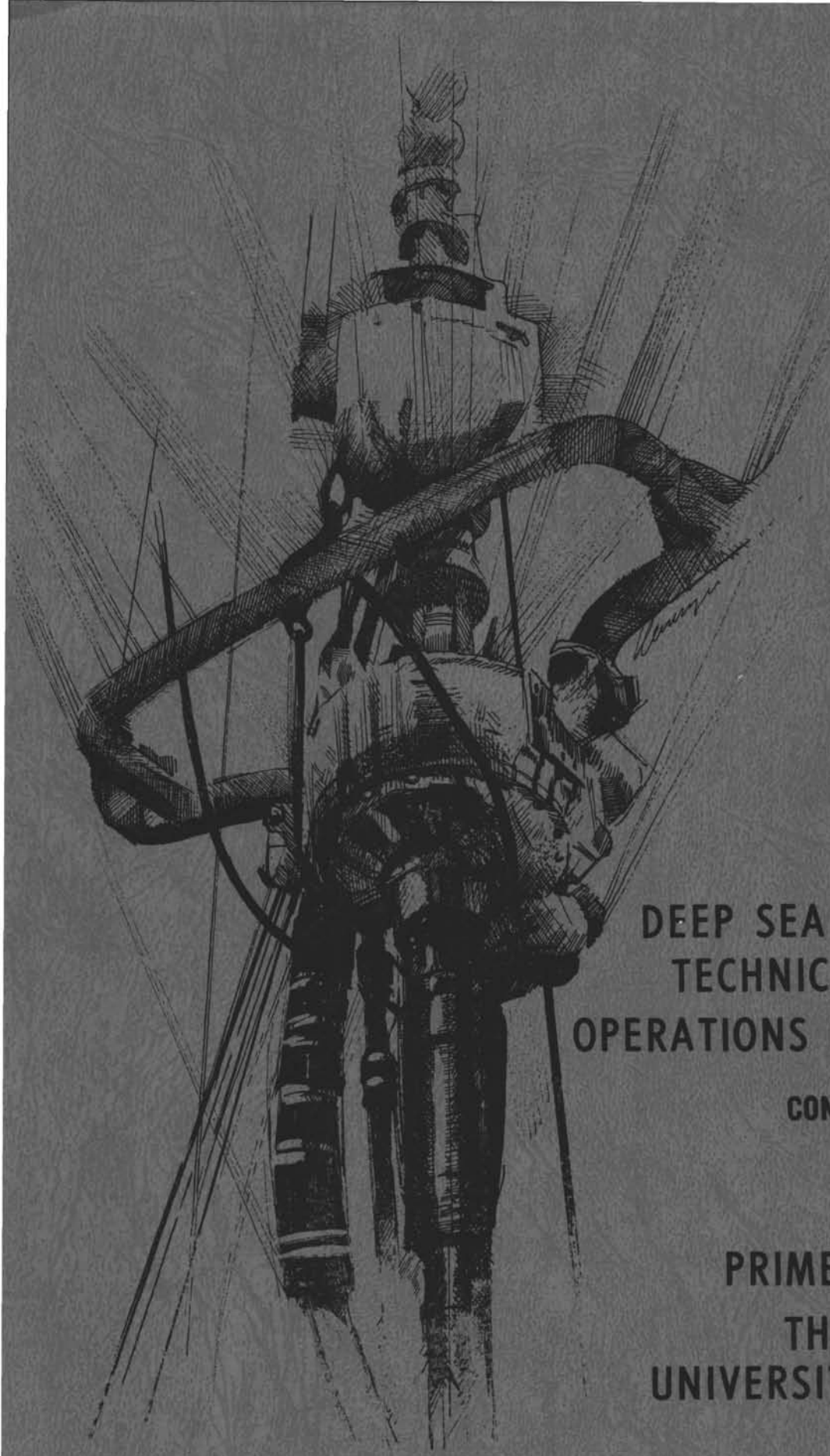

DEEP SEA DRILLING PROJECT
TECHNICAL REPORT NO. 5
OPERATIONS RESUMES - PART II

CONTRACT NSF C-482

PRIME CONTRACTOR
THE REGENTS,
UNIVERSITY OF CALIFORNIA

SCRIPPS INSTITUTION OF OCEANOGRAPHY
University of California at San Diego

OPERATIONS RESUMES

LEG 19 through LEG 25

JULY 20, 1971 through AUGUST 22, 1972

Prepared for

NATIONAL SCIENCE FOUNDATION

Under Provisions of Contract NSF C-482

By

DEEP SEA DRILLING PROJECT
Scripps Institution of Oceanography
University of California at San Diego

OCTOBER 1972

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INTRODUCTION

Publication in October 1971 of Technical Report No. 1 - Operations Resumes for the first 18 legs of the Deep Sea Drilling Project - touched off much interest throughout the world in operational and engineering procedures aboard D/V GLOMAR CHALLENGER.

This latest report contains Operations Resumes for Leg 19 through Leg 25, which with Technical Report No. 1, covers four years of highly rewarding drilling and coring work in the deep oceans of the world.

Scripps Institution of Oceanography of the University of California, San Diego, is managing the Deep Sea Drilling Project under contract to the National Science Foundation. The Project is part of the Foundation's National Ocean Sediment Coring Program.

As in Technical Report No. 1, the resumes list technical achievements, drilling and coring results, drill bit performance and improvements, coring equipment modifications, tests of new procedures and equipment, improvements of drilling and coring procedures, plus problems encountered and anticipated and the steps taken or proposed.

Drilling engineers loaned to DSDP by major oil companies of the United States were cruise operations managers on four of the seven legs covered in this report. The resumes were written at the conclusion of each expedition by the cruise operations managers. As on earlier legs, the drilling expertise of these engineers was invaluable to DSDP in constantly refining operational procedures aboard D/V GLOMAR CHALLENGER.

October 1972

ACKNOWLEDGEMENTS

The advice of Cruise Operations Managers loaned to the Deep Sea Drilling Project by Major oil companies of the United States and the direction of Mr. Valdemar F. Larson, Project Operations Manager and Mr. Lamar P. Hayes, Resident Cruise Operations Manager, have been instrumental in the overall operational success of the Project. Cruise Operations Managers from major oil companies directed drilling and coring operations aboard D/V Glomar Challenger on four of the seven expeditions reported.

Mr. Frank C. MacTernan, Deputy Project Manager; Mr. Norman J. Sattler, Project Contracts Officer and Mr. William T. Soderstrom, Project Finance Administrator, contributed greatly to the essential business functions and Mr. Robert W. Gilkey, Project Logistics Officer, coordinated successfully all logistics functions necessary to achieve these operational successes.

Global Marine Inc., of Los Angeles, California, who own and operate D/V Glomar Challenger, contributed heavily to the technical and scientific success of the Project during this reporting period.

The continuing help of Mr. A. R. McLerran, National Science Foundation Field Project Officer with DSDP and the support of the Foundation are gratefully acknowledged.

Scientific direction has been provided by members of the Joint Institutions for Deep Earth Sampling (JOIDES).

M. N. A. Peterson
Co-Principal Investigator
Deep Sea Drilling Project

OPERATION RESUMES

Contents

Technical Report No. 5

Operations Resumes

(Part 2)

Legs 19 through 25

DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 19

SUMMARY

Leg 19 of the Deep Sea Drilling Project which commenced on July 20, 1971 at Kodiak, Alaska, consisted of operations in the North Pacific and Bering Sea. The leg terminated at Yokohama, Japan on September 13, 1971.

During the 55.16 day voyage, the Glomar Challenger cruised 4,341 miles, drilled sixteen holes at eleven sites and cored 2,186 meters in 256 coring attempts with recovery on 238 or 92%. A total of 1,062.1 meters of core was recovered for an average of 48.6%. In addition to the coring, 7,783 meters were drilled for a total penetration of 9,969 meters.

Major time distribution for the 55.16 days consisted of 3.15 days in port, 20.33 days cruising and 31.60 days on site. Major time distribution of the 31.60 site days consisted of 13.84 days coring, 8.50 days drilling and 8.04 days for trips.

The dynamic positioning system of the vessel failed in the early part of the voyage but after repairs were made the vessel held station well even in very rough seas. Several new Ocean Research Equipment (ORE) beacons were tested and gave excellent service and signals from which to position. Weather was a major factor during the voyage and even though seas ranged from perfectly smooth to waves of 20 feet, operations continued with a total of only four and one-half hours downtime caused by inclement elements.

One of the significant operational highlights of Leg 19 was the establishment of a total penetration record of 9,969 meters for the 16 holes investigated. Contributing to this record was 2,237 meters of penetration by one bit (Smith Type 93-3 cone sealed bearing core bit) used on three different holes. This style chisel insert bit did an excellent job of penetrating the hard mudstone and when the bit was returned to the surface after accumulating 39 hours two minutes of rotating time, the cutting structure was in excellent condition, however, the bearings and shirt-tail were badly worn. The excellent runs made by this bit illustrate just one of the many technical strides made during the life of the Deep Sea Drilling Project.

The Soviet vessel SODKO maintained surveillance of the Challenger the entire time while on station at Site 191 and an unidentified Soviet vessel continued the surveillance on Site 192. The vessels normally observed the coring operations from a distance of two to four miles but at times they came in very close to the Challenger. At no time did they attempt to interrupt operations or cause any kind of problem.

DRILLING AND CORING

The geologic sections on all 11 sites were similar and consisted basically of soft diatomaceous muds near the sea floor and grading with depth to either very hard mudstone, sandstone, chalk or a combination of the three. Site 183 contained turbidites in the lower section of the hole while Sites 186, 190, and 191 had turbidites mixed with other sediments in various sections of the hole. Basalt was cored on Sites 183, 191, and 192 with the maximum penetration being 13 meters.

To drill and core the above type sediments on Leg 19, the same basic bottom hole assembly configuration was used on all sites. The assembly consisted of the core bit, one 8-1/4 inch drill collar, two bumper subs, two 8-1/4 drill collars, one 7 inch drill collar, and one joint of heavy wall drill pipe. The assembly was approximately 127 meters long and provided approximately 30,000 pounds of weight in sea water. A drill pipe float valve was run in the above assembly on the last 13 holes. The float was placed below the lower support bearing as part of the outer barrel.

The bottom hole assembly gave excellent results in seas ranging from a dead calm to a maximum swell of 20 feet. Drill pipe rotation ranged from 25 to 50 rpm and bit weight varied from 1,000 to 25,000 pounds. Minimum circulation was used for coring and maximum for drilling.

The new float valve design gave excellent results in preventing plugged bits and stuck core barrels even though several holes were unstable due primarily to turbidites. After the use of the float was initiated, only one core barrel was stuck and it cleared prior to pulling the entire drill string to the surface. The new large diameter high strength pin and the new one piece flapper valve gave excellent service as evidenced by the complete absence of failure. The maximum number of drops of the core barrel on the flapper valve was 41. Some modification of the flapper may be necessary, however, as the holes in the valve tend to become egged after 20 to 30 drops of the core barrel.

There were no losses of drilling equipment on Leg 19, however, some problems were experienced with bumper subs. The service connection of one Baash Ross sub was galled beyond repair, while the other failure occurred on a Shaffer Type 5PB sub. On Leg 17, the Shaffer sub, which does not have a service connection on the body section, was used on two sites and both times, when pulled, was completely inoperable due to sand. On Leg 18, six 1 inch diameter holes were drilled in the body section of the sub and run on three sites before the locking nut on the sub backed off causing loss of the bottom hole assemble. On Leg 19, six 1 inch diameter holes were drilled in another sub and self locking screws installed in the locking nut. This sub was used on Sites 183 through 193 but was stuck in the open position after Site 193. Service of the sub requires that it be in the closed position for the removal of the set screws from the locking nut. All efforts to free and collapse the sub failed and there is no way to enter the sub without removing the set screws. Modifications that will allow servicing by rig personnel are needed. It is suggested that further field evaluation be deferred until these design modifications are made.

A total of nine bits were used on the 11 sites with one bit being used on two sites and one

bit being used on three sites. Site 184 required two bits as three holes were drilled. Shown below is a summary of the bits used.

One	4 cone, non-sealed bearing, compact inserts, Type 9C
One	3 cone, non-sealed bearing, compact inserts, Type 9C
One	4 cone, sealed bearing, compact inserts, Type 9C
Four	3 cone, sealed bearing, shaped inserts, Type 93
One	4 cone, sealed bearing, shaped inserts, Type 94
One	Diamond, Light Set, controlled bite

The new three cone, sealed bearing, shaped insert, Type 93 bits did an excellent job, however, the limiting factor still seems to be the bearing life even though total rotating time remains low along with low bit weights. The average rotating time for the four Type 93 bits was 25 hours 57 minutes with the average penetration being 1,793 meters. The average dull grade for these four was T-2, B-8. The cutting structures were in excellent condition and appeared almost new. None of the inserts were broken or missing, which is quite a contrast to the Type 94 bits used on Leg 17, which exhibited many broken inserts.

The weak point in the bearing still appears to be the thin portion of the shirt-tail which supports the bearing grease seal. Sediments and debris in the hole apparently cut away the metal of the shirt-tail which supports the seal thus exposing the seal to abrasive conditions. The seal fails and, of course, the bearings then fail. It was thought that the cherts on Leg 17 were causing this type failure but on Leg 19 no cherts were encountered. The hardest formation encountered other than basalt was mudstone along with some limestone and sandstone. The limestone and sandstone were not very thick sections.

The one bit that was used on three holes was of the Type 93, sealed bearing and penetrated 2,237 meters in 39 hours two minutes of rotating time. This is the maximum penetration for a single bit to date and the cutting structure, when pulled, looked almost brand new. The bearings were so badly worn that the cones were riding on the throat and cutting a core of only one and one-half inch diameter.

A great amount of difficulty was experienced this leg due to failure of plastic inner barrel core liners. An estimated 60 percent of the liners were "flat" to the extent that they would not enter the inner core barrel. Many other liners collapsed or just completely shattered within the inner core barrel. The reason for failure was never defined but it is thought that they may have been damaged in transit. Also, the supply of liners was very low and many of those used may have been on the vessel for a long period of time and deteriorated with age and heat.

Considerable time was lost on both Leg 17 and 19 in determining the exact water depth and penetrating the ocean floor on the first coring attempt. At this time, it is not known if this difficulty was due to the precision depth recorder, the correction factors obtained from Matthews tables or the measured length of the drill string. As shown below, the average difference in the corrected Precision Depth Recorder (PDR) depth and the sea floor depth determined by evidence of core in the core barrel was 16.3 meters on Leg 17 and 26.0 meters on Leg 19.

Leg 17

1. Site	2. PDR Depth Corrected Meters	3. Evidence of Core In Barrel Meters	4. Difference Between Columns 1 & 2	5. Time to Cut & Pull First Core Hours - Minutes
164	5,485	5,513	28	2 21
165	5,041	5,053	12	1 40
166	4,950	4,962	12	1 28
167	3,166	3,184	18	1 10
168	5,406	5,413	7	2
169	5,391	5,415	24	2
170	5,774	5,792	18	2 10
171	2,283	2,295	12	1 1
		Average	16.3 Total	14

Leg 19

183	4,698	4,718	20	1 30
184	1,901	1,920	19	1 5
185	2,110	2,120	10	1 10
186	4,992	4,532	40	1 45
187	4,554	4,587	33	1 50
188	2,623	2,659	36	1 10
189	3,410	3,447	37	1 15
190	3,864	3,885	21	1 20
191	3,849	3,864	15	1 15
192	3,009	3,024	15	1 10
193	4,781	4,821	40	1 30
		Average	26.0 Total	15

The differences resulted in an average of at least one "water core" being obtained per site. On Leg 19, this resulted in a total time loss of 14 hours; on Leg 19, a loss of 15 hours; and a total of 29 hours during the two legs. Based on the minimum operating cost of $600 per hour for the Glomar Challenger, the total dollar cost in looking for bottom and obtaining "water cores" was in excess of $17,000.

Based on these numbers, it is recommended that a study be initiated to determine an inexpensive, expedient method of determining exactly when the core bit penetrates the ocean floor.

Two possible methods (using small transducers) of determining the height of the bit above

the ocean floor are: (1) an expendable beacon attached to the core bit or outer core barrel and, (2) a recoverable beacon whose transducer extends through the core bit. The basic mechanics of a recoverable tool compatible with existing coring equipment have already been proven and presently exist in the JOIDES/NSF "heat flow" system used on Leg 19. This system would require only the design of an electronics package to fit in the heat flow hardware and would allow the recovery of a bottom core when the beacon was recovered.

CLATHRATE SAMPLING

Attempts were made to sample what was believed to be sediments containing clathrate three times on Site 185 and one time on Site 188. The sampling system consisted of a pressure barrel with an option of either five foot or 20 foot long chamber, traveling piston with O-rings forming the upper sealing system in the barrel and a Baker float valve forming the lower sealing system.

A total of six meters of core was cut, however recovery was basically only the material lodged in the 1-19/32 inch inside diameter extension sub. This sediment was packed very tight and appeared to be dehydrated. Only on the first attempt with the twenty foot core barrel did the piston effectively travel as it should have. Several minor modifications were made to the system but appeared to have no real effect. They were:

1. Removed .014 of an inch from the piston to permit easier travel. This reduced the operating pressure to approximately 5,000 psi.

2. Ran no check ball in the inner core barrel relief valve and also preloaded the inner barrel with water so as to equalize the pressure on the piston and prevent premature shearing.

3. Extended piston beyond nose of extension sub prior to installing shear pin so as to eliminate need of packing sediment into the sub to effect shearing of the pin.

A possible cause of failure could have been the firmness of sediments where the coring attempts were made. These attempts to core required 15,000 to 20,000 pounds bit weight and 150 to 450 psi circulation pressure. The core attempt on Site 188 required 8,000 pounds weight and the breaking of circulation to penetrate just one meter. If hard clathrate sediments are to be sampled in the future, a true cutting structure needs to be placed on the extension sub.

HEAT FLOW MEASUREMENT

A total of 15 attempts to obtain heat flow data were made on three sites. Two basic types of equipment were on board, however only one type was used; this being the equipment which allowed a core to be obtained with normal coring procedures on the same trip. It

was commonly called "core-heat flow" system. The other equipment required an additional trip with the sandline and was referred to as the "stinger" system.

Core-Heat Flow

Offers the advantage of being used in conjunction with the normal coring procedures and under normal continuous coring operations requires only an extra 10 to 15 minutes per core per heat flow measurement. When used in conjunction with a core and drilling ahead operation, it becomes necessary to obtain two cores in series so as not to have the delicate probe extending beyond the bit during the drilling operation.

The core-heat flow system, with the probe extending some 18 inches beyond the nose of the inner core barrel, suffered very little damage even when passing through the drill pipe float valve. The rig pump was slowed to 3 to 5 spm just prior to the landing of the core barrel to prevent damage to the electronics package and only minor deflection and wear was noted on the probe extension as a result of opening the flapper of the float.

Stinger

Offers the advantage of being able to penetrate firmer sediments but had the distinct disadvantage of requiring an extra wireline trip for recovery.

The most critical element in the process of obtaining heat flow data appears to be during the 10 to 15 minutes while the measurement is actually being made. The drill system must be static at that time with the bit sitting on or near bottom and with no circulation of fluid. With any degree of hole instability, the 15 minutes is certainly sufficient time to stick the bottom hole assembly.

Some valid data was obtained from the system used on Leg 19 and with some minor mechanical modifications, the tools should be completely operational.

POSITIONING EQUIPMENT AND BEACONS

The vessels automatic positioning system operated very well on the first location, Site 183, but failed completely on Site 184. Vessel positioning was accomplished at Sites 184, 184A, 184B, and 185, by operating primarily in the manual mode. Some degree of semi-automatic positioning was possible on 184B and 185. Several DX 15 cards in the digital to analog converter had failed and sufficient spares were not on board for replacement.

Repair personnel and spare parts were brought aboard at Adak and the repairs were made to the system while operations were conducted on Sites 186 and 187. The exact cause of the system breakdown was never positively defined, however, it appeared to have been caused by a power supply failure. The system operated very good on all remaining sites with the exception of one where severe weather was experienced.

On Site 189, a 997 millibar low was experienced with winds up to 55 mph and 20 foot seas. The vessel successfully held station by operating in semi-automatic and, at times, in manual mode. The major problem during this time was the loss of acoustics caused by the pitch and roll of the vessel. This loss of acoustics seldom occurs in moderate or calm seas but seems to be associated only with rough seas. Installation of domes over the existing hydrophones to eliminate the trapping of air would help alleviate this loss of acoustics problem.

A total of 13 beacons were used with 11 performing satisfactorily and two failing. The satisfactory beacons included two Burnett 13.5 kHz, one Burnett 16.0 kHz and eight ORE 16.0 kHz. One Burnett 13.5 and one ORE 16.0 kHz beacon failed. Both failures, a complete loss of acoustics, occurred within one hour after entering the water. The average operating time of the satisfactory beacons was 68.9 hours.

All beacons with the exception of two were placed in the water while underway at speeds of four to eight knots and resulted in excellent marking of the desire drilling site. Close observation of all beacons entering the water indicated that the beacons placed in the water while underway received no more intense shock than those dropped with the vessel dead in the water. All beacons were presoaked prior to releasing.

Weak signals were picked up several days later from the two beacons which apparently failed within one hour after dropping. It was surmised that the beacons were "lost" after dropping, however reconstruction of events at the time of placing the beacons in the water indicated the vessel should have been well within the normal range of the beacons. However, the reconstruction of events did lead to several recommendations which should improve the effectiveness of dropping beacons while underway.

1. The Chief Scientists need to provide sufficient lead time prior to a beacon drop to insure that the vessel is slowed to four to six knots and not merely making the proper number of prop turns for four to six knots.

2. All towed gear except that absolutely necessary to make the final site selection should be retrieved.

3. Following the release of a beacon, the remaining gear should be retrieved as quickly as possible.

4. Return to the drop area as quickly as possible so as to remain in the immediate area while the beacon is falling to the ocean floor and assure that it is not "lost".

5. Double check all dead reckoning navigational plots to insure immediate return to beacon drop area.

6. In adverse weather, such as strong winds and currents, a spar buoy (with light at night) released at the same time as the beacon is a recommended aid to DR navigation.

COMMUNICATIONS

General Communications

During the 55 day cruise 461 messages were transmitted from the Glomar Challenger. 60 were to Global Marine, 179 to Scripps (DSDP), 152 were meterological reports and 20 were personal messages for the crew over commercial channels. A total of 165 messages were received. All messages were transmitted by radio telegraph via Scripps radio station WWD except for the commercial and some meterological messages. No delays longer than a few hours were encountered with any traffic. Radio teletype communication was impractical due to low signal strength and interference experienced during most of the leg.

About 150 telephone "patches" were placed using the amateur radio.

Due to great distances, it is expected that CW communications will be difficult during the forthcoming legs based on problems experienced on Leg 19. Some of these problems were:

1. On many headings, while drilling, the ship's transmitting antenna (WNCU) is shielded from WWD by the derrick. This often gives the impression that the TMC transmitter is not operable, however, it is usually just a problem that must be tolerated until conditions permit the changing of the ship's heading.

2. When WWD's signal is weak, "break in" operation is still difficult due to spurious MMX radiation.

3. Radio Rome, IRM, is on precisely the same frequency as WWD and occasionally caused problems. On several occasions this problem was overcome by WWD or WNCU shifting frequency a few hundred cycles. On this leg, WNCU also experienced interference from UFW (Russia) and XSG (China) on the 12 and 17 mHz WWD frequencies, although these stations may not be heard by WWD.

To overcome the problems mentioned, a vertical trapped receiving antenna has been requested. This antenna, if mounted atop the derrick, would improve the ship's (WNCU) reception.

Air Rescue Communications

At about 080200Z September, a man was seriously injured while operations were being conducted some 1,000 miles from Tokyo. AMVERS medical operations were immediately initiated, Fuchu Air Rescue being the coordinating organization, with communications support from the naval radio station at Yokosuka (NDT). A heavy communications load with these organizations was maintained for the next three days until the man was disembarked at Kushiro, Japan. Because of the heavy rescue

traffic, it was not possible to maintain continuous communications with WWD and it was found that at night heavy radio interference from the Japanese Islands and Russia blanked out all of WWD's frequencies most of the time. During daylight hours, the frequencies were usually reliable. It was noted that the watch at WWD was alert for WNCU signals at all times and that inability to get through was usually due to the Japanese and other local interference.

A total of some 50 messages were handled plus numerous schedules with Fuchu Rescue, the Soviet vessel Shazhma and Japanese shore stations.

WEATHER

Weather on Leg 19 varied from dead calm seas with the sun shining to 20 foot seas, 55 mph winds and zero visibility. Temperatures ranged from 40 to 55 degrees F. with rain and fog a large percentage of the time. Even though inclement weather was experienced much of the leg, only four and one-half hours of downtime was directly attributed to the weather.

On Site 189, a 997 millibar low passed in the immediate vicinity of the vessel. Coring operations were continued in the Force Eight gale with the vessel holding station in the semi-automatic mode. It would not have been safe to trip the pipe during the storm due to the vessel's motion, however, coring operations presented only minor problems.

Two typhoons, Virginia and Wendy, effected operations to some extent. Virginia passed within 130 miles of the Challenger after the vessel departed from Site 193 and was enroute to Kurilsk, Ostrov Iturup, in an effort to air evacuate an injured man. The airport was closed, however, due to wind and rain from the typhoon. It was necessary to divert to Kushiro, Japan for the evacuation.

As the Challenger was enroute from Kushiro to Yokohama from the north, Wendy was approaching Yokohama from the southeast. At the time, she was a 930 millibar typhoon with winds of 100 knots. On the eve of the arrival of the Challenger at Yokohama, Wendy made a sharp turn and headed to the northeast. She left seas of 18 feet and winds of 30 mph which created uncomfortable but not dangerous conditions.

NAVIGATIONAL EQUIPMENT

Most of the data for navigating on Leg 19 was obtained from the satellite navigational system which performed very well following correction of initial problems resulting from being out of tune. The Loran "A" and "C" received limited use due to lack of Loran transmission within the area of the cruise. Celestial navigation was virtually useless due to the high percentage of days with rain, fog and cloud cover.

The new Decca Model 914 radar saw extensive use, performed very well, and was extremely useful in negotiating the passes of the Aleutian Islands and manuevering in the extremely heavy ship traffic along the coast of Japan. The Marconi radar served as a back up

during the 55 day voyage.

All other navigational equipment, gyro, RDF, and fathometer operated satisfactorily with the exception of the pit log which read consistently low.

PERSONNEL

Since the objectives of Leg 19 included clathrate sampling and heat flow measurements in addition to the normal stratagraphic and geological work, two rendezvous were made at Adak to change out scientific personnel. Automatic positioning personnel also embarked and disembarked at the rendezvous.

Three lost time accidents occurred during the cruise with two individuals being disembarked for treatment at shore medical facilities and one individual recovered on board. The individual disembarked at Adak was an oiler who suffered a sprained back and the individual remaining on board was a rotary helper who suffered bruises from a short fall.

