) (*Alvin* dive 2358 survey of the East Pacific Rise).

Table 4. Development engineering time distribution for Holes 864A, 864B, and 864C.

Date (1992)	HRB deployment	First DI-BHA	Second DI-BHA	Bit guide/ center bit	Tubing rig/trip	Platform rig-up	Drilling joints strip-over	Platform system test	Jay-in tension	DCS drilling/ coring	DCB drilling/ coring	Total	Remarks
30 Jan.	18.75	—	—	—	—	—	—	—	—	—	—	18.75	—
31 Jan.	2.25	21.00	—	—	—	—	—	—	—	—	—	23.25	—
1 Feb.	—	24.00	—	—	—	—	—	—	—	—	—	24.00	1
2 Feb.	—	21.75	—	—	—	—	—	—	—	—	—	21.75	1
3 Feb.	—	21.50	—	—	—	—	—	—	—	—	—	21.50	1
4 Feb.	—	22.75	—	—	—	—	—	—	—	—	—	22.75	1
5 Feb.	—	23.25	—	—	—	—	—	—	—	—	—	23.25	1
6 Feb.	—	22.75	—	—	—	—	—	—	—	—	—	22.75	1
7 Feb.	—	5.00	—	18.75	—	—	—	—	—	—	—	23.75	2
8 Feb.	—	—	—	23.25	—	—	—	—	—	—	—	23.25	3
9 Feb.	—	—	—	23.50	—	—	—	—	—	—	—	23.50	4
10 Feb.	—	—	—	9.25	—	—	—	—	12.25	—	—	21.50	4
11 Feb.	—	—	—	—	—	—	—	—	23.75	—	—	23.75	5
12 Feb.	—	—	—	—	13.00	—	—	—	10.75	—	—	23.75	—
13 Feb.	—	—	—	—	3.50	20.50	—	—	—	—	—	24.00	—
14 Feb.	—	—	—	—	—	14.00	7.50	—	2.50	—	—	24.00	5
15 Feb.	—	—	—	—	—	—	1.25	7.75	—	15.00	—	24.00	6
16 Feb.	—	—	—	—	—	—	—	1.50	12.00	10.50	—	24.00	7
17 Feb.	—	—	—	—	—	—	—	10.50	—	13.50	—	24.00	—
18 Feb.	—	—	—	—	6.25	6.00	3.75	—	8.00	—	—	24.00	—
19 Feb.	—	—	16.25	6.25	—	—	—	—	1.00	—	—	23.50	8
20 Feb.	—	—	16.25	7.25	—	—	—	—	—	—	—	23.50	9
21 Feb.	—	—	4.25	—	5.75	—	2.00	6.00	4.50	—	—	22.50	—
22 Feb.	—	—	—	—	—	—	2.25	—	1.00	19.50	—	22.75	—
23 Feb.	—	—	—	—	—	—	—	10.00	—	14.00	—	24.00	10
24 Feb.	—	—	—	—	11.50	2.25	4.00	6.25	—	—	—	24.00	10
25 Feb.	—	—	—	—	—	—	3.25	17.25	0.50	2.75	—	23.75	—
26 Feb.	5.25	—	—	—	5.75	2.75	3.00	—	4.25	3.00	—	24.00	—
27 Feb.	24.00	—	—	—	—	—	—	—	—	—	—	24.00	11
28 Feb.	9.75	14.25	—	—	—	—	—	—	—	—	—	24.00	12
29 Feb.	—	5.50	—	—	—	—	—	—	—	—	15.00	20.50	—
1 Mar.	—	8.50	—	—	—	—	—	—	—	—	14.25	22.75	—
2 Mar.	—	22.75	—	—	—	—	—	—	—	—	0.50	23.25	—
3 Mar.	—	9.00	—	—	—	—	—	—	8.50	—	—	17.50	—
4 Mar.	12.50	—	—	—	8.50	—	—	—	2.75	—	—	23.75	—
5 Mar.	4.00	9.50	—	—	9.25	—	—	—	—	—	—	22.75	13
6 Mar.	—	10.25	—	—	—	—	—	—	—	—	—	10.25	13
Hours	76.50	241.75	36.75	88.25	63.50	45.50	27.00	59.25	91.75	78.25	29.75	838.25	
Days	3.2	10.1	1.5	3.7	2.6	1.9	1.1	2.5	3.8	3.3	1.2	34.9	
Percent (%)	9.1	28.8	4.4	10.5	7.6	5.4	3.2	7.1	10.9	9.3	3.5	100	

Remarks:
1 Lost bit cones/inserts in hole required deployment of mills, junk baskets, and tricone bits.
2 Jay-slot/jay-dog interference problem—possible damaged jay-slots in casing hanger.
3 Lost bit guide while running to bottom—latch pre-release?
4 Trouble engaging overshot—possible alignment problem. Stuck center bit.
5 Several meters of fill/cuttings (?) in hole.
6 Overran sand line. Also unrelated Totco depth indicator problem.
7 Tensioning tool unable to slide in jay-slots. No circulation except up drill-pipe annulus to ship.
8 Required recovering bit guide with fishing tool.
9 Deployed modified 6-3/4-in. back-off assembly with 10-3/4-in. back-off nut.
10 Troubleshooting DCS secondary heave compensator.
11 Assembling second HRB for deployment.
12 Deploying 6-3/4-in. back-off system (7-1/4-in. bit) as first-stage DI-BHA.
13 Initiating hole at seafloor with 7-1/4-in. diamond bit/2-cone center bit.

ridge crest at Site EPR-2. These were designated Holes 864A, 864B, and 864C.

The first HRB assembly was used to spud Hole 864A at a drill-pipe dual-elevator stool depth of 2581.7 m (Fig. 4). Deployment went smoothly except for interference problems getting the base past the locking fingers on the lower guide horn assembly in the moonpool. This problem was rectified by removing two of the leg guides and the two angle brackets welded to the rim of the base halves. After completion of the modifications the HRB was deployed (narrowly slipped) through the moonpool and run to bottom. The trip was slowed somewhat due to the necessity to gage (confirm that only N80 turned-down joints were on the bottom), strap (measure length), and rabbit (drift the inside diameter) all tubulars on the way in. Landing the heavy base (128,000 lb) on the hard seafloor was facilitated by stroking the compensator out to its full stroke and then setting it to begin closing with a 30,000-lb load. This enabled the base to "land" somewhat gently in the moderate sea and swell conditions. The technique worked perfectly and the HRB came to rest comfortably on the seafloor. Two methods of determining base tilt angle were used. The electronic "tilt" beacon signal and the two mechanical slope indicators (bull's-eyes) agreed remarkably well and the composite slope of the base was determined to be 2° to 5° and holding firm. Once the base was released from the double-jay running tool, a short TV survey of the seafloor was conducted. Results of the survey determined that the base was resting just off the ODP flow unit in a trough parallel to the west wall of the axial summit caldera. The base was reattached to the drill string via the double-jay tool and moved 145 ft east and 10 ft south to the desired drilling location. The initial tilt angle was less than 2°; however, after the base "settled in" overnight the final tilt angle resulted in a slope of 6.0° to the west and 4.4° to the north. This attitude remained constant for the remainder of drilling operations at this hole. A second TV survey indicated that the landing spot was free of any major cracks or fissures (Fig. 4). The drill string was recovered and preparations begun for deploying the first-stage drill-in BHA.

First Primary Drill-in BHA (12-1/2-in.) and First Deployment of Positive Displacement Coring Motor

Hole 864A was spudded with a primary or first-stage DI-BHA. This initial deployment of the upgraded Leg 142 version of the

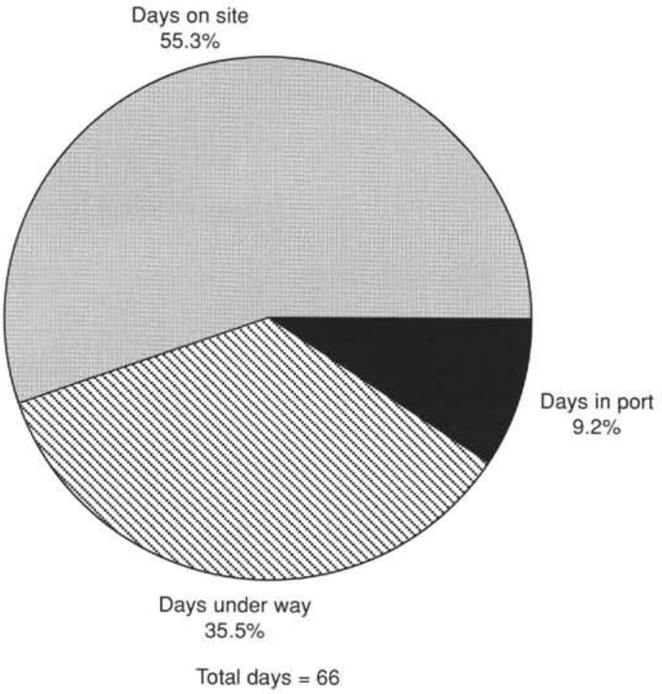

Figure 3. Total time distribution during Leg 142.

DI-BHA consisted of a 12-1/2 × 7-3/8-in. M89TF 6-cone bit, a spiral blade stabilized bit sub/crossover sub, one 20-ft 10-3/4-in. drill collar and a 10-3/4-in. back-off assembly. Inside the throat, and spaced out 2.0 in. ahead of the primary drill bit face, was a 7-1/4-in. M89TF 2-cone center bit. Rotational torque for the center bit was transferred through a casing advancer latch in series with a modified XCB latch for hold-down. Drilling with this assembly progressed very slowly, as would be expected in drilling a 12-1/2-in. hole into bare, hard rock right from the surface. Drilling parameters were kept quite modest, with weight-on-bit (WOB) initially kept at 2000–6000 lb and eventually reaching 6000–10,000 lb as the bit progressed into the formation. Circulation rates varied between 150 gallons per minute (gpm) initially to 450 gpm later in the bit run. Rotational torque was provided by a 9-1/2-in. Mach I mud motor (modified as a positive displacement coring motor, or PDCM). During the course of the next 24 hr approximately 3.4 m of 12-1/2-in. hole was made into the crust. During this period the pipe became stuck three times requiring 20,000, 15,000, and 60,000 lb of overpull, respectively, to free. Use of the mud motor, although convenient for leaving the TV/VIT frame deployed, was not optimum for drilling. The motor tended to stall often, not allowing any consistent rotational speed/torque to be achieved. Another large drawback to use of the motor was the required use of extremely high flow rates (400–600 gpm) in order to achieve maximum motor torque (8000 ft-lb). This undoubtedly led to an eroded hole at the top and contributed significantly to the hole-cleaning problems experienced later in the drilling operation. A final drawback to operational use of the motor was the limited drilling data received. The only input received by the driller is pump pressure and flow rate. Actual downhole rpm and torque must be derived from the motor curves and is only theoretical at best. The hole was swept liberally during and after drilling operations with high-viscosity bentonite gel mud, and a wiper trip to mud line indicated that the hole was left clean and relatively stable.

Upon recovery of the BHA the 12-1/2-in. tricone bit was found to have 5 of 6 cones missing. The sixth cone was in very good condition with little wear on the cutting structure and the bearing/seal in good condition. The 2-cone center bit bearings/seals and cutting structure was also found to be in good condition. The five failed bearing shafts were bent (rolled) upward, indicating that the failure mode of the bit was dynamic loading of the small diameter shafts. This was obviously due to pounding of the drill bit on bottom. With literally no lateral stabilization of the BHA during bare-rock spudding, very light bit weights must be used. With only light bit weight it becomes increasingly more difficult to keep the bit on bottom if there is any significant heave/swell condition present. Surface observations were that the heave was 2–3 m over the last 12 rotating hr; however, it is not known what kind of cyclical loading the bit was actually seeing on bottom.

First 9-1/2-in. Mill/Junk Basket/Tricone Deployment

The loss of bit cones/inserts in the hole necessitated a round trip of the drill pipe to deploy a concave, carbide-faced, mill and junk basket. This assembly appeared to be successful at cleaning out the hole. A bonus was the coarse volcanic glass cuttings recovered in the junk basket. These were of great interest to the scientific party and drillers alike, as they indicated that the "spudded" ponded lava flow had apparently been penetrated and a new glassy formation encountered. No junk was recovered, apparently indicating what was left in the hole had either been ground up and circulated away or had been pushed to the side in the eroded hole.

