Harding, B. W., Storms, M. A., et al., 1990
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14. SITE 773[1]

Shipboard Engineering and Scientific Parties[2]

HOLE 773A

Date occupied: 13 January 1989

Date departed: 14 January 1989

Time on hole: 1 day, 5 hr, 30 min

Position: 20°12.30′N, 121°39.00′E

Bottom felt (rig floor: m, drill-pipe measurement): 1604.0

Distance between rig floor and sea level (m): 10.5

Water depth (drill-pipe measurement from sea level, m): 1593.5

Total depth (rig floor, m): 1741.4

Penetration (m): 137.40

Number of cores: 5

Total length of cored section (m): 13.1

Total core recovered (m): 0

Core recovery (%): 0

Oldest sediment cored:
Depth sub-bottom (m): 137.40
Nature: rubbly conglomerate, basalt, and gabbro pebbles

HOLE 773B

Date occupied: 14 January 1989

Date departed: 20 January 1989

Time on hole: 6 days, 13 hr, 30 min

Position: 20°12.30′N, 121°39.20′E

Bottom felt (rig floor: m, drill-pipe measurement): 1604.0

Distance between rig floor and sea level (m): 10.5

Water depth (drill-pipe measurement from sea level, m): 1593.5

Total depth (rig floor, m): 1721.4

Penetration (m): 117.4

Number of cores: 4

Total length of cored section (m): 19.1

Total core recovered (m): 15.75

Core recovery (%): 82.46

Oldest sediment cored:
Depth sub-bottom (m): 101.7
Nature: volcaniclastic silty claystone
Measured velocity (km/s): 1.75

Principal results: Site 773, in Luzon Strait at the original ENG-1 site, was drilled in an attempt to find more favorable conditions for reaching basement so that the diamond coring system (DCS) could be more effectively deployed.

Again, engineering tests and procedures were the main objectives at the site.

Two holes were drilled. Hole 773A was washed, drilled, and XCB-cored to a total depth (TD) of 137.4 mbsf. It was abandoned because of hole instability. Hole 773B penetrated to a TD of 117.4 mbsf after cutting two DCS cores, the first ever in ODP operation. Because of adverse weather conditions and other problems with DCS deployment, the hole was abandoned before basement was reached. These two DCS cores achieved 81.6% recovery, and the overall performance of the DCS was generally successful.

Subordinate scientific objectives were attained in describing the DCS cores and in making samples available for the geriatric core study.

Only one lithostratigraphic unit was recognized. Unit I is composed of brown volcaniclastic claystone and silty claystone with fractures and microfaults. Minor amounts of igneous conglomeratic rubble were washed in at the tops of both the DCS cores by the drilling process.

BACKGROUND AND OBJECTIVES

The objectives for this site were essentially the same as for Site 772. The main engineering objective was deployment and successful testing of the diamond coring system (DCS). In order to achieve this objective, we decided to steam to our original ENG-1 site in Luzon Strait, where water depth and basement were expected to be suitable.

Scientific objectives included describing and curating cores, conducting additional analyses of the samples such as paleomagnetic and physical-property determinations, and collecting additional samples for the geriatric core study.

These objectives were only partly realized, as we did not reach basement.

OPERATIONS

Seismic gear was not streamed until 2230 hr on 12 January, when both water guns were deployed (all times given are Universal Time Coordinated or UTC). Site 773, or ENG-1, in Luzon Strait, was crossed at 0015 hr on 13 January on a west-to-east track, but just after we crossed the site the global positioning system (GPS) was reduced. A north-to-south crossing line was run, and after some tighter survey work was done under better GPS conditions, the guns were pulled at 0255 hr. A Datasonics UAB-354 17-kHz beacon was dropped at 0345 hr on a final pass at 4 kt over the site (Fig. 1). The thrusters and hydrophones were lowered, and the vessel was in a dynamic-positioning mode over the site by 0430 hr. The depth according to the precision depth recorder (PDR) was 1603.4 m, and the drill-pipe measurement verified the water depth at 1604 m.

A modified XCB/DCS BHA was made up, which consisted of a special drillable landing sub below the top sub and head sub on which the XCB could be landed to initiate the hole and later drill out with the mining drill rod and continue using the DCS out the end of the bit. The bit used for Site 773 was a modified Security XCB bit that had the throat bored out an extra 0.26 in.; the cones were set back in order not to interfere with the tool joints of the drill rod. The outside diameter (OD) of the bit after modification was 11.625 in., or 0.187 in. larger than a standard XCB bit. The BHA consisted of three stands of drill

[1] Harding, B. W., Storms, M. A., et al., 1990. *Proc. ODP, Init. Repts.*, 124E: College Station, TX (Ocean Drilling Program).