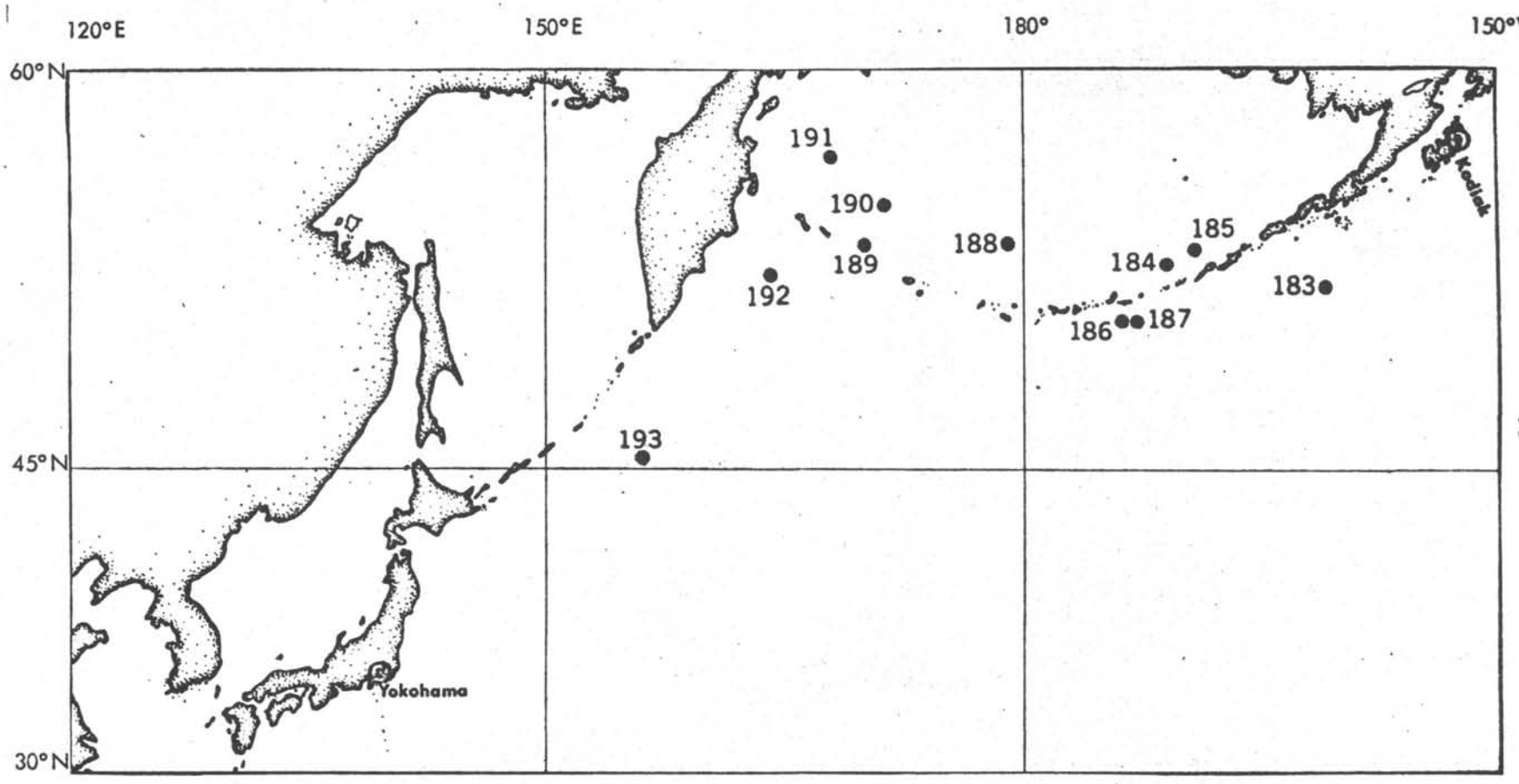
The other accident resulted in very serious injury to a DSDP Laboratory Assistant. Operations were terminated prematurely on Site 193 in order to evacuate the individual. Plans were made to rendezvous with the Soviet vessel Shazhma, proceed to Kurilsk in the Kuril Islands and evacuate by air, however, word was received from Soviet authorities via the Shazhma that the airport at Kurilsk was closed due to typhoon Virginia. The Challenger then proceeded to Kushiro, Japan for the air evacuation to Tachikawa Air Force Hospital in Tokyo.

All Global Marine personnel performed in an outstanding manner and contributed greatly to a successful cruise and successful handling of the emergency situations.

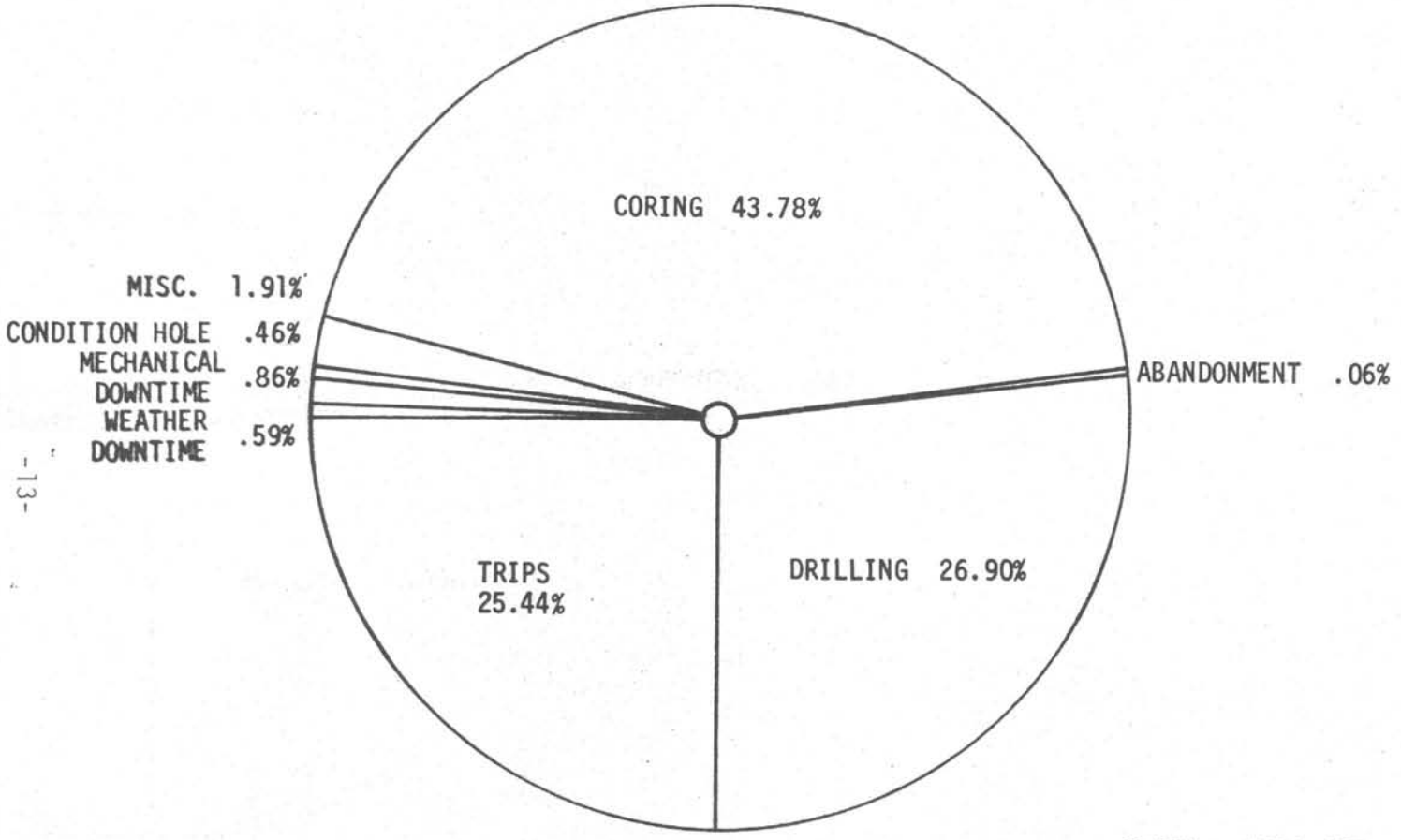
DEEP SEA DRILLING PROJECT
SUMMARY OF OPERATIONS
LEG 19

Total Days Leg 19 (July 20, 1971 - September 14, 1971)			55.16
Total Days In Port			3.15
Total Days Cruising			20.33
Total Days Profiling			.08
Total Days On Site	(758.5 hours)		31.60
Trip Time	(193.0 hours)		8.04
Drilling Time	(204.0 hours)		8.50
Coring Time	(332.0 hours)		13.84
Mechanical Downtime	(6.5 hours)		.27
Condition Hole	(3.5 hours)		.14
Miscellaneous	(19.0 hours)	(Including 4-1/2 hour weather downtime)	.79
Abandonment	(0.5 hours)		.02
Re-entry	-----		-----
Total Distance Traveled (Nautical Miles			4,341
Average Speed (Knots)			8.58
Sites Investigated			11
Holes Drilled			16
Number of Cores Attempted			256
Number of Cores With Recovery			238
Percent of Cores With Recovery			92
Total Meters Cored	(7,172 feet)		2,186
Total Meters Recovered	(3,485 feet)		1,062.1
Percent of Meters Recovered			48.6
Meters Drilled	(25,534 feet)		7,783
Total Penetration	(32,706 feet)		9,969
Percent of Penetration Cored			22
Maximum Penetration Per Hole (Meters)	(3,468 feet)		1,057
Minimum Penetration Per Hole (Meters)	(30 feet)		9
Average Penetration Per Hole (Meters)	(2,044 feet)		623
Maximum Water Depth (Meters)	(15,817 feet)		4,821
Minimum Water Depth (Meters)	(6,299 feet)		1,920
Average Water Depth (Meters)	(11,804 feet)		3,598

LEG 19 DRILLING SITES

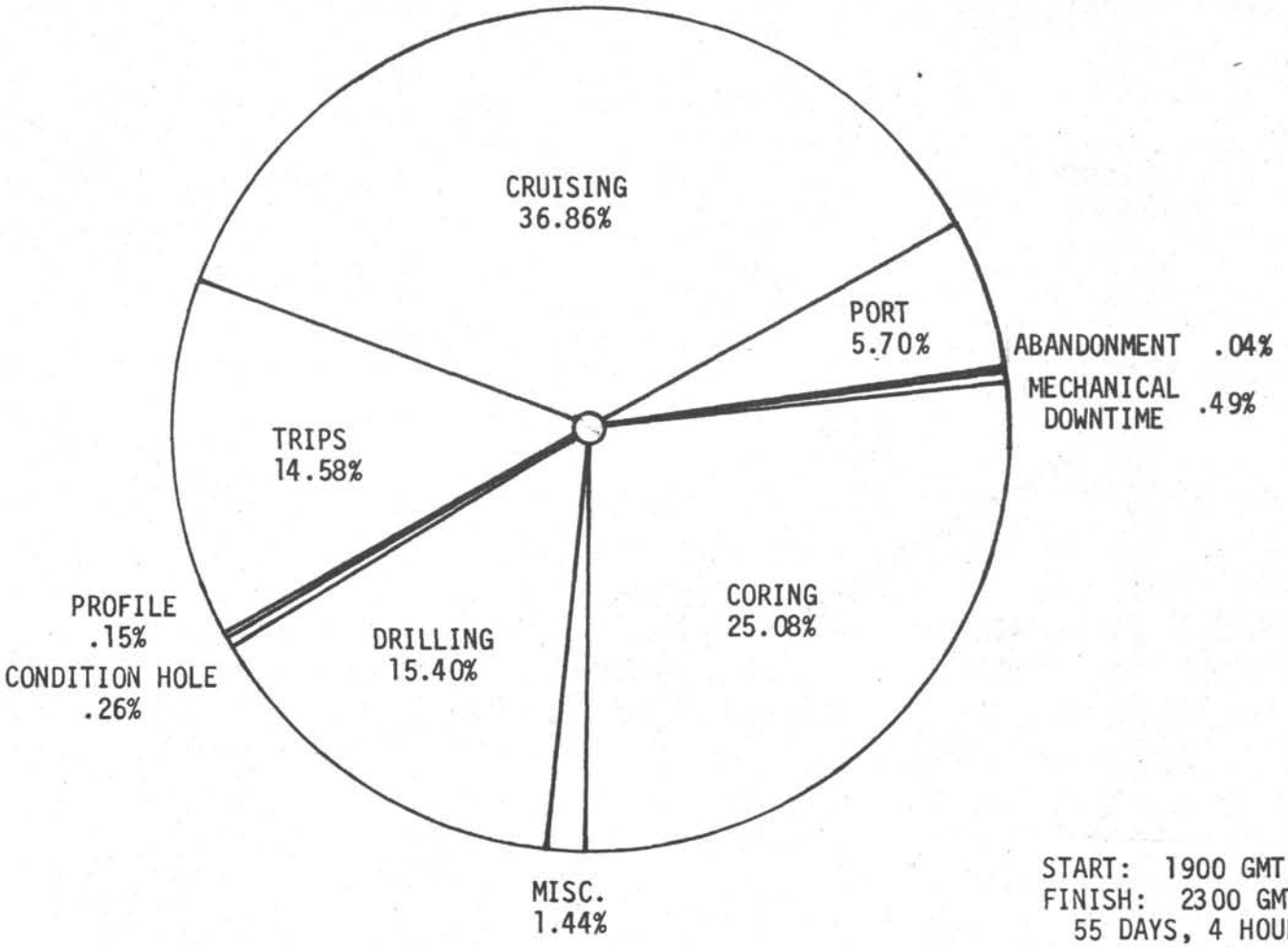


LEG XIX - DSDP
SITE TIME DISTRIBUTION



START: 1900 GMT, 20 JULY 1971
FINISH: 2300 GMT, 13 SEPT. 1971
ON SITE: 31 DAYS, 14-1/2 HRS
11 SITES, 16 HOLES

LEG XIX - DSDP
TOTAL TIME DISTRIBUTION



START: 1900 GMT, 20 JULY 1971
FINISH: 2300 GMT, 13 SEPT. 1971
55 DAYS, 4 HOURS
11 SITES, 16 HOLES

SUMMARY TIME ANALYSIS – LEG 19 – DEEP SEA DRILLING PROJECT

DATE	SITE NUMBER	CRUISE TIME	PROFILE TIME	TRIP TIME	DRILLING TIME	CORING TIME	CONDITION HOLE	ABANDON TIME	RE-ENTRY TIME	MECHANICAL DOWNTIME	IN-PORT TIME	MISC.	TOTAL	REMARKS
7-20	PORT	-	-	-	-	-	-	-	-	-	14	-	14	CAPT. CLARKE RELIEVE CAPT DILL AT 1000 HR.
7-21	PORT	-	-	-	-	-	-	-	-	-	24	-	24	LOAD EQUIP. & SUPPLIES
7-22	PORT	-	-	-	-	-	-	-	-	-	11	-	11	DEPART DOCK 1048 HR.
TOTAL	PORT	-	-	-	-	-	-	-	-	-	49	-	49	TOTAL PORT TIME - 49 HR.
LEG	CUM.	-	-	-	-	-	-	-	-	-	49	-	49	CUM. TOTAL = 49 HR.
7-22	133	*13	-	-	-	-	-	-	-	-	-	-	13	*2 HR. RETRIEVE LOST STARBOARD ANCHOR. DEPART SEA BUOY 1618 HR.
7-23	183	24	-	-	-	-	-	-	-	-	-	-	24	UNDERWAY TO SITE 183
7-24	183	18½	-	5½	-	-	-	-	-	-	-	-	24	BEACON IN H_2O @ 1830HR
7-25	183	-	-	4½	1	18½	-	-	-	-	-	-	24	CORING. SPUD 0645. COLD. RAIN, FOG, SEAS FAIRLY CALM
7-26	183	-	-	-	-	24	-	-	-	-	-	-	24	CORING, COOL, SEAS CALM
7-27	183	-	-	-	4	19½	½	-	-	-	-	-	24	HOLE UNSTABLE, TURBIDITES
7-28	183	-	-	10	-	3	-	-	-	-	-	*½	13½	*REMOVE STUCK INNER BBL. FROM CORE BBL. DEPART 183@ 1330
TOTAL	183	55½	-	20	5	65	½	-	-	-	-	½	146½	TOTAL SITE 183 - 146½ HR. ON STATION - 91 HR.
LEG	CUM.	55½	-	20	5	65	½	-	-	-	49	½	195½	CUM. TOTAL = 195½ HR.
7-28	184	10½	-	-	-	-	-	-	-	-	-	-	10½	UNDERWAY TO SITE 184 - HEAVY SEAS
7-29	184	25	-	-	-	-	-	-	-	-	-	-	25	UNDERWAY TO 184, CHANGE CLOCKS 1 HR. THRU UNIMAK PASS - 0600
7-30	184	8	-	6	4	6	-	-	-	½	-	½	25	BEACON IN H_2O@0700, SPUD 1330, H_2O DEPTH 1920 M, CHANGE CLOCK 1HR
7-31	184	-	-	2½	6	14½	-	-	-	1	-	--	24	TD AT 2923M. 2045HR. 7-31-71 603 M PENETRATION
8-1	184	-	-	3	-	-	-	-	-	*½	-	-	3½	*REPAIR STABBER, DEPART 184 @ 0330
TOTAL	184	43½	-	11½	10	20½	-	-	-	2	-	½	88	TOTAL SITE 184 - 88 HR. ON STATION 44½ HR.
LEG	CUM.	99	-	31½	15	85½	½	-	-	2	49	1	283½	CUM. TOTAL = 283½ HR.
8-1	184A	-	-	9	8	-	-	-	-	*½	-	**3	20½	6HR TIH, 3HR TOH, *REPAIR WKM VALVE, **ATTEMPT PULL STUCK CB
8-2	184A	-	-	3½	-	-	-	-	-	-	-	-	3½	DEPART SITE 184A @ 0330
TOTAL	184A	-	-	12½	8	-	-	-	-	½	-	3	24	TOTAL SITE 184A = 24 HR. ON STATION, 24 HR
LEG	CUM	99	-	44	23	85½	½	-	-	2½	49	4	307½	CUM. TOTAL = 307½ HR

DATE	SITE	NUMBER CRUISE TIME	PROFILE TIME	TRIP TIME	DRILLING TIME	CORING TIME	CONDITION HOLE	ABANDON TIME	RE-ENTRY TIME	MECHANICAL DOWNTIME	IN-PORT TIME	MISC.	TOTAL	REMARKS
8-2	184B	-	-	6	11½	2½	½	-	-	-	-	-	20½	SPUD 0915, H_2O DEPTH 1920M. OFFSET 400' NW OF 184
8-3	184B	-	-	-	9	14	-	-	-	*1	-	-	24	*SHIP OFF LOCATION, COMPUTER INOPERATIVE
8-4	184B	-	-	6	4½	5	-	-	-	-	-	-	15½	TD 973M. BEARING ON BIT FAILED. DEPARTED @ 1530
TOTAL	184B	-	-	12	25	21½	½	-	-	1	-	-	60	TOTAL SITE 184B - 60 HR. ON STATION 60 HR.
LEG	CUM	99	-	56	48	107	1	-	-	3½	49	4	367½	CUM. TOTAL - 367½ HR.
8-4	185	8½	-	-	-	-	-	-	-	-	-	-	8½	UNDERWAY TO SITE 185
8-5	185	5	-	7	3	8	-	-	-	*1	-	-	24	BEACON IN H_2O @ 0500, SPUD 1330 @ 2120M. *NO POWER TO BOWEN
8-6	185	-	-	-	6	18	-	-	-	-	-	-	24	RAN HEAT FLOW & PRESSURE CORE BBL EQUIP.
8-7	185	-	-	6	-	3½	-	-	-	-	-	-	9½	DEPART SITE 185 @ 0930
TOTAL	185	13½	-	13	9	29½	-	-	-	1	-	-	66	TOTAL SITE 185 - 65 HRS. ON STATION - 52½ HR.
LEG	CUM.	112½	-	69	57	136½	1	-	-	4½	49	4	433½	CUM. TOTAL 432½ HRS.
8-7	186	14½	-	-	-	-	-	-	-	-	-	-	14½	UNDERWAY TO SITE 186
8-8	186	24	-	-	-	-	-	-	-	-	-	-	24	TRANSFER PERSONNEL AT ADAK @ 1700
8-9	186	12½	-	9	-	-	-	-	-	-	-	*2½	24	BEACON IN H_2O @ 1230 HRS. *CUT TWO H_2O CORES
8-10	186	-	-	-	4½	18½	-	-	-	-	-	1	24	SPUD 0045. H_2O DEPTH 4532 M *PULL H_2O CORE
8-11	186	-	-	-	7½	16½	-	-	-	-	-	-	24	CORING, WEATHER MODERATE
8-12	186	-	-	2½	3	3½	½	½	-	-	-	-	10	PULL 500' ABOVE MUD LINE. DEPART 186 @ 1003 HR
TOTAL	186	51	-	11½	15	38½	½	½	-	-	-	3½	120½	TOTAL SITE 186 - 120½ HR, ON STATION - 69½ HR
LEG	CUM	163½	-	80½	72	175	1½	½	-	4½	49	7½	554	CUM. TOTAL 554 HRS.
8-12	187	2	-	2	5½	4½	-	-	-	-	-	-	14	MOVE 2½ mi., 186 TO 187 w/ DRILL STRING BELOW VESSEL. SPUD 1400
8-13	187	-	-	9	1½	1½	-	-	-	-	-	-	12	DEPART SITE 187 @ 1200
TOTAL	187	2	-	11	7	6	-	-	-	-	-	-	26	TOTAL SITE 187 - 26 HR, ON STATION - 24 HR.
LEG	CUM	165½	-	91½	79	181	1½	½	-	4½	49	7½	580	CUM. TOTAL 580 HRS.
8-13	188	12	-	-	-	-	-	-	-	-	-	-	12	ENROUTE ADAK TO TRANSFER PERSONNEL
8-14	188	24	-	-	-	-	-	-	-	-	-	-	24	ENROUTE TO SITE 188

DATE	SITE	NUMBER CRUISE	TIME PROFILE	TIME TRIP	TIME DRILLING	TIME CORING	TIME CONDITION HOLE	TIME ABANDON	TIME RE-ENTRY	TIME MECHANICAL DOWNTIME	TIME IN-PORT	TIME MISC.	TOTAL	REMARKS
8-15	188	3½	-	7	5	8½	-	-	-	-	-	*1	25	CORING, 1 HR TIME CHANGE, *LOCATE BOTTOM, SPUD 1100 HR.
8-16	188	-	-	5½	4	6½	-	-	-	-	-	-	16	1 HR TIME CHANGE. DEPART 188 @ 1530 HR. = 1600 (TIME CHANGE)
TOTL	188	39½	-	12½	9	15	-	-	-	-	-	1	77	TOTAL SITE 188 = 77 HRS. ON STATION - 37½ HR.
LEG	CUM.	205	-	104	88	196	1½	½	-	4½	49	8½	657	CUM. TOTAL - 657 HRS.
8-16	189	9	-	-	-	-	-	-	-	-	-	-	9	ENROUTE TO 189. PORTION OF 1 HR TIME CHANGE
8-17	189	-	-	-	-	-	-	-	-	-	-	-	-	CROSSED INTERNATIONAL DATE LINE
8-18	189	20½	-	2½	-	-	-	-	-	-	-	*1	24	BEACON IN H_2O @ 2030. *POSITION ON BEACON (BAD WEATHER)
8-19	189	-	-	6	9	7½	-	-	-	-	-	*1½	24	*LOCATE BOTTOM SPUD 0900. WTR. DEPTH 3447M
8-20	189	-	-	-	17	7	-	-	-	-	-	-	24	CORING - WINDS INCREASING TO 30K
8-21	189	-	-	3½	8½	11½	½	-	-	-	-	-	24	CORING - 40K WINDS, 18' SEAS, OPERATE IN SEMI-AUTO.
8-22	189	-	2	6	-	-	-	-	-	-	-	-	8	DEPART 189 @ 0600. PROFILE 189 TO 0900.
TOTAL	189	29½	2	18	31½	26	½	-	-	-	-	2½	113	TOTAL SITE 189 - 113 HR. ON STATION - 81½ HR.
LEG	CUM.	235½	2	122	122½	222	2	½	-	4½	49	11	770	CUM. TOTAL 770 HRS
8-22	190	11½	-	4½	-	-	-	-	-	-	-	-	16	BEACON IN H_2O @ 1930 HR.
8-23	190	-	-	4	4½	13½	-	-	-	*2	-	-	24	SPUD 0600, H_2O DEPTH 3895M. NO POWER TO BOWEN
8-24	190	-	-	*10	3	4	-	-	-	-	-	-	17	*INCL 3½ HR MAGNAFLUX DRILL COLLARS, DEPART 190 @ 1700
TOTAL	190	11½	-	18½	7½	17½	-	-	-	2	-	-	57	TOTAL SITE 190 = 57 HR., ON STATION - 45½ HR.
LEG	CUM.	246	2	140½	130	239½	2	½	-	6½	49	11	827	CUM. TOTAL = 827 HRS
8-24	191	7	-	-	-	-	-	-	-	-	-	-	7	ENROUTE TO 191
8-25	191	10½	-	6½	2	4	-	-	-	-	-	*1	24	BEACON IN H_2O @ 1030 - FAILED* - DROPPED 2ND, SPUD @ 1800
8-26	191	-	-	-	14½	9½	-	-	-	-	-	-	24	CORING & DRILLING
8-27	191	-	-	-	16½	7½	-	-	-	-	-	-	24	" "
8-28	191	-	-	3	-	5	-	-	-	-	-	-	8	TOTAL PENET. 919 M. CLEAR MUDLINE @ 0800, MOVE 400' TO 191A
TOTAL	191	17½	-	9½	33	26	-	-	-	-	-	1	87	TOTAL SITE 191 - 87 HRS., ON STATION 69½ HRS.
LEG	CUM	263½	2	150	163	265½	2	½	-	6½	49	12	914	CUM. TOTAL 914 HR.

DATE	SITE NUMBER	CRUISE TIME	PROFILE TIME	TRIP TIME	DRILLING TIME	CORING TIME	CONDITION HOLE	ABANDON TIME	RE-ENTRY TIME	MECHANICAL DOWNTIME	IN-PORT TIME	MISC.	TOTAL	REMARKS
8-28	191A	1	-	1	-	5½	-	-	-	-	-	-	7½	Moved 400' east of 191. Spud @ 0930, Depart @ 1530
Total	191A	1	-	1	-	5½	-	-	-	-	-	-	7½	Total Site 191A - 7½ hr On Station 6½ hr.
Leg	Cum.	264½	2	151	163	271	2	½	-	6½	49	12	91½	Cum. Total 921½ hrs.
8-28	191B	-	-	6	-	1	-	-	-	-	-	-	7	Moved 100' east of 191A. Spud @ 1530 Depart @ 2230
Total	191B	-	-	6	-	1	-	-	-	-	-	-	7	Total Site 191B = 7 hrs. On Station 7 hr.
Leg	Cum	264½	2	157	163	272	2	½	-	6½	49	12	928½	Cum. Total 928½ hrs
8-28	192	1½	-	-	-	-	-	-	-	-	-	-	1½	Underway to Site 192
8-29	192	24	-	-	-	-	-	-	-	-	-	-	24	Underway to Site 192
8-30	192	3	-	6½	3½	8	-	-	-	-	-	*3	24	*Beacon in H_2O @ 0300, Failed, Dropped 2nd, Spud 1230
8-31	192	-	-	-	9½	14½	-	-	-	-	-	-	24	Coring & Drilling
9-1	192	-	-	-	8	12½	-	-	-	-	-	*3½	24	*Off Station, 40K winds, confused swell, 3 directions, max. 12'
9-2	192	-	-	2½	-	5½	-	-	-	-	-	-	8	Clear mud line, depart 192 @ 0800, move to 192A
Total	192	28½	-	9	21	40½	-	-	-	-	-	6½	105½	Total Site 192 = 105½ hr. On Station 77 hr.
Leg	Cum	293	2	166	184	312½	2	½	-	6½	49	18½	1034	Cum. Total = 1034 hr.
9-2	192A	-	-	1½	13½	½	½	-	-	-	-	-	16	Site 192A 300' south of 192. Spud @ 0930
9-3	192A	-	-	4½	5½	13	1	-	-	-	-	-	24	Drill & Core
9-4	192A	-	-	3	-	-	-	-	-	-	-	-	3	Depart Site 192A @ 0300
Total	192A	-	-	9	19	13½	1½	-	-	-	-	-	43	Totas Site 192A = 43 hr. On Station 43 hr.
Cum	Total	293	2	175	203	326	3½	½	-	6½	49	18½	1077	Cum. Total = 1077
9-4	193	21	-	-	-	-	-	-	-	-	-	-	21	Underway to Site 193
9-5	193	24	-	-	-	-	-	-	-	-	-	-	24	Underway to Site 193
9-6	193	22	-	2	-	-	-	-	-	-	-	-	24	Beacon in H_2O @ 2200
9-7	193	-	-	16	1	6	-	-	-	-	-	*½	23½	Technician seriously injured, Abandon Hole. Depart 2330
Total	193	67	-	18	1	6	-	-	-	-	-	½	92½	Total Site 193 - 92½ hr. On station, 25½ hr.
Cum.	Total	360	2	193	204	332	3½	½	-	6½	49	19	1169½	Cum. Total - 1169½ hr.