To ensure a clean hole and, it was hoped, to extend the hole depth closer to the 6.3 m required for back-off, a 12-1/2-in. tricone drilling bit was run in the hole. This bit was significantly more robust in cone/bearing size and we felt it had a much better chance of survival in the hostile drilling conditions encountered. To increase the chances for removing junk and obtaining valuable scientific samples, two junk baskets were run in tandem this time.

Drilling proceeded rapidly at first through the suspected glassy, rubble layer. A drilling break was detected after penetrating about 1.2 m in 18 min. At this point the drilling again became hard and the penetration rate fell way off. An additional (apparent) 1.2 m of penetration took 2.7 hr to drill in what was interpreted to be a very massive or at least a very hard formation. All drilling was done with the Varco top drive this time, but the very light bit weights that were required hampered efficient penetration once again. At this point actual vs. perceived depth below seafloor became an issue. The 1.0- to 1.5-m tidal cycle on site was found to be somewhat inconsistent and obviously other forces were at work influencing water depth at any given point in time. With very slow rates of penetration (1.0–2.0 m per day) the actual depth below seafloor became somewhat questionable. This problem was somewhat circumvented later in the leg by painting marks on the drill collars and judicial use of the TV/VIT assembly. With an apparent penetration depth below seafloor of 6.6 m, the hole was swept with gel mud and a wiper trip made. The hole appeared stable and the drill string was recovered. Upon recovery of the BHA the tricone bit was found to be in re-runable condition and both junk baskets again recovered a significant amount of rock/cuttings samples.

Second Primary Drill-in BHA (12-1/2-in.)

For the second time the primary DI-BHA was run in the hole (RIH) for a back-off attempt. This time a new 12-1/2 × 7-3/8-in. 6-cone bit was used and the original 2-cone center bit was re-run. In theory, neither bit would have to make any hole since the hole depth required to seat the back-off nut on the landing seat was only 6.3 mbsf. Upon reentry, the hole was found to have approximately 1 m of fill. Circulation gained another 1/4 m and the TV/VIT assembly was recovered. Drilling down to the original total depth progressed quite rapidly once rotation was initiated, but once on the hole bottom conditions deteriorated rapidly. High, erratic, torque and stuck pipe led to several false back-off indications. It was unclear whether the downhole problems were related to hole instability, junk in the hole, or hardware problems with the back-off assembly. The drill string was recovered at that point so that all hardware could be inspected and so that the required breakout torque on the 10-3/4-in. back-off nut could

Table 5. Operations time distribution for Holes 864A, 864B, and 864C.

Date (1992)	Hole	In port	Transit	Survey	Waiting on weather	SEDCO breakdown	Trip	Drilling	Coring	Stuck pipe and hole troubles	Logging and downhole measurement
12 Jan.		6.50	—	—	—	—	—	—	—	—	—
13 Jan.		24.00	—	—	—	—	—	—	—	—	—
14 Jan.		24.00	—	—	—	—	—	—	—	—	—
15 Jan.		24.00	—	—	—	—	—	—	—	—	—
16 Jan.		24.00	—	—	—	—	—	—	—	—	—
17 Jan.		24.00	—	—	—	—	—	—	—	—	—
18 Jan.		19.50	4.50	—	—	—	—	—	—	—	—
19 Jan.		—	25.00	—	—	—	—	—	—	—	—
20 Jan.		—	25.00	—	—	—	—	—	—	—	—
21 Jan.		—	24.00	—	—	—	—	—	—	—	—
22 Jan.		—	24.00	—	—	—	—	—	—	—	—
23 Jan.		—	25.00	—	—	—	—	—	—	—	—
24 Jan.		—	24.00	—	—	—	—	—	—	—	—
25 Jan.		—	24.00	—	—	—	—	—	—	—	—
26 Jan.		—	24.00	—	—	—	—	—	—	—	—
27 Jan.		—	24.00	—	—	—	—	—	—	—	—
28 Jan.		—	25.00	—	—	—	—	—	—	—	—
29 Jan.		—	24.00	—	—	—	—	—	—	—	—
30 Jan.	864A	—	2.00	—	—	—	—	—	—	—	—
31 Jan.	864A	—	—	—	—	—	—	—	—	—	—
1 Feb.	864A	—	—	—	—	—	—	—	—	—	—
2 Feb.	864A	—	—	—	—	—	—	—	—	—	—
3 Feb.	864A	—	—	—	—	—	—	—	—	—	—
4 Feb.	864A	—	—	—	—	—	—	—	—	—	—
5 Feb.	864A	—	—	—	—	—	—	—	—	—	—
6 Feb.	864A	—	—	—	—	—	—	—	—	—	—
7 Feb.	864A	—	—	—	—	—	—	—	—	—	—
8 Feb.	864A	—	—	—	—	—	—	—	—	—	—
9 Feb.	864A	—	—	—	—	—	—	—	—	—	—
10 Feb.	864A	—	—	—	—	—	—	—	—	—	—
11 Feb.	864A	—	—	—	—	—	—	—	—	—	—
12 Feb.	864A	—	—	—	—	—	—	—	—	—	—
13 Feb.	864A	—	—	—	—	—	—	—	—	—	—
14 Feb.	864A	—	—	—	—	—	—	—	—	—	—
15 Feb.	864A	—	—	—	—	—	—	—	—	—	—
16 Feb.	864A	—	—	—	—	—	—	—	—	—	—
17 Feb.	864A	—	—	—	—	—	—	—	—	—	—
18 Feb.	864A	—	—	—	—	—	—	—	—	—	—
19 Feb.	864A	—	—	—	—	—	—	—	—	—	—
20 Feb.	864A	—	—	—	—	—	—	—	—	—	—
21 Feb.	864A	—	—	—	—	—	—	—	—	—	—
22 Feb.	864A	—	—	—	—	—	—	—	—	—	—
23 Feb.	864A	—	—	—	—	—	—	—	—	—	—
24 Feb.	864A	—	—	—	—	—	—	—	—	—	—
25 Feb.	864A	—	—	—	—	—	—	—	—	—	—
26 Feb.	864A	—	—	—	—	—	—	—	—	—	—
27 Feb.	864B	—	—	—	—	—	—	—	—	—	—
28 Feb.	864B	—	—	—	—	—	—	—	—	—	—
29 Feb.	864B	—	—	—	—	—	—	—	—	—	—
1 Mar.	864B	—	—	—	—	—	—	—	—	—	—
2 Mar.	864B	—	—	—	—	—	—	—	—	—	—
3 Mar.	864B	—	—	—	—	—	—	—	—	—	—
4 Mar.	864C	—	—	—	—	—	—	—	—	—	—
5 Mar.	864C	—	—	—	—	—	—	—	—	—	—
6 Mar.	864C	—	9.50	—	—	—	—	—	—	—	—
7 Mar.	864C	—	24.00	—	—	—	—	—	—	—	—
8 Mar.		—	25.00	—	—	—	—	—	—	—	—
9 Mar.		—	24.00	—	—	—	—	—	—	—	—
10 Mar.		—	24.00	—	—	—	—	—	—	—	—
11 Mar.		—	25.00	—	—	—	—	—	—	—	—
12 Mar.		—	24.00	—	—	—	—	—	—	—	—
13 Mar.		—	24.00	—	—	—	—	—	—	—	—
14 Mar.		—	25.00	—	—	—	—	—	—	—	—
15 Mar.		—	24.00	—	—	—	—	—	—	—	—
16 Mar.		—	24.00	—	—	—	—	—	—	—	—
17 Mar.		—	24.00	—	—	—	—	—	—	—	—
18 Mar.		—	8.00	—	—	—	—	—	—	—	—
19 Mar.		—	0.00	—	—	—	—	—	—	—	—
Hours		146.0	559.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Days		6.1	23.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent (%)		9.2	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Port call:	Transit:	On site:	Total:
Days:	6.1	23.3	36.5	65.9
Percent (%):	9.2	35	55.4	100.0

Table 5 (continued).

Reentry	Casing and cementing	Fishing and remedial	Development engineering	ODP breakdown	Other	Total	Remarks
—	—	—	—	—	—	6.50	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	25.00	Retired clock
—	—	—	—	—	—	25.00	Retired clock
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	25.00	Retired clock
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	25.00	Retired clock
—	—	—	—	—	—	24.00	
2.25	—	—	18.75	—	1.00	24.00	Development engineering
0.75	—	—	23.25	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
2.25	—	—	21.75	—	—	24.00	Development engineering
2.50	—	—	21.50	—	—	24.00	Development engineering
1.25	—	—	22.75	—	—	24.00	Development engineering
0.75	—	—	23.25	—	—	24.00	Development engineering
1.25	—	—	22.75	—	—	24.00	Development engineering
0.25	—	—	23.75	—	—	24.00	Development engineering
0.75	—	—	23.25	—	—	24.00	Development engineering
0.50	—	—	23.50	—	—	24.00	Development engineering
1.00	—	—	21.50	—	1.50	24.00	Development engineering
0.25	—	—	23.75	—	—	24.00	Development engineering
0.25	—	—	23.75	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
0.50	—	—	23.50	—	—	24.00	Development engineering
0.50	—	—	23.50	—	—	24.00	Development engineering
—	—	—	22.50	—	1.50	24.00	Development engineering
1.25	—	—	22.75	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
0.25	—	—	23.75	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
—	—	—	24.00	—	—	24.00	Development engineering
3.50	—	—	20.50	—	—	24.00	Development engineering
1.25	—	—	22.75	—	—	24.00	Development engineering
0.75	—	—	23.25	—	—	24.00	Development engineering
1.50	—	5.00	17.50	—	—	24.00	Development engineering
0.25	—	—	23.75	—	—	24.00	Development engineering
1.25	—	—	22.75	—	—	24.00	Development engineering
—	—	—	10.25	—	4.25	24.00	Development engineering
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	25.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	24.00	
—	—	—	—	—	—	25.00	Retired clock
—	—	—	—	—	—	24.00	Estimate
—	—	—	—	—	—	24.00	Estimate
—	—	—	—	—	—	25.00	Retired clock
—	—	—	—	—	—	24.00	Estimate
—	—	—	—	—	—	24.00	Estimate
—	—	—	—	—	—	24.00	Estimate
—	—	—	—	—	—	8.00	Estimate
—	—	—	—	—	—	0.00	Estimate
25.0	0.0	5.0	838.3	0.0	8.3	1581.5	
1.0	0.0	0.2	34.9	0.0	0.3	65.9	
1.6	0.0	0.3	53.0	0.0	0.5	100.0	

Table 6. HRB emplacement for Holes 864A, 864B, and 864C.

HRB no.	Hole	Deployment date (1992)	DES depth (m)	Assembly (hr)	Deployment (hr)	1st stage DI-BHA depth (mbsf)	2nd stage DI-BHA depth (mbsf)	Total DCS depth (mbsf)	Remarks
1	864A	30 Jan.	2581.7	31	22.75	6.3	13.3	15	1
2	864B	27 Feb.	2582.9	31	11.25	N/A	7.3	N/A	2
2	864C	4 Mar.	2582.9	N/A	13.00	N/A	6.8	N/A	3

Notes: Assembly time includes ballasting and weld-out time. N/A = not applicable.

Remarks: 1 Deployment time includes BHA make-up and round-trip time, TV, rig floor preparations, gauging/drifting all tubulars while RIH, reading slope indicators, and checking bottom for proximity of cracks/fissures. Also includes 1.75 hr to reenter and jay-in and move HRB to new site and 8 hr to load bulk barite for additional ballast. Status: 6-3/4-in. DI-BHA installed (minimum 4.05-in. bore). Surface set and impregnated diamond bit crown matrix in hole.

2 Heavy (12 lb) mud slurry used instead of bulk ballast required 30 min to load. Deployment time includes all indicated in 1.0 above except gauging and drifting was not required. Status: HRB was moved to a new location and used for spudding Hole 864C. Drilled-in 6-3/4-in. DI-BHA was left in-hole.

3 This hole was spudded using the HRB originally deployed for Hole 864B. It was drilled to 6.8 mbsf with a 7-1/4-in. diamond bit. Installed in the HRB is a 7-3/8-in. landing seat for a 6-3/4-in. DI-BHA. This limits future drilling systems to 7-1/4-in. maximum outside diameter. Status: Open to further drilling operations with DCB or DCS.

be confirmed at the rig floor. Once recovered it became apparent that the taper on the back-off nut did not reach the landing seat. Hole depth was apparently short of that required for back-off. The 6-cone bit was again damaged, leaving one cone in the hole. Again, the other cones did not show appreciable cutter or bearing wear; however, the bit body suffered severe damage from junk and/or formation after only 10 min rotating time downhole. Several small, angular chunks of volcanic rock were found wedged between bit cones and extended wear pads probably preventing the bit cones from rotating. This, coupled with the same dynamic bit loading problem, probably lead to premature bit failure.