[2] Shipboard engineering and scientific parties are as given in the listing of participants preceding the contents.

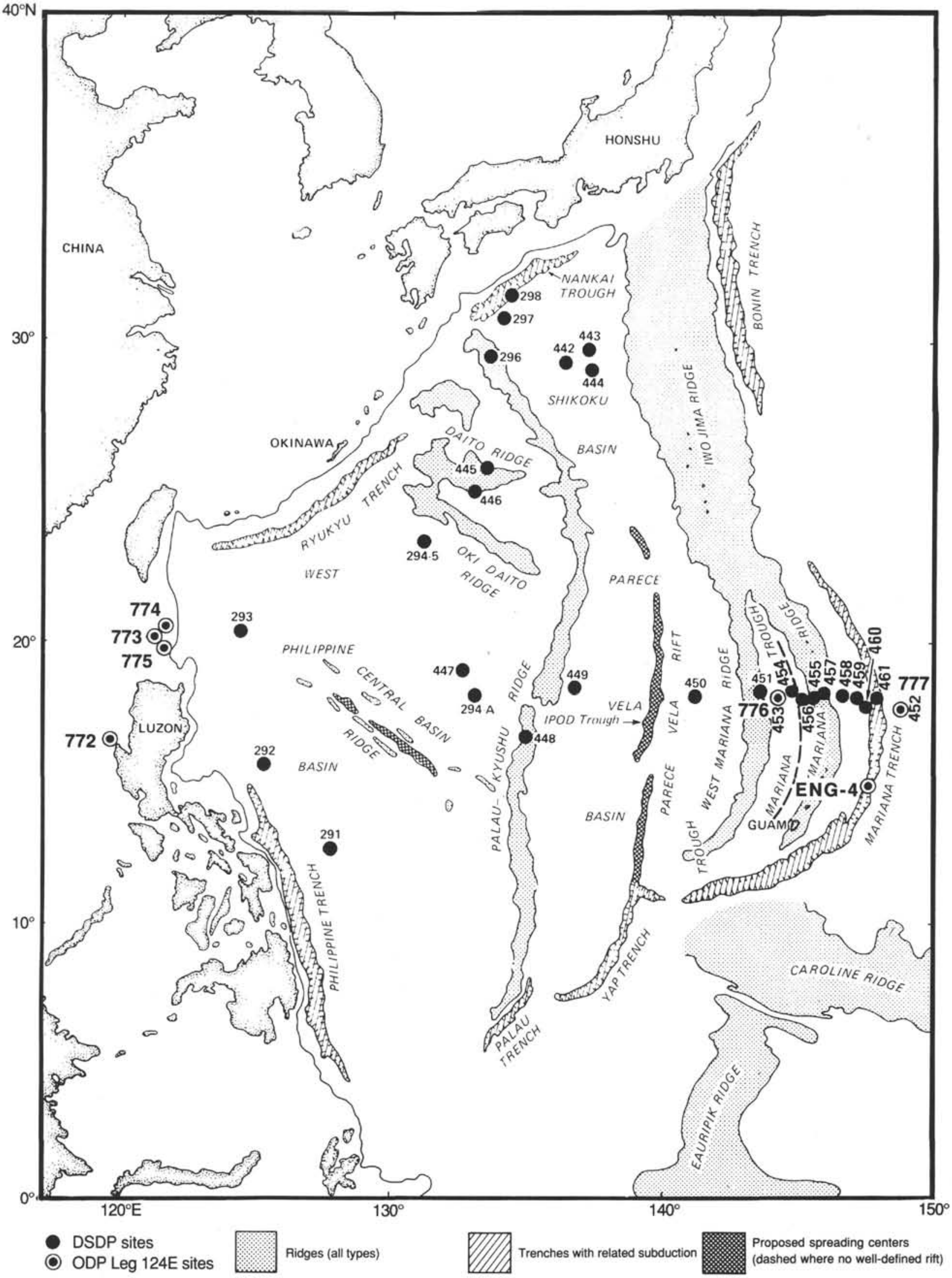

Figure 1. Map of western Pacific region showing DSDP sites and ODP Leg 124E sites. Adapted from Hussong et al. (1982, Fig. 1).

collars and crossed back over to the 5.5-in. drill pipe. The entire drill string consisted of 5.5-in. drill pipe to give a maximum safety factor in case of encountering stuck drill pipe. While we hoped that the extra safety factor would never be needed, we knew that while rigging up and running the drill rod and DCS platform, the API string would be left stationary in the borehole.