DATE	SITE	NUMBER	CRUISE TIME	PROFILE TIME	TRIP TIME	DRILLING TIME	CCRING TIME	CONDITION HOLE	ABANDON TIME	RE-ENTRY TIME	MECHANICAL DOWNTIME	IN-PORT TIME	MISC.	TOTAL	REMARKS
9-7		1-1/2	-	-	-	-	-	-	-	-	-	-	1-1/2	UNDERWAY TO OSTROV ITERUP TO DISCHARGE INJURIED MAN (1HR TIME CHANGE)
9-8		*24	-	-	-	-	-	-	-	-	-	-	24	*INCL. 5HR RENDEZVOUS W/ SOVIET VESSEL SHAZHMA - C/C TO HOKKAIDO
9-9		24	-	-	-	-	-	-	-	-	-	-	24	UNDERWAY TO KUSHIRO, HOKKAIDO
9-10		19	-	-	-	-	-	-	-	-	*6	-	25	*DISCHARGE PATIENT AT KUSHIRO · 1HR TIME CHANGE
9-11		24	-	-	-	-	-	-	-	-	-	-	24	UNDERWAY TO YOKOHAMA
9-12		24	-	-	-	-	-	-	-	-	-	-	24	UNDERWAY TO YOKOHAMA
9-13		11½	-	-	-	-	-	-	-	-	12½	-	24	UNDERWAY TO YOKOHAMA
9-14		-	-	-	-	-	-	-	-	-	8	-	8	CREW RELIEVED AT 0800
TOTAL		128	-	-	-	-	-	-	-	-	26½	-	154½	TOTAL TO PORT = 152½ HRS
LEG	CUM	488	2	193	204	332	3½	½	-	6½	75½	19	1324	CUM. TOTAL = 1324 HRS.

YOKOHAMA

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 19

Site No.	Beacon Description			Battery Ser. No.	Time On Site	
	Make	Freq. kHz	Ser. No.		Hours	
183	Burnett	16.0	87	170	91	Beacon in H_2O at 1830 on July 24, 1971. Dropped underway at 5 knots. Large float arrangement. Operated satisfactorily.
184 A & B	ORE	16.0	146	---	128 1/2	Beacon in H_2O at 0700 on July 30, 1971. Dropped underway at 6 knots. New type. Round Floatation. Operated satisfactorily.
185	ORE	16.0	145	---	52 1/2	Beacon in H_2O at 0500 on August 5, 1971. Dropped underway at 5 knots. Operated satisfactorily.
186	ORE	16.0	137	---	69 1/2	Beacon in H_2O at 1230 on August 9, 1971. Dropped underway at 6 knots. Operated satisfactorily.
187	ORE	16.0	110	---	24	Beacon in H_2O at 1210 on August 12, 1971. Dropped underway at 6 knots. Operated satisfactorily.
188	ORE	16.0	116	---	37 1/2	Beacon in H_2O at 0300 on August 15, 1971. Dropped underway at 7 knots. Operated satisfactorily.
189	ORE	16.0	114	---	81 1/2	Beacon in H_2O at 2030 on August 18, 1971. Dropped underway at 5 knots. Operated satisfactorily.
190	Burnett	13.5	168	151	45 1/2	Beacon in H_2O at 1930 on August 22, 1971. Dropped underway at 6 knots. Positioned very good in moderate weather.
191	ORE	16.0	113	---	3/4	Beacon in H_2O at 1030 on August 25, 1971. Dropped underway at 6 knots. Failed in 3/4 hour. Started operating again at approximately 0400 on August 28, 1971.

Beacon Summary
Continued

Site No.	Beacon Description			Battery Ser. No.	Time On Site	
	Make	Freq. kHz	Ser. No.		Hours	
191	Burnett	13.5	159	154	69 1/2	Beacon in H_2O at 1115 on August 25, 1971. Operated satisfactorily.
191A	Burnett	13.5	159	154	6 1/2	Location 400' offset from Site 191.
191B	Burnett	13.5	159	154	7	Location 500' offset from Site 191.
Total	Burnett	13.5	159	154	83	Beacon operated satisfactorily.
192	Burnett	13.5	160	505	1	Beacon in H_2O at 0300 August 30, 1971. Dropped underway at 4 knots. Presoaked OK. Failed before reaching bottom.
192	ORE	16.0	123	---	77	Beacon in H_2O at 0600 on August 30, 1971. Dropped underway at 5 knots. Operated satisfactorily.
192A	ORE	16.0	123	---	43	Location 300' offset from Site 192.
Total	ORE	16.0	123	---	120	Operated satisfactorily.
193	ORE	16.0	138	---	25 1/2	Beacon in H_2O at 2200 on September 6, 1971. Dropped while dead in H_2O. Operated satisfactorily.

SUMMARY

1	Burnett	16.0 kHz	Satisfactory
3	Burnett	13.5 kHz	2 Satisfactory, 1 Failure
9	ORE	16.0 kHz	8 Satisfactory, 1 Failure
13			11 Satisfactory, 2 Failures

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 19

Site	Hole	Latitude	Longitude	Water Depth Meters	No. Of Cores	Cores With Rec.	Meters Cored	Meters Rec.	Meters Drilled	Total Meters Penet.	Avg. Rate Penet. (M/Hr.)	Time On Hole (Hours)	Time On Site (Hours)
Aleutian Abyssal Plain													
183	0	52° 34.30'N	161° 12.33'W	4718	40	35	361	150	155	516	61 1/2	91	91
Umnak Plateau													
184	0	52° 42.64'N	170° 55.39'W	1920	23	22	186	123.2	417	603	75	44 1/2	44 1/2
184	A	52° 42.64'N	170° 55.39'W	1920	0	0	0	0	669	669	252	24	68 1/2
184	B	52° 42.64'N	170° 55.39'W	1920	14	14	121	50.2	852	973	57	60	128 1/2
NE of Umnak Plateau													
185	0	54° 25.70'N	169° 14.59'W	2120	27	25	216	97.6	512	728	91	52 1/2	52 1/2
Atka Basin, Aleutian Ridge													
186	0	51° 07.81'N	174° 00.34'W	4532	28	28	245	140.7	681	926	80	69 1/2	69 1/2
187	0	51° 06.32'N	173° 57.23'W	4587	4	3	36	6.8	334	370	127	24	24
Bowers Ridge													
188	0	53° 45.21'N	178° 39.56'E	2659	18	16	146	57.4	492	638	141	37 1/2	37 1/2
Aleutian Ridge, Base of the North Slope													
189	0	54° 02.14'N	170° 13.38'E	3447	20	19	174	74.2	697	871	33	81 1/2	81 1/2
Aleutian Basin - Shirshou Basin													
190	0	55° 33.57'N	171° 38.56'E	3885	16	15	142	85	485	627	143	45 1/2	45 1/2

Site Summary
Continued

Site	Hole	Latitude	Longitude	Water Depth Meters	No Of Cores	Cores With Rec.	Meters Cored	Meters Rec.	Meters Drilled	Total Meters Penet.	Avg. Rate Penet. (M/Hr.)	Time On Hole (Hours)	Time On Site (Hours)
Kamchatka Basin													
191	0	56° 56.70'N	168° 10.72'E	3864	16	13	130	44.1	789	919	31 1/2	69 1/2	69 1/2
191	A	400' East of Site 191		3870	4	3	36	21.5	14	50	188	6 1/2	76
191	B	500' East of Site 191		3870	1	1	9	8.5	0	9	270	7	83
Emperor Seamount, Position Doubtful													
192	0	53° 00.57'N	164° 42.8°"E	3024	35	35	308	152.4	634	942	72 1/2	77	77
192	A	300' South of Site 192		3024	6	6	47	38.2	1010	1057	63	43	120
Hokkaido Rise													
193	0	45° 48.19'N	155° 52.11'E	4821	4	3	29	12.3	42	71	177	25 1/2	25 1/2

SUMMARY

Totals for 11 Sites - 16 Holes		256	238	2186	1062.1	7783	9969	--	758 1/2	758 1/2
Percentage			92	22	48.6	78				
Average/Sites 1 1/2 Holes	3598	23	21	198.7	96.5	707.5	906	116	47	69
Maximum/Sites 3 Holes	4821	40	35	361	152.4	1010	1057	270	91	128 1/2
Minimum/Sites 1 Hole	1920	0	0	0	0	0	9	31 1/2	6 1/2	24

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 19

Site	Bit Description Make	Size	Type	Ser. No.	Cores Taken Core No.	Recovery No.	Recovery %	Footage Cored Core m	Recovery m	Recovery %	Total Penet. m	Rot. Time hr	Penet. Rate m/hr	Bit Condition	Remarks
183	Smith	10 1/8	94C ② ④	HC757	40	35	87.5	361	150	41.5	516	8 hr 23 min	61.5	T-1, B-4, IG 1 Broken Insert	Cored 11 m Basalt
184	Williams	9 7/8 x 2-15/32	Diamond	Z962	23	22	95.8	186	123.2	66.2	603	8 hr 3 min	75	20% Salvage	
184A	Smith	10 1/8 x 2 7/16	93CJS ① ③	HM619							669	2 hr 38 min	252	T-1, B-1 OK For Rerun	Siltstone and Hard Mudstone
	Hycalog		Center Bit	#2371							669	11 min	252	OK For Rerun	
184B	Smith	10 1/8 x 2 7/16	93CJS ① ③	HM619 RR	14	14	100	121	50.2	41.6	973	17 hr 48 min	57	T-2, B-8 Cones Loose	Siltstone and Hard Mudstone
	Cumulative		93CJS ① ③	HM619	14	14	100	121	50.2	41.6	1642	20 hr 26 min	80	T-2, B-8	Shirt Tail Cutoff, Bearing Exposed
185	Smith	10 1/8 x 2 7/16	93CJS ① ③	HM621	27	25	92.5	216	97.6	45.1	728	8 hr 3 min	91	T-1, B-1, IG OK For Rerun	Drilled Soft To Firm Sediments - No Chert
186	Smith	10 1/8 x 2 7/16	93CJS ① ③	HM620	28	28	100	245	140.7	57.6	926	11 hr 35 min	80	Pulled To Mudline Moved To Site 187	
187	Smith	10 1/8 x 2 7/16	93CJS ① ③	HM620 RR	4	3	75	36	6.8	18.9	370	2 hr 55 min	127	T-1, B-2, IG	Bright Wear On Shirt Tail
	Cumulative		93CJS ① ③	HM620	32	31	97	281	147.5	52.5	1296	14 hr 30 min	88	T-1, B-2, IG	Ok For Rerun

-24-

Bit Summary
Continued

Site	Make	Bit Description Size	Bit Description Type	Ser. No.	Cores Taken Core No.	Cores Taken Recovery No.	Cores Taken Recovery %	Footage Cored Core m	Footage Cored Recovery m	Footage Cored Recovery %	Total Penet. m	Rot. Time hr	Penet. Rate m/hr	Bit Condition	Remarks
188	Smith	10 1/8 x 2 7/16	93CJS ① ③	HM621 RR	18	16	89	146	57.4	39.3	638	4 hr 35 min	141	T-1, B-3, IG	OK For Rerun
189	Smith	10 1/8 x 2 7/16	93XJS ① ③	HM621 RR	20	19	95	174	74.2	42.6	871	26 hr 24 min	33.2	T-2, B-8, IG	Hard Sandstone & Mudstone
	Cumulative		93CJS ① ③	HM621	65	60	92.5	536	229.2	42.7	2237	39 hr		T-2, B-8, OS Cones Riding On Throat	
190	RSS	11 1/2	93 ① 4	0	16	15	94	142	85	59.9	627	4 hr 22 min	143	T-1, B-1, IG OK For Rerun	
191	Smith	10 1/8	9C ① ④	GT644	16	13	81.5	130	44.1	34	919	28 hr	31.7	Pulled to Mudline Moved to Site 191A	Cored Mudstone & 1 1/2 m Basalt
191A	Smith	10 1/8	9C ① ④	GT644 RR	4	3	75	36	21.5	59.6	50	16 min	188	Not Pulled	Moved 400' East of Site 191
191B	Smith	10 1/8	9C ① ④	GT644 RR	1	1	100	9	8.5	94.5	9	2 min	270	T-3, B-5, OG	Site 191B is 500' East of Site 191
	Cumulative	10 1/8	9C ① ④	GT644	21	17	81	175	74.1	42.3	978	24 hr 2 min	33.6	T-3, B-5, OG	Inserts Missing On Cone Nose
192	Smith	10 1/8	93CJS ① ③	HM617	35	35	100	308	152.4	49.5	942	13 hr 3 min	72 1/2	hr-Pulled Above Mudline - Moved To Site 192A	

Bit Summary
Continued

Site	Make	Bit Description Size	Type	Ser.No.	Cores Taken Core No.	Recovery No.	%	Footage Cored Core m	Recovery m	%	Total Penet. m	Rot. Time hr	Penet. Rate m/hr	Bit Condition	Remarks
192A	Smith	10 1/8	93CJS 1 3	HM617 RR	6	6	100	47	38.2	81.3	1057	16 hr 49 min	63	T-2, B-8, OG	Mudstone 13 m Basalt
	Cumulative	10 1/8	93CJS	HM617	41	41	100	355	190.6	53.6	1999	29 hr 52 min	67	T-2, B-8, OG Shirt Tails Cut Off Cone Missing	
193	Smith	10 1/8	9C 2 3	FK945	4	3	75	29	12.3	42.4	71	24 min	177	T-1, B-1 OK For Rerun	

SUMMARY OF BITS USED

1	Smith	10 1/8 x 2 7/16	Type 94C	4 Cone Non-Sealed Bearing
4	Smith	10 1/8 x 2 7/16	Type 93CJS	3 Cone Sealed Bearing
1	Smith	10 1/8 x 2 7/16	Type 9C	4 Cone Sealed Bearing
1	Smith	10 1/8 x 2 7/16	Type 9C	3 Cone Non-Sealed Bearing
1	Research Support Shop	11 1/2	Type 93	4 Cone Sealed Bearing
1	Williams	9 7/8 x 2 15/32	Diamond Bit	
9				

① Sealed Bearing
② Non-Sealed Bearing
③ 3-Cutter
④ 4-Cutter

DEEP SEA DRILLING PROJECT
OPERATIONS REPORT
LEG 20

SUMMARY

Leg 20 commenced on September 13, 1971 in Yokohama, Japan, proceeded through the Western Pacific Ocean and terminated in Suva, Fiji on November 10, 1971.

During this 57.8 day voyage, the "Challenger" cruised 5,414 nautical miles, drilled 13 holes on 9 sites, cored 473 meters in 55 coring attempts with recovery on 46 (83%) of the cores for a total of 161 meters and drilled 2,698 meters for a sub-bottom penetration totaling 3,171 meters. Water depth ranged from 6,194 meters (20,316 feet) to 1,479 meters. Total depths ranged from 6,571 meters (21,552 feet) to 1,595 meters.

Major time distribution for the 57.8 days consisted of 4.37 days in port, 24.7 days cruising. Of the 28.46 days spent on site 5.18 days were used for drilling, 4.88 days for coring, and 10.92 days for trips.

The dynamic positioning was very good throughout Leg 20, however, because of confused swell conditions, the drilling operations were hampered by the ship's continuous roll.

Generally, the weather was good, however some very heavy rain was encountered while drilling Sites 197 and 198. While drilling on the Ita Mai Tai Guyot on Sites 200 through 202, rain squalls did cause the ship's heading to be changed frequently to maintain a wind heading. No time was lost due to bad weather.

The average water depth for the first eight holes was 19,664 feet. The average total depth was 20,772 feet. While drilling on these sites, a number of new depth records were established.

1. Deepest water drilled in, to date, 6,194 meters (20,316 feet).
2. Recovered core from greatest depth, 6,571 meters (21,552 feet).
3. The deepest combined water and penetration depth, 6,571 meters (21,552 feet).
4. Successfully shot off pipe at mud line in 20,000 feet of water.

DRILLING AND CORING

The bottom hole assembly used on Sites 194 through 198 consisted of a bit, core barrel, three 8-1/4 inch drill collars, two bumper subs, two 8-1/4 inch drill collars, one seven inch drill collar and one joint of heavy wall drill pipe. From Sites 198A through 202, only three bumper subs were used.

An initial concern regarding sufficient overburden for spud proved to be unwarranted. The abyssal floor in the West Pacific, east of the Bonin Trench and north of Marcus Island, provided in excess of 100 meters of soft sediment for all eight holes drilled.

Site 194 was spudded in 5,754 meters of water. In core number three, from 5,991 meters, only a few pieces of chert were recovered. At 6,000 meters, sticking hole conditions became a problem. Gel and fresh water mud was pumped in to help flush the hole and did help in freeing the pipe on several occasions. The current and swells were 90° apart. The current was the stronger of the two forces and required that the ship maintain a heading into the current, which resulted in four to seven degree rolls. The hole was abandoned at 6,010 meters because of poor hole conditions and excessive pounding on bottom caused by the ship's roll and bumper subs which had sanded up with chert cuttings. After pulling out of the hole, it was discovered that the second bumper sub from the bottom (Baash-Ross Model) had a longitudinal crack from the service break down to the box.

Site 195 was spudded in 19,578 feet of water. After penetrating the first 180 meters of sediment, the same problems that were encountered at Site 194 again became evident. The ship's roll was less severe than at the previous site, but hole conditions were the same. Coring was kept to a minimum as sticking at both Site 194 and 195 was associated with core barrel retrieval. Before the core barrel or center bit was retrieved, the hole was flushed with 20 barrels of mud and on many occasions one or two stands of pipe were pulled prior to a wireline run to prevent sticking. After two hours of freeing stuck pipe, the hole was abandoned at 6,275 meters.

A second attempt to reach basement was made at Site 195 with Hole 195A. Since hole condition was a problem in this area, it was decided to continuously drill through the opaque layer until basement was reached. This would minimize the chances of sticking the drill string during core recovery. While penetrating the chert section, the hole was flushed with 20 barrels of mud every 20 to 30 meters. Hole conditions were greatly improved over the two previous holes. Maximum pump (60 strokes at 1,100 psi) was used. At 6,348 meters (388 meters penetration) a wireline trip to remove center bit was unsuccessful and drilling was terminated. The pin in the inner barrel latch assembly had backed out. A third attempt was then made. On Hole 195B three cores were attempted. Hole conditions were much worse than on Hole 195A. The only difference in the drilling techniques were the additional three cores on 195B which required the pump strokes to be reduced from 50 strokes to 10 strokes per minute while actually coring. Pipe became stuck while retrieving a core at 6,356 meters (388.5 meters of penetration). Pipe was freed after three and one half hours. Approximately 500 barrels of mud were used to drill the hole and to free the stuck pipe.

Site 196 was drilled in 6,194 meters of water east of the Bonin Trench. This 20,316 feet of water was a new record for the Challenger, however, the drilling problems were still the same as experienced at Sites 194 and 195.

Gray chert was recovered in core number four from 6,500 meters. Hole conditions were bad and 45 minutes were required to free stuck drill pipe. Drilling operations were stopped because of excessive torque on the drill string when touching bottom. It appeared

that either a cone was off the bit or the bit was locked. While pulling out of the hole one of the drill pipe elevators broke while supporting the drill string on the rotary table while a stand was being rotated out. The entire 21,000 feet of drill pipe (450,000 pounds) dropped about 18 inches. The partially unscrewed stand withstood that impact somehow and another elevator was quickly installed around the drill pipe. After pulling out of the hole, the button bit was found to be completely worn out. 90 percent of the buttons were gone, all bearings were gone, and the bit was one and three fourths inch out of gauge (legs appeared to be pinched).

Site 197 was drilled east of the Bonin Trench in a water depth of 6,153 meters (20,181 feet). Drilling proceeded at a steady rate to 6,425 meters. From 6,425 meters to 6,428 meters the drilling rate decreased to ten minutes to the meters.

Core number one (6,428 - 6,436 meters) was cut. While cutting the core, the pipe was torquing up while the bit was on bottom. One meter of basalt was recovered, the diameter of the core was only about 1.5 inches indicating that the cones on the bit were pinched in.

The drill pipe stuck while receiving the core barrel. While working stuck pipe no bumper sub action was noticeable on the weight indicator. Either the botton hole assembly was stuck above the top bumper subs or the bumper subs were sanded open.

35 barrels of used engine oil and 20 barrels of diesel fuel was mixed with 200 barrels of gel and water and pumped into the hole. Pump pressure remained the same as when drilling. Apparently the string was stuck by chert fragments that broke off and fell in around the bit and bumper subs.

An electrical severing charge was run on the logging unit to 6,150 meters. The collar locator quit working while running the charge in the hole. The shot failed to fire probably because of the faulty collar locator. Sufficient current did not reach the severing tool to detonate the fuse.

A McCullough mechanical severing tool was then run three different times. After recovering and disarming the explosives, it was noticed on each attempt that the packing around the firing pin had leaked water into the firing sub. On two of the attempts, the cartridge had fired; on the other, the cartridge had imploded.

The mechanical tool should be a simple and dependable way of shooting off drill pipe. Redesign and/or modification of the packing around the firing pin is needed.

After four attempts to sever the drill string were made without success, 480 feet of pipe was added to the stuck string and for several hours the Challenger was moved forward and aft and starboard to port. 2,000 feet was the maximum excursion from beacon while manuevering in a cross pattern. Several more hours were spent attempting to break off the drill pipe by putting 18,000 foot-pounds of torque in drill pipe and then moving the Challenger in a circle to the right in a 750 foot radius. The Challenger proved to be capable of these critical maneuvers, but they were unsuccessful in breaking off of the drill string.

The electrical severing tool was then rigged to run again with the collar locator replaced with an adapter sub. The pipe was severed at the mud line.

Water depth at Site 198 was reported incorrectly to be 6,043 meters (19,821 feet) from PDR readings. The near bit float sub was installed in the bottom hole assembly as had been on the previous holes. The flapper valve in the float was propped open with a small piece of wood to permit the pipe to fill while going in the hole. After running 2,000 meters of pipe, the piece of wood became dislodged and the flapper closed. A core barrel was dropped to keep the flapper open, however was ineffective. Finished trip in hole to the PDR reported mud line at 6,043. Circulation was hard to establish. The pipe would not rotate and was unable to recover core barrel. Pulled up 100 meters and drill string had lost 30,000 pounds of weight. Pulled out of hole, bottom hole assembly had broken off at the pin on the top drill collar (7") and mud was discovered on the drill pipe. The PDR depth was then discovered to be in error and the correct depth was 5,858 meters.

The 185 meter mistake and the failure of the core barrel to open the float valve and permit the drill string to float was the cause of losing this bottom hole assembly.

On Site 198A, after the loss of the bottom hole assembly on Site 198, a new assembly was removed from the storage area in the lower deck. After the bit and three 8-1/4" drill collars were made up and setting in the slips with the safety clamp in place, the slips gave way, the safety clamp slipped, and three more drill collars were lost.

The new drill collars were well painted and were being picked up during a hard rain. Three drill collars makes a very stiff assembly and long enough to be in the swell area. The slip segments were like new but were full of red paint. New segments were installed in slips, the safety clamp replaced and a new bottom hole assembly assembled.

Site 198A was spudded in 5,858 meters (19,214 feet) of water. Six cores were taken while drilling to 6,116 meters (20,060 feet) when the pipe began torquing up. After pulling up 200 meters of pipe, the problem was discovered to be mechanical. The bearings in the swivel had failed. No replacement bearings were aboard and the ship was diverted to Guam to pick up new bearings and effect repairs. The swivel was repaired and tested in only 14 hours of port time.

Site 199, was drilled on the east edge of the Caroline Abyssal Plain in 6,100 meters (20,008 feet) of water. Before the site was spudded attempts were made to find a suitable heading to minimize the ship's roll. The swells were four to six feet but were very confused. The swells were actually coming from three directions.

Twelve cores were cut while drilling to 6,556 meters (21,503 feet). Hole conditions were the best of any previous holes. Drilling operations were, however suspended when it became apparent that all bumper subs had sanded up and the Challenger was rolling from six to ten degrees. The drilling weight fluctuated from zero to 100,000 pounds.

With 21,000 feet of pipe weighing approximately 470,000 pounds suspended from the

elevators with the ship rolling from six to ten degrees, the string weight fluctuated between 370,000 to 570,000 pounds.

The centralizer collar that holds the horn in place broke while clearing the mudline. The lateral impact of the drill string against the horn caused the collar to break. Many of the drill pipe rubbers were stripped off the drill pipe while pulling out of the hole because of the vessel roll.

When the trip out was completed it was discovered that the bit was partially plugged, the bottom three joints of drill pipe were bent at the pin end and all bumper subs were sanded open. While servicing the crown a noise was detected in the fast line sheave, which indicated that a bearing was going bad.

Because of concern about the crown, shallow water sites were selected. Sites 200, 200A, 201 and 202 were drilled on the crest of Ita Mai Tai Guyot. The water depth was only about 1,500 meters. Sites 200 and 200A were abandoned because of poor hole conditions. Apparently a fine sand was causing sticking of the drill string.

Sites 201 and 200 had the same sticking problems as the first two holes. Site 201 was drilled from 1,564 meters to 1,630 meters and was abandoned at the Chief Scientists request.

Site 202 was spudded in 1,515 meters of water. Six cores were attempted while drilling and coring to 1,668 meters. Hard limestone was cored from 73 meters to 83 meters.

From 83 meters to a total of 153 meters the formation was so soft that bottom could not be determined by watching the weight indicator.

Pipe stuck 14 meters off bottom while recovering a core. Mud was circulated but apparently the drilling assembly was stuck above the top bumper sub. 35 barrels of used engine oil and 15 barrels of diesel was mixed with 250 barrels of gel mud. The bit was worked up from 139 meters sub-bottom to 93 meters. At 93 meters, the hole was apparently in gauge so that when the bit got into this area it was firmly stuck.

The logging unit was rigged and only the collar locator was run and the bottom bumper sub was located at 1,543 meters. The electric severing tool was then lowered to 1,543 meters and an attempt made to sever the pipe at that depth failed. A second shot was lowered to 1,543. The severing charge was detonated but did not sever the drilling assembly. Additional severing charges were not on board. 30 meters of pipe was then added to the stuck string. After working the string up and down three times, the drill string broke. The drilling assembly broke off at the double box sub between top bumper sub and third drill collar from the top of the bottom hole assembly.

The Challenger then cruised south to Kusaie Island and positioned in protected waters about one mile offshore so that the crown sheaves could be inspected.

The drilling line was removed from the fast line and dead line sheaves. The dead line sheave appeared to be in good shape but the fast line sheave was warped or bent. The bearing had a bumping noise when rotated.