Second 9-1/2-in. Mill/Junk Basket Deployment

After milling on downhole junk and/or formation rubble for 3-1/4 hr the borehole again appeared to be clean and the milling/junk basket BHA was recovered. Supposition was that some rubble may be forced into the hole by the bit sub stabilizer blades while heaving in the hole during TV/VIT recovery. This will have to be studied further for future drilling operations in these areas. The drill string was then recovered in preparation for another back-off attempt.

Third Primary Drill-in BHA (11-1/4-in.) and Second PDCM Deployment

Prior to a repeat RIH with the primary drill-in BHA, the back-off assembly was broken out and re-torqued at the rig floor as added insurance that all systems were functioning as they should. Although the breakout torque was lower than expected, the testing was successful and the tools were made up for RIH. This time the BHA was terminated with an 11-1/4-in. surface-set diamond bit using a natural "carbonado" diamond. These diamonds, known as "black" diamonds, have no natural cleavage planes and are considered to be the toughest natural diamond in existence. The center bit used was a prototype 7-1/4-in. C-7/1-cone bit. This single-cone center-bit design was brand new and had not been used on any earlier leg. The cone/bearing assembly was extremely robust and we felt that this relatively benign test would be a good first trial. Although it was uncertain whether the diamond bit could drill this formation, we decided that another roller cone–type bit should not be run in the hole and that any new hole required to reach the back-off point would be quite small. Because of the aforementioned rationale, and in order to conserve the amount of time spent waiting on TV/VIT trips, the PDCM mud motor was again picked up as part of the BHA.

After reentry was accomplished, 2 hr were required to slowly ream/wash through 2.0 m of fill/rubble. According to the drill-collar paint marks viewed via subsea TV the back-off nut had to be close to seating. Several false indications of back-off were experienced (another drawback to using the mud motor) before it was finally determined that something must be wrong downhole. Little or no additional penetration had been achieved.

Upon recovery of the BHA the primary bit and center bit were found to be virtually unscathed. Little or no wear was evident and there was no evidence that the back-off nut had ever seated in the landing sleeve. A thorough inspection of the remaining BHA shed no light on the failure to drill ahead since there were no distinctive marks anywhere to indicate a mechanical interference problem downhole. The resultant conclusion was that the diamond bit failed to penetrate due to inadequate junk slots to remove fill/rubble in the hole or possibly because the single-cone center bit was acting as a pivot point and was not allowing the diamond bit to actually contact the formation and drill ahead. Since this was the second time that the back-off nut showed no sign of contacting that landing taper it was also determined that the hole still must be short of the required 6.6-m depth. The PDCM mud motor was circulated with fresh water and rigged down since it was unlikely that it would be used again during the remainder of the leg.

Second Tricone/Third Junk Basket Deployment

A 12-1/2-in. tricone bit (re-run) was put downhole, again in concert with a tandem junk basket arrangement. This time the junk baskets were more for collecting rock samples than for actually removing junk from the hole. A little over 5 m of fill was encountered on this trip but this was reamed/washed out in short order (15 min) with the tricone/top-drive system. Paint marks on the drill collars seemed to indicate that the hole was actually 6.1 m deep or 0.2 m shy of the necessary depth. The next 5-1/2 hr were spent alternately drilling ahead and then deploying the TV/VIT assembly for a seafloor depth check. The pipe became stuck once during this time frame, requiring 65,000-lb overpull to become free. Liberal use of high-viscosity mud flushes were required to aid in holding the hole open and removing cuttings. The last 15 min of drilling achieved a gain of 0.3 m when another obvious drilling break occurred. An additional 2-1/2 hr were required to stabilize the hole using wiper trips, high-viscosity mud sweeps, and ultimately displacing the hole with 12 lb per gallon of drilling mud. Once completed, the hole appeared stable and the drill string was recovered.

Fourth Primary Drill-in BHA and Clean-out Bit Body

Since there was no question that an adequate amount of hole had been made and there was concern over losing bit cones or inadequate junk slots in the diamond bits, a homemade clean-out bit was used on

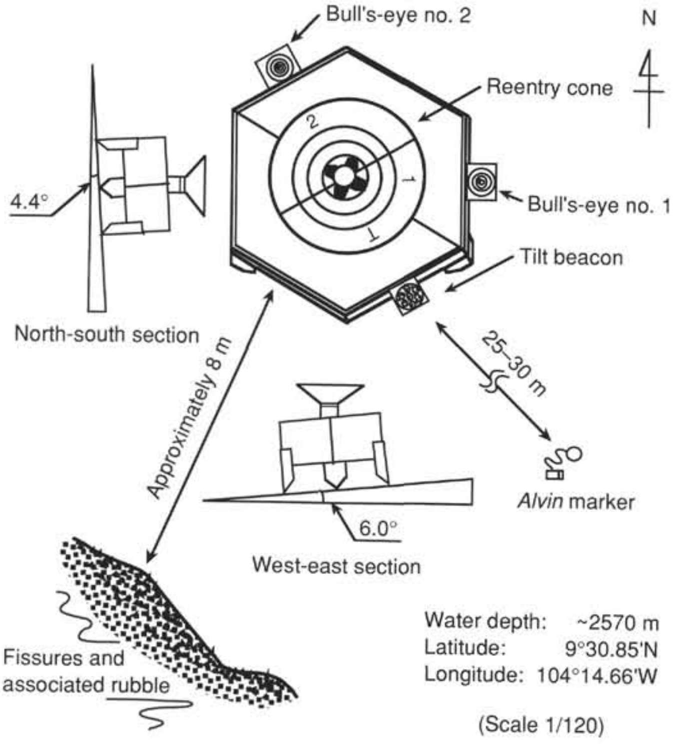

Figure 4. Hard-rock guide-base orientation, Hole 864A. Scale 1:120.

this DI-BHA deployment. The body from the originally deployed 6-cone bit had the remaining bit cone/leg removed. The three robust, carbide-tipped, extended-wear pads were left intact to act as drag-type cutters and, it was hoped, to aid in getting any cuttings/rubble out of the hole while cleaning out to bottom. This bit, mated with another 7-1/4-in. 2-cone center bit and a "smooth" (no stabilizer blades) bit sub, was RIH below the 6.3-m-long 10-3/4-in. DI-BHA. The deployment from this point on was routine. The hole was entered and the bit went straight to bottom without encountering any fill. The TV/VIT frame was recovered and an initial back-off attempt was made with 4000–6000-lb weight down and 5000 ft-lb torque. When picked up, all BHA weight was there, so a second attempt was made with more weight (8000–10,000 lb) applied to the landing taper. This time a torque of 9500 ft-lb was noted and when picked up, the BHA hanging weight was 4000–6000 light. At this point the VIT frame was deployed, and as the drill string was pulled out of the hole a successful back-off was verified. The drill string and TV/VIT frame was then recovered back to the ship.

First Bit-Guide Deployment with Tensioning Jay-Tool

The first attempt to deploy the bit-guide assembly with the tensioning jay-tool met with problems when the dogs of the jay-tool would not fully enter the jay-slots of the casing hanger at the seafloor. The jay-tool had been fit-tested on deck in the casing hanger jay-slots prior to RIH in all four possible positions. Therefore, we believed that the problem resulted from one of three possibilities. One explanation was that the tolerance between the dogs and slots may have been too tight and the alignment downhole too critical to allow insertion without perfect attitude of the drill pipe/jay-tool relative to the jay-slots in the casing hanger. Another explanation was that the jay-slots on the casing hanger had been damaged by the repeated rotation of the BHA inside the hanger while attempting to drill/ream the hole down to the 6.6 mbsf. Hardened stabilizer blades on the bit subs of the DI-BHA assembly also could have contributed to the excessive wear, brinelling, and/or damage. In either of these cases the only fix was to recover the tensioning jay-tool and grind down the dogs, providing more clearance in the suspect jay-slots. It was possible that the DI-BHA was actually setting too high in the hole, thus preventing the jay-tool from traveling far enough down into the hanger to reach the end of the jay-slots. Based on a TV survey over the top of the cone, with the VIT frame after back-off, this was not felt to be the case. Therefore, the drill string was tripped out of the hole for modification of the jay-dogs.

After modifying the jay-dogs, the tools were again run to bottom and a reentry made. Attempts to jay-in were made without picking up the top drive to save time; however, jay-in was unsuccessful and it was decided that the top drive should be used on further attempts. The pipe was pulled out of the cone and the sinker bars were recovered. The sinker bars and wireline retrieving tool had been inserted earlier to allow recovering the bull nose plug from behind the bit-guide deployment tool when it was time to drop the bit guide in place. After picking up the top drive a reentry search was begun. While maneuvering for reentry it was noticed that the bit guide had pre-released from the deployment tool and was no longer there. It would have been too risky to reenter and check for jay-in capability with the exposed "flipper dogs" on the bottom of the jay-tool. It was quite possible that during the reentry attempt a dog could have been broken off and then fallen into the hole. Therefore, the drill string was pulled out of the hole to check the tensioning jay-tool/bit-guide delivery tool. Once recovered on deck, nothing seemed to be wrong with the assembly. It is not known why the tool prematurely released the bit guide unless it was not firmly latched when it was originally started in the hole. A thorough inspection of the bottom end of the jay-tool gave no indication that the drilled-in BHA was sitting high in the hole, thus preventing jay-in.

An additional pipe trip was then made with the back-off assembly to positively verify DI-BHA location in the borehole. After reentry, drill-collar paint marks confirmed that the first stage of the DI-BHA was located in the correct position downhole and was not interfering with the jay-in operation.

After recovering the drill string the BHA was changed over to a tensioning jay-tool/bit-guide deployment tool and a new bit guide was RIH. About 30 min were required after reentry before jay-in was achieved. Eventually the correct offsets were entered into the ship's positioning system and the drill pipe aligned itself well enough to allow full engagement of the jay-dogs. A tension of 20,000 lb verified proper engagement of the jay-tool. The overshot assembly was then deployed via the coring line and the bull plug go-devil was recovered, releasing the bit guide.

After un-jaying, and pulling clear of the reentry cone, the coring line was again RIH to engage and remove the center-bit assembly from the DI-BHA. Upon reentering the cone, difficulty was experienced engaging the overshot. This was not unanticipated because of the amount of clearance directly above the pulling neck and the relatively small diameter of the overshot engaging tool. Centralizer springs, brought out for this reason, were not used because of past problems losing centralizer springs from logging tools downhole. Since the available centralizers were not particularly robust it was decided to modify the overshot lead-in cup instead with a small reverse funnel. Engagement of the pulling neck was achieved but the center bit would not come free despite several attempts to jar it loose with the wireline jars. The drill string was then recovered and run back in the hole with the lower sub (including latch engagement profile) attached to the bottom. This arrangement allowed tension to be applied to the stuck center bit via the drill pipe while tension was applied to the pulling neck with the coring line in order to unlatch the latch dogs. An overpull of 10,000 lb with the drill string did not free the center bit but actually lifted the entire DI-BHA assembly and bit guide. When this was witnessed via TV the entire assembly was circulated back to bottom. While sweeping the pipe with a 30-bbl high-viscosity mud pill the BHA weight was lost and the center bit came free leaving the BHA in place.

Deployment of Tensioning BHA

After slipping and cutting the drill line the tensioning BHA was made up. This assembly consisted of a tensioning jay-tool, a tapered stress joint, and a prototype break-away "safety" joint. This sub was new for Leg 142 and was incorporated into the tensioning assembly to allow clean separation from the HRB should a positioning drive-off occur. The flange mating the tensioning jay-tool to the lower end of the tapered stress joint was made up with 16 each, 1-1/8-in. diameter, grade SAE J-429 bolts torqued to 900 ft-lb. The tensioning BHA was run in the hole without incident and a wiper plug (poly plug) was pumped through the drill pipe to clear any loose accumulation of rust/scale.