Hole 773A

Hole 773A was spudded at 1345 hr on 13 January with an XCB barrel in place. The first two stands were washed in before pulling the barrel. Core 124E-773A-3X was cut from 95.2 to 104.8 mbsf and resulted in 8.91 m of brown sandy clay. This core took only 8 min to cut, which indicated that basement was still some distance down. Core 124E-773A-4W consisted of a stand washed down to 133.9 mbsf, and another XCB was dropped. Core 124E-773A-5X took 60 min of rotating time to cut 3.5 m, and we decided that the formation was sufficiently lithified to deploy the DCS. (None of the cores from Hole 773A were curated.)

Prior to running the 3.5-in. tubing through the API drill string, a conditioning trip was made to check the hole for bridges. The pipe was pulled up to 30 mbsf, and, upon getting back to bottom, 3 m of fill was encountered. Minor bridging that took 10,000 lb of weight was pushed through at 1704 m (100 mbsf) en route to bottom. A second wiper trip up to the 104-mbsf depth was made, and tight spots were worked through at 120 and 125 mbsf.

At 0730 hr on 14 January, Hole 773A was abandoned because of hole instability, and the drill string was pulled clear of the seafloor.

Hole 773B

Hole 773B was spudded at 0915 hr on 14 January with a center bit in place. Three stands were drilled in to 1686.6 m (82.6 mbsf) prior to pulling the center bit. Cores 124E-773B-1X and -2X were cut in 14–15 min each to a depth of 98.7 mbsf, with recoveries of 82% and 86%, respectively. (These cores were not curated.) At that point, the depth of the hole was above the zone of instability encountered in Hole 773A. After a 30-bbl sweep of gel, high-viscosity mud was spotted in the annulus, and a wiper trip to 40 mbsf was made. Once the pipe was back on bottom, another 2.75 hr was spent conditioning the hole while the spaceout required for the DCS was checked.

After the top-drive was set back and scaffolding was rigged up, a mining bit and outer core barrel were made up. The initial trip in the hole with the 3.5-in. tubing was a little slow, because each connection between stands was made up twice in order to break in the new connections. Previously, in port, 70 stands of the Hydril Wedge-lok tubing had been made up and broken in to save operating time at sea. Also, the tool joints on the first 200 m of tubing had been turned down in order to give a little more clearance through the bit, and those tool joints were gauged during the trip. After attaching the two guide dollies for the DCS mast to the derrick guiderail, the DCS platform and mast were skidded to well center, attached to the links, and picked up. The rig's top-drive was then picked up with the second set of links that pinned below the DCS platform so that the API drill string could be both rotated and circulated through.

Initial drilling of the top landing shoulder inside of the outer core barrel began at 2300 hr on 15 January, and by 0100 hr on 16 January both inserts had been drilled out and the core barrel retrieved. Following 4 hr of repair on both the hydraulic power unit and the wireline winch, a second core barrel was dropped. The API drill string had become stuck during the 40 hr since it had last been moved. A 220,000-lb overpull was required to free the drill string, and the hole was swept with 55 bbl of high-viscosity mud. Mud was left both inside the pipe and also spotted in the annulus. At 1200 hr the 11.625-in. bit was landed on bottom, and the secondary heave-compensation system on the platform was monitored relative to the heave of the *Resolution*. The API drill string was drilled down 4.4 m after another 1.75 hr of troubleshooting the DCS hydraulic system. From 2000 to 2230 hr the first-ever DCS core was cut on the *Resolution* from 1702.73 to 1704.33 mbrf (98.73 to 100.33 mbsf) and yielded 56.3% recovery. Another DCS core was then cut to 1705.77 mbrf (101.77 mbsf), but upon retrieval of the core the mining overshot parted. A total of 13.5 hr then was spent trying to fish the overshot out of the hole, until at 1430 hr on 17 January it was decided to abandon the fishing attempts. The large bit was pulled off bottom, and the 3.5-in. tubing was tripped out of the hole in order to retrieve the core barrel with Core 124E-773B-4M. The trip out of the hole with the drill rod took 4.5 hr after the top-drive was set back, the DCS landed and skidded back, and the mast crosshead lowered. During the trip out repairs had to be made to ODP's slip-type elevators. The second DCS core had advanced 1.4 m and recovered 1.5 m of volcaniclastic claystone, with the top 20 cm containing igneous rubble that had been washed from above. The coring summary is given in Table 1; only results from the two DCS cores are shown, as the two XCB cores were not curated.