The Challenger then proceeded directly to Suva, Fiji for repairs and a thorough inspection of all hoisting and traveling equipment.

The first eight holes of Leg 20 all exceeded 20,000 feet with some below 21,000 feet. The drill string weight was between 440,000 and 475,000 pounds. While working stuck pipe as much as 600,000 pounds was pulled on several occasions. The roll of the vessel caused by confused seas and strong currents further subjected drilling tools and machinery to maximum abuse and certainly had an effect on the failure of the elevator, swivel and crown.

DEEP WATER DRILLING IN THE WESTERN PACIFIC

Previous work in the Western Pacific was hampered by weak bottom hole assembly connections, weak bumper subs and excessive torque. These have been generally corrected and were not a problem on Leg 20. However, while working in 20,000 feet of water in the Western Pacific during the months of September and October, the ship's roll, pitch and heave did create other problems. Because of confused swells no heading provided a ship stable enough to maintain a constant weight on the drill bit.

The major problems that exist now are as follows:

1. A method of controlling weight on the bit regardless of ship's motion.
2. More drilling mud on board so the large chert cuttings can be pumped out.
3. A bumper sub that won't sand up so quickly.
4. Bits will probably drill the opaque sections if the weight on the drill bit can be controlled.

If a heave compensator could be installed in the complex traveling system in the derrick of the Challenger, this would prevent the ship's motion from disturbing the bit weight. By controlling the bit weight, this would minimize the mud requirements, provide a means of drilling after the bumper subs had sanded up without endangering the drilling assembly and bit life would be greatly increased. Controlled bit weight would provide a means of spudding in with less overburden than the 100 meters that is now required.

Little is known about the behavior of 20,000 feet of drill pipe suspended from any kind of vessel or platform. One thing is for sure, the vessel movement is amplified by the time this movement reaches the bit. With only two or three degree rolls, the weight will fluctuate 100,000 pounds. The ship's roll or pitch from six to ten degrees will cause the drill string weight to fluctuate 200,000 pounds when the ship's movement and drill pipe stretch are moving in opposite directions.

BEACONS

A total of 12 beacons were used on Leg 20. One ORE beacon 13.5 kHz quit transmitting signal while on decent on Site 195 in 19,575 feet of water.

A structual failure in the floatation ring was the cause of a ORE 16 kHz being dropped into the sea. The beacon was suspended over the water by a crane with a rope sling connected to the metal circle at the top of the floatation balls. The floatation ball covers tore away from the metal circle and the beacon was dropped prematurely.

1 - Burnett beacon 13.5 kHz
3 - ORE beacons 16 kHz
8 - ORE beacons 13.5 kHz

CREWS

Throughout Leg 20, the Global crews performed as professionals.

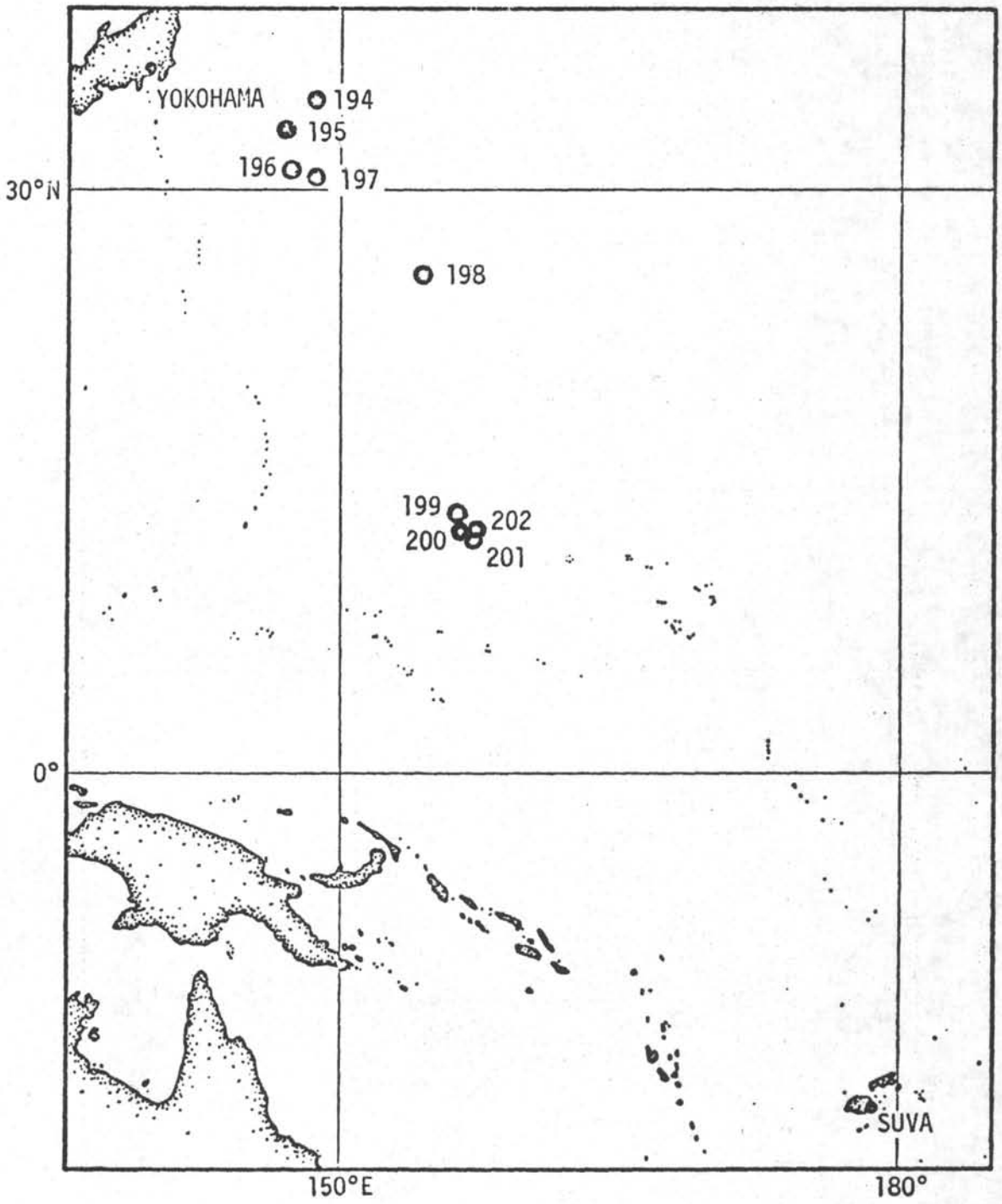
Lamar Hayes

Lamar P. Hayes
Cruise Operations Manager
Deep Sea Drilling Project

DEEP SEA DRILLING PROJECT
SUMMARY OF OPERATIONS
EASTERN PACIFIC OCEAN
LEG 20

Total Days Leg 20 (September 13, 1971 - November 10, 1971		57.8
Total Days in Ports		4.37
Total Days Cruising		24.61
Total Days on Site		28.46
Trip Time	(262.25 hours)	10.92
Drilling Time	(124.25 hours)	5.18
Coring Time	(117.00 hours)	4.88
Stuck Pipe Time	(106.25 hours)	4.42
Condition Hole	(15.00 hours)	.62
Mechanical Downtime	(23.75 hours)	.99
Other Miscellaneous Times	(34.75 hours)	1.45
Total Distances Traveled	(Nautical Miles)	5,269
Average Speed		9.2
Sites Investigated		9
Holes Drilled		13
Number of Cores Attempted		55
Number of Cores With Recovery		46
Percent of Cores With Recovery		83
Percent of Cored Recovered		34
Total Meters Cored	(1,553 feet)	473.5
Total Meters Recovered	(528 feet)	161
Total Meters Drilled	(8,849 feet)	2,698
Total Meters Penetrated	(10,400 feet)	3,171
Deepest Water (Meters)	(20,316 feet)	6,194
Deepest Penetration (Meters)	(21,552 feet)	6,571

LEG 20 - DRILLING SITES




SAKHALIN
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HOKKAIDO
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CONTINENTAL SLOPE
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BOGOROV SEAMOUNT
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NINTOKU SEAMOUNT
OUIN SEAMOUNT
17000
15500
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MENDOCINO
KOREA
Seoul
HONSHU
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Tokyo
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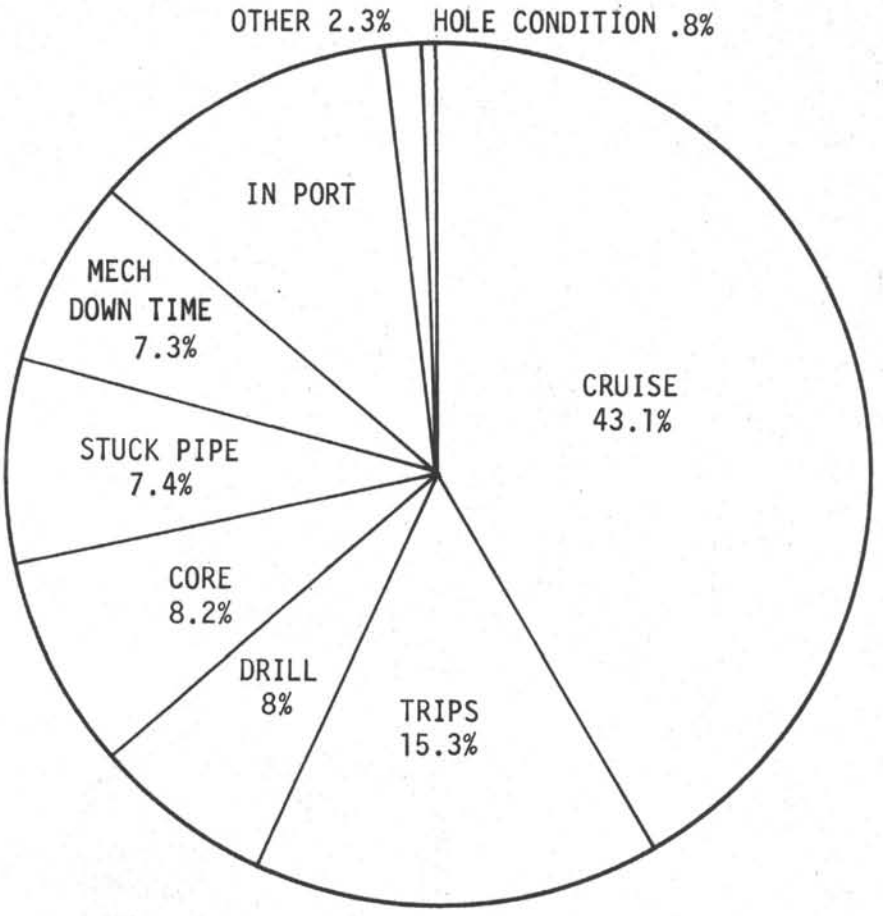
IZU TRENCH
18000
18400
CONTINENTAL SHELF
1657
21000
DAITO ISLANDS
19800
198
18100
MIDWAY ISLANDS
2100
15100
HAWAIIAN RIDGE
150
RYUKYU ISLANDS
RYUKYU TRENCH
PAREECE VELA BASIN
PAREECE VELA RIDGE
18500
7300
18200
18000
NECKER RIDGE
HORIZON GUYOT
22400
WAKE ISLAND
CAPE JOHNSON GUYOT
HESS GUYOT
18600
18500
LUZON
PHILIPPINE SEA
15400
Quezon City
Manila
PHILIPPINE ISLANDS
PHILIPPINE TRENCH
MARIANA TRENCH
31700
17200
JOHNSTON ISLAND
20000
199
200
201
202
MARSHALL ISLANDS
34400
LEYTE
19800
36198
World's greatest ocean depth
MINDANAO
9369
YAP TRENCH
26300
CAROLINE ISLANDS
16700
26500
CELEBES SEA
15400
EAURIPIK RIDGE
14800
16500
GILBERT ISLANDS
SOLOMON 7200 RISE
17500
NAURU
OCEAN I.
BISMARCK ARCHIPELAGO
19000
NEW GUINEA
14793
BANDA SEA
14800
NEW BRITAIN TRENCH
30000
VITYAZ TRENCH
20150
16500
ELLICE ISLANDS
FUNAFUTI ATOLL
MANIHIKI PLATEAU
CONTINENTAL SHELF
SOLOMON SEA
Darwin
360
180
78
QUEENSLAND PLATEAU
15500
NEW HEBRIDES
5940
FIJI
10000
FIJI ISLANDS
PLATEAU
SAMOA ISLANDS
5094
17000
COOK
3070
5287
GREAT DIVIDING RANGE
NEW HEBRIDES TRENCH
145 (15855)
CORAL SEA
5341
NEW CALEDONIA
30100
AUSTRALIA
2955
4955
4000
78
14500
220
35700
LAU RIDGE
TONGA TRENCH
TONGA IS.
2370
Brisbane
52
LORD HOWE RISE
3800
NORFOLK I.
1043 (1943)
PHILIP I.
120
14300
2800 (13200)
8200
3570
Darling
1374
3822
LORD HOWE I.
432 (15568)
BALL'S PYRAMID 2700
KERMADEC TRENCH
33000
CONTINENTAL SHELF
240
CONTINENTAL SLOPE
GREAT DIVIDING RANGE
Murray
Sydney
Adelaide
Canberra
Australia's highest point
Mt. Kosciusko 7310
ABYSSAL PLAIN
15000
150 (5850)
3400
GREAT BIGHT
18300
NORTH

TOTAL TIME DISTRIBUTION
LEG 20

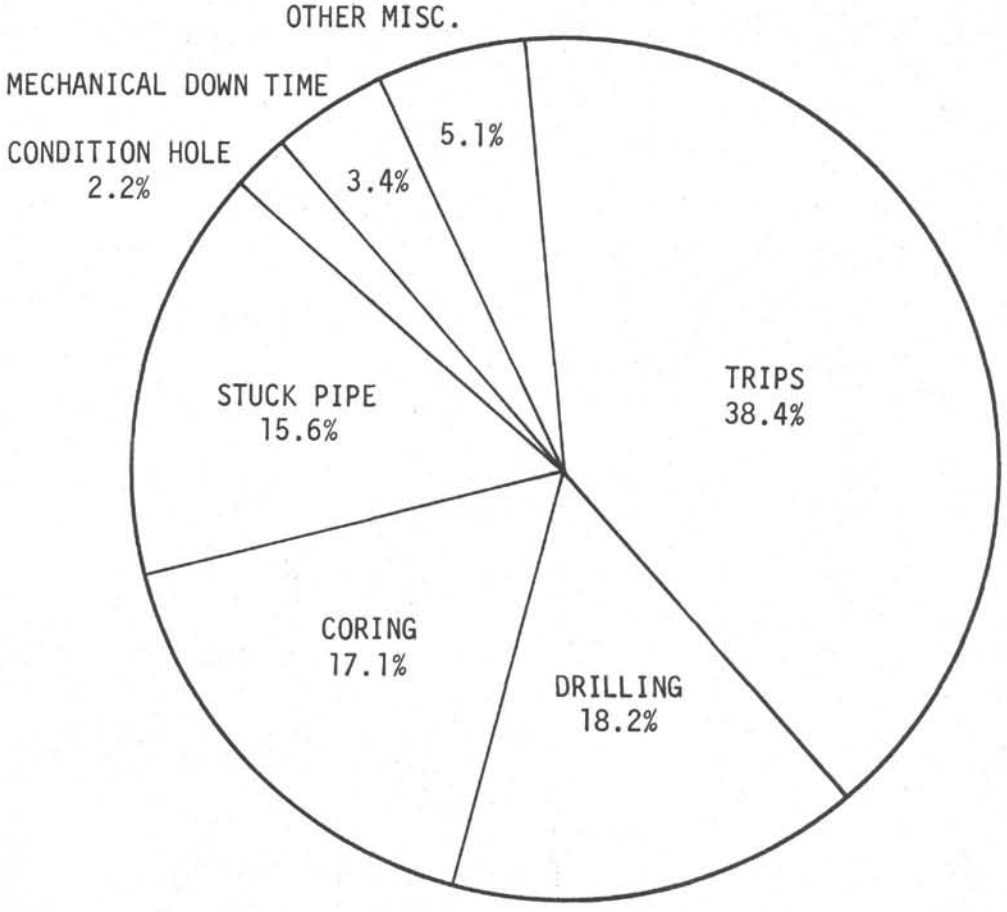


START: 11:30 HRS., SEPT. 13, 1971
FINISH: 10:15 HRS., NOV. 10, 1971
9 SITES - 13 HOLES

DEEP SEA DRILLING PROJECT

LEG 20

ON-SITE TIME DISTRIBUTION



START: 11:30 HRS., Sept. 13, 1971

FINISH: 10:15 HRS., Nov. 10, 1971

9 SITES - 13 HOLES

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 20

Site No.	Beacon Description			Battery Ser. No.	Time On Site	
	Make	Freq. kHz	Ser. No.		Hours	
194	Burnett	13.5	169	156	70	Good signal.
195	Burnett	16	142		144	Good
195	ORE	13.5	156		.75	Dropped ORE because of time on first beacon. ORE quit after 40 minutes in water.
195	ORE	13.5	168		21	Signal OK. During decent beacon drifted 1,500 feet south due to strong currents.
196	ORE	13.5	154		100	Good signal.
197	ORE	13.5	152		123	Good signal. Lost signal for four minutes while trying to break off stuck pipe. Drill pipe probably interferred with signal.
198	ORE	13.5	153		86	Good signal. Excellent positioning.
199	ORE	13.5	149		106	Good
200	ORE	13.5	148			
200A	ORE	13.5	148		22	Good signal. Very good positioning.
201	ORE	16	140		9	Good signal. Very good positioning.
202	ORE	16	129			Floatation ring broke Beacon fell into water.
202	ORE	13.5	150		67	Good positioning. Pipe stuck in hole.

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 20

Size	Make	Bit Description Size Inches	Type	Ser. No.	Cores Taken Core Recovery Cored	Recovered	%	Footage Recovered Core Recovery Meters	%	Total Penet. Meters	Rot. Time Hours	Penet. Rate M/RH	Conditions	Remarks
194	Smith	10 1/8	94CJS	H2022	5	5	100	39.5	37.9	256	5.25	48	B-5,T-2,G	Cut 20 meters of chert.
195	Smith	10 1/8	SS942	H2028	4	4	100	31	45.1	307	5.50	55		Shirt tail 15% of buttons gone.
195A	Smith	10 1/8	SS942	H2028	0	0				380	7.50	50	B-7,T-5,G1	
195B	Smith	10 1/8	94CJS	HZ2014	3	3	100	19.5	0	388.5		40	B-2,T-4,G	Few buttons gone w/shirt tail worn bit was 1 1/4" OG.
196	Smith	10 1/8	94CJ3	HZ023	6	5	83	40	21.2	377	9.15	41	B-8, T-8, OG	
197	Smith	10 1/8	SS49C	HZ029	1	1	100	8	12.5	283	12	24		Lost in hole.
198	Smith	10 1/8	9CJS	6R753	0	0	0	0						Lost in hole.
198A	Smith	10 1/8	4CTR	GR568	0	0	0	0						Dropped in hole.
198A	Smith	10 1/8	4CTR	GR552				51	50.9	258	8.50	30	B-5,T-2,G	Swivel locked.
199	Smith	10 1/8	4CTR	HE200				114	51.3	456.5	10.9	41	B-2,T-2,G	Ship rolling.
200	Smith	10 1/8	3CTR	GR566	10	8	80	95	37.8	114	1.38	82	See 202	
200A	Smith	10 1/8	3CTR	GR566	2	2	0	19	0	132	1.26	104	See 202	
201	Smith	10 1/8	3CTR	GR566									See 202	
202	Smith	10 1/8	3CTR	GR566	6	3	50	56.5	3.5	153.5	3.15	48		Lost in hole.

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG 20

Date	Site Number	Cruise	Survey	Trips	Drill	Core	Stuck Pipe	Condition Hole	Mechanical Downtime	In Port	Other Misc.	Total	Total On Site
9/22	194	47.25	3.50	33.75	10.00	12.25		7.25	4.50	90.75	1.75	211.00	73.00
9/24	195	7.75	.25	18.00	16.00	8.50	2.00		2.50			55.00	47.25
9/26	195A			13.50	21.25						6.75	41.50	41.50
9/28	195B			28.25	15.75	8.25	3.50	2.25				58.00	58.00
10/2	196	26.25	1.00	25.50	24.25	13.00		2.00	7.75		1.00	100.25	73.00
10/3	197	7.75	.50	30.00	10.25	4.50	66.00	1.25			2.00	123.75	115.50
10/12	198	51.25	2.50	29.50		3.50			.50		9.25	94.50	42.75
10/14	198A			32.50	10.75	15.50		2.25	5.75			66.75	66.75
10/19	Guam	95.50								14.25		109.75	
10/26	199	88.75		29.75	11.00	35.50			2.25		3.50	170.75	82.00
10/27	200	8.50	.50	7.75	1.25	7.50			.50			26.00	17.00
10/27	200A			.75	1.50	1.00	1.00				1.25	5.50	5.50

Time Distribution
Continued

Date	Site Number	Cruise	Survey	Trips	Drill	Core	Stuck Pipe	Condition Hole	Mechanical Downtime	In Port	Other Misc.	Total	Total On Site
10/28	201			5.00	1.75						4.50	11.25	11.25
10/30	202	3.00	4.25	8.00	.50	8.00	33.75				3.25	60.75	53.25
	Suva	252.75										252.75	
Total		586.75	12.50	262.25	124.25	117.00	106.50	15.00	23.75	105.00	34.75	1,387.50	683.25

DEEP SEA DRILLING PROJECT
DRILLING & CORING RECORD
LEG 20

Site	Hole	Latitude	Longitude	Water Depth Meters	Number of Cored	Cores With Recovered	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet Meters	Total Depth Meters	Average Coring Rate	Average Drilling Rate
Abyssal Floor, West Pacific														
194	0	33° 58.64'N	146° 48.64'E	5,754	5	5	39.5	15	37.9	216.5	256	6,010	26	61
195	0	32° 46.40'N	146° 58.73'E	5,968	4	4	31	14	45.1	276	307	6,275	31	61
195	A	32° 46.40'N	146° 48.73'E	5,968	0	0	0	0	0	380	380	6,348	0	38
195	B	32° 46.39'N	146° 58.76'E	5,968	3	3	19.5	0	0	369	388.5	6,356	19	41
East of Bonin Trench														
196	0	30° 06.97'N	148° 58.76'E	6,194	6	5	40	8.5	21.2	337	377	6,571	22	44
197	0	30° 17.44'N	147° 40.46°E	6,153	1	1	8	1	125	275	283	6,437	3	47
East of Bonin Trench North of Marcus Island														
198	0	25° 49.54'N	154° 35.05'E	5,858	0	0	0	0	0	0	0	5,858	0	0
198	A	25° 49.54'N	154° 35.05'E	5,858	6	5	51	26	50.9	207	258	6,116	30	31
East Edge of Caroline Abyssal Plain														
199	0	13° 30.78'N	156° 10.37'E	6,100	12	12	114	58.5	51.3	342.5	456.5	6,556.5	26	51

Drilling & Coring Record
Continued

Site	Hole	Latitude	Longitude	Water Depth Meters	Number of Cores	Cores With Recovery	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet Meters	Total Depth Meters	Average Coring Rate	Average Drilling Rate
Crest of Ita Mai Tai Guyot														
200	0	12° 50.12'N	156° 46.96'E	1,479	10	8	95	36	37.8	19	114	1,595	84	95
200	A	12° 50.12'N	156° 46.92'E	1,479	2	0	19	0	0	113	132	1,611	57	104
201	0	12° 49.89'N	156° 44.59'E	1,564	0	0	0	0	0	66	66	1,630	0	62
202	0	12° 48.90'N	156° 57.15'E	1,515	6	3	56.6	2	3.5	97	153.5	1,668.5	30	74
SUMMARY														
Totals					55	46	473.5	161		2,698	3,171			
Percent						83			34					
Average				4,604	4.2	3.5	36	12.3	34	207	243	4,848	32.8	60.7
Maximum				6,194	12	12	114	58.5	51.3	380	456	6,571	84	104
Minimum				1,479	0	0	0	0	0	0	0	1,595	3	31

DEEP SEA DRILLING PROJECT
OPERATIONS REPORT
LEG 21

SUMMARY

Leg 21 of the Deep Sea Drilling Project began on November 9, 1971 in Suva, Fiji and was completed on January 11, 1972 in Darwin, Australia. On this "Down-Under" leg eight sites were investigated in the area of the South Pacific bounded by New Guinea, Fiji, New Zealand, and Australia. The Challenger traveled 6,503 miles on this leg and drilled fourteen holes on the eight sites. 4,707 meters of ocean sediments were penetrated of which 2,574 meters were cored and 2,133 meters were drilled. 288 cores were attempted with usable recovery obtained on 268 (93.1%) of them. Total core recovery amounted to 1,388.6 meters or 53.9%.

Major time distribution for the 62.29 day leg consisted of 5.56 days in port, 23.45 days cruising, 25.63 days on site and 7.65 days lost time. Of the 25.63 days on site, 15.42 days were spent coring, 2.44 days drilling, and 5.98 days were consumed in trip time.

The dynamic positioning system functioned well on Leg 21 except for low RPM on the bow thruster on Sites 203 and 210. In both cases adjustments were made which corrected the condition.

While coring on Site 206 in the New Caledonia Basin, a crack was discovered in the stem of the Bowen power sub which necessitated pulling out of the hole and terminating coring operations. The Challenger then departed for Wellington, New Zealand where a new stem was installed in the Bowen power sub and where, at the same time, repairs were made to the bow thruster. A total of 7.65 days lost time, in port and in transit, were expended due to the power sub failure.

The Safety and Pollution Prevention Panel of JOIDES recommended continuous coring on six of the eight sites that were drilled and compliance with these recommendations led to two new records being established on Leg 21: (1) most cores attempted (288), and (2) most meters cored (2,574). Of much greater importance are the detailed and complete biostratigraphic studies made possible by the recovery of long continuous sections. Basement was not reached at any of the sites primarily because of the thickness of the sediments encountered. Coring operations were terminated once due to unstable hole conditions and once due to equipment failure. Weather conditions varied from clear skies and calm seas to squall conditions with fifteen foot waves and forty knot winds. No time was lost due to weather, but rough seas and squalls prevented use of the Kelly after failure of the Bowen sub on Site 206.

DRILLING AND CORING

From an operations standpoint, the geologic sections penetrated were quite similar. Sea floor sediments were soft, chalky ooze which became firmer as depth increased. Below these sediments were siltstones and mudstones with occasional thin stringers of chert. On Site 203, entry of volcanic sands into the hole caused the drill string to become stuck and although the pipe was ultimately worked loose, the hole was terminated because of the sand entry problem.

The bottom hole assembly for Leg 21 from the bottom up was as follows: core head, one 8-1/4 inch core barrel, three 8-1/4 inch drill collars, two bumper subs, three 8-1/4 inch drill collars, two bumper subs, two 8-1/4 inch drill collars, one 7-1/4 inch drill collar, and one joint of heavy wall drill pipe. This assembly was approximately 127 meters long and provided about 30,000 pounds of weight in sea water. It was standard on all holes on Leg 21.

The only loss of drilling tools on Leg 21 occurred on Hole 207A when the drill string became stuck while retrieving the last core. Attempts to free the pipe were unsuccessful and the bottom hole assembly was successfully severed between the two lower bumper subs. The core head, float sub, latch sub, four 8-1/4 inch drill collars, and one bumper sub were left in the hole. The hole was filled with 10 pound per gallon mud before leaving the site.