Space-out for reentry, jay-in, and proper DCS platform positioning was then worked out. Reentry was made to verify that the space-out technique was correct, to verify platform location with 50,000-lb tension applied to the drill string, and to ensure that the jay-slots were operational prior to tripping in the DCS tubing string. Upon entering the cone the jay-dogs slipped immediately into the vertical jay-slots, but before tool could be run to bottom of the jay-slots, lack of available travel on the guide rails necessitated picking up another 5-ft drilling pup joint. After adding the pup the jay-dogs would not re-engage the slots in the casing hanger. After several futile hours the tensioning BHA was recovered and it was found that the slip joint on the end of the jay-tool was jammed in the closed position and had fine cuttings around the lower end. Apparently fine cuttings/fill had been swabbed into the primary DI-BHA while heaving in the hole and picking up the 5-ft pup joint. The fill prevented the jay-tool from engaging the slots in the casing hanger during the second jay-in attempt.

Another round trip of the pipe was made after remedial work was made on the lower end of the slip joint and additional shaving of the jay-dogs was completed. This assembly, when RIH, encountered 3.8 m of fill in the hole. Washing to bottom was slow because rotation of the slip joint was not possible and the assembly was not designed for hole cleaning. Once on the "apparent" bottom of the hole, the jay-tool still was unable to reach the bottom of the jay-slots and it was feared that the DI-BHA was sitting too high in the hole. It was possible that the BHA did not go completely to bottom when the center bit came free earlier. Upon recovery of the BHA, distinctive marks were found on the lower end of the tensioning tool indicating that the tool was bottoming out on the top of the bit guide. To circumvent the problem the sub used for the bit-guide deployment was modified (flipper dogs removed and slots sealed) and made up to the bottom of the jay-tool. This sub was significantly shorter than the other crossover sub. Later it was determined that a vendor had made a mistake in designing the crossover sub in failing to allow enough clearance below the upset outside diameter to accommodate the bit guide. The DI-BHA was again confirmed as being in the correct position. Once the modified tensioning assembly was RIH, the tensioning jay-tool engaged the jay-slots without any problem and 50,000-lb overpull was applied to the drill string as a test of the tensioning system and to allow verification of the DCS space-out dimensions. The tools were then un-jayed, pulled clear of the reentry cone, and hung-off in the rotary table in preparation for picking up the DCS platform and stripover operations.

DCS Platform Rig-up, Stripover, and Tubing Tripping

The first rig-up and trip of the DCS tubing string went exceptionally well considering that this was a nonstandard routine for the floor crew. Eight extra stands of S-130 tubing were made up and racked in the forward starboard corner of the rig floor. This allowed the crew to become familiar with the equipment and also get the Weatherford spinning wrench adjusted to the right pressures for correct make-up/breakout torques. Prior to RIH with the first tubing joint the DCS core-barrel assembly was made up. This consisted of a Longyear series-2 impregnated diamond core bit (4.960 × 2.2 in.), a reaming shell, an outer tube, and an adapter coupling. The bit had a carbon plug glued (with Baker-Loc) to the face for damage protection during the trip in the hole.

The first trip in the hole was also slowed by the need to gage (ensure only N-80 turned down joints on bottom) and drift (check for adequate inside diameter clearance) each joint. The tubing had already been tallied and strapped (measured) while under way to the site. With each successive trip of the tubing string, the rig-up/rig-down time got progressively shorter and the actual tubing trip times became faster.

Once the tubing string had been RIH it was hung-off in a set of tubing slips made to set on the upper box connection of the 5-in. API drill string. Preparations were then begun to pick up the DCS platform.

DCS Platform Rig-up and Stripover

The initial deployment (rig-up) of the DCS platform was slower than those done later in the leg. This was due to several one-time tests, adjustments, etc., that had to be done but would not need to be repeated prior to later rig-up sequences. Details of the rig-up/rig-down and stripover procedure are included in the DCS engineering report (Briggs et al., this volume). In general, the following operations had to be performed: rig-down tubing running equipment; rig-down the iron roughneck and dual-elevator handler and remove the mouse hole from the rig floor; install the forward I-beam (platform-handling dolly track) and DCS dolly rollers; move DCS platform over well center, fit dolly roller assemblies to the guide rail in the derrick and pin bales to DCS mast; modify and secure coring winch sinker-bar guide; replace broken roller on guide dolly; install tubing spool on top drive; install roof and wind walls on DCS platform; load 10-ft drilling joints into DCS rod basket; remove 45-ft diving board in derrick; prepare platform shock-cylinder system; charge shock cylinders with nitrogen; repair hydraulic leaks in forward shock-cylinder circuit; replace shock-cylinder relief-valve cartridge; troubleshoot and repair check valve in aft shock-cylinder hydraulic circuit; install kelly hose; clean out DCS drip pans; raise/lower platform mast assembly to check shock-cylinder system and check for adequate clearances in derrick; adjust shock-cylinder pre-charge pressure and retest; test-run DCS coring winch and check/adjust level wind system; and retract core winch line spooler. Finally two knobby drilling joints were taken out of the string and the Varco top drive was picked-up. Once these and scores of more minor operations were completed (33-1/2 hr later) the platform was finally in the air and the stripover operation was ready to begin.

Stripover is a complex, time-consuming operation critical to the DCS deployment. Once the drill pipe has been run and hung-off, the DCS tubing string has been run and hung-off inside the drill pipe, and the DCS platform has been picked up, then the stripover operation can begin. The purpose of stripover is to connect the DCS tubing string to the raised platform and the 5-in. API drill string to the bottom of the Varco top drive or elevator bales. Details of this operation are contained in the DCS engineering report (Briggs et al., this volume). The first stripover operation was completed in 6-1/2 hr. One problem was experienced: when three stripover DCS drilling joints were lowered into a knobby drilling joint (sitting in the mouse hole) with the DCS core line, the joints were inadvertently lowered too far and went out through the bottom of the mouse hole. When the driller raised the blocks to pick up the knobby joint, the adapter sub on top of the drilling joints hung up on the bottom of the mouse hole and the core line then failed at the rope socket. The incident resulted in three lost 10-ft DCS drilling joints and the DCS core line had to be re-terminated with a new rope socket.

Jay-in and DCS Platform Operations

With the HRB reentered and the stripover operation completed, attempts were made to jay-in and tension-up the drill string. The assembly began to take weight 5 m off bottom, indicating a substantial amount of fill had again entered the cased hole. The fill must have been systematically "swabbed" into the hole during the time-consuming stripover operation. The fill was eventually circulated out of the hole and approximately 2-1/2 hr later jay-in was completed. While tensioning the system initially to 50,000 lb all personnel were kept off the platform. This was a safety precaution to ensure that all tensioning systems were functioning normally and that no failure occurred soon after the load was applied. During this time period the packing rubber for the stripper head on top of the Varco top drive was installed and Baravis polymer was mixed for circulation into the drill pipe/tubing string annulus to be used as a friction reducer. The stripper head is designed to allow circulation down the annulus while the DCS tubing string is inserted in the pipe.

Once the tensioning test was completed the DCS rig personnel went aloft and DCS platform operations commenced. There was a three-man team working each 24-hr tour on the DCS platform. Each team consisted of an ODP engineer, a TONTO diamond driller, and a SEDCO driller. The first order of business was to begin pumping and establish baseline pump pressures with the DCS core barrel both landed in place and removed from the outer tube. Several problems occurred during this first DCS platform deployment. Fill was swabbed into the hole during the initial inner-tube recovery sequence due to retrieval of the tube at too high a rate coming off bottom. The DCS coring line was overrun while running in to recover the DCS inner tube. The Totco wireline weight indicator required repair. While recovering the first core barrel the overshot pin sheared and the stripper head packing required replacement. Once these problems had been overcome it was discovered that the DCS inner tube was stuck downhole. Eventually the barrel was freed after multiple 8000-lb overpulls and jarring attempts were made. Once the barrel was recovered, however, circulation remained plugged off and all attempts to restore it were to no avail. The fine sandy fill had apparently infiltrated everywhere.

Once the DCS inner tube was on deck attempts were made to un-jay it from the casing hanger so that the DCS tubing could be recovered. It became apparent immediately that the tensioning jay-tool could not stroke down in the slots that allow un-jaying to take place. The hole beneath the jay-tool had also filled with cuttings, eliminating the required 22 in. of open hole required for downward stroke of the jay-tool. The slip joint had either been sanded up or was in the fully collapsed position already. Several hours were spent attempting to restore circulation and free up the jay-tool. After much discussion it was decided that drilling/coring should be pursued with the DCS taking returns up the drill string/tubing annulus. This had never been done before but the thought had been entertained that someday a return circulation system could be developed and utilized. Since the tubing was free to rotate and move up/down it was felt that this just might work. It was also felt that this may also free up the jay-tool and allow detachment from the HRB. Since the formation was providing a natural downhole packer/seal the only additional requirement was to line out the standpipe manifold piping slightly differently. The piping was lined out to allow pumping down the DCS tubing with the no. 1 mud pump (dressed with 4-in. liners, 1.95 gallons per stroke) and back up the drill string annulus, then over the side of the ship. Before resuming DCS drilling operations several Baravis mud sweeps were pumped to ensure that all loose rust was purged from the string and the annulus was as clean as possible.

DCS Drilling/Coring with Return Circulation to the Ship

Drilling began with the DCS, using a surface-set diamond center bit in conjunction with the narrow-kerf impregnated diamond bit and taking cutting returns back to the drillship. This procedure worked extremely well and ultimately the plumbing was altered to allow returns into the slug pit. DCS drilling was done without an operational secondary compensation system but the weather was calm enough that it did not create a problem in cleaning out the 7 m of fill contacted up inside the DCS tubing string itself. Initial DCS drilling parameters were as follows: 8000–9000 lb WOB, 50 rpm, 15 spm (30 gpm), 1180–1520 psi, 700–2100 ft-lb torque.

Once the DCS bit passed through the nose of the slip joint/DI-BHA bit the pump pressure dropped radically to 400 psi and the torque also dropped significantly. As drilling proceeded ahead with the DCS it became noticeably harder to control the WOB. The DCS engineers periodically shut down coring operations to troubleshoot the system, but were convinced that the problem was with the radically different drill string pump pressures affecting pump-off pressure and thus DCS "perceived" string weight. With the DCS bit out in open hole the returns did not always come back to the ship. There would be periods of return circulation at high pump pressure, followed by periods during which some of the returns would go out into the formation. Occasionally there would be a big eruption of cuttings at the seafloor and no return circulation would be achieved at all. The pump-pressure swings during all this amounted to more than 1000 psi—a significant amount.

The first DCS core run was attempted from 8.2 to 8.5 mbsf. Throughout the cored interval the secondary compensator acted erratically and there was obvious bit-pounding taking place. After 0.3 m of penetration the tubing flow blocked off, indicating a core block and terminating the cored interval. When attempting to recover the inner tube it was found to be tightly stuck in the outer tube. After several jarring attempts the barrel came free and was recovered back to the ship. Upon arrival the core-lifter case on the bottom of the inner tube was found to be worn back square about 1/4 in. This indicated that the crown on the DCS core bit was likely completely gone. A second barrel was pumped down in an attempt to latch in and check downhole circulating pressure. The pressure blocked immediately upon landing, confirming the downhole problem.

Prior to pulling out of the hole with the DCS string, it was considered advantageous to continue running some secondary compensator tests in an attempt to determine and correct the compensator problems before putting a new DCS bit in the hole on the next tubing trip. Once the testing was completed, high-viscosity mud was spotted in the hole and the DCS drilling joints were tripped, pulling the end of the DCS string up inside the tensioning jay-tool. A mere 15 min were required to un-jay from the casing hanger. The DCS circulation through the DI-BHA was sufficient to free up the jay-tool and clear out any cuttings that were preventing the required downstroke.

The reverse stripover operation was completed, the platform rigged down, and preparations were made for pulling out of the hole with the primary drill string. It was decided to pull this string because of the enormous difficulties brought on by the fill/cuttings in the borehole. It was decided that the only reasonable approach to giving the DCS system a fair chance at coring ahead in this environment was to set the second-stage "nested" DI-BHA, isolate the upper-level fill problem, and deepen the hole farther into what was hoped to be a less hostile interval. The desire was to end the second-stage DI-BHA in a massive volcanic layer rather than in a glassy/void layer where a conduit for fine-grained fill/cuttings could exist. Once the tensioning assembly was on deck preparations began for making up a 7-1/4-in. tricone drilling assembly for predrilling the DI-BHA hole.