After the tubing was tripped out, the top-drive was picked up and the hole was advanced 18.67 m in order to get two knobby drilling joints through the guide-horn because the weather was deteriorating. The hole was conditioned, and 50 bbl of mud was left in the drill pipe. The 3.5-in. tubing was tripped in the hole in 3.75 hr, and the DCS platform once again picked up. The API drill string had once again become stuck, and a maximum of 370,000 lb of overpull was required to free the pipe. A total of 50 bbl of high-viscosity mud was spotted in both the 5.5-in. drill pipe and the annulus. The drill rod was then landed on bottom and was thought to be up inside the API drill pipe. Immediately upon tagging the fill(?), the secondary heave-compensation system began giving trouble, and 5.5 hr was required to fix it. The DCS drill rod was washed from 1716.12 to 1718.35 mbrf in 15 hr. At 0330 hr on 20 January, the DCS sand line was run to pull the wash barrel in order to see what had taken 15 hr to ream 2.23 m. Upon recovery of the barrel, the mining overshot rod suffered a tension failure. An immediate decision was made to trip out of the hole with the drill-rod string and to look at both the core and the cutting shoe to determine what was happening downhole. Upon recovery of the mining BHA, we discovered that the face of the cutting shoe was completely destroyed and the core barrel had fallen out in the hole, as the core barrel lands and is contained in the bit itself. Since the API drill string had to be pulled at least to the mud line to begin a new hole, we decided to move the ship to a new location in search of basement.

By this time it was apparent that deployment of the DCS system was a very time-consuming operation and that the time allotted to DCS drilling was expiring quickly. A site to the north,

Table 1. Coring summary for Site 773.[a]

Core no.	Date (Jan. 1989)	Time (UTC)	Interval cored (mbsf)	Length cored (m)	Length recovered (m)	Recovery (%)
124E-773B-						
3M	16	2210	98.7–100.3	1.6	0.9	56.3
4M	18	0550	100.3–101.7	1.4	1.5	107.0
				3.0	2.4	81.6

[a] Represents only those cores that were curated.

in what was hoped to be more protected water in the lee of one of the islands, was chosen for lack of a better prospect. The bit cleared the rotary table at 2210 hr on 20 January, and the thrusters and hydrophones had already been raised and secured. Then we were under way to the next site.

LITHOSTRATIGRAPHY

Only one lithostratigraphic unit was recognized at Site 773. Unit I consists of brown volcaniclastic claystone and silty claystone in the two cores that were curated and described, Cores 124E-773B-3M and -4M, which were the first cores cut with the DCS. A minor lithology comprises conglomeratic rubble that was washed in at the top of the core by the drilling process, composed of igneous silt, sand, pebbles, and some finer reddish material indicating weathering. The claystone exhibited natural fracturing and microfaulting; mineral infill and slickensides are visible along some fractures and/or microfaults. The lower part of the cored interval was highly broken up by drilling disturbance.

Because of problems with stability in both Holes 773A and 773B, and difficulties with the DCS at this site, the basement objective was not realized.

SITE GEOPHYSICS

The location of Site 773 was at the original ENG-1 site in Luzon Strait, where basement was expected at a depth of about 1800 m, based upon the *Vema* multichannel line. Our approach to the site was from the southwest, where we deployed the water guns and eel about 1 hr prior to arrival. The *Vema* line was reoccupied, and our single-channel record showed essentially the same features, namely, a "basement" subcrop with thin pelagic sediment cover to the west and a sediment-filled basin to the east. The basin contains at least 350 m of sediment in its deeper parts and thins abruptly, or is tectonically truncated, at its western boundary.

Our survey made a second crossing parallel to the *Vema* line (shown in Fig. 2) and continued to the northwest and then back on a southeast course to provide a track parallel to the north-northwest tectonic grain. This crossing line confirmed the features shown in Figure 2, and a site was chosen essentially on the *Vema* line about 1 km from the western margin of the basin. The *Resolution*'s survey track in the immediate vicinity of the drill site is shown in Figure 3.