A total of five bits were used on Leg 21, all of which were of the 4-cone shaped insert type. Four of them had sealed bearings and the other was a journal bearing bit which was being evaluated in Hole 207A where it was lost. This bit had run for over 22 hours at the time the pipe became stuck with no indication of dullness or wear at that time. Bit weight varied from less than 1,000 pounds to 25,000 pounds and RPM varied from 20 to 80. The average amount of rotating hours per bit was 22.2.

The excellent performance of the sealed-bearing, shaped-insert bit makes re-entry appear unnecessary at this time. In grading the dull bits, it was interesting to note that the bearings began to wear out before the teeth and that the bearing wear was accompanied by erosion on the shirt-tail portion of the bit legs. It is believed that the erosion on the shirt-tail was sufficient to allow entry of foreign material causing early seal failure and subsequent bearing wear. If it were possible to additionally harden or hard-face the shirt-tail during the manufacturing process, bit life might be extended.

The extended core head was run to take the first "punch-core" at the mudline on each site. There is no conclusive evidence that the cores recovered were any less disturbed than a normal core.

Core recovery amounted to 53.9% which appears to be about average. Typically, when the sediments were very soft and no circulation was necessary, core recovery was very high. Recovery was also high in the very firm sediments, but where soft sediments were interbedded with hard streaks, the necessary circulation washed out the soft material making recovery very low.

On Hole 206A, a special flapper was run in the Baker float sub. This flapper, made of 8620 steel, had been specially hardened to increase wear resistance in the hinge area and an evaluation was requested. 100 meters of penetration were made using a center bit. The center bit was retrieved and the heat probe with the 20 foot stinger attached was run on the sandline. After four attempts to recover the heat probe, the instrument section alone was recovered leaving the 20 foot stinger in the hole. The pipe was pulled up to clear the mudline and Hole 206B was spudded. The sea floor was penetrated for a distance of 202 meters, drilling with a center bit. The center bit was pulled, the heat probe was run in the core barrel in the conventional manner, and nine meters were cored with the heat probe in place. Three wireline runs were required before the core barrel was recovered. Inspection of the shoe on the inner barrel revealed prominent gouge marks. A center bit was run to confirm the probability of jagged metal in the hole and nine more meters were drilled with the center bit in place. The center bit was pulled and inspected and identical gouge marks were found. The drill string was then pulled and the major portion of the flapper was recovered. The flapper had been broken in two places; across the hinge arms and parallel to raised center portion on the face. In addition, several conchoidal chipped areas were found along the beveled edge. It was concluded that the 8620 steel flapper was too brittle to withstand the required impact and 4340 steel flappers were run on the remainder of the holes.

HEAT FLOW MEASUREMENT

Downhole temperature measurements were attempted on all the sites on Leg 21 except Site 203. 26 runs were made to acquire heat flow data with some information being obtained on 23 of these runs. Unfortunately, only nine of the runs resulted in information which was considered useful for heat flow.

Both the stinger system and the conventional heat probe system were employed on Leg 21. On Hole 207, the heat flow instrument and 20 foot stinger were dropped down the drill pipe. Only the instument case was recovered on this run; apparently the shear pin broke upon impact leaving the 20 foot stinger in the hole. As a result of this, the drill string was pulled to clear the mudline and Hole 207A was spudded.

On Hole 206A, the heat flow instrument and 20 foot stinger were run on the sandline in order to minimize the impact when the stinger reached the bottom of the drill string. After four attempts, the instrument case alone was recovered and the stinger was left in the hole. It was on this hole that the drill string had to be pulled to recover the broken float valve flapper, but whether or not this was due to the impact of the stinger is debatable.

All other heat flow runs were made running the heat probe up inside the bottom of the core barrel in the conventional manner. Operational difficulties were also associated with these runs.

The major problem appeared to be premature unlatching of the instrument from inside the core barrel, presumably caused by the pressure differential across the core barrel. The net effect of this was to drive the instrument to the top of the barrel where it suddenly stopped against the base of the check valve. Semi-circular dents on top of the instrument

case gave evidence as to the severity of the shock encountered. Some steps were taken on board ship to correct the problem. A collar on the instrument case was fluted to allow more rapid passage of water within the close confines of the barrel and care was taken to insure the drill pipe being full before dropping the core barrel, but these efforts were not entirely successful.

It appears that a major problem lies in the cushioning of a rather sophisticated electronics package for survival in a brutal environment. It is recommended that additional shock proofing of the instrument case be considered and that additional means of reducing the pressure differential across the barrel be investigated.

DYNAMIC POSITIONING

The Dynamic Positioning system performed well on Leg 21 except on the first and last site. On Site 203, the maximum RPM obtainable on the bow thruster was 240 at 99% thrust in semi-automatic mode. An adjustment was made to the control circuit in the engine room. This corrected the problem and no further difficulty was experienced until Site 210 where, again, the bow thruster RPM's were down to 240.

A small adjustment was made in the engine room but the problem was not completely corrected until Hole 210 was terminated. When the drill string cleared the mudline, adjustments were made to control circuits after which the ship held position very well. Indications are that the Dynamic Positioning system is still capable of erratic behavior on occasion. It is recommended that the system be further inspected and calibrated as necessary until it performs with the maximum reliability possible.

BEACONS

Ten ORE beacons were used on Leg 21. Eight of these performed satisfactorily and two of them failed, both on Site 206. ORE beacon No. 151, 13.5 kHz, failed on deck when it was plugged in preparing for launch although it had operated satisfactorily on test two days before. ORE beacon No. 130, 16 kHz, was dropped. It operated with a continually diminishing signal until complete failure two hours after launch. ORE beacon No. 155, 13.5 kHz, was then dropped and its performance was excellent. It provided a strong steady signal during the time Hole 206 was drilled and was still emitting a strong signal on which the Challenger homed-in on her return to Site 206. The beacon was still operating when Hole 206C was abandoned, 491 hours after launching.

COMMUNICATIONS

Except for a two day period, daily communications were established on CW with WWD and all traffic was cleared with no excessive delays. Volume and type of traffic were about the same as on previous legs, that is, about ten outgoing CW messages and five incoming each day. In the area in which the Challenger operated, weak signals became a problem. The 17105 kHz frequency was good from about 1700 to 0000 Greenwich Mean Time and

The 22419 kHz frequency was usable during the period when a daylight path lay between the ship and WWD.

A new doublet receiving antenna was installed forward of the derrick and brought to the RCA console.

Good voice communications with the USA were established on the 22 MHZ band with KMI nearly every day between 2300 and 0100 Greenwich Mean hours. Amateur band communications were relatively poor although a number of patches were made on the 15 meter band.

PERSONNEL

Drill pipe inspection prior to arrival in Darwin was planned so the Challenger transferred six people to the pilot boat just off Point Moresby and embarked the Tuboscope technician, Scripps laboratory officer, and Global Marine's new manager for the Challenger.

Three minor accidents occurred on Leg 21, one of which involved a small amount of lost time. The victim of the lost time accident was a rotary helper who suffered bruises in a fall while chipping paint in the personnel basket. Examination by the ship's doctor revealed no serious injuries. One other rotary helper had received a bruise on the thigh from the back-up tongs. First aid was provided by the ship's doctor and no time was lost, however, the man later complained of back pains and on the advice of the ship's doctor, he was disembarked at Point Moresby. The third accident victim fell off a board at water level while scrubbing down the moon pool. Minor bruises were received and no time was lost.

Global Marine's personnel, bith drilling and marine, performed in a thoroughly creditable manner and contributed greatly to the success of the cruise.

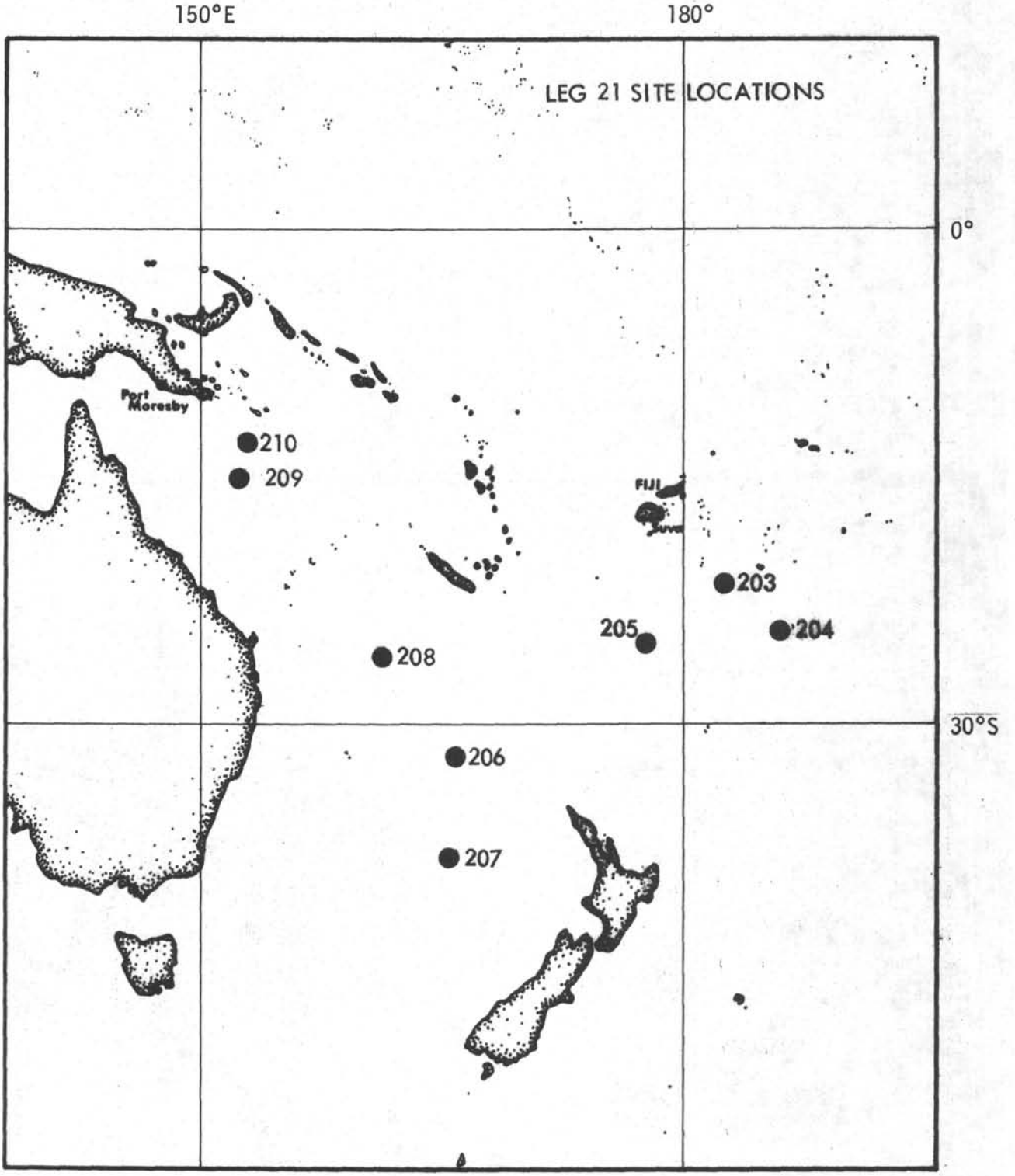
T. C. Bangs
Cruise Operations Manager

February 1971

DEEP SEA DRILLING PROJECT
SUMMARY OF OPERATIONS
LEG 21

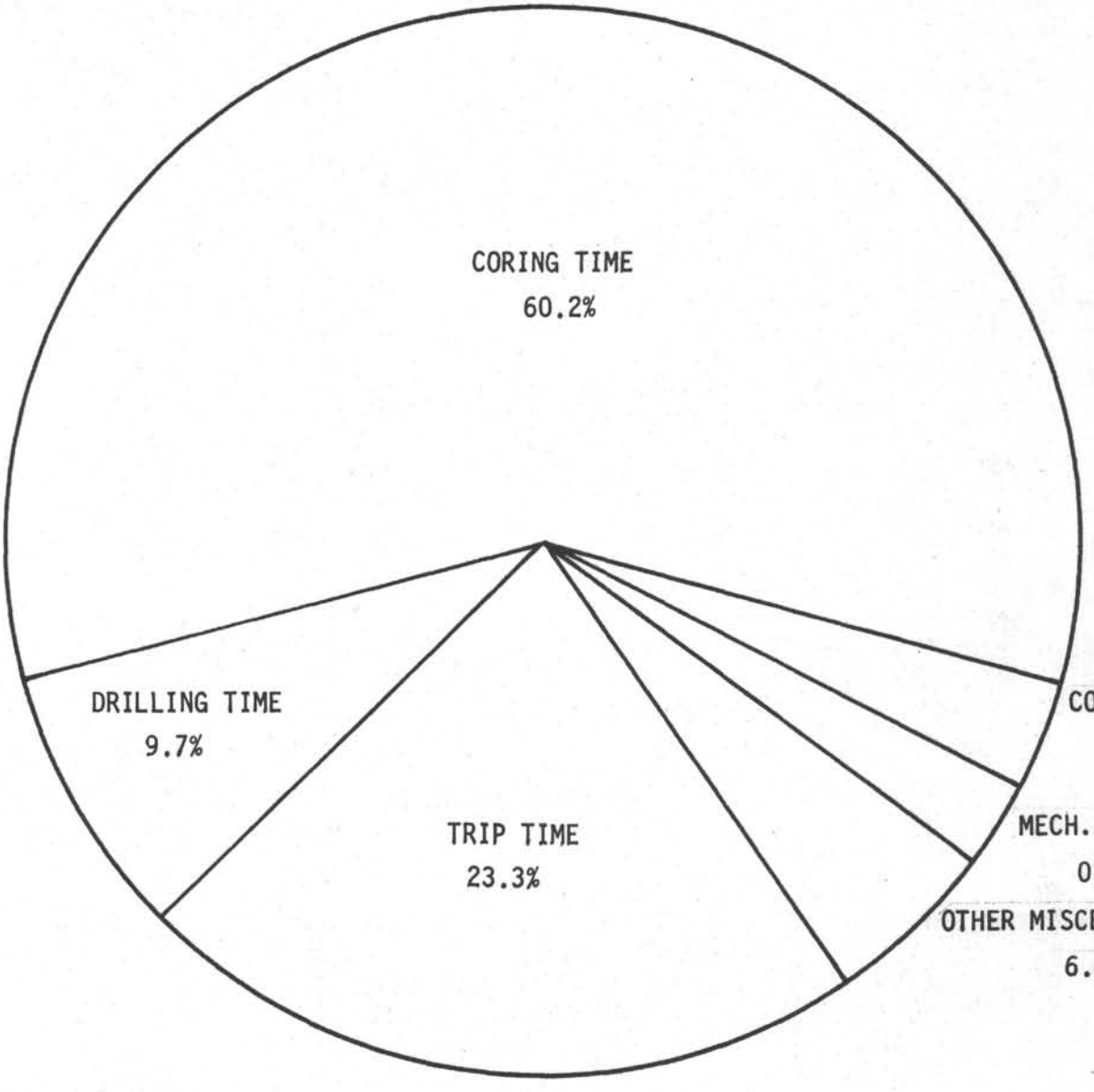
Total Days Leg		62.29
Total Days in Port (Wellington, New Zealand not included		5.56
Total Days Cruising		23.45
Total Days on Site		25.63
Lost Time *		7.65
Trip Time	(143.5 hours)	5.98
Drilling Time	(58.5 hours)	2.44
Coring Time	(370.0 hours)	15.42
Condition Hole	(4.0 hours)	0.17
Mechanical Downtime	(1.0 hours)	0.04
Other Miscellaneous Time	(38.0 hours)	1.58
Total Distance Traveled (Nautical Miles)		6,503
Average Speed (Knots)		9.15
Sites Drilled		8
Holes Drilled		14
Number of Cores Attempted		288
Number of Cores With Recovery		268
Percent of Cores With Recovery		93.1
Total Meters Cored		2,574
Total Meters Recovered		1,388.6
Percent Recovery		53.9
Meters Drilled		2,133
Total Penetration		4,707
Percent of Penetration Cored		53.9
Maximum Penetration (Meters)		734
Minimum Penetration (Meters)		9
Average Penetration Per Hole		336

* Consists of the net time consumed traveling from Site 206 to Wellington, New Zealand and return, plus 2.0 days port time in Wellington, all of which is attendant to the repair of the Bower power sub.


150°E
180°
LEG 21 SITE LOCATIONS
0°
30°S
Port Moresby
210
209
FIJI
203
205
204
208
206
207

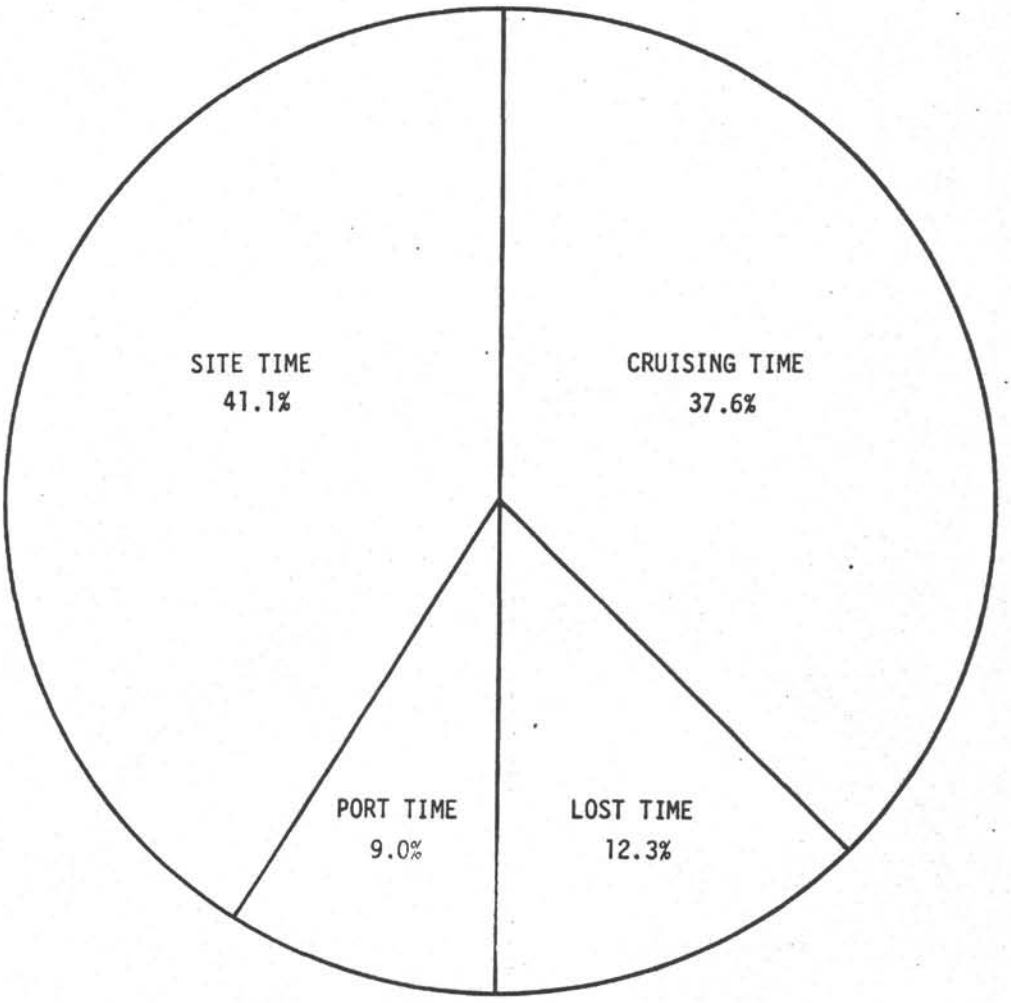

AUSTRALIA
GREATER
CELEBES
BANDA SEA
JAVA
BALI
LESSER SUNDA ISLANDS
NEW GUINEA
BISMARCK ARCHIPELAGO
NEW BRITAIN
SOLOMON SEA
CORAL SEA
CONTINENTAL SHELF
Darwin
EXMOUTH PLATEAU
QUEENSLAND PLATEAU
GREAT DIVIDING RANGE
Brisbane
Perth
Darling
Murray
Adelaide
Canberra
Sydney
Australia's highest point Mt. Kosciusko 7310
Melbourne
CONTINENTAL SLOPE
GREAT BIGHT ABYSSAL PLAIN
TASMAN ABYSSAL PLAIN
LORD HOWE RISE
LORD HOWE
BALL'S PYRAMID
NORFOLK I.
PHILIP I.
TASMAN SEA
TASMANIA
Hobart
NEW CALEDONIA
NEW HEBRIDES TRENCH
NEW HEBRIDES PLATEAU
FIJI
FIJI ISLANDS
VITYAZ TRENCH
FUNAFUTI ATOLL
SAMOA ISLANDS
TONGA TRENCH
LAU RIDGE
KERMADEC TRENCH
NORTH NEW ZEALAND
Wellington
KIWA CANYON
SOUTH NEW ZEALAND
Mt. Cook 12349
CHATHAM RISE
CHATHAM ISLANDS
BOUNTY TROUGH
BOUNTY ISLANDS
CAMPBELL PLATEAU
ANTIPODES IS.
AUCKLAND ISLANDS
MACQUARIE RISE
MACQUARIE I.
DIAN OCEAN
210
209
208
207
206
205
204
203

DEEP SEA DRILLING PROJECT
LEG 21
ON-SITE TIME DISTRIBUTION



TOTAL TIME ON SITE: 25 DAYS, 15 HOURS
8 SITES - 14 HOLES

DEEP SEA DRILLING PROJECT
TOTAL TIME DISTRIBUTION
LEG 21



START LEG: 2209 GMT, 9 NOV. 1971
FINISH LEG: 0500 GMT, 11 JAN. 1972
TOTAL TIME: 62 DAYS, 06 HOURS, 51 MIN.
TOTAL SITES: 8
TOTAL HOLES: 14

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 21

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	Remarks
203	ORE	16.0	144	33.0	Performance satisfactory.
204	ORE	16.0	141	51.5	Performance very good.
205	ORE	16.0	136	77.0	Performance very good.
206	ORE	13.5	151	0	Failed on surface plug-in. Tested OK two days before.
206	ORE	16.0	130	2.0	Performance poor. Failed two hours after launching.
206	ORE	13.5	155 (1)	491.0	Excellent performance. See note (1).
207	ORE	16.0	133	86.5	Performance very good.
208	ORE	16.0	139	42.0	Excellent performance.
209	ORE	13.5	166	41.0	db level low but performance OK.
210	ORE	13.5	162	117.5	Performance OK for 79 hours then had to increase gain to get 5 volts. Leveled off OK.

(1) Time on site includes time consumed on trip to Wellington, New Zealand, plus all time consumed at Site 207 and Sites 206 A, B, and C.

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 21

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
203	Smith	10-1/8 x 2-7/16	94CJS	HZ021	42	367	409	3.47	Excellent	As new. For Rerun.
204	Smith	10-1/8 x 2-7/16	94CJS	HZ021	79	81	160	8.33	Good	Rerun
204A	Smith	10-1/8 x 2-7/16	94CJS	HZ021	9	86	95	0.71	Good	Rerun
205	Smith	10-1/8 x 2-7/16	94CJS	HZ021	288	67	355	6.82	Good	Rerun
					418	601	1,019	19.33	T-1,B-3,IG	Worn
206	Smith	10-1/8 x 2-7/16	94CJS	HG648	400	16	416	7.40		
206A	Smith	10-1/8 x 2-7/16	94CJS	HG648	0	100	100	0.43		
206B	Smith	10-1/8 x 2-7/16	94CJS	HG648	9	211	220	0.87		
206C	Smith	10-1/8 x 2-7/16	94CJS	HG648	189	545	734	15.97		
					598	872	1,470	24.67	T-1,B-1,IG	Two broken teeth

(Continued)

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 21

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
207	Smith	10-1/8 x 2-7/16	S94C	HZ836	42	5	47	0.26		
207A	Smith	10-1/8 x 2-7/16	S94C	HZ836	450	63	513	21.80		
					492	68	560	22.06	Unknown	Lost in hole
208	Smith	10-1/8 x 2-7/16	94CJS	HZ026	306	288	594	9.4		
209	Smith	10-1/8 x 2-7/16	94CJS	HZ026	301	43	344	6.3		
209A	Smith	10-1/8 x 2-7/16	94CJS	HZ026	9	0	9	0.4		
					616	331	947	16.1	T-1,B-5,OG	Not suitable for rerun
210	Smith	10-1/8 x 2-7/16	94CJS	HZ024	450	261	711	28.9	T-1,B-4,IG	Not suitable for rerun

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 21

Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent Recovered	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet. Meters	Total Depth Meters	Coring Rate M/Hr	Drilling Rate M/Hr
Southern Lau Basin														
203	22° 09.22'S	177° 32.77'W	2,730	5	5	100	42	20.3	48.3	367	409	3,139	62.6	132.5
Tonga Trench (Pacific Side)														
204	24° 57.27'S	174° 06.69'W	5,364	9	9	100	79	49.4	62.5	81	160	5,524	16.0	24.0
204A(1)	24° 57.27'S	174° 06.69'W	5,364	1	1	100	9	4.3	47.8	86	95	5,459	112.5	136.5
South Fiji Basin														
205	25° 30.99'S	177° 53.95'E	4,330	32	24	75	288	134.7	46.8	67	355	4,685	44.2	223.3
New Caledonia Basin														
206	32° 00.75'S	165° 27.15'E	3,206	45	45	100	400	243.6	60.9	16	416	3,622	55.6	80.0
206A(1)	32° 00.75'S	165° 27.15'E	3,206	0	0	0	0	0	0	100	100	3,306	N/A	232.6
206B(1)	32° 00.75'S	165° 27.15'E	3,206	1	1	100	9	0.7	7.8	211	220	3,426	52.9	301.4
206C	32° 00.75'S	165° 27.15'E	3,206	21	19	90.5	189	88.7	46.9	545	734	3,940	18.9	90.8
Lord Howe Rise (South Portion)														
207	36° 57.75'S	165° 26.06'E	1,399	5	5	100	42	38.0	90.5	5	47	1,446	182.6	166.7
207A(2)	36° 57.75'S	165° 26.06'E	1,399	50	45	90	450	212.3	47.2	63	513	1,912	21.1	126.0
Lord Howe Rise (North Portion)														
208	26° 06.61'S	161° 13.27'E	1,555	34	33	97.1	306	255.4	83.5	288	594	2,149	46.4	102.9

(Continued)

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 21

Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Recovery	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet. Meters	Total Depth Meters	Coring Rate M/Hr	Drillin Rate M/Hr
Queensland Plateau														
209	15° 56.19'S	152° 11.27'E	1,438	34	30	88.3	301	76.7	25.5	43	344*	1,782	51.0	102.5
209A(3)	15° 56.19'S	152° 11.27'E	1,438	1	1	100	9	2.2	24.4	0	9	1,438	180.0	N/A
Coral Sea														
210	13° 45.99'S	152° 53.78'E	4,653	50	50	100	450	262.3	58.3	261	711	5,364	18.8	52.2
				288	258	93.1	2,574	1,388.6	53.9	2,133*	4,707*			

* Includes depth correction of (+) 2 meters.

(1) Drilled or cored specifically for heat probe.
(2) Drilled and cored as replacement after loss of heat probe equipment in #207.
(3) For piston corer test only.

DEEP SEA DRILLING PROJECT
OPERATIONS REPORT
LEG 22

SUMMARY

Leg 22 commenced Darwin, Australia, January 11, 1972 and arrived at Colombo, Ceylon on March 6, 1972. During this voyage the Challenger steamed 5,724 nautical miles and drilled 11 holes on 8 sites. While on these 8 sites, 2,543 meters were cored; 1,379.7 meters were recovered. Of 275 coring attempts, 273 had useable core. In addition, 2,090 meters were drilled making the total penetration for the leg 4,633 meters.