Predrilling and Emplacement of Second-stage Drill-in BHA

After reentry, the bit was washed to bottom with no rotation and with the TV/VIT frame down. Hard bottom was tagged at 6.6 mbsf, according to paint marks on the drill collars. A new 7-1/4-in., C-7 tricone drill bit was used to deepen the hole an additional 6.7 m for a total depth of 13.3 mbsf. Drilling proceeded reasonably smoothly. Some occasional light torquing was experienced but nothing like that experienced while drilling the 12-1/2-in. hole at the surface. Drilling parameters were as follows: 50–55 rpm, 50 spm (260 gpm), 350 psi, 8000–10,000 lb WOB, and variable torque of 1000–6000 ft-lb.

After pulling up to mud line, difficulty was experienced getting back down to the bottom of the hole. The pipe appeared to be stopping at about 6.6 mbsf or the original 12-1/2-in. hole depth. Mud sweeps, working the pipe, and offsetting the ship all were ineffective at getting the pipe down to the bottom of the 7-1/4-in. hole. After running in the TV/VIT assembly the pipe appeared to be offset against the south side. The cone also appeared to be gimballing freely when the pipe location was altered. Since the cone cannot rotate on the gimbal when the primary DI-BHA is in place it was immediately suspected that the 10-3/4-in. DI-BHA had moved downhole. The C-ring designed to prevent this occurrence apparently did not engage the slot. It is likely that circulation returns during the drilling of the 7-1/4-in. hole eroded enough of a hole (or natural void) to allow the BHA to slide downward. It is suspected that the square shoulder on the C-ring groove in the casing hanger may have been damaged (brinelled or worn to a taper), preventing the C-ring from engaging properly. The tricone drilling assembly was then pulled out of the hole with the drill string.

Before any remedial action on the hole could be undertaken, the bit guide had to be recovered. A simple fishing tool was constructed and run in the hole to engage the plastic covering of the bit guide. Once the hole was reentered, weight was applied to the bit guide several times and then the tool was pulled out of the hole. Visual observations with the TV/VIT assembly confirmed that the bit guide was recovered and the pipe trip back to the ship began.

After a plan of attack was discussed, the following was decided. First, it was thought unlikely that the primary BHA fell very far or was leaning at too great an angle to reenter with an appropriate termination on the next assembly. Second, it was felt that a 6-3/4-in. back-off nut could be modified by welding on an adapter plate, allowing it to be attached to a larger 10-3/4-in. back-off nut. In this way, a second-stage DI-BHA could be emplaced all the way to bottom, landed, and backed off on the 10-3/4-in. landing seat. If this were accomplished it would no longer matter where the original 10-3/4-in. DI-BHA ended up since the hole would now be cased all the way to bottom anyway. Work was thus begun on the back-off sub modification while the drill string was being pulled out of the hole with the recovered bit guide. In addition to the work on the back-off assembly, thought was also given to piloting the end of the 6-3/4-in. DI-BHA with a bull nose plug latched in place with the modified XCB latch just as a center bit would be. This idea was ultimately rejected (while RIH) when it was realized that the plug could not be retrieved through the back-off nut and therefore would have to be left in place until the assembly was completely reamed/washed to bottom and backed off.

After running in the hole and reentering with the modified 6-3/4-in. DI-BHA it took about 45 min to initiate penetration below seafloor. Whether the problem was fill, bridging, or the wayward 10-3/4-in. DI-BHA was unknown. Ultimately, however, progress was made below mud line with occasional large clouds of black cuttings erupting from beneath the HRB and out of the reentry cone funnel. On the basis of this evidence it was assumed that the 10-3/4-in. DI-BHA had dropped about 1 to 1-1/2 m, leaving it flush or slightly below the surface of the seafloor. Another 1-1/2 hr were required to wash/ream the assembly to bottom and seat the 6-3/4 × 10-3/4-in. back-off nut on the 10-3/4-in. landing taper. Drilling parameters used in reaming to bottom were as follows: 50–60 rpm, 10,000–12,000 lb WOB, pump pressure 300–350 psi, and torque 2000–3000 ft-lb. After seating on the landing taper the pump pressure dropped slightly to 270 psi and the torque increased to 7500 ft-lb. The drill pipe was picked up off bottom slightly to see if any BHA weight had been lost. Although difficult to ascertain, it was believed that some weight may have been lost. Another meter was picked up at that point to ensure that the back-off assembly did not pound on and damage the upward-looking splines should a successful back-off occur. After deployment of the TV/VIT assembly it was confirmed that back-off had occurred but the pipe had heaved out of the reentry cone, requiring a return to the HRB to confirm that the throat of the funnel was clear and not obstructed. Once this was accomplished the drill string was tripped back to the ship.

Second Tensioning BHA/DCS Platform Deployment

Once out of the hole with the remaining back-off assembly, the drill line was slipped/cut, and the tensioning BHA again made up and RIH. Once hung off, the DCS tubing string was RIH, the DCS platform was picked up, and the stripover operation was once more conducted. The stripper head packing was then installed, the HRB reentered, tensioning system jayed-in, 50,000-lb tension applied, and the dynamic positioning (DP)/tubing annulus displaced with Baravis polymer. A bit deplugger was deployed inside the DCS string to aid in piloting the DCS bit into the backed-off 6-3/4-in. DI-BHA. At this point DCS drilling joints were slowly made up and the DCS bit advanced to bottom. Significant chatter was experienced when rotating above 30 rpm. Since both freshwater- and seawater-based Baravis polymer was ineffective at preventing the chatter, the DP/tubing annulus was displaced with an EP Mud Lube/Baravis combination. This mixture solved the problem.

Second DCS Bit Run

After recovering the bit deplugger, the last two DCS drilling joints were run while feeling for bottom. No feel was encountered inside the DCS tubing string this time and DCS coring operations commenced on bottom. After 16 rotating min, coring was stopped with indications of a core block. Little, if any, penetration was achieved. After recovering the DCS inner tube there was no core nor any evidence of a core block. The diamond drillers decided that the problem may have been related to drilling out the double carbon plug and not necessarily a core block.

DCS coring attempts from this point on were frustrating at best. Very little penetration was achieved despite continual adjustments to drilling parameters. The one bright side was that *the borehole continued to be free of fill/cuttings and bottom was tagged consistently at the same penetration depth.* Continual troubleshooting and refinements to the DCS secondary compensation system were required. Several individual problems were identified and rectified. Two separate hoses on the passive nitrogen accumulator system were found to be faulty and leaking. In addition, a leaking nitrogen charge valve was located and had to be replaced. Each time a leak was found the passive accumulator system had to be recharged with nitrogen before resuming DCS coring operations. Each time a repair was made, attempts would be made to cut a DCS core—each time without success. Recovery was limited to a few "chunks" of rock jammed in the core-lifter sub but no diamond-trimmed "core" was obtained. All evidence was that the bit was picking up off bottom and was not penetrating into the formation. Eventually, it appeared that the bit was drilling, advancing approximately 1.5 m in 40 rotating min. Only 0.2 m had been gained in addition to that over the last 31-3/4 hr. After stopping to make a drilling joint connection, penetration halted and it was felt that the tube was core-blocked. When attempting to recover the core tube it was found stuck on bottom. The core tube was ultimately jarred free and the recovery was found to be 0.33 m of broken rock pushed up inside the tube. Again no diamond-cut surfaces were identified. The face of the core-lifter case, however, was found to be severely damaged, indicating that the DCS bit was, in fact, destroyed. The damage to the core-lifter case appeared to be the result of impact loading.

Prior to pulling out of the hole with the DCS tubing string it was agreed that further testing of the secondary compensator was warranted. A prime suspect in the failure of the system to perform properly was the load-cell string-weight input data. The DCS drilling teams complained of erratic string-weight readings, according to the position of the top drive/core head in the mast. Testing was done and it was confirmed that the weight indicator readings were not consistent throughout the travel of the core head. This added further evidence to what was already suspected as a possible reason for the poor performance of the secondary heave compensator—erroneous load-cell weight data possibly resulting from a bent-forward feed cylinder. Once testing was completed, eight DCS drilling joints were tripped back to the DCS platform, placing the DCS bit inside the tensioning jay-tool.

After un-jaying from the HRB, rigging down the DCS platform, and conducting the reverse stripover operation, the DCS tubing string was tripped out of the hole. When the DCS BHA reached the rig floor the bit crown was found to be totally gone as a result of impact loading.

Third DCS Bit Run

A new DCS bit was made up on the outer tube with a new lower reaming shell. The upper adapter coupling was deemed acceptable for continued use. The DCS tubing was then RIH and hung off as before. The DCS platform was rigged up, and troubleshooting of the feed cylinder load-cells began. Several problems were identified and corrected on this latest round of testing. The forward load cell was indeed giving erroneous, erratic string-weight data. To circumvent this problem the software code was altered to take only information from the aft (good) load cell and multiply it by a factor of two rather than taking the sum of each load-cell reading. In addition, it was determined that the velocity signal (accelerometer input) was 180° out of phase. This was easily corrected by reversing two wires. While troubleshooting of the secondary heave compensation system was taking place, a damaged level wind arm on the DCS coring winch was repaired.

With these changes made, the DCS sequence was again initiated and preparations made to resume DCS coring operations. Prior to tripping the DCS drilling joints to bottom, additional testing was conducted on the secondary heave compensation system. Another problem was found and rectified when it was determined that a hydraulic tripping valve was leaking internally and required replacement. In addition, a second accelerometer was mounted on the DCS tubing at the platform level to be used in troubleshooting and measuring performance of the secondary compensator system. Once this testing was completed, the accelerometer was removed and the tripping of DCS drilling joints to bottom commenced.

A DCS center bit was deployed on this bit run. Bottom was tagged approximately 1 m high and drilling ahead was initiated. The secondary compensation system still did not appear to be working correctly, although it was vastly improved over earlier bit runs. Periodically, coring activities were suspended to allow additional adjustments to be made to the secondary compensator. Finally the system appeared to be functioning reasonably well in "standby" mode using only the accelerometer (velocity) signal, but when put into "auto advance" mode (using both velocity signal and load-cell input), the system still became erratic and all control of WOB was lost. One-half meter of fill was drilled out but then lost again when the bit was picked up off bottom to make a drilling joint connection. After about 3-1/2 hr of coring attempts the center bit was recovered and found to be totally destroyed, with the crown separated from the body and missing downhole. Based on this depressing information, the DCS tubing string was again pulled out of the hole. Upon recovery the DCS bit was again totally destroyed and again the crown had separated from the bit body. After another discussion of possible options we decided to abandon this hole and deploy the second guide base. The rationale for this decision was based on several facts. It was highly probable that there was junk (i.e., bit crown segments) in the hole. Not only were there no 4-in.-diameter mills aboard ship, there was a reluctance to fabricate something on board. The secondary compensator was still not operating correctly and time was needed to assess the situation. Finally, by deploying the second guide base a great deal of information could be learned about spudding a 7-1/4-in. hole from the surface as opposed to spudding a 12-1/2-in. hole as was initially attempted on Hole 864A. Another overriding concern was the possible medical evacuation of the SEDCO drilling superintendent, Bob Caldow, who had been hospitalized early that morning with severe back pains. The initial diagnosis was a possible kidney problem and if the pains did not subside significantly within a few hours the vessel would have to get under way as soon as possible for Acapulco, the nearest major medical facility. Given this situation it was deemed wise to begin to pull the primary 5-in. drill string out of the hole so that the ship could get under way in a hurry if required to do so. While pulling pipe, initial preparations were begun to assemble and ballast the second HRB. This work was initiated as soon as the TV/VIT frame was recovered aboard ship and rigged down out of the way. Hole 864A officially ended at 1835 hr on 16 February 1992, when the tensioning jay-tool cleared the rotary table.

Hole 864B

Assembly and Deployment of the Second HRB

Assembly of the second guide base proceeded well, with all available hands working on expediting the unit for deployment as soon as possible. A tilt beacon was not deployed this time since the landing zone was to be on the same relatively flat volcanic flow unit. Two mechanical slope indicators (bull's-eyes) were mounted on the rim of the HRB, however. The decision was made to top off the iron pipe ballast modules with 12-lb barite/gel slurry rather than bulk barite as was used before. The resultant wet weight of the base was 15,000 lb less (125,000 vs. 140,000 lb), but because the slurry was pumped rather than tediously hand-loaded, 6 hr were trimmed from the earlier ballasting time. Some grinding was required on one of the tensioning tools to enable it to slide smoothly into the jay-slots in all four possible orientations. Artwork for this HRB/cone assembly consisted of an "8," "6," "4," "–," and "B" painted both on the reentry cone and on five of the six HRB sides. After about 31 hr of assembly and check-out of jay-tools, the second HRB was ready for deployment.