Based upon the above surveys, the western boundary of the basin appears to be fault controlled, with the fault having a north-northwest trend. Side echoes observed during the local bathymetric survey suggest that the hills to the west are also sediment covered, with sediment thicknesses of more than 10 m. To the southeast about 1 km the basin deepens by about 150 m, and the topography at the western margin is not a simple sediment-covered basin but appears to be cut by a canyon parallel to the basin margin.

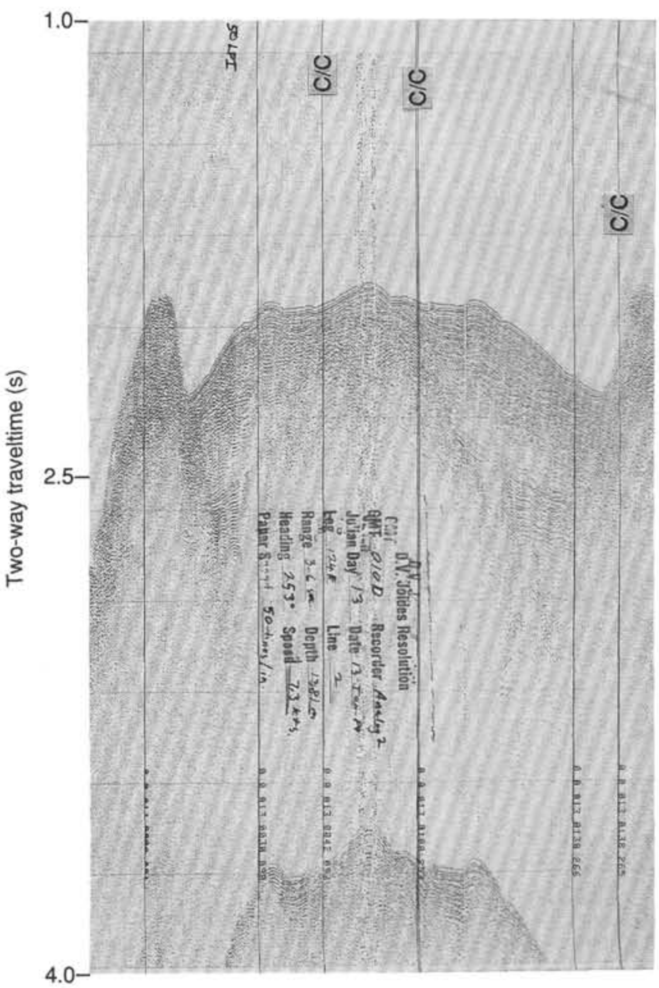

Figure 2. Water-gun record in the vicinity of Site 773, showing boundary of sedimentary basin at right.

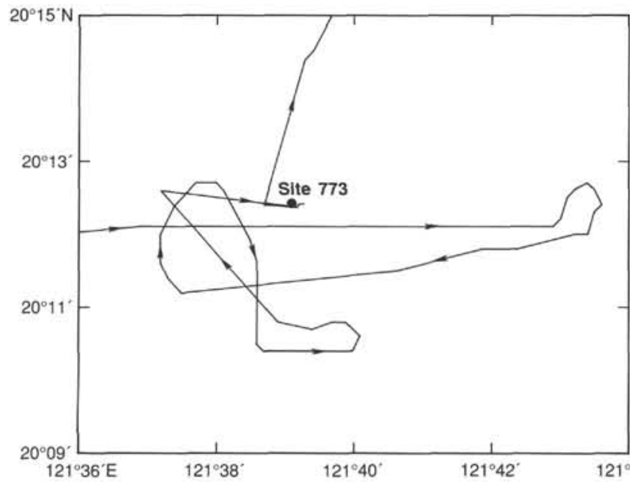

Figure 3. *Resolution*'s survey track in the vicinity of Site 773.

SUMMARY AND CONCLUSIONS

Introduction

Two holes were drilled at Site 773 (ENG-1) in 1604 m of water. Hole 773A was terminated at a total depth of 1741.4 mbrf or 137.4 mbsf. An apparent rubble zone was encountered between 119 and 134 mbsf. Several ledges were identified in that zone. The formation was composed primarily of interbedded clay and rubble. Gabbro was recovered in the core catcher of the last XCB core, indicating that basement may have been close. Unfortunately, formation instability in this zone made the hole inappropriate for deployment and testing of the diamond coring system (DCS).