Time distribution for 55 days of Leg 22 consisted of 2.42 days in port, 24.52 days cruising, and 28.6 days on site. The on site time consisted of 17.94 days of coring, 2.09 days of drilling, 6.53 days of trips, 0.15 days of mechanical down time and 1.31 days of other (including working stuck pipe, running heat flow and rig service).

Significant accomplishments of Leg 22 included:

(1) Worked in the deepest water to date, 6,243 meters (20,483 feet) on Site 212.
(2) Established a new total depth record for the Challenger of 6,764 meters (22,192 feet) on Site 212.
(3) Recovered the deepest basalt core at 6,764 meters (22,192 feet) at Site 212.
(4) Established a new record of 2,543 meters (8,344 feet) for total coring on a leg, surpassing the previous record on Leg 18 of 2,483 meters.
(5) 275 cores were attempted with recovery on 273, which was second to Leg 18 which had 280 cores attempted, 275 with recovery.
(6) A total of 110 meters (361 feet) of basalt was cored, 66 meters (216 feet) was recovered.
(7) Only four new bits and one rerun bit were used while penetrating 4,633 meters (15,201 feet)
(8) A Smith 4-cone chisel tooth bit (Type 94) drilled 1,522 meters (4,994 feet) including 27.5 meters of basalt.
(9) No tools were lost, no beacon failures and no time lost because of bad weather. The scientific objectives were reached on all the sites.

DRILLING AND CORING

The bottom hole assembly used throughout Leg 22 consisted of the core bit, float sub, 8-1/4" core barrel, three each 8-1/4" drill collars, two each Baash Ross bumper subs, three each 8-1/4" drill collars, two each Baash Ross bumper subs, one 8-1/4" drill

collar, one 7-1/4" drill collar, and a joint of heavy wall drill pipe.

Our scientific objectives were to penetrate basement on the first six sites. Basement was penetrated from 10 to 20 meters on these sites. On Site 211, a basalt flow was cored from 406 meters to 416 meters. Basement was cored from 435 meters to total depth at 447 meters. Another basalt flow was cored on Site 214 from 444 to 472 meters, basement was cored from 488 meters to 500 meters. On both sites, after penetrating the flows, a fine sand caused some drilling difficulties because of fill and sticky hole conditions. While drilling these intervals some drilling mud was used to flush out sand.

The drill string became stuck only at one time during Leg 22. This occurred on Site 215 after 14 meters of basement had been cored. When the drill string stuck, the pipe torqued up while rotating and using low pump volume. The bit was 13 meters off bottom. 50 barrels of mud was then spotted above the bit. The pipe came free after one and three-quarter hours of working of the pipe. The maximum pull on the stuck pipe did not exceed 100,000 pounds. The pipe was freed by hitting down on the bumper subs.

Site 212 was drilled in the northwest side of the Wharton Basin. The presite survey indicated that basement could be reached just short of the contract depth (22,500 feet). Bottom was established at 6,243 meters (20,483 feet), which established a new water depth record for the Challenger (or any floating drilling vessel). This site was continuously cored from 6,540 meters to 6,764 meters (22,192 feet). Four meters of basement were recovered. The 22,192 feet is only 308 feet short of the 22,500 feet contract limit and established a new depth record. Weather and sea conditions were perfect while on Site 212.

The first five sites were south of the equator and all had soft chalk ooze for the first 200 meters. The ooze created no hole problems and generally, the recovery was good, however, some of the soft chalk apparently was very water sensitive and recovery would drop off as low as 20%. The extended core barrel was used on a few occasions with great success in these soft chalk oozes.

The last two sites were on the southern end of the Bengal Fan. Prior to these last two sites, the core recovery was 61.4%. The core recovery on Holes 217, 217A, and 218, was only 37.5%.

On Holes 217 and 217A, the first few meters consisted of soft clay which soon turned into a hard chalk. The bottom 70 meters were very hard sand laminated with very hard (block) chert stringers. Drilling was suspended on Hole 217 when it appeared that the bit had locked or had lost a cone. A trip was made for a new bit and Hole 217A was spudded. All of the bit cones were left in Hole 217.

Hole 217A was drilled 233 meters deeper than Hole 217. Drilling was terminated in hard sand, chert, and thick sections of dolomite, as in Hole 217.

It is becoming more evident that the ability to successfully drill chert is related to the sea condition. If a constant weight can be applied on the bit, the life of the bit is greatly increased (in some cases it would be doubled). The bumper subs performance is also related to the sea state. Holes 217 and 217A would probably have sanded up the bumper subs with sand and chert cuttings if the ship had any roll or pitch. Throughout Leg 22 there was no evidence of bumper subs sanding up. We had perfect sea conditions.

No tools were lost on Leg 22. One Baash Ross bumper sub was damaged on Site 215. The third bumper sub above the bit was stuck half open and the bumper sub body was egg shaped. This damage was probably caused by hitting down on the drill string while freeing stuck pipe.

The 20 foot pup joint that is used under the power sub was replaced while drilling the last site. A crack was detected eight inches below the external upset on the box end of the pup joint.

HEAT FLOW

On previous heat flow tests, the mechanical latch that secures the instrument (DHI) to the bottom of the core barrel had been damaged on impact when the core barrel hit bottom. Some operational people thought the latch was damaged when the core barrel hit the water level inside the drill pipe. This caused the latch to release prematurely and drove the instrument to the top of the core barrel. Some damage to the top of the instrument case was noted. To facilitate the heat flow test, some new handling procedures were initiated on Leg 22.

(1) The drill string was filled with water prior to dropping the core barrel with the instrument. The core barrel was secured in the drill string at the surface by two set screws in a short sub (saver sub) and the drill string was filled with water from the rig pump. When the pipe was full the set screws were loosened and the core barrel released.

(2) To prevent damage to the top of the instrument case, a spring type shock absorber was installed on the top of the instrument case and is now an integral part of the heat flow instrument.

(3) To prevent the mechanical latch from being damaged when the core barrel hits bottom, the latch is protected in a recessed seat on the bottom of the core barrel.

A new method of dropping the instrument was tried utilizing a prototype break-away latch. The latch is basically an aluminum cylinder secured by set screws to the shaft of the instrument probe. Two or more one half inch diameter brittle plastic rods protrude out at right angles to the cylinder axis and are also held in place with set screws.

After pumping the drill pipe full of water, the core barrel is dropped and the saver sub removed; the pipe is then joined and the bit lowered to bottom. The velocity and momentum of the free falling core barrel will bury the instrument probe in the sediment and shear the plastic rods. The drill bit is left on the bottom for ten minutes until the probe comes to equilibrium.

The break-away latch worked both times it was used and indicates that this method of releasing the instrument can be used in soft sediments. Only two plastic rods were used to latch the instrument on these two runs. It is thought that as the sediment gets firmer more plastic rods would be used to insure against premature unlatching of the instrument. After taking measurement, the bit is raised off the bottom and the pump started to assure that the core barrel has seated and latched. An eight meter core is then taken.

Another method of lowering the instrument, especially in firm sediments or in the present case where the instrument is very delicate, is to secure the instrument to the shoe of the core barrel and lower on the sandline. With the bit off bottom, the core barrel is gently latched and then the bit lowered on to bottom with the weight of the bottom hole assembly pushing the probe into the sediment. This method requires a little extra time and no core is recovered with the instrument. This system was the most successful one used on Leg 22. Two excellent heat flow measurements were recorded on two attempts.

POSITIONING

The dynamic positioning system operated extremely well throughout Leg 22. The ship was positioned in manual mode twice. One occasion was due to a faulty relay in the stern thruster which caused the ship to lose heading. The maximum excursion was 600 feet, however, there was no danger to the bottom hole assembly during this excursion as the bit was above the mud line when the stern thruster was lost.

Throughout Leg 22, the ship maintained a heading into the swells. The wind was usually from the same direction as the swells.

BEACONS

All beacons were pre-tested on deck prior to dropping. There were no beacon failures on test or on bottom. Eight beacons were used, six 13.5 kHz and two 16 kHz (six Ocean Research Equipment beacons and two Burnett beacons).

CREW PERFORMANCE

The success of Leg 22 can be attributed to the efforts and enthusiasm of its personnel. The Global Marine's crew, the scientific staff and the Scripp's personnel all performed as professionals. It was a pleasure to be a part of the Leg 22 team.

Lamar Hayes

Lamar P. Hayes
Cruise Operations Manager
Deep Sea Drilling Project

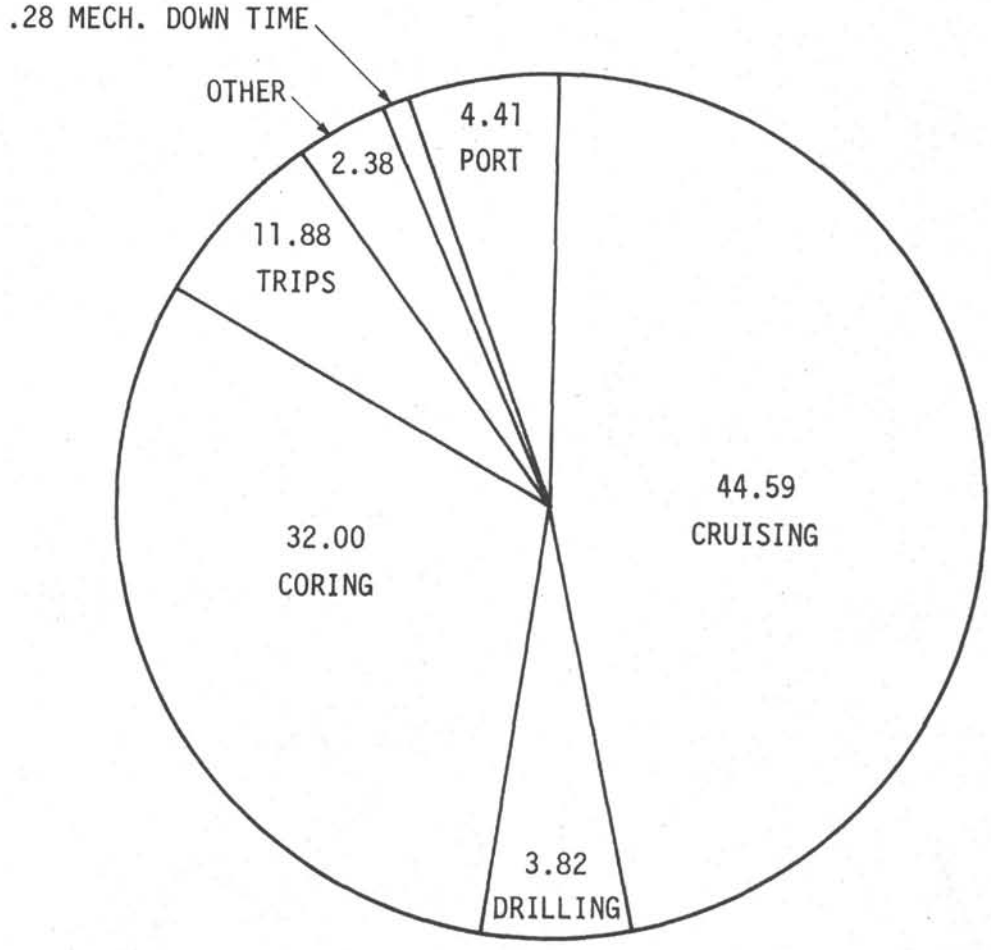
DEEP SEA DRILLING PROJECT
SUMMARY OF OPERATIONS
LEG 22

Total Days (January 13 - March 6, 1972)	55
Total Days in Port	2.42
Total Days Cruising	24.52
Total Days On Site	28.06
Coring Time	17.94
Drilling Time	2.09
Trip Time	6.53
Mechanical Down Time	.15
Other Miscellaneous Time	1.31
Total Distance Traveled (Nautical Miles)	5,724
Average Speed (Knots)	9.88
Sites Investigated	8
Holes Drilled	11
Number of Cores Attempted	275
Number of Cores With Recovery	271
Percent of Cores With Recovery	98.5
Total Meters Cored	2,543
Total Meters Recovered	1,379.7
Percent of Penetration Cored	55
Total Meters Drilled	2,090
Total Meters Penetration	4,633
Percent of Core Recovered	54.3
Maximum Penetration Per Hole (Meters)	763.5
Minimum Penetration Per Hole (Meters)	130.5
Average Penetration Per Hole (Meters)	420
Maximum Water Depth (Meters)	6,243
Minimum Water Depth (Meters)	1,665
Average Water Depth (Meters)	4,025

LEG XXII

TOTAL TIME DISTRIBUTION

PERCENTAGES



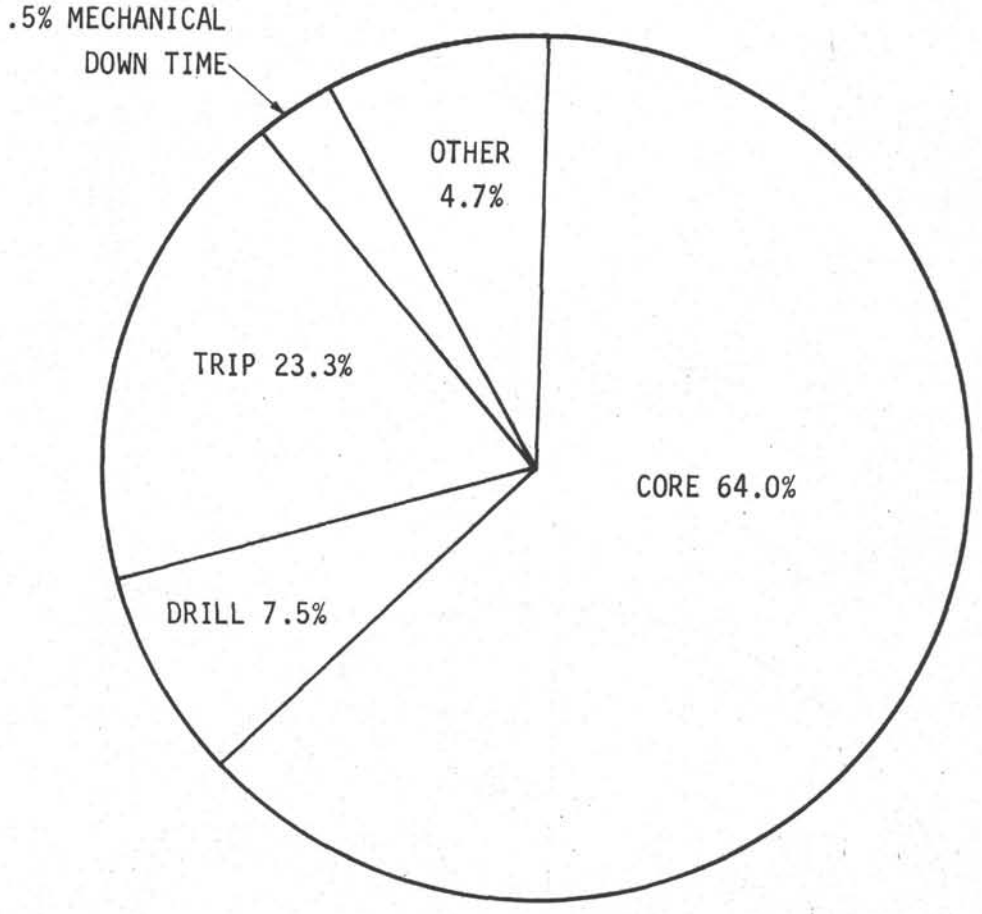
OTHERS:

MAGNAFLUX B.H.A.
SERVICE DRILLING LINE
RUN HEAT FLOW

START: 11 JAN 1345 HRS
END: 6 MAR 0945 HRS
11 HOLES, 8 SITES

LEG XXII

ON SITE TIME DISTRIBUTION

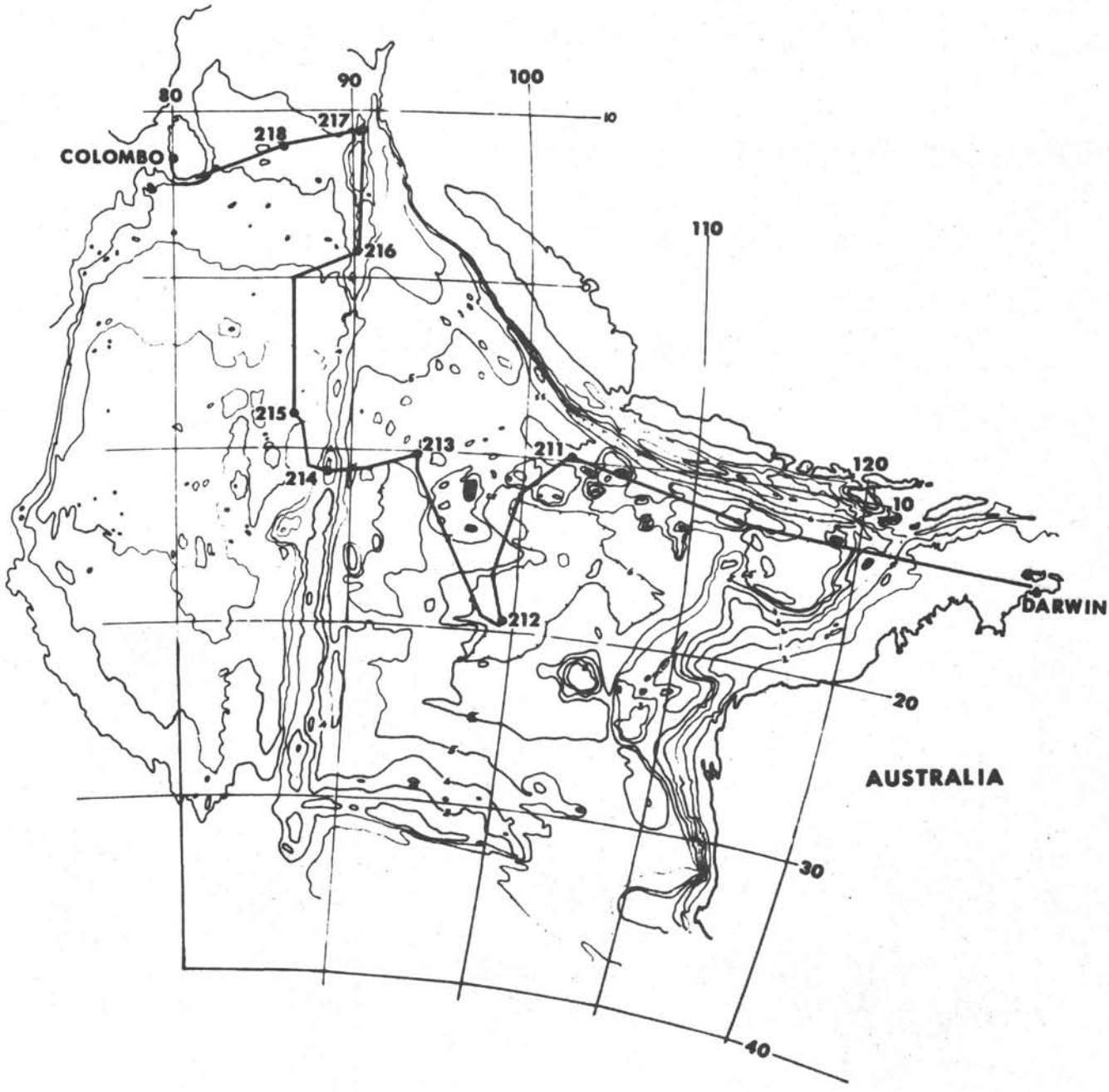


INCLUDED IN OTHER

MAGNAFLUX B.H.A.
SERVICE DRILLING LINE
RUN HEAT FLOW

LEG XXII TRACK

8 SITES



DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 22

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Conditions	Remarks
211	Smith	10 1/8	94CJS	HZ015	142.5	304.5	447	15.5	T1, B2	
213	Smith	10 1/8	94CJS	HZ015	172.5		172	5.1		
213A	Smith	10 1/8	94CJS	HZ015	24.5	106	130.5	1.2	T1, B3	74 meters of basalt formation were drilled. No shirt tail wear. Bit in gauge.
214	Smith	10 1/8	94CJS	HZ015	494.5	5.5	500	16	T2, B5	
					834	416	1,249.5	37.8		
212	Smith	10 1/8	93CJS	JK192	366	155	521	16	T1, B2	Drilled 5 meters of basalt.
217	Smith	10 1/8	93CJS	JK192	345.5	269	614.5	13.9		Drilled 70 meters of chert, limestone and very hard sand. Left cones in hole.
					711.5	424	1,135.5	29.9		
215	Smith	10 1/8	94CJS	HZ024	175		175	8.5	T2, B2	
216	Smith	10 1/8	94CJS	HZ024	353	124.5	477.5	8.6		Drilled 38 meters of basalt formation. Bit in gauge.
216A	Smith (Rerun from Leg 21, Site 110)	10 1/8	94CJS	HZ024	57	101.5	158.5	1.7	T5, B5	
					585	226	811	18.8		

(Continued)

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 22

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
217A	Smith (Journal Bearing)	10 1/8	FS94C	HZ835	345.5	502	663.5	18.3	T6, B4	Had shirt tail wear. Drilled 130 meters of chert, very hard sand and dolomite.
218	Smith	10 1/8	94CJS	HZ027	251	522	763.5	17.8	T1, B1	

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 22

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	Bat. No.	Remarks
211	ORE	13.5	193	74.00		Good signal. Beacon is easy to handle.
212	ORE	16	170	123.50		Good signal. Dropped on run.
213	Burnett	13.5	166	69.23	152	Good signal. Ship was stopped for beacon drop.
214	Burnett	13.5	161	73.75	155	Signal dropped 7db after 3 hours on bottom - 3 hours later, signal was normal again.
215	ORE	13.5	167	64.5		Dropped still in water. Good signal.
216	ORE	13.5	160	77.00		Dropped still in water. Good signal.
217	ORE	13.5	163	123.75		Dropped still in water. Good signal.
218	ORE	16	172	72.00		Dropped still in water. Good signal.

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG 22

Date	Site Number	Cruise	Trips	Drill	Core	Stuck Pipe	Mechanical Down Time	In Port Time	Other	Total Time
1/11 - 24	211	179.00	25.25	9.50	38.50		.75	58.25		311.25
1/24 - 2/1	212	74.75	25.00	4.75	88.50				5.25	198.25
2/1 - 13	213	74.25	12.00		35.00		1.75			123.00
2/6 - 2/7	213A	1.00	10.25	2.25					8.00	21.50
2/7 - 12	214	32.00	13.25		60.50					105.75
2/12 - 15	215	26.75	19.50		38.25	1.75			5.00	71.25
2/15 - 21	216	73.25	7.25	2.00	44.50					127.00
2/21	216A		3.00	5.00	6.25		1.25		3.50	19.00
2/21 - 27	217	53.00	12.75	3.75	49.25				3.00	121.75
2/27 - 29	217A		15.00	10.00	30.00					55.00
2/29 - 3/4	218	26.50	16.50	13.00	40.25				2.25	3.50
3/4 - 6	To Colombo	47.75								47.75
		588.25	159.75	50.25	431.00	1.75	3.75	58.25	27.00	1,320.00

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 22

Site	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent Recovered	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet. Meters	Avg. Rate Penet.	Time On Hole	Time On Site
211	09° 46.53'S	102° 41.95'E	5,535	15	15	100	142.5	67.2	47.1	304.5	447	29	74.0	74.0
212	19° 11.34'S	99° 17.84'E	6,243	39	39	100	366	174.3	47.6	155	521	32	123.5	123.5
213	10° 12.71'S	93° 53.77'E	5,611	19	19	100	172.5	145.5	84.4		172.5	33	48.7	69.2
213A	10° 12.71'S	93° 53.77'E	5,611	3	3	100	24.5	24.5	100	106	130.5	10	20.5	
214	11° 20.21'S	88° 43.08'E	1,665	54	53	98	494.5	346	70	5.5	500	32	73.7	73.7
215	08° 07.30°S	86° 47.50'E	5,319	20	20	100	175	113.3	64.7		175	21	64.5	64.5
216	01° 27.73'N	90° 12.48'E	2,247	38	38	100	353	170.8	48.3	124.5	477.5	55	53.7	77.0
216A	01° 27.73'N	90° 12.48'E	2,247	6	6	100	57	53.7	94.2	101.5	158.5	90	23.3	
217	08° 55.57°N	90° 32.33'E	3,020	37	36	97	345.5	183.4	53.1	269	614.5	44	68.7	123.7
217A	08° 55.57'N	90° 32.33'E	3,020	17	16	94	161.5	41.6	25.8	502	663.5	36	55.0	
218	08° 00.42°N	86° 16.97°E	3,759	27	26	96	251	59.4	24	522	773	44	72.0	72.0
Total - 8 Sites, 11 Holes				275	271		2,543	1,379.7		2,090	4,633		677.6	677.6
Average			4,025	25	24.6	98.6	231	125.4	54.3	190	421		61.6	84.7
Maximum			6,243	54	53	100	494.5	346	94.2	5.5	130.5		123.5	123.7
Minimum			1,665	6	6	94	24.5	24.5	24	522	773		23.5	64.5

DEEP SEA DRILLING PROJECT
OPERATIONS REPORT
LEG 23

SUMMARY

Leg 23 of the Deep Sea Drilling Project commenced March 6, 1972 in Colombo, Ceylon, proceeded across the Arabian Sea and into the Red Sea and finally terminated at Djibouti, F.T.A.I. on May 1, 1972.

During the 56-day voyage the Challenger traveled 4,866 nautical miles and investigated 12 sites, six in the Arabian Sea and six in the Red Sea. 14 holes were drilled in the two areas resulting in a total penetration of 5,393 meters. Of this amount, 2,808 meters were drilled and 2,594 meters were cored with one 9 meter interval having been cored twice. 308 cores were attempted with usable recovery being obtained on 306 (99.4%) of them. Total core recovery amounted to 1426.9 meters or 55.0% of the amount attempted.

Major time distribution for the 55.92 days consisted of 2.48 days in port, 22.63 days cruising and 30.81 days on site. Of the 30.81 days on site, 4.94 days were spent in drilling, 16.48 days in coring, 6.42 days in making trips and 2.97 days were spent in conditioning hole, rig repair, and miscellaneous operations.

On March 16, while coring on Site 220, the dynamic positioning computer lost its program and repairs proved impossible with the spare parts available on board. The ship was successfully positioned using the manual mode of operation until computer repairs were completed. The Challenger made a scheduled rendezvous off Djibouti on April 12 to exchange scientific personnel before entering the Red Sea and a computer technician carrying additional spare parts boarded the vessel at that time and repairs were completed on April 15. No other difficulties in maintaining station was experienced until Site 230 in the Red Sea where a combination of very shallow water (851 meters), high seas, and gale force winds made position holding impossible due primarily to "lost acoustics".

While operating in the "brine area" of the Red Sea, contact was made with the German research vessel "Valdivia" and exchange visits by members of the respective scientific staffs were made.

Significant accomplishments on Leg as included:

(1) Deepest penetration below the sea floor to date for the Project. This occurred on Hole 222 in the Arabian Sea where the sea floor was penetrated to a depth of 1300 meters.

(2) Most cores attempted (308) for any leg in the Project.

(3) Most cores with usable recovery (306) for any leg in the Project.

(4) Most meters cored (2594) for any leg in the Project.

(5) The 1426.9 meters of core recovered ranks second in the entire Project.

(6) Shallowest location to be successfully drilled (861 meter water depth at Site 229).

Items (1) and (6) are considered particularly significant since they indicate extended operational capabilities of the Challenger when proper conditions exist.

Weather conditions were almost ideal in the Arabian Sea and varied only slightly from this in the Red Sea, except for Site 230 where gale force winds and 15 to 18 foot seas were recorded. Coring operations were terminated once due to down hole equipment failure and once because of a stuck inner core barrel. Three other coring attempts were terminated when hard formation was encountered with no soft sediment cover.

DRILLING AND CORING

Geologically, the Arabian Sea and the Red Sea differed enough to be treated as separate areas on Leg 23. To a large extent this was also true from an operations standpoint.

In the Arabian Sea, the sediments encountered at the sea floor were soft gray, green oozes which gradually became firmer with depth. Beneath the oozes were clays, siltstones, and mud stones with occasional thin stringers of chert. Sand stringers were rarely present. Four of the holes in the Arabian Sea bottomed in basalt. No serious problems were encountered drilling in this area.

In the Red Sea, particularly in the "brine area" it proved impossible to locate a site which was geologically desirable and on which there were soft sediments thick enough to provide reasonable lateral support for the bottom hole assembly. In the interests of achieving the scientific objectives in the area, the established practice of having a minimum of 100 meters of sediment cover before coring was waived. Using extreme caution for the first 100 meters, Hole 225 was spudded in firm sediments and was continuously cored to a penetration of 230 meters. The hole was abandoned in anhydrite at that point. On Hole 226, the bottom hole assembly twisted off in the service break of the lower most bumper sub after coring only 14 meters. Three successive offsets to the original hole failed to provide any sediment cover and the site was abandoned.

In Hole 227, hard formation was again encountered at the sea floor, however, cautious penetration was possible. The hole was abandoned in halite after a total penetration of 359 meters.

Hole 228 was abandoned when all four bumper subs sanded up after penetrating the sea floor 325 meters. Inoperable bumper subs also caused early abandonment of Hole 229

after a penetration of 108 meters. Hole 229A penetrated the sea floor to a depth of 212 meters in water only 861 meters deep. This was the shallowest water in which the Challenger has successfully operated. Continuous shows of methane together with indications of increasing ethane concentration were observed on the gas chromatograph. Hole 229A was filled with 12 ppg mud and abandoned at this point.

An attempt was made to drill and core Hole 230 in water only 851 meters deep. 55 to 60 mph winds and 15 to 18 foot seas were encountered and the Challenger was unable to hold position under these adverse conditions. Hole 230 was therefore abandoned after taking two punch cores at the sea floor.

The bottom hole assembly used on Leg 23 from the bottom up was as follows: core head, one 8-1/4 inch core barrel, three 8-1/4 inch drill collars, two bumper subs, three 8-1/4 inch drill collars, two bumper subs, two 8-1/4 inch drill collars, one 7-1/4 inch drill collar, and one joint of heavy wall drill pipe. This assembly was approximately 127 meters long and provided about 30,000 pounds of weight in sea water. It was standard on all holes on Leg 23.

The only loss of drilling tools on Leg 23 occurred on Hole 226 in the Red Sea. Hard formation was encountered at the sea floor with no detectable sediment cover and established practice was to not attempt to core under these conditions. However, the possibility of finding a better location in the immediate area was poor and the scientific objectives had high priority so an attempt was made to cautiously core ahead. A 5 meter and a 9 meter core were cut running very light weight and low rpm. In attempting to cut a third core, the bottom hole assembly twisted off at the service break in the bottom bumper sub. The core head, float sub, latch sub, four 8-1/4 inch drill collars, and the lower portion off the bumper sub were left in the hole. Unfortunately the bumper sub was a new type which was being evaluated for its ability to resist sanding up. It had performed well up to the time of its loss.

Seven bits were used on Leg 23, all of which had sealed bearings. Four of them were 4-cone type 94, two were 4-cone type 93, and one was a tri-cone type 93. This tri-cone was run for 12 hours and was graded T-3, B-8 when pulled. By way of comparison, a 4-cone type 93 core head was run under similar conditions for 24 hours and 39 minutes and was graded T-1, B-2 when pulled. As predicted, the hard facing of the shirt-tail portion of the bit leg has lengthened bit life by delaying bearing failure. The overall performance of these insert bits is outstanding.

An extended inner barrel was run routinely to take the first punch core at the sea floor. Performance was about the same as on previous legs, there being no evidence that core recovery was any greater or core disturbance any less than with the conventional coring system.

Core recovery amounted to 55.0% which is slightly above average. The amount of recovery varied typically with the type of sediment. In extremely soft, soupy sediments recovery was very poor. In soft to firm sediments recovery was usually high. In interbedded hard and soft sediments, recovery was low because the softer sediments washed away when the pump was used. Hard, massive formations yielded high recovery.

HEAT FLOW MEASUREMENT

Either the Von Herzen heat probe or the Kuster Recording Thermometer or both were run in four of the seven holes in the Red Sea. Twelve runs were made with the Von Herzen heat probe. On all of these runs the heat probe was latched into the inner barrel and the entire assembly was lowered down the drill pipe on the sandline thus minimizing impact shock when the instrument reached bottom. This is probably the best method of handling the rather fragile heat flow package but it must be recognized that a wireline run is made solely for heat flow measurements; no core is taken.

Six runs were made with the Kuster Recording Thermometer. This is an oil field instrument which performed exactly as it was intended. It measures the temperature and records it on a chart so that temperature change versus time can be read. Unfortunately it measures only the temperature inside the well bore at its given location and not the temperature of the formation. The latter is needed for heat flow information.

DYNAMIC POSITIONING

On March 16, 1972, on Site 220 in the Arabian Sea, the Challenger's dynamic positioning computer failed. A maximum effort was made to effect repairs, but the necessary parts were not aboard. Aided by almost perfect weather, the ship's officers positioned the vessel in the manual mode with no difficulty. The manual mode utilizes time delay information from the hydrophone directly to plot the approximate location of the vessel. The throttles for the ship's thrusters and main propulsion are controlled from the bridge. The computer is bypassed completely. On April 12, the Challenger rendezvoused with a small craft nine miles off Djibouti in order to exchange scientific personnel. A Xerox electronic technician carrying necessary spare computer parts boarded the Challenger at that time. The computer was repaired and back in operation on April 15. A record of investigations together with a list of recommendations for future operation was submitted to GMI by the Xerox computer technician. The computer used in positioning is a Sigma 2 built by Scientific Data, which is now controlled by Xerox Corporation.

BEACONS

Fifteen beacons were used on Leg 23 on twelve sites. There were three failures of which all were 13.5 kHz beacons. In addition, one 16 kHz beacon and one 13.5 kHz beacon failed on plug-in tests before launching. Of the failures, one failed after 30-1/2 hours operations; one, after only 4 hours; and one, immediately upon launching. An additional beacon was found to have an "O" ring gasket protruding from under the cover presumably extruded by the pressure of gas from a defective battery. This beacon, as well as those which failed on shipboard test, will be returned to the manufacturer under the warranty.

COMMUNICATIONS

On Leg 23, direct communication with WWD, La Jolla, was not possible. For the first two

weeks of the leg, communications were via the Navy Communication Station, Northwest Cape, Australia. Subsequent communication was through the Navy Communication Station, Asmara, Ethiopia. The relatively small amount of incoming Challenger traffic allowed direct communication through the Navy system rather than through the Navy Mercast system. Radio telephone communication to the U.S.A. was possible through WCC Chatham, Massachusetts until the Challenger entered the Red Sea. After that, communications were through WOM, Miami but only between 0000 and 0130 hours GMT on the 13 KHZ band. Connections were usually good during this time. Commercial radio-telegraph traffic for scientific purposes was handled without difficulty to Djibouti, Switzerland, and England.

PERSONNEL

The Challenger made a rendezvous with a local small craft nine miles off Djibouti in order to exchange scientific personnel. Five scientists left the Challenger and five new scientists, specialists in the Red Sea, boarded the vessel. The Xerox computer technician also boarded at this time.

The resignation of Global Marine's Drilling Superintendent and one of their drillers resulted in promotions and changes in the drilling staff. Two new rotary helpers and a new driller were assigned to the Challenger. All of these men had prior offshore drilling experience and the transition to the somewhat specialized operations on the Challenger was smooth and rapid.

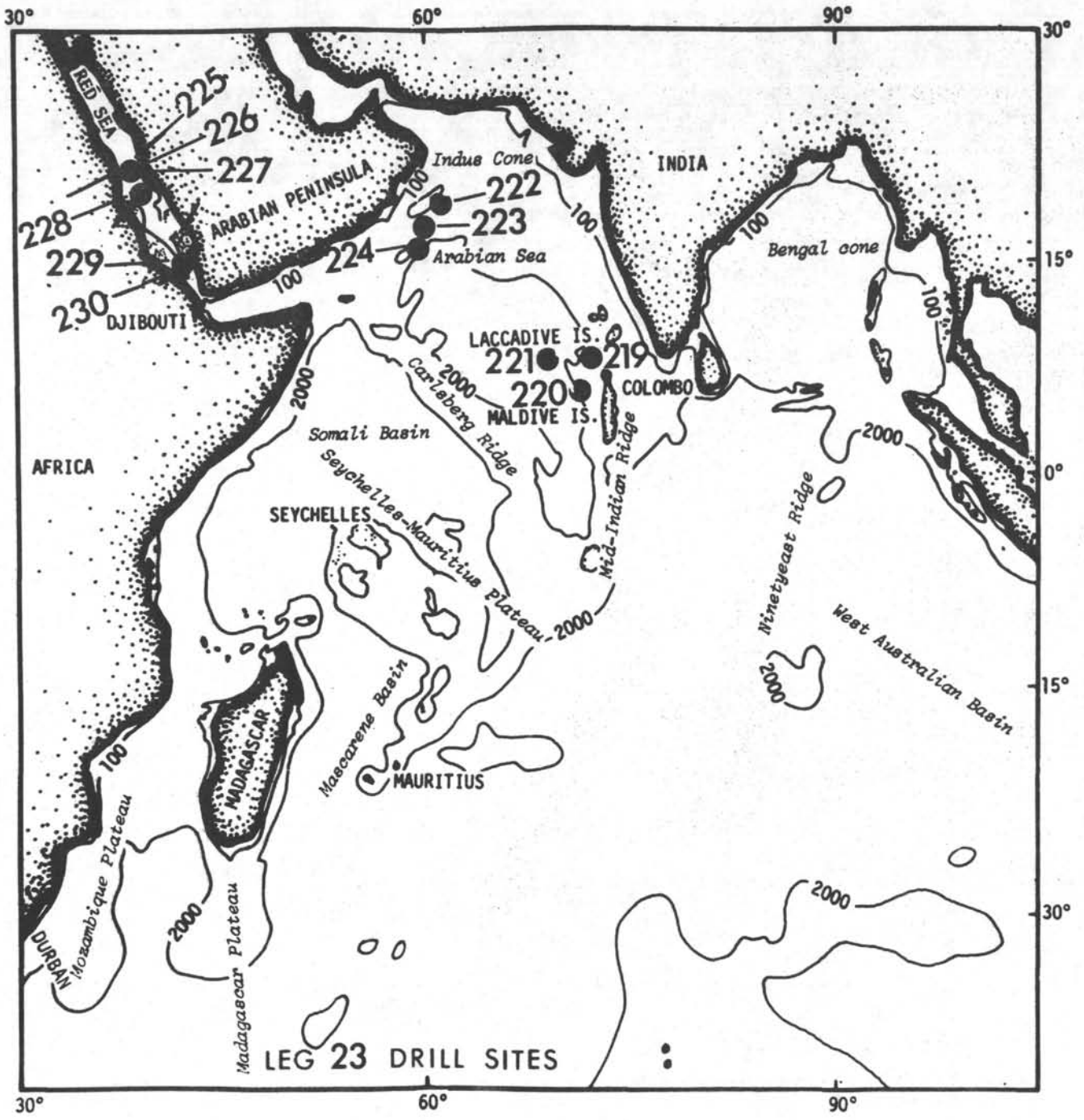
The performance of Global Marine's crews, drilling and marine, was commendable and contributed greatly to the success of Leg 23.

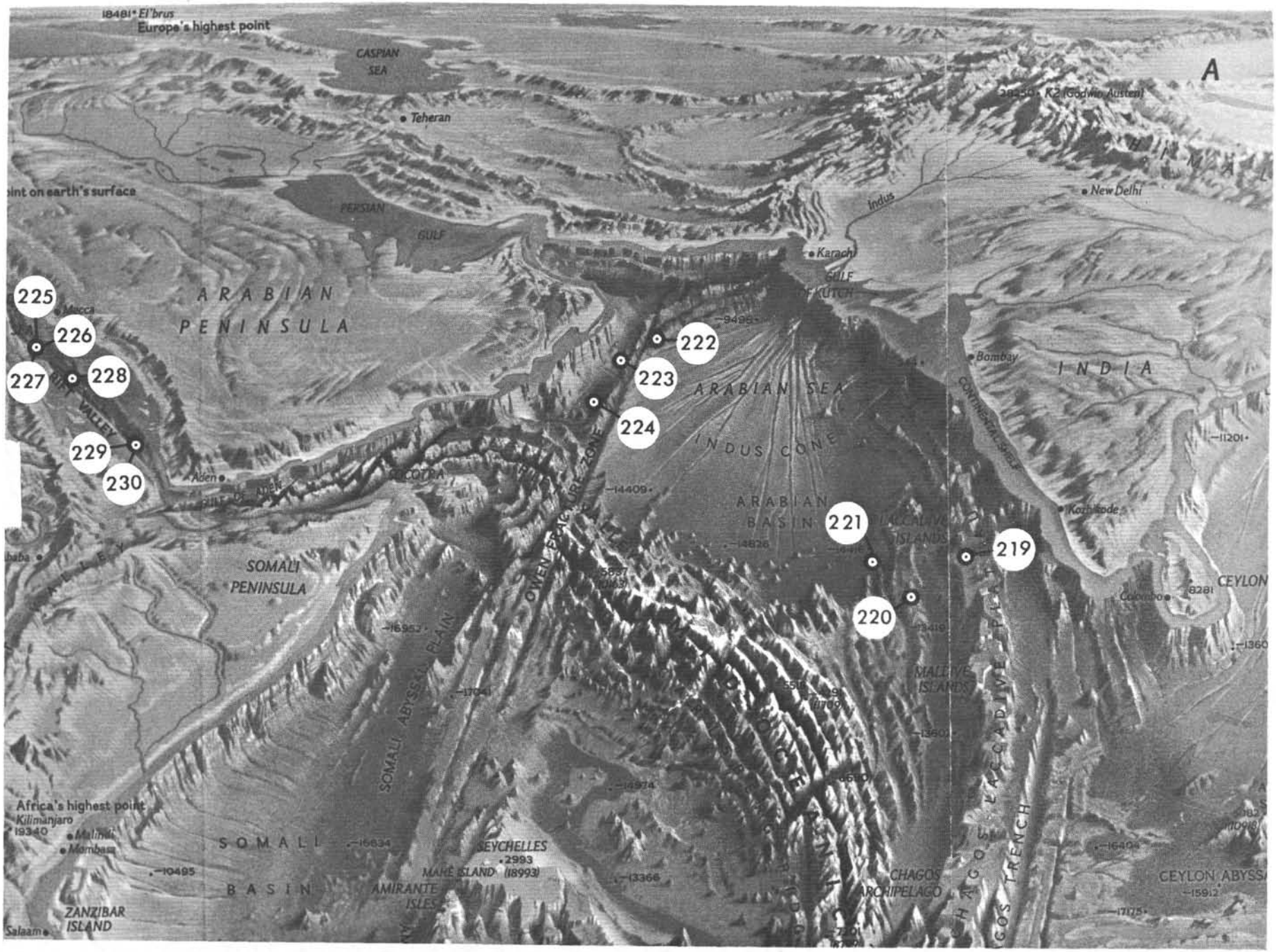
T. C. Bangs
Cruise Operations Manager

May 1972

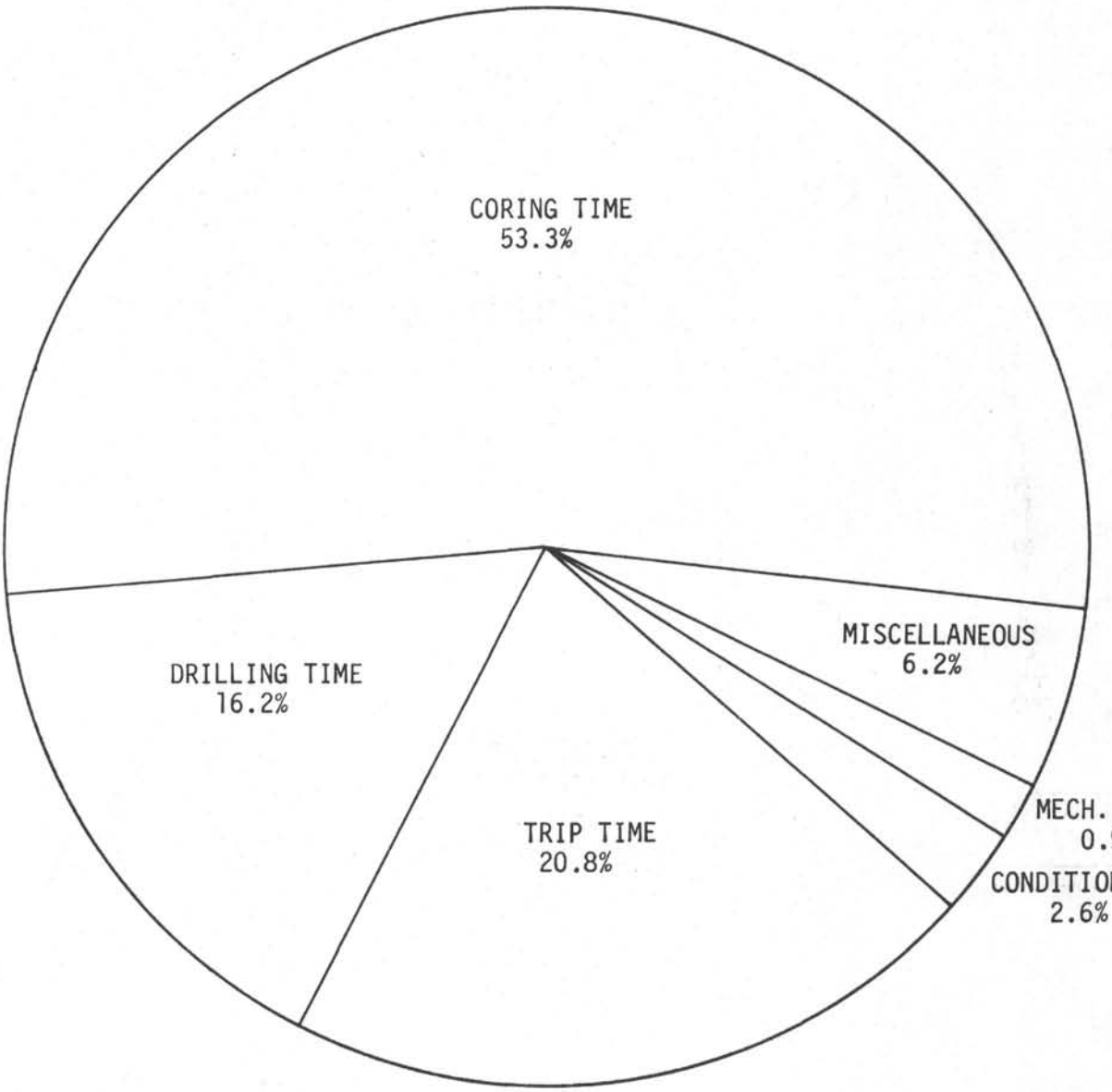
DEEP SEA DRILLING PROJECT
SUMMARY OF OPERATIONS
LEG 23

Total Days Leg		55.92
Total Days in Port		2.48
Total Days Cruising		22.63
Total Days On Site		30.81
Trip Time	(154.0 hours)	6.42
Drilling Time	(118.5 hours)	4.94
Coring Time	(395.5 hours)	16.48
Condition Hole	(19.5 hours)	0.81
Mechanical Downtime	(6.5 hours)	0.27
Other Miscellaneous Time	(45.5 hours)	1.90
Total Distance Traveled (Nautical Miles)		4866.0
Average Speed (Knots)		9.17
Sites Drilled		12
Holes Drilled		14
Number of Cores Attempted		308
Number of Cores With Recovery		306
Percent of Core With Recovery		99.4
Total Meters Cored		2594
Total Meters Recovered		1426.9
Percent Recovery		55.0
Meters Drilled		2808
Total Penetration		5393
Percent of Penetration Cored		48.1
Maximum Penetration (Meters)		1300
Minimum Penetration (Meters)		9
Average Penetration Per Hole		359.5


30°
60°
90°
30°
15°
0°
15°
30°
RED SEA
225
226
227
228
229
230
DJIBOUTI
ARABIAN PENINSULA
Indus Cone
222
223
224
Arabian Sea
INDIA
Bengal cone
100
2000
LACCADIVE IS.
221
219
220
MALDIVE IS.
COLOMBO
Carlsberg Ridge
Mid-Indian Ridge
Somali Basin
AFRICA
SEYCHELLES
Seychelles-Mauritius Plateau
Ninetyeast Ridge
West Australian Basin
Mascarene Basin
MAURITIUS
MADAGASCAR
Mozambique Plateau
Madagascar Plateau
DURBAN
LEG 23 DRILL SITES

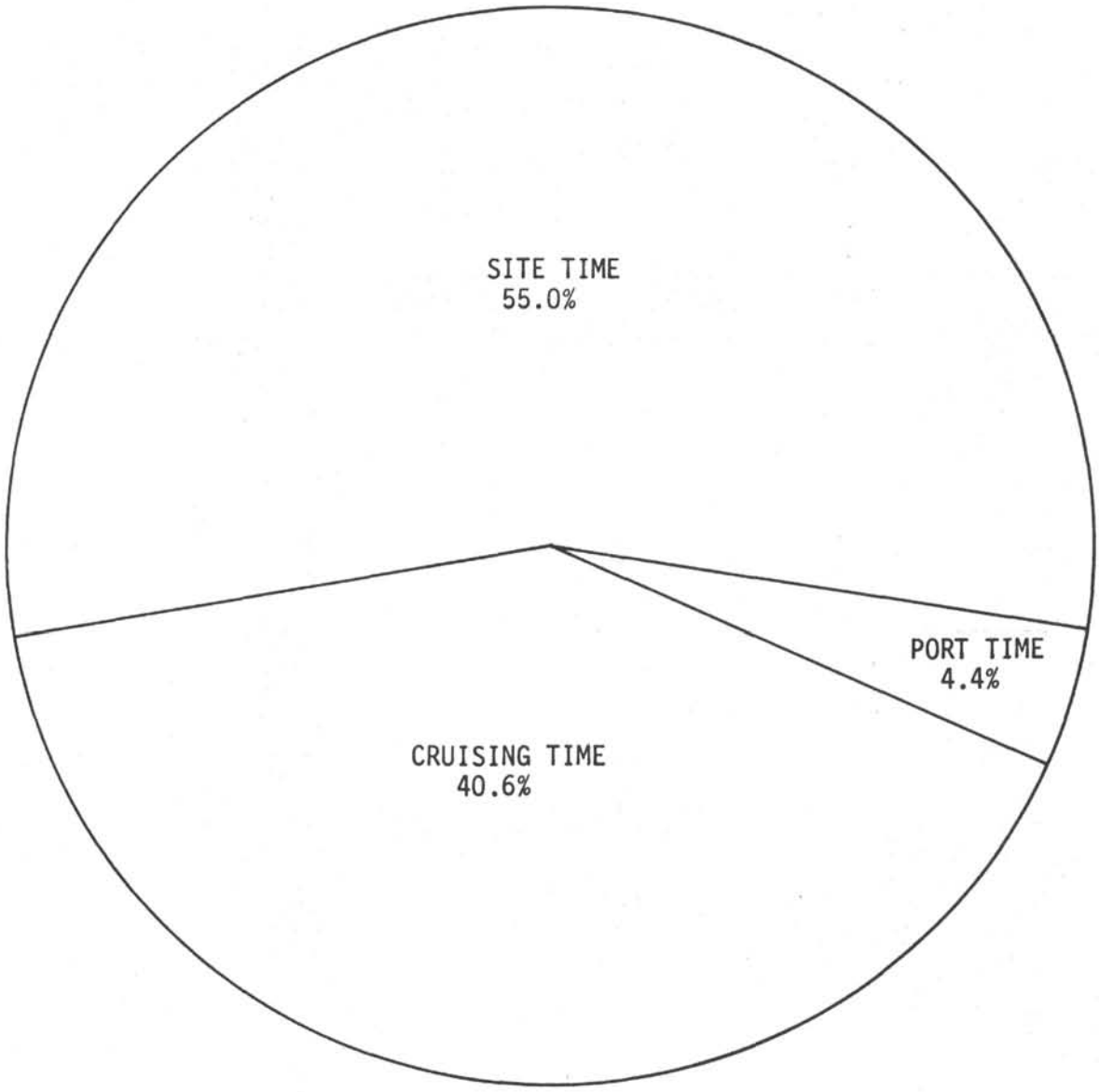

18481' El'brus
Europe's highest point
CASPIAN SEA
Teheran
int on earth's surface
PERSIAN GULF
ARABIAN PENINSULA
Mecca
225
226
227
228
RIFT VALLEY
229
230
Aden
GULF OF ADEN
SOCOTRA
SOMALI PENINSULA
Africa's highest point
Kilimanjaro
19340
Malindi
Mombasa
SOMALI BASIN
ZANZIBAR ISLAND
Salaam
SOMALI ABYSSAL PLAIN
OMEN FRACTURE ZONE
SEYCHELLES
2993
(8993)
MAHÉ ISLAND
AMIRANTE ISLES
CHAGOS ARCHIPELAGO
222
223
224
ARABIAN SEA
INDUS CONE
ARABIAN BASIN
221
220
219
MALDIVE ISLANDS
Karachi
GULF OF KUTCH
Indus
Bombay
CONTINENTAL SHELF
INDIA
New Delhi
Kozhikode
CEYLON
Colombo
8281
CEYLON ABYSS
CHAGOS TRENCH
A

DEEP SEA DRILLING PROJECT
LEG 23
ON-SITE TIME DISTRIBUTION



TOTAL TIME ON SITE: 30 DAYS, 19 1/2 HRS.
12 SITES - 14 HOLES

DEEP SEA DRILLING PROJECT
TOTAL TIME DISTRIBUTION
LEG 23



START LEG: 0420 GMT, 6 MARCH 1972
FINISH LEG: 1250 GMT, 1 MAY 1972
TOTAL TIME: 55 DAYS, 22 HOURS
TOTAL SITES: 12
TOTAL HOLES: 14

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 23

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	
219	ORE	13.5	159	77 1/2	Satisfactory.
220	ORE	16.0	128	0	Failed on shipboard test.
	ORE	16.0	134	33 1/2	Satisfactory.
221	ORE	13.5	147	0	Failed on launch.
	ORE	16.0	132	31 1/2	Satisfactory.
222	ORE	16.0	126	146 1/2	Satisfactory - Operated ship in manual mode.
223	ORE	13.5	165	30 1/2	Failed after 30 1/2 hours of operation.
	ORE	16.0	127	64 1/2	Satisfactory.
224	ORE	13.5	158	54 1/2	Satisfactory
225	ORE	13.5	208		Failed on shipboard test.
	ORE	16.0	182	43	Satisfactory.
226	ORE	13.5	207	32 1/2	Performance good.
227	ORE	13.5	205	76 1/2	Satisfactory.
228	ORE	16.0	188	57 1/2	Performance good.
229	ORE	16.0	189	35	Performance very good.
230	ORE	13.5	198	4	Failed after four hours.
	ORE	16.0	131	6 1/2	Performance good.

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 23

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
219	Smith	10-1/8 x 2-7/16	94CJS	HZ025	235	38	273	4.1	Excellent, T-1, B-1	For rerun.
219A	Smith	10-1/8 x 2-7/16	94CJS	HZ025	115	296	411	13.6	Excellent, T-1, B-1	For rerun.
220	Smith	10-1/8 x 2-7/16	93CJS 3 CTR	JK190	177	173	350	12	T-3, B-8, BT, OG	Worn out.
221	Smith	10-1/8 x 2-7/16	94CJS 4 CTR	HZ161	170	100	270	10.9	T-1, B-1	For rerun.
222	Smith	10-1/8 x 2-7/16	94CJS 4 CTR	HZ013	313	987	1300	59.4	T-3, B-7, BT, OG	Worn out.
223	Smith	10-1/8 x 2-7/16	93CJS 4 CTR	JK241	369	371	740	24:7	T-1, B-2	For rerun.
224	Smith	10-1/8 x 2-7/16	93CJS 4 CTR	JK241	99	693	792	22.8	T-1, B-5	Worn out.
225	Smith	10-1/8 x 2-7/16	94CJS	HZ025 RR	230	0	230	10.9	T-1, B-2	Good condition for rerun.
226	Smith	10-1/8 x 2-7/16	94CJS	HZ025 RR	14	0	14	0.3	Unknown	Lost in hole.
227	Smith	10-1/8 x 2-7/16	94CJS	HZ161 RR	344	15	359	31.7	T-1, B-2	For rerun.
228	Smith	10-1/8 x 2-7/16	93CJS	JK195	315	10	325	22.6	T-1, B-3	Took severe pounding.
229	Smith	10-1/8 x 2-7/16	94CJS	HZ488	33	75	108	2.	T-1, B-1	For rerun.
229A	Smith	10-1/8 x 2-7/16	94CJS	HZ488	162	50	212	4.4	T-1, B-1	For rerun.
230	Smith	10-1/8 x 2-7/16	94CJS	HZ488	18*	0	9	0.5	T-1, B-1	Good condition for rerun

* Cored Interval Twice

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 23

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
219	Smith	10-1/8 x 2-7/16	94CJS	HZ025	235	38	273	4.1	Excellent, T-1, B-1	For rerun.
219A	Smith	10-1/8 x 2-7/16	94CJS	HZ025	115	296	411	13.6	Excellent, T-1, B-1	For rerun.
220	Smith	10-1/8 x 2-7/16	93CJS 3 CTR	JK190	177	173	350	12	T-3, B-8, BT, OG	Worn out.
221	Smith	10-1/8 x 2-7/16	94CJS 4 CTR	HZ161	170	100	270	10.9	T-1, B-1	For rerun.
222	Smith	10-1/8 x 2-7/16	94CJS 4 CTR	HZ013	313	987	1300	59.4	T-3, B-7, BT, OG	Worn out.
223	Smith	10-1/8 x 2-7/16	93CJS 4 CTR	JK241	369	371	740	24.7	T-1, B-2	For rerun.
224	Smith	10-1/8 x 2-7/16	93CJS 4 CTR	JK241	99	693	792	22.8	T-1, B-5	Worn out.
225	Smith	10-1/8 x 2-7/16	94CJS	HZ025 RR	230	0	230	10.9	T-1, B-2	Good condition for rerun.
226	Smith	10-1/8 x 2-7/16	94CJS	HZ025 RR	14	0	14	0.3	Unknown	Lost in hole.
227	Smith	10-1/8 x 2-7/16	94CJS	HZ161 RR	344	15	359	31.7	T-1, B-2	For rerun.
228	Smith	10-1/8 x 2-7/16	93CJS	JK195	315	10	325	22.6	T-1, B-3	Took severe pounding.
229	Smith	10-1/8 x 2-7/16	94CJS	HZ488	33	75	108	2.	T-1, B-1	For rerun.
229A	Smith	10-1/8 x 2-7/16	94CJS	HZ488	162	50	212	4.4	T-1, B-1	For rerun.
230	Smith	10-1/8 x 2-7/16	94CJS	HZ488	18*	0	9	0.5	T-1, B-1	Good condition for rerun

* Cored Interval Twice

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 23

Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent Recovered	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet. Meters	Total Depth Meters	Coring Rate M/Hr.	Drilling Rate M/Hr.
Laccadive - Chagos Ridge														
219	09° 01.75'N	72° 52.67'E	1779	27	27	100	235	172.5	73.4	38	273	2052	50.2	211.1
219A	09° 01.75'N	72° 52.67'E	1779	14	13	92.8	115	50.6	44.0	296	411	2190	13.0	63.4
Plateau - West of Maldives														
220	06° 30.97'N	70° 59.02'E	4043	21	21	100	177	100.9	57.0	173	350	4393	17.9	140.7
Distal End Arabian, Abyssal Plain														
221	07° 59.18'N	68° 24.37'E	4679	19	19	100	170	76.6	45.0	100	270	4949	17.1	102.0
East Side, Owen Fracture Zone														
222	20° 05.49'N	61° 30.56'E	3570	36	36	100	313	175.6	56.1	987	1300	4870	15.8	25.9
West Side, Owen Fracture Zone														
223	18° 44.98'N	60° 07.78'E	3654	41	41	100	369	203.7	55.2	371	740	4394	20.6	62.9
224	16° 32.51'N	59° 42.10'E	2523	11	11	100	99	30.9	31.2	693	792	3315	17.9	39.8
Near Axial Valley, Red Sea														
225	21° 18.58'N	38° 15.11E	1240	29	29	100	230	137.5	59.8	0	230	1470	11.3	N/A
Hot Brine Area														
226	21° 20.51'N	38° 04.93'E	2208	2	2	100	14	8.9	63.5	0	14	2222	42.4	N/A
Near Axial Valley, Red Sea														
227	21° 19.86'N	38° 07.97'E	1821	45	45	100	344	123.5	35.9	15	359	2180	10.9	180.0

Site Summary (Continued)
Leg 2

Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent Recovered	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet. Meters	Total Depth Meters	Coring Rate M/Hr.	Drilling Rate M/Hr.
West Side of Red Sea														
226	19° 05.16'N	39° 00.20'E	1055	39	39	100	315	184.7	58.6	10	325	1380	14.3	142.8
South of Zubayir Island														
229	14° 46.09'N	42° 11.47'E	861	4	4	100	33	29.1	88.2	75	108	969	30.0	80.6
229A	14° 46.09'N	42° 11.47'E	861	18	17	94.4	162	119	73.5	50	212	1073	40.5	142.9
West Side of Axial Valley, North of Zubayir Island														
230	15° 19.00'N	41° 50.05'E	851	2	2	100	18*	13.4	74.4	0	9	860	30.0	N/A
		Totals		308	306	99.4	2594	1426.9	55.0	2808	5393			

* Interval Cored Twice

DEEP SEA DRILLING PROJECT
OPERATIONS REPORT
LEG 24

SUMMARY

Leg 24 of the Deep Sea Drilling Project commenced on May 1, 1972 in Djibouti, F.T.A.I., and proceeded south through the western Indian Ocean and terminated in Port Louis, Mauritius on June 26, 1972.

During this period the "Glomar Challenger" cruised 5435.9 nautical miles, drilled 11 holes at 8 sites, cored 3194 meters in 349 coring attempts, recovered 1994.1 meters (62.4%) of core, and drilled 1259.5 meters for a total sub-bottom penetration of 4,453.5 meters.

Significant operational accomplishments of Leg XXIV included:

1. More intervals cored than any previous Leg, 3194 meters.
2. Most cores attempted, 349.
3. The most core recovered, 1994.1 meters.
4. The deepest penetration into basement, 80.5 meters on Site 238. The 40.6 meters of basalt recovered was the most from one hole.
5. The 62.4% recovery ranks second to Leg XVI on core recovery since the introduction of the roller insert bit.
6. A total of 163 meters of basement was cored and 74.1 meters was recovered.
7. No tools were lost.
8. A total of 4 new bits and 2 used bits were used.

Two unscheduled stops were made. The first stop was in the Seychelles on June 2 to put one member of the scientific staff ashore to return to the states because of illness. In addition a GMI computer technician came aboard to train for Leg XXV. The second stop was on June 13 while in route to Site 238. The course was altered to proceed toward Diego Garcia and a GMI drilling supervisor debarked the "Glomar Challenger" at Diego Garcia to return to the states for medical treatment. A total of approximately five days were lost on the two stops.

The weather and sea conditions were mostly a result of the trade winds. On the last two

sites strong winds did affect the drilling program. On Site 237 the wind increased to 30 miles per hour and required the ship to maintain a wind heading. This resulted in drilling with the ship rolling 5° to 10°.

DRILLING AND CORING

The first three sites were in the Gulf of Aden and the geologic section were all quite similar for the first 150 meters, soft unconsolidated clays turning to a stiff clay with depth. Recovery was good on the Gulf of Aden sites and drilling difficulties were minimal.

The next site, #234, located in the Somoli basin, was drilled in 4738 meters of water. The first 10 cores were in a soft sticky clay. At 4900 meters, there was a noticeable increase in both the drill pipe torque and pump pressure. At 4937 meters, the drill string was sticking on all connections or any time the hole was not being pumped. Thirty barrels of mud was then circulated, but no improvements in hole conditions resulted. After freeing the drill string a number of times, the hole was abandoned at 4985 meters. Apparently the clay swelled when it encountered sea water and caused the bottom hole assembly to ball up. This Site 234 was the only site abandoned because of bad hole conditions.

The weather did have some effect on the last two sites. On Site 237, chert stringers embedded in chalk were encountered at 300 meters. At 400 meters, the chalk had turned to limestone. While penetrating these chert zones, the ship had a roll of 4° to 10° caused by the wind and swell conditions. The 20 to 25 knot wind was too much for the thrusters to maintain position properly and the ship had to maintain a wind heading regardless of the seas. The problem was aggravated by below normal thruster RPM, which is being investigated by GMI. The site was eventually abandoned without reaching basement because of a locked bit (which can be probably traced to a lack of constant weight).

Site 238 was probably the most successful site of Leg 24 from an operational standpoint. The site was continuously cored for 586.5 meters with an overall recovery of 72.3%. Basement was cored from 506 meters to TD at 586.5 meters. The 80.5 meters represents the deepest penetration into basement since the Project began and the recovery of 40.6 meters of basalt was the most basement recovered from any hole to date. While drilling this site, the ship had from 4° to 10° roll and 3° pitch, however, these rolls and pitch were not constant. The bow thrusters had been adjusted before spudding in the site and a heading was maintained into the seas throughout the site. With no chert, hard sand, or limestone above basement, the chances of sticking the drill string were minimized. Some sloughing of basalt fragments did require a slugs of drilling mud to keep the hole clean. Approximately 20 barrels of mud was circulated for each 9.5 meters of hole cored. The bumper subs remained free and absorbed most of the ship motion. Drilling was terminated after 80.5 meters of basement had been penetrated because the bit had locked. There is little doubt that the bits now being used can penetrate a 100 meters or more into basement if conditions are right, i.e. constant weight maintained along with stable hole conditions.

Sites 232A, 233A and 234A had to be drilled because of minor tool failures. On Site 232A,

a drift indicator was installed in the sinker bars to study the problem of hole deviation. The first picture was made on core number 14 at 126 meters, the hole was 6-1/4° off vertical. The second picture was made on core number 19 at 173.5 meters. While retrieving the core barrel the instrument case parted, dropping the core barrel. A round trip was required to retrieve the core barrel, hole 232A was then drilled into basement.

On Site 233, the fishing neck on the Hycalog core barrel latch broke while retrieving core number 19. A round trip with the drill pipe was required to recover the core barrel. Then Site 233A was drilled and basement was cored from 235 meters to 270.5 meters; of this 35.5 meters cored only 2.5 meters were recovered. Cores number 10 and 11 had no recovery. A center bit was pumped down to dislodge anything that might be preventing the core barrel from seating. Cores 12 and 13 produced no recovery. The hole was abandoned and after the drill string was recovered one meter of core was found wedged in the support bearing which was preventing the inner core barrel from seating.

Site 234A was drilled to about the same depth as Site 234 when it became apparent that the montmorillonite clay mentioned above could not be drilled using sea water as a drilling fluid because of the "balling up" and sticking of the bottom hole assembly. Hole 234A was abandoned.

DRILLING AND CORING TOOLS

The routine inspection of the bottom hole assembly, handling tools, and coring tools prevented a bottom hole assembly failure. All bumper subs were disassembled and magnafluxed. A Baash-Ross bumper sub was found to have cracks in the body around 75% of the mud slots and the thread end of the spline was cracked at the second thread. In addition, another failure was prevented by routine inspection when a crack was detected in the fishing neck of a Hycalog core barrel latch.

Drilling was suspended on Site 237 when the bit locked. The last core was not recovered until the drill pipe was on board. The core barrel would not release. A bolt in the Hycalog core barrel latch had vibrated loose. To prevent this on future holes the bolt head was welded in place.

The check valve retainer in the top of the inner core barrel would consistently vibrate loose and would be found on top of the core. On almost every core while penetrating basalt or chert this would happen. To prevent a reoccurence of this problem the check valve was stuck in place with an epoxy (Baker lock).

DYNAMIC POSITIONING EQUIPMENT

Through Site 234 the weather was good and the positioning was with $\pm$ 80 feet. On Site 235, the vertical gyro failed and caused the screws to function erratically. The ship would over position in both the + and y axis. The gyro was replaced and again the positioning was normal.

On Site 236 there was a loss of power to all the positioning system except the computer. The result was the loss of accoustics and no visual display of position on the bridge. Without power to the bridge the ship drifted for 5 minutes. However, during this time the ship drifted off station only 40 ft. What actually caused the power failure was never determined. There was no reoccurence of this problem on the remainder of the Leg.

Positioning did create drilling difficulties on Site 237. The lack of thruster RPM on both bow thrusters necessitated a wind heading at all times. This resulted in the ship taking 4° to 10° rolls and 3° pitch. The results were a locked bit before the desired depth was achieved.

Before Site 238 was spudded, the bow thruster electrical control circuits were adjusted. Some mechanical problems were located and corrected on the caterpiller engines that drive the bow thrusters. Site 238 was drilled with the same wind and sea conditions that existed on Site 237. The 420 RPM on the bow thrusters was sufficient to maintain a heading into the swells and thrust against the wind. The low thruster RPM was attributed to the inability of obtaining designed horsepower from the engines.

BEACONS

Eight beacons were used on the 8 sites investigated. All beacons were pre-tested before being dropped. There were no beacon failures.

1	Burnett 16 kHz
1	Burnett 13.5 kHz
3	ORE 13.5 kHz
3	ORE 16 kHz

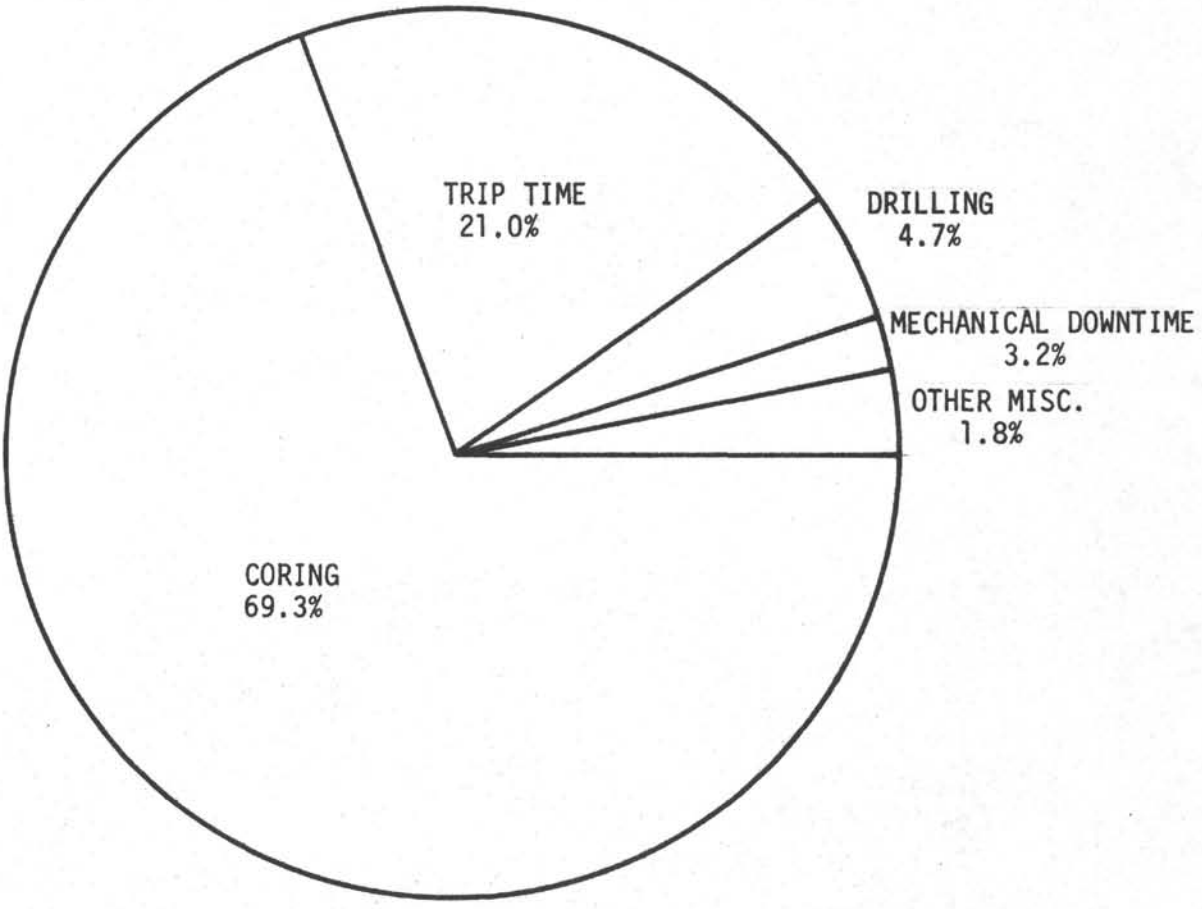
CREW

Crews' performance again was outstanding.

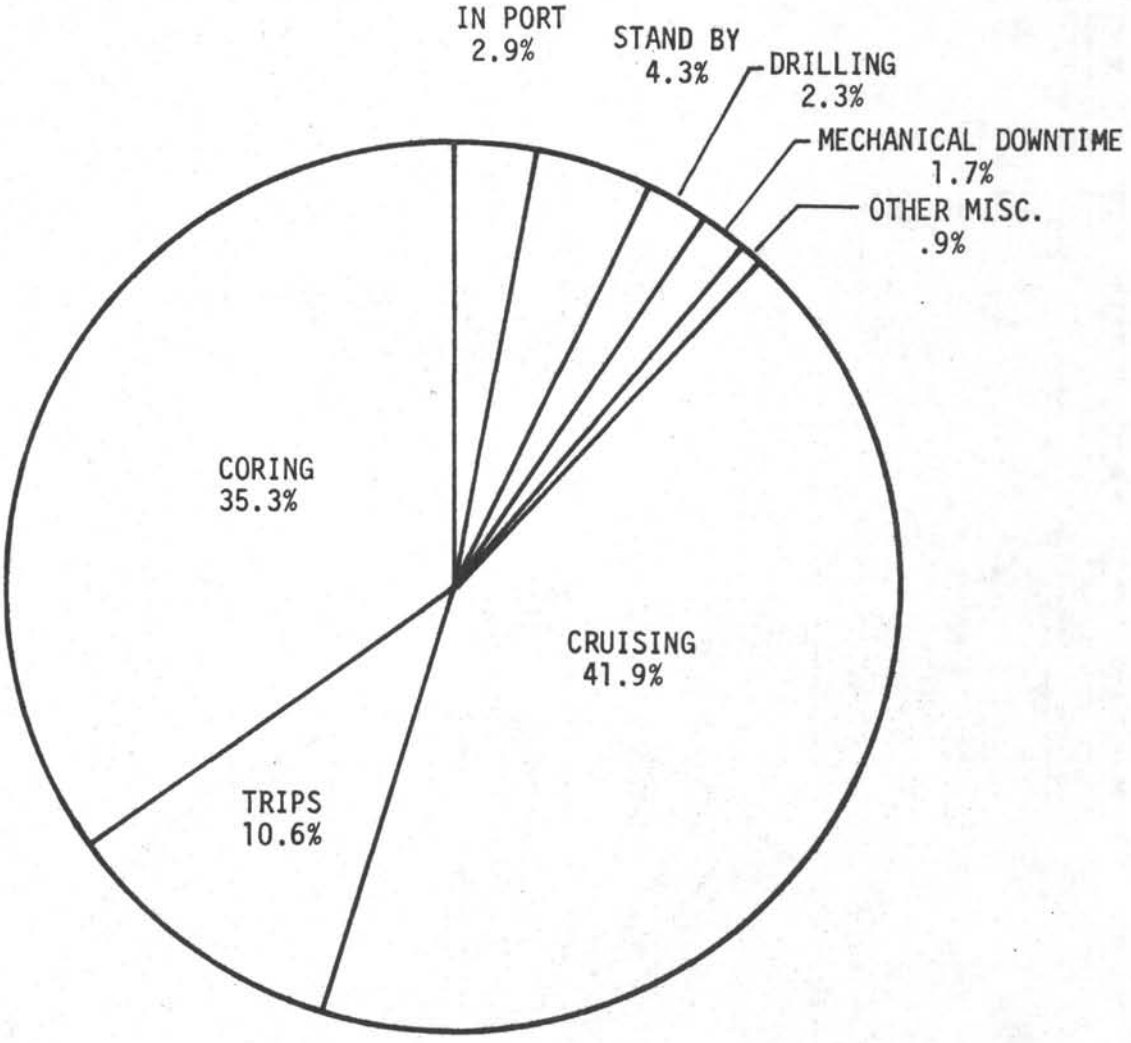
DEEP SEA DRILLING PROJECT
SUMMARY OF OPERATIONS
LEG 24

Total Days Leg	55 days 15 hrs.
Total Days in Port	1.66
Total Days Standby	2.41
Cruising Time	23.27
Trip Time	5.92
Drilling Time	1.32
Coring Time	19.63
Mechanical Downtime	.93
Other Miscellaneous Time	.49
Total Distance Traveled (Nautical Miles)	5435.9
Average Speed (Knots)	8.92
Sites Drilled	8
Holes Drilled	11
Number of Cores Attempted	349
Number of Cores Recovered	337
Percent of Cores With Recovery	96
Total Meters Cored -- 10,478'	3194
Total Meters Recovered -- 6,542'	1994.1
Percent Recovery	62.4
Meters Drilled -- 4,132'	1259.5
Total Penetration -- 14,611'	4453.5
Percent of Penetration Cored	71.7
Maximum Penetration -- 2,275'	693.5
Minimum Penetration -- 569'	173.5
Average Penetration per Hole -- 1,325'	404

DEEP SEA DRILLING PROJECT
LEG XXIV
ON-SITE TIME BREAKDOWN



DEEP SEA DRILLING PROJECT
LEG XXIV
LEG TIME BREAKDOWN



STAND BY TIME IS AT ANCHOR IN
THE SEYCHELLES AND DIEGO GARCIA.

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 24

Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent of Cores With Recovery	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet. Meters	Avg. Rate Penet.	Time On Hole	Time On Site
Gulf of Aden "Half Degree Square"														
231			2161	64	64	100	584.0	424.9	72.8	----	584.0	46	95.50	95.50
West Side of Alula-Fartak Trench														
232	14°28.93'N	51°54.87'E	1757.5	19	19	100	173.5	126.7	73.0	----	173.5	30	27.75	73.50
232A	275' Off Set N.W.		1753	30	28	93.3	275.0	125.2	45.5	159	434.0	44	45.75	
East Side of Alula-Fartak Trench														
233	14°19.68'N	52°08.11'E	1859.5	19	19	100	176.0	135.3	76.9	----	176.0	41	26.00	----
233A	14°19.68'N	52°08.11'E	1858	13	9	69	102.5	37.3	34.4	168	270.5	28	32.50	58.50
Chain Ridge														
234	04°28.95'N	51°13.48'E	4738	15	15	100	142.5	90.1	63.2	104.5	247.0	52	37.50	----
234A	04°28.95'N	51°13.48'E	4738	1	1	100	9.5	1.4	14.7	267.5	277.0	92	22.50	60.00
West Of Chain Ridge														
235	03°14.06'N	52°41.64'E	5146	20	19	95	190.0	98.1	51.6	494.0	684.0	29	96.25	96.25
Somali Basin North of Seychelles														
236	01°40.68'S	57°38.85'E	4504	37	37	100	327.5	218.5	66.7	----	327.5	54	93.25	93.25
Mascorene Plateau														
237	07°04.99'S	58°07.48'E	1640	67	63	94	627.0	312.1	49.8	66.5	693.5	25	93.50	93.50

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 24

Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent of Cores With Recovery	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet. Meters	Avg. Rate Penet.	Time On Hole	Time On Site
North End of Argo Fracture Zone														
235	11°09.21'S	70°31.56'E	2844.5	64	63	98	586.5	424.5	72.3	----	586.5	16.5	111.00	111.00
	Totals			349	337	96	3194.0	1994.1	62.4	1259.5	4453.5	26.3	681.25	681.25
Minimum				1	0	69	9.5	1.4	14.7	0	173.5	16.5	26	58.5
Average				31.7	30.6	96	290.3	181.2	62.4	114.5	404	26.3	61.9	85.1
Maximum				67	64	100	627	424.9	76.9	494	693.5	92	111.00	111.00

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 24

(Cored 163 m of basalt, recovered 74.1 m)

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
Rerun From Site 230										
231	Smith	10-1/8	94CJS	HZ488	584.0	----	584.0	26.75	T1-B2-Gage	Cut 17.5 m of basalt & recovered 7.5 m
232	Smith	10-1/8	94CJS	HZ488	173.5	----	173.5	5.73		
232A	Smith	10-1/8	94CJS	HZ488	275	159.0	434.0	9.90	T5-B5-Gage	Cut 10m VH sand
					1032.5	159.0	1191.5	42.38		
Rerun From Site 227										
233	Smith	10-1/8	94CJS	HZ161	176.0	----	176.0	4.25		
233A	Smith	10-1/8	94CJS	HZ161	102.5	168.0	270.5	9.60	T2-B5-Gage	Cut 11 m of basalt & recovered 2.6
					278.5	168.0	446.5	13.85		
234	Smith	10-1/8	94CJS	HZ250	142.5	104.5	247.0	4.80		
234A	Smith	10-1/8	94CJS	HZ250	9.5	267.5	277.0	3.00	T1-B1-Gage	Drilling in clay
235	Smith	10-1/8	94CJS	HZ250	190.0	494.0	684.0	22.90	T3-B5-Gage	Cut 32.5 m of basalt & recovered 12.5 m
					342.0	866.0	1208	30.70		
236	Smith	10-1/8	94C	HC754	327.5	----	327.5	19.50	T2-B7-UG	Cut 21.5 m of basalt & recovered 10.6 m
237	Smith	10-1/8	94CJS	JZ254	627.0	66.5	693.5	27.40	T3-B7-Gage	Cut 214 m of chert & L.S.
238	Smith	10-1/8	94CJS	JZ251	586.5	----	586.5	32.50	T3-B7-3/4"UG	Cored 80.5 m of basalt recovered 40.6 m

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 24

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	Remarks
231	Burnett	16	3	95.50	Strong signal. Dropped dead in water.
232	Burnett	13.5	2	73.50	Strong signal. Dropped dead in water.
233	ORE	13.5	164	58.50	Good signal. Dropped at 4 knots.
234	ORE	16	174	60.00	Good signal. Dropped at 4 knots.
235	ORE	13.5	191	96.25	Good signal. Dropped on the run.
236	ORE	16	173	93.25	Good signal. Dropped