Finessing the tight-fitting guide base through the moonpool and past the locking fingers on the lower guide horn again proved to be a challenge. This time the base was rotated 90° prior to deployment with two corners following down the inside of the lower guide horn. Although this orientation theoretically gives the most clearance, the base still was a tight fit. Plans are to reduce the base dimensions by 12 in. in both directions on future models. Once past the guide horn, the HRB was run smoothly to bottom. Within 45 min an appropriate landing spot, without fissures and relatively level, was located (Fig. 5). The HRB was un-jayed from the drill string and the ship was moved back to the original HRB coordinates for Hole 864A in order to double check on the relative location of each base. The final resting place for the second guide base was judged to be about 40 ft north of the original base. The DP was then tripped back to the ship.

Predrilling a 7-1/4-in. Hole

A 7-1/4-in. carbonado surface-set diamond bit was made up with a 4.0-in. single-cone center-bit assembly followed with one 20-ft-long 6-3/4-in. drill collar. No back-off assembly was run since this was to be a diamond bit test; any pre-drilled hole gained would be a bonus later when the back-off assembly was deployed. Prior to running in the hole with the BHA, a test of the single-cone center bit was conducted on a plank of wood staged on the rotary table. This was to assure all concerned that the single cone really would rotate and not act strictly as a bearing downhole.

Once the reentry was made, and the bit was worked past the jay-slots in the casing hanger, drilling began. After 30 min of rotation it appeared that a full meter of hole had been made. After that, however, drilling slowed significantly and intermittent torquing was experienced. After another 2 hr of rotation, drilling was halted due to lack of any additional penetration. Upon recovery of the BHA, the diamond bit was found to be "rung out" on the leading edge of the outside diameter (OD). Both the inside diameter (ID) and OD gage

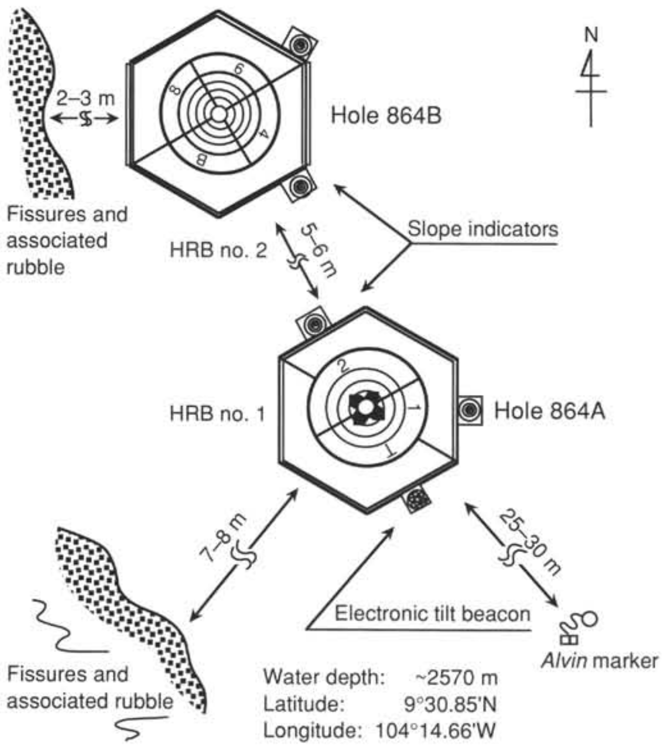

Figure 5. Hard-rock guide-base orientation, Holes 864A and 864B.

was in good condition, as were the diamonds on the bit face. It was believed that failure of the bit was induced by an eccentric loading of the cutting structure due to the single-cone center bit causing lateral motion of the poorly stabilized bit. The face diamonds also showed no typical teardrop pattern associated with normal drilling wear, indicating that the center bit was also most likely keeping the diamond bit from contacting the formation correctly and with full WOB.

First Diamond Core Barrel Deployment

Because we believed that a meter of "rat hole" now existed, we decided that the new diamond core barrel (DCB) coring system would be run next in the hole. Additional experience would be gained on the use of diamond bits in these formations and quite possibly a core might be recovered in the process. The DCB system uses a 7-1/4 × 2.312-in. diamond core bit (either surface-set or impregnated). It also uses 6-3/4-in. drill collars and three specially designed outer core-barrel components (latch sleeve, support bearing, and float valve assemblies). The system uses the identical, proven rotary core barrel (RCB) wireline components.

The DCB system was RIH with a diamond-impregnated core bit. After another routine reentry, almost 2 hr were spent attempting to wash to the bottom of the existing 1-m hole. It is now believed the problem may have been related to one of two things: the stabilizer pads on the DCB outer barrel impinged on the landing seat in the casing hanger due to DP offset and misalignment, or inadequate flow area (junk slots) in the full-diameter diamond bit led to the inability to remove cuttings from the hole efficiently. Both of these issues are correctable. The DCB outer barrel can be made slick walled (i.e., no stabilizer blades on initial bit trip) or the stabilizer blades can be made integral spiral blades rather than individual pads. Larger junk slots in the diamond bits can also be provided on future bits. After coring with the DCB for another hour, a net gain of 0.1 m to the hole was made and it was decided to pull the bit. No core was recovered. Inspection of the diamond-impregnated bit showed it to be in surprisingly good condition. The inside and outside gage were both still good. The bit face was somewhat polished, indicating that either there was inadequate WOB or the matrix material was too hard to be worn away and effectively expose new diamonds. It is likely that both contributed to the problem.

First 7-1/4-in. Tricone Bit Run

A 7-1/4-in. tricone M89FL bit was run next in the hole to deepen it farther in preparation for setting the 6-3/4-in. DI-BHA. After reentry and recovery of the TV/VIT assembly, drilling was initiated. After 2-3/4 hr the hole was deepened to 7.3 mbsf and displaced with 12 lb of mud. After several wiper trips to the seafloor, fill/rubble was still entering the borehole, most probably from a glassy volcanic layer approximately 2–4 mbsf. The tricone drilling assembly was pulled out of the hole at that point in preparation for a second run with the DCB assembly.

Second Diamond Core Barrel Deployment

The DCB coring assembly was RIH for the second time with the same impregnated diamond bit, only with the face somewhat "roughed up" to expose new diamonds in the hope that it would drill/core more efficiently then the previous deployment. After reentering the hole, fill was tagged at about 1 mbsf. The TV/VIT assembly was recovered and washing/reaming to bottom began. After advancing an additional 2.0 m the bit stopped penetrating. The favored explanation is that the relatively large pieces of rubble that could fall into the hole were not able to get past the relatively small junk slots (external cuttings flow slots) on the OD of the diamond bit. The diamond bit normally would generate much smaller cuttings (rock flour) and its full-round geometry was unlike that of the tricone-style rock bit with large areas between bit legs. The cuttings therefore had nowhere to go and could stay under the bit face only until ground up into small enough particles to be circulated out of the hole. Again, it is possible that the stabilizer blades on the outer barrel also contributed to the lack of penetration by not allowing the full drilling weight to be applied to the diamond bit. After pulling out of the hole with the DCB assembly, the impregnated bit was again found to be in re-runable condition. Two pieces (totaling 14 cm) of diamond-trimmed core were recovered from the wireline core barrel. The barrel was not core-blocked or jammed. The core had apparently been cut out of a large chunk of rubble that had fallen into the hole from above. Because of the possible problems cleaning the hole with a 7-1/4-in. diamond bit it was considered wise to make another trip in the hole with the 7-1/4-in. tricone bit.

Second Tricone Bit Run and 6-3/4-in. DI-BHA Deployment

Upon entering the hole with the tricone drilling assembly, fill was tagged at a depth of 1.7 mbsf. The TV/VIT assembly was recovered and the washing/reaming operation was initiated. It took approximately 5 hr to wash and ream the hole four separate times to total depth. Each time the hole condition got progressively better. After the final clean-out run the hole was displaced with 12 lb of mud and the drill string was recovered back to the ship.

The 6-3/4-in. DI-BHA was made up with a specially made clean-out bit fabricated from the body of the earlier-deployed surface-set diamond bit that was rung out. A squared-off sawtooth profile was cut on the remaining bit body after removal of the remaining diamond crown. The resultant cutting structure was protected with hard facing and carbide chips. A 20-ft 6-3/4-in. drill collar was then made up immediately below the 6-3/4-in. back-off sub assembly. The remaining BHA was then made up and RIH.

After entering the hole fill/rubble was contacted at 3.7 mbsf. The TV/VIT assembly was recovered and the back-off assembly was washed/reamed to bottom. Within 30 min the assembly was on bottom and thought to have backed off. The TV/VIT assembly was deployed, which confirmed that the BHA was still intact and that no separation had occurred. Paint marks on the drill collar indicated that approximately 0.2 m of additional hole was required before landing in the back-off taper. The TV/VIT assembly was recovered and drilling resumed. After an additional 45 min of rotating the drilling torque became quite erratic and the pump pressure dropped to 150 psi. This was interpreted as a sign of back-off, although earlier torque/pressure variances had also indicated a possible back-off. At that time drilling continued because the time to deploy the TV/VIT was significant and it was felt additional rotation was warranted to be sure that full separation had taken place. There should have been no problem with this as long as the splines in the back-off sub were kept engaged and there was always weight down so as to prevent damage. The TV/VIT assembly was again deployed and successful back-off was confirmed. Upon recovery of the remaining back-off assembly, the lower 7-1/2-in. of the upper sub (pilot nose) was found to have been broken off and left downhole. The failure occurred at the reduced section of the uppermost O-ring groove. Supposition is that the sub suffered a fatigue failure at that point due to unsupported rotation after the actual back-off had occurred. This part can be made stronger in the future and, if run in conjunction with the bit guide, a future similar failure should be avoidable.

Because of time constraints it was decided that any fishing attempt to remove the broken part had to be via wireline. There was not enough time left in the leg to make an additional round trip of the drill string for a fishing operation and still have time for one last deployment of the DCS. Therefore, a DCS tensioning BHA was made up and RIH. After entering the jay-slots vertical travel was possible but it was not possible to jay-in with left-hand rotation. Several attempts were made but all were to no avail. It was hoped that by fishing the piece of junk out of the hole, jay-in and tensioning could be accomplished, but all wireline fishing attempts failed to attain the desired goal. Three separate wireline tools were tried—a spear, an Itco spiral grapple, and a modified Itco spiral grapple. The latter was an attempt to pilot the grapple into the throat of the "fish." After several hours of fishing attempts, the sleeve portion of the spiral grapple was left in the hole, thereby ending all fishing attempts. At this point it was agreed that further deployments of the DCS system were not possible in the remaining time, given all the preparatory work that had to be done prior to DCS operations. The decision was to pull out of the hole with the tensioning assembly, rig up a shortened version of a jay-tool, and then attempt to jay-in and move the HRB to a new location for a final diamond drilling test in the "C" hole. At 0200 hr on 4 March 1992, the tensioning jay-tool cleared the rotary table, thus ending Hole 864B.

Hole 864C

Relocation of the HRB

A jay-tool was shortened as much as possible by cutting off all of the tool located below the jay-dogs and trimming the dogs themselves about 2 in. A total of 13 in. was removed in fabricating this "special" jay-tool. It was hoped that this additional clearance would be sufficient to allow jay-in and thus allow the relocation of the HRB used in spudding Hole 864B. After the modifications were completed the tool was RIH and still another reentry was made. This time there was no problem jaying-in and the HRB was lifted up and stripped over the drilled-in assembly.

Several attempts were made at finding an acceptable landing spot for the HRB. After offsetting in nearly every direction except south, a spot free of fractures and rubble was found. Several landing attempts were aborted prior to jay-out because of excessive angle being registered on the mechanical slope indicators. After 3 hr a suitable spot was found and the base was landed without difficulty. Both slope indicators showed little, if any, tilt and the terrain appeared to be reasonably free of any massive or large fissuring. The jay-tool was removed from the guide base and the ship was offset back to the original coordinates in order to verify relative proximity of the new hole to Hole 864B, to see if visual evidence could be collected as to the orientation of the previous DI-BHA, and finally to see if the "junk" that terminated the hole could be seen. The final resting place for the HRB was determined to be about 60 ft north and 20 ft east of Hole 864B (Fig. 6). The TV survey clearly showed the 6-3/4-in. DI-BHA sticking upright out of the volcanic flow unit in the proper attitude, and little evidence of hole washout or massive destruction to the seafloor crust at the spud location could be seen. The drill string was then recovered and preparations begun for the spudding of Hole 864C.

Drilling Test with the 7-1/4-in. Diamond Bit and 2-cone Center Bit

Prior to initiating the final drilling test of the leg, it was decided that the stands of DCS tubing racked in the derrick should be broken back down into singles and packaged for the return shipment from Honolulu. This was the one remaining operation for which a time estimate was the most difficult to do. It was logical to get this operation out of the way and then spend the remaining time doing the final drilling test. A total of 17-3/4 hr were required to rig-up/rig-down, break down the tubing into singles, and complete all packaging requirements. The primary 5-in. drill string was then pulled out of the hole and preparations were begun for making up the diamond drilling assembly.

The final drilling test of the leg was conducted with a 7-1/4-in. carbonado surface-set diamond bit and a 2-cone center bit. This combination had not been run during the leg, and information was needed in order to determine if the bit had potential for ridge-crest drilling environments. It was felt that earlier deployments of the bit had been tainted by the use of the unproven and questionably designed single-cone center bits. After the 35th reentry during the leg (undoubtedly an ODP record), Hole 864C was spudded.

The drilling of the 7-1/4-in. hole with the 2-cone center bit was perhaps one of the highlights of the leg. The bit drilled exceptionally well and was still drilling ahead at an average penetration rate of 0.8 m/hr (Fig. 7) with a maximum and minimum rate of 0.5–2.0 m/hr. The drilling test was terminated after 6.8 m of hole was drilled in (3.75 rotating hr) so that both bit and center bit could be recovered before total failure, thereby yielding important design information. Prior to pulling out, the hole was displaced with 12-lb/gal mud and a wiper trip was made to check stability. Fill was tagged at 3.5 mbsf, indicating that even though the hole was drilled with a 7-1/4-in. diamond bit, it was no more stable than those drilled with the tricone bits. The center bit was then recovered via the forward coring line without incident and the drilling assembly was tripped back to the drillship. The coring line was coated with preservative on this last trip out of the hole. When recovered, both bits were in excellent condition and obviously could have drilled farther. The carbonado diamond proved itself worthy on this final test on the East Pacific Rise, and the 2-cone 4.0-in. center bits continued their impressive list of successes dating back to Leg 132. Both the bearings and cutting structure on the center bit were good but there was evidence of shirt-tail erosion, likely due to the abrasive formation.

After the all pipe was recovered, both positioning beacons were released and recovered, all drill collars were magna-fluxed, and preparations were made for getting under way. At 1430 hr on 6 March 1992, the last remaining thruster was pulled up and the vessel maneuvered for getting under way to Honolulu, Hawaii.

TRANSIT TO HONOLULU

In addition to the routine cleaning and painting associated with the end of the leg, the 11-plus-day transit to Honolulu was put to other good uses. All rig-down and preparation of the DCS platform was performed, as well as preparation for the offloading of all drill-in BHA

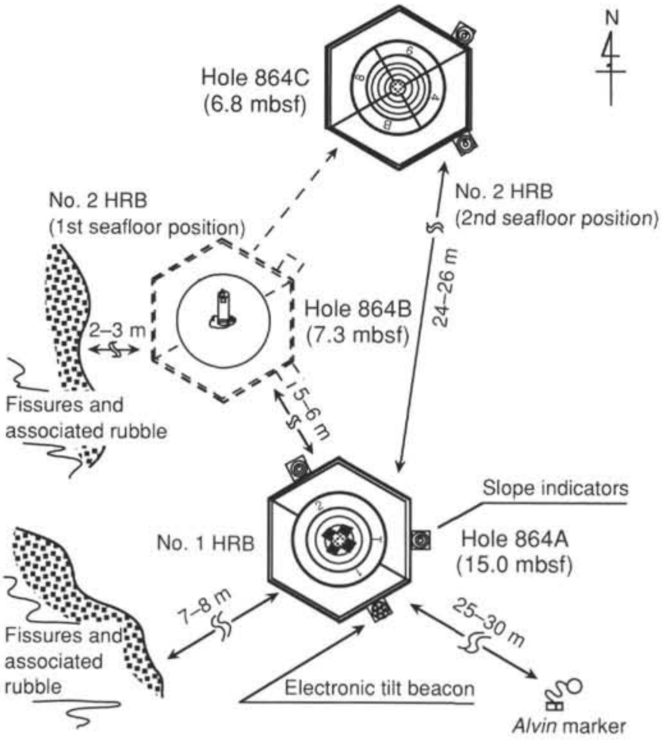

Figure 6. Hard-rock guide-base orientation, Holes 864A, 864B, and 864C.

hardware. The 6-3/4-in. drill collars and DCB system components were all left aboard for possible use on Legs 143 and 144.

The SEDCO engineering complement conducted major work on the seawater cooling lines for one of the aft refrigeration systems, and the Varco top-drive motor was changed out and the frame overhauled by the drill crew.

The highlight of the transit, however, was the deferred equator crossing ceremony that took place on Saturday, 14 March 1992. At that time all polliwogs were indoctrinated into the mysteries of King Neptune's realm.

Another activity that took place during the transit was the deployment and testing of a high-speed seismic profiling system that tested the gathering of seismic data with the *JOIDES Resolution* (SEDCO/BP 471) while under way at full speed between sites. Results of this test are included in the Leg 142 lab officer's report.

After arrival at the pilot station, the vessel transited into Honolulu harbor for docking at pier number one. The first line went ashore at 1000 hr on 18 March 1992, ending Leg 142 nearly one day ahead of schedule.

ATLANTIS II RENDEZVOUS

Several rendezvous with the research vessel *Atlantis II* took place during this leg. The initial rendezvous was on 25 February, with the transfer of a mail bag and some other requested hardware/logging tools to the *JOIDES Resolution.* The *Atlantis II* is the mother ship for the deep-diving research submersible *Alvin,* which played a major role in the site selection for the Leg 142 drilling effort on the East Pacific Rise. The Leg 142 chief scientist (Rodey Batiza) departed the drillship twice (for approximately 24 hr each) to make research dives in the *Alvin.* In addition, three other members of the Leg 142 scientific party (Rachel Haymon, Karen Von Damm, and Marvin Lilley) were obliged to transfer to the *Atlantis II* toward the end of the leg for participation in other EPR research activities. All transfers were done in good weather and with the full consent of both captains. Multiple trips with both the *JOIDES Resolution's Zodiac* and with the *Atlantis II's Avon* were made without incident.

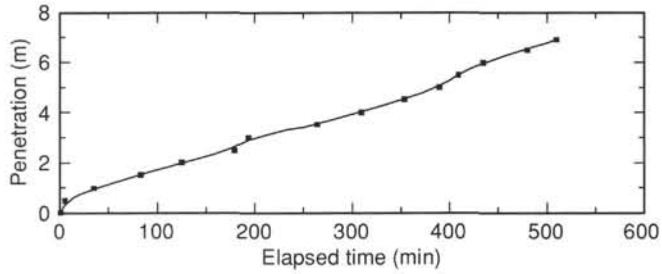

Figure 7. Penetration depth below seafloor vs. elapsed time for 7-1/4-in. carbonado diamond bit run with a 4-in. 2-cone center bit.

DRILL BITS

No "conventional" drill or core bits were used on Leg 142. All bits used were either associated with the DI-BHA systems, the DCB, or the DCS. Primary bits that were used consisted of 12-1/2-in. tricone drill bits, 12-1/2 × 7-3/8-in. 6-cone DI-BHA bits, and 11-1/4 × 7-3/8-in. diamond bits (both carbonado surface-set and impregnated). Secondary bits included 7-1/4-in. tricone bits, and 7-1/4 × 4.05-in. diamond bits (both carbonado surface-set and impregnated). The diamond core barrel option of the secondary DI-BHA system used 7-1/4 × 2.312-in. diamond bits, as well as both carbonado surface-set and impregnated versions. Center bits that were used included 7-1/4-in. 2-cone, 7-1/4-in. single cone, 4.0-in. 2-cone, and a 4.0-in. single cone. Several runs were made with 9-1/2-in. concave junk mills, as well as with junk baskets that were run both individually and in tandem. Mills and junk baskets for the 7-1/4-in. size, and 3.96-in.-OD mills for the DCS system, are definitely required for future legs. DCS bits that were used consisted of 3.960 × 2.2-in. diamond-impregnated core bits and 2.12-in. surface-set diamond center bits. All bit data is included in Table 7, the bit summary report. A detailed report on the performance of all bits used can be found in the chapter entitled "Design and Performance of Diamond and Roller Cone Bits" (Holloway, this volume).

REENTRY/TV/MESOTECH SONAR/COAX WINCH

Performance of the reentry systems on this leg was excellent. A record number of reentries (35) were made using the Colmek subsea television system mounted on the VIT frame. All reentries were made into an 8-ft-diameter reentry funnel attached to the gimballed/counter-balanced casing hanger mounted on the HRB. Search/maneuver/reentry time ranged from 1-3/4 hr to 2.0 min with the average reentry taking 15 min or less. Absolutely no problems were experienced with the 8-ft cone; however, weather conditions were generally good and heave on most occasions was moderate.

The Mesotech color-imaging sonar system was used several times early on during the leg to successfully identify the boundaries of the axial summit caldera (ASC) of the East Pacific Rise. The color-imaging sonar readily identified the east and west walls of the ASC, aiding in proper positioning of the HRB. The sonar was ineffective for locating the HRB structure when out of TV range due to the hard bottom.

Late in the leg, after rigging down the VIT frame in preparation for assembly and deployment of the second HRB, the sonar system began demonstrating signs of ill health. The SEDCO electronics supervisor and electronics technician traced the problem to a defective CPU PCB board. This same board caused problems on an earlier leg, resulting in the return of a sonar unit to the manufacturer. No additional information on the problem is available at this time but the suspect part is on order and two functional sonar systems remain on board.

The TV/VIT-mounted system was instrumental in aiding seafloor operations during this trip, both in observing back-off and conducting un-jaying operations, as well as in checking actual seafloor penetra-

Table 7. Bit summary report, Leg 142.

Bit no.	Hole	Manufacturer	Size (in.)	Type	Jets	Serial number	Depth cored (m)	Depth drilled (m)	Total penetration (m)	Cumulative total meters	Time on hole (hr)	Total time (hr)	Conditions[a]	Remarks
DI-BHA primary bits														
1	864A	Security	12-1/2 × 7-3/8	M89TF 6-cone	—	498999	0	3.4	3.4	3.4	24.00	24.00	2,2,LC,1-5,3,O,JD,TD	Left in hole
2	864A	Gotco	9-1/2	Concave mill	4 #32	N/A	0	0.2	0.2	0.2	6.00	6.00		Return for rebuilding
3	864A	Security	12-1/2	M89FL 3-cone	3#14	564550	0	2.5	2.5	2.5	3.00	3.00	0,1,CT,H,I,E,R,TD	Return to Security
4	864A	Security	12-1/2 × 7-3/8	M89TF 6-cone	—	498998	0	0	0	0	3.00	3.00	0,0,LC,X,E,I,X,TD	Return to Security
5	864A	Gotco	9-1/2	Concave mill	4#32	N/A	0	0	0	0	2.75	2.75		Return for rebuilding
6	864A	Longyear	11-1/4 × 7.3	Surface-set carbonado diamond	—	L84062	0	0	0	0	3.00	3.00	2,3,JD,N,X,I,NO,TD	Rubble/fill
7	864A	Security	12-1/2	M89FL 3-cone	3#14	564550	0	9.4	9.4	11.9	7.50	7.50	1,6,LT,H,I,E,R,TD	Fill/rubble
8	864A	Rock Bit Ind.	7-1/4	C-7 3-cone	3#14	BD202	0	6.7	6.7	6.7	3.25	3.25	2,1,BT,A3,E,3/32,SD,BHA	Glass/matrix
9	864A	Hobic	7-1/4 × 4.05	Impregnated extra-hard	—	1DI424	0	0	0	0	0.00	0.00		Left in hole
10	864B	Longyear	7-1/4 × 4.05	Surface-set carbonado diamond	—	L84064	0	0.6	0.6	0.6	2.50	2.50	3,3,RO,S,X,2/16,ER,PR	Used F/#13
11	864B	Rock Bit Ind.	7-1/4	C-7 3-cone	3#14	BD203	0	7.3	7.3	7.3	1.50	1.50	2,2,CT,H1,E,2/16,SD,BHA	Return to Rock Bit
12	864B	Rock Bit Ind.	7-1/4	C-7 3-cone	3#14	BD203	0	0	0	0	1.75	3.25	2,2,BT,H1,E,3/32,SD,BHA	Rubble/fill
13	864B	Rig-made	6-3/4	Stoody drag	—	1	0	0.2	0.2	0.2	1.25	1.25		Left in hole
14	864C	Longyear	7-1/4 × 4.05	Surface-set carbonado diamond	—	L84063	0	6.8	6.8	6.8	8.50	8.50	4,6,SD,S,X,1/32,TD	Begin to ring
DCB core bits														
1	864B	Hobic	7-1/4 × 2.31	Impregnated diamond	—	1HI430	0	0	0	0	0.75	0.75	1,1,P,A,X,I,PN,PR	Polished
2	864B	Hobic	7-1/4 × 2.31	Impregnated diamond	—	1HI430	0	3	3	3	4.00	4.00	3,3,P,A,X,I,NO,PR	Rubble/fill
DI-BHA center bits														
1	864A	Security	7-1/4	M89TF 2-cone	2#20	498838	0	3.4	3.4	3.4	24.00	24.00	2,2,ND,A,3E,I,NO,BHA	Return to Security
2	864A	Rock Bit Ind.	7-1/4	C-7, 1-cone	2#16	BD134	0	0	0	0	3.00	3.00	0,0,NO,X,E,I,NO,TD	
3	864A	Security	7-1/4	M89TF 2-cone	2#20	498837	0	0	0	0	0.00	0.00	0,1,CT,M,E,I,LC,TD	Return to Security
4	864B	Rock Bit Ind.	4.0	C-7, 1-cone	2#16	BD132	0	0.6	0.6	0.6	2.50	2.50	0,0,NO,X,E,I,NO,PR	
5	864C	Security	4.0	H100F 2-cone	2#16	499265	0	6.8	6.8	6.8	8.50	8.50	2,2,SD,E,1/16,NO,TD	Return to Security
DCS core bits														
1	864A	Longyear	3.960 × 2.20	Series 2 impregnated	—	L85797	0.3	1.6	1.9	1.9	13.25	13.25	Lost crown	
2	864A	Hobic	3.960 × 2.20	Series 1 impregnated	—	1HI432	1.6	0	1.6	1.6	2.00	2.00	Lost crown	
3	864A	Hobic	3.960 × 2.20	Series 2 impregnated	—	1HI431	0	2	2	2	3.75	3.75	Lost crown	Rubble/fill

Notes: N/A = not applicable.

[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 eduction of teeth or bearings; A = all rows; BHA = change bottom-hole assembly; BT = broken teeth/cutters; CT = chipped teeth; E = bearing seals effective; ER = erosion; H = heel rows; I = in gage; JD = junk damage; LC = lost cone; LT = lost teeth/cutters; N = nose rows; NO = no dull/no other wear; ND = nose damage; O = outer one-third of bit; P = polished; PR = penetration rate; R = row; RO = ring out; S = surface set; SD = shirttail damage; TD = total depth; X = chisel tooth.

tion paint marks on drill collars. The primary shortcomings of the system include the lack of pan and tilt (which would have been extremely valuable in several instances), and the inability to rotate the drill string with the VIT frame deployed. The latter cost a significant amount of ship's time this leg due to the heavy emphasis on seafloor operations. If operations of this nature are to be continued, serious consideration should be given to the development of a remotely operated vehicle (ROV)-based TV system that could be deployed independent of the drill string. This system could then be left on bottom, housed in a "garage," and used whenever required without paying a large "lost time" premium. The system could stay down for the duration of the operation and then be recovered after the completion of all seafloor/on-site activities.

The coax winch system gave good service on this leg with no breakdowns; however, it is obvious that the primary drive chain and sprocket assembly needs to be strengthened. This system suffers heavy wear because it is not encased in an oil bath as designed. It is my understanding that action is under way to provide additional spares for this system in the short term and to investigate a redesign for the long term.

POSITIONING/TILT BEACON PERFORMANCE

Two types of beacons were used on Leg 142. Three Datasonics Model 354B positioning beacons one special Datasonics Model 359 "Tilt" beacon were deployed on a hard-rock guide base in order to determine the attitude of the base on the seafloor. Two operational positioning and/or tilt beacons were maintained on the seafloor at all times because of the critical nature of DCS platform drilling operations. As the beacons have demonstrated a very reliable record of recovery, it was felt that this was an acceptable operating plan.

Performance of the Model 354B positioning beacons varied. The initial beacon (serial no. 754) deployed on 30 January performed well, logging 36.3 days on site in 2570 m of water. This beacon maintained a strong signal and was released/recovered without any problem. The tilt beacon (serial no. 841), mounted on the side of the HRB, was used as a back-up positioning beacon until it died of battery failure on 8 February. This beacon experienced no problems other than the relatively short battery life. The tilt beacon was not recoverable since it was hard-fixed to the guide-base structure. A second positioning beacon (serial no. 751) was deployed on 8 February to be used as a back up for the initial beacon deployed while coming on site. This beacon performed well until it pre-released unexpectedly on 29 February after 20.9 operating days. This is a worrisome problem since a spontaneously releasing positioning beacon could initiate a major operational disaster if not caught and corrected quickly. The SEDCO electrical supervisor has recommended some suggestions for improvement on his failure report form and the beacon will be returned to the vendor for failure analysis. A third Model 354B beacon pre-released twice on deck while being readied for deployment. Had the primary positioning beacon released rather than the back-up one, this new failure could have taken the form of an operational nightmare (as alluded to previously). A shipboard failure report was prepared, and this beacon will also be returned to the vendor. The fourth positioning beacon (serial no. 752) used during Leg 142 was deployed on 29 February and was released/recovered without incident on 6 March after 5.9 operating days. All four deployed beacons were successfully recovered this leg, albeit one came back of its own volition.

The Model 359 tilt beacon (serial no. 841) gave good service while adequate battery power was maintained. Both x and y-axis data were consistent, reliable, and extremely helpful during the early setting and moving of the guide base. Input from the beacon was at times critical when the mechanical slope indicators (bull's-eyes) could not be viewed from the VIT-mounted TV camera. Later, when initial drilling operations were under way, the VIT/TV assembly was removed. During this time the x-y tilt data proved invaluable in allowing the base attitude and stability to be monitored regularly for any sign of a problem. A second tilt beacon (serial no. 842) suffered a broken "frequency select" switch on the transmitter PCB. This beacon will be kept aboard for field repair when spare switches are received. These should have been ordered per telex earlier in the leg. Details on all of the beacons used are contained in Table 8, the beacon summary report.

WEATHER

Weather during Leg 142 was not particularly bad nor was it the mill pond that was anticipated. Mostly sunshine and occasional overcast days were the norm, with an occasional rain squall now and then. Temperatures were generally mild, hovering around 70°F for most of the leg. Swell conditions were generally moderate but with occasional "rogue" swell trains, commonly appearing at night, which exceeded the norm. The nominal heave was in the 1–2-m range, extending to 3–4 m on occasion in response to the rogue swells. On occasion the heave did complicate on-site activities when particularly delicate operations were taking place. These included stripover, reentry, jay-in/jay-out operations, and drilling with the DCB and the 12-1/2-in. 6-cone drill-in BHA bit. All of these operations were weight/displacement sensitive and were complicated at times by the heave/swell conditions. There is some question at the time of this writing as to whether or not the sea states experienced were related to the failure of the DCS secondary compensator system to maintain proper WOB control of the fragile, narrow-kerf DCS core bits. An investigation will be made into what can be done to extend the operating range of the system, once it has been determined that this is a problem.

LOGGING

No logging was conducted during Leg 142 since no suitable hole was ever attained. Lamont-Doherty Geological Observatory did respond to urgent pleas of the chief scientist to get slimhole caliper/temperature tools aboard via the rendezvous with the *Atlantis II*; however, these tools were never deployed.

AUTOMATIC STATION KEEPING SYSTEM

The automatic station keeping (ASK) system performed flawlessly this trip but was also relatively unchallenged. Aside from maintaining position without problem, the system was useful in maneuvering the ship for reentry into the smaller-than-normal 8-ft-diameter reentry cones on the HRB system and also for offsetting the ship in relatively finely controlled moves that aided in precisely locating the best landing spot for the HRB deployments. The DP operators of the system, especially the electrical supervisor himself, Phil Gardner, did an excellent job maneuvering the drillship, reading/monitoring the electronic tilt-beacon signals, and communicating with the rig floor during critical operations.

ENGINE ROOM AND RIG FLOOR

There were no major problems with rig floor or engine room equipment during Leg 142, although a lot of preventive maintenance work was accomplished during the two long transit periods. On the transit enroute to Site 864 the SEDCO electrical and marine departments gave much support to the ODP technical staff in the renovation of the core lab.

During the transit into Honolulu, the drill crew spent most of their time initially assisting with the clean-up and rig-down of the DCS platform, followed by the complete renovation of the Varco top drive. The top drive had been in service since 1984, and a change-out and overhaul was deemed long overdue. During Leg 141 the rig crew detected an odd noise believed to be coming from the top-drive motor. A test conducted during Leg 142 indicated higher-than-normal oil temperatures, leading to the decision to replace the top-drive motor with the back-up unit which had been refurbished and put on board as a spare several years ago. After the rebuilt motor (spare) was checked out by the electricians and rig mechanic, the currently installed top drive was torn down. Included in the overhaul was replacement of all hoses and the fabrication of new support plates for the hinge pins. The existing plates showed definite deformation of the pin holes. The entire frame was also cleaned and painted in preparation for the installation of the spare top-drive motor.

In addition to the top-drive work, the engine room worked diligently on the replacement of approximately 15 ft of 8-in.-diameter seawater piping for one of the aft air-conditioning systems. The crew took advantage of the long transit to effect the required repair work.

PERSONNEL

Support from the SEDCO crew was exceptional throughout the leg. This was a grueling leg both mentally and physically. During 36.5 operating days on site a total of 35 reentries were made. The rig/floor crews performed continually at a high level of competence despite the rigorous work level. Most operations performed during the leg were out of the ordinary, yet they were done efficiently and safely. Much credit goes to Bob Caldow and Mike Pottier for their continual attention to detail and constant effort at finding the quickest, safest, most expeditious way to get the job done. This outstanding effort on their part was appreciated indeed by the DCS engineering team. The marine, electrical, and engine room departments, and especially Ken Yesson, the rig mechanic, supported the DCS effort with skill and dedication.

Ms 142IR-101

Table 8. Beacon summary report, Leg 142.

Hole	Manufacturer	Model number	Serial number	Frequency (kHz)	Decibels	Water depth (m)	Days on site	Remarks
864A, 864B	Datasonics	354-B	754	16.0	208	2570.1	36.3	1
864A	Datasonics	359	841	18.0	208	2570.1	9.3	2
864A, 864B	Datasonics	354-B	751	14.0	208	2570.1	20.9	3
N/A	Datasonics	354-B	758	N/A	208	N/A	N/A	4
864B	Datasonics	354-B	752	15.0	208	2570.1	5.9	5
N/A	Datasonics	359	842	N/A	208	N/A	N/A	6

Notes: N/A = not applicable.

Remarks:
1 Primary beacon, commandable, deployed 0240 hr, 30 January, recovered 1010 hr, 6 March.
2 HRB tilt beacon, noncommandable, deployed 0300 hr, 30 January, signal weak 0915 hr, 8 February.
3 Back-up, commandable, deployed 1215 hr, 8 February, pre-released 0910 hr, 29 February, recovered 1015 hr, 29 February.
4 Pre-released on deck twice—was not deployed.
5 Back-up beacon, commandable, deployed at 1215 hr, 29 February, recovered 1010 hr, 6 March.
6 HRB tilt beacon, was not deployed, broken frequency select switch.

Post-leg action items: (1) Beacon numbers serial numbers 751 and 758 were returned via surface freight for repair – failure reports were prepared. (Note that all lithium batteries were removed prior to shipment.) (2) Tilt beacon serial number 842 was kept aboard for field repair. Repair of broken frequency select switch on transmitter PCB required. (Switches will have to be ordered). Failure report was prepared.