Hole 773B was drilled to a depth of 98.7 mbsf so as to position the drill pipe above the unstable rubble zone encountered while drilling Hole 773A. Plans were to keep the drill pipe above the rubble zone so that the pipe would not become stuck during subsequent DCS coring operations. Drilling through the rubble and underlying basement would have been a good demonstration of the DCS potential.

Engineering Results

The extended core barrel (XCB-124E) system was deployed only twice as spot cores between washed intervals. Again, just as on Hole 772A, no conclusions could be reached concerning overall system performance. There were no mechanical failures.

DCS Operations

The first deployment of the DCS occurred at Hole 773B under less than ideal wind and sea conditions. A thorough evaluation of the DCS took place despite the fact that the ship's heave amplitude and period exceeded the design parameters of the system.

Although some aspects of the DCS were not tested, many positive highlights of the system were identified as well as some improvements to be implemented prior to future shipboard testing. Highlights of the DCS testing at Site 773 include the following:

1. Established the feasibility of handling and deploying a slim-hole diamond coring system through ODP 5½-in. drill pipe suspended from a floating vessel.
2. Demonstrated the concept of cutting core with the system in 1600 m of water under severe operating conditions.
3. Demonstrated successful secondary "active" heave compensation under environmental conditions exceeding the design parameters of the system.
4. Successfully tested the deployment, operation, and recovery of the DCS tubing string (3½-in. working drill rod), including wedge-thread connections, without adverse effects.
5. Confirmed satisfactory performance of the DCS top drive, power pack, and mud-pump equipment.
6. Confirmed satisfactory performance of the DCS platform, mast, and feed-cylinder hardware.
7. Established the feasibility of spudding a sedimentary hole with an APC/XCB BHA and then deepening the hole to total depth with the DCS.

Necessary changes and improvements to any prototype system are always identified, based on the initial test deployment. That was also true of the DCS development. Based on the Leg 124E sea trials, the following areas were singled out for improvement prior to the next DCS test:

1. All mining-industry wireline tools and coring systems need to be strengthened to hold up better when deployed in the more rigorous ODP offshore, deep-water environment.
2. The core winch, installed on the platform and used to recover the DCS core barrels, must be upgraded or replaced with a more standard "oilfield"-type winch equipped with mechanical braking, and level wind systems.
3. Handling/deployment time, although already reduced significantly by the end of Leg 124E, must still be improved further. A variety of improvements can be made that will lead to significantly more efficient DCS rig-floor and platform operations.
4. Future deployments must seriously address the problem of hole instability leading to the sticking of the API 5½-in. drill string. Use of reentry cones, casing, and HRB systems, modified for DCS compatibility, will aid in solving this problem.

Some aspects of the DCS were not tested on Leg 124E. The ability to penetrate and recover crystalline rock was not demonstrated. An evaluation of the wider kerf diamond core bits (4.0-in. OD by 1.87-in. ID) was not conducted. The dynamic effect of rotating a long tubing string inside API drill pipe, although evaluated at 120 rpm, was not investigated at the higher, 500- to 600-rpm speeds likely to be used in coring crystalline rock.

Finally, the use of rig triplex mud pumps dressed with 5-in. liners was not evaluated for use in the DCS coring operation. In spite of the shortcomings, DCS testing on Leg 124E generated a large amount of data that will be invaluable to the productive development of the DCS destined for future ODP operational use. For more complete test details, refer to the DCS test reports contained in the major section near the front of the volume entitled "Contributed Papers."

Scientific Results

The volcaniclastic claystone obtained at the site is characteristic of an island-arc environment. Additional core samples were made available for analysis in the geriatric core study.

REFERENCE

Hussong, D. M., Uyeda, S., Knapp, R., Ellis, H., Kling, S., and Natland, J., 1982. Deep-Sea Drilling Project Leg 60: cruise objectives, principal results, and explanatory notes. *In* Hussong, D. M., Uyeda, S., et al., *Init. Repts. DSDP*, 60: Washington (U.S. Govt. Printing Office), 3–30.

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NOTE: All core description forms ("barrel sheets") and core photographs have been printed on coated paper and bound as Section 3, near the back of the book, beginning on page 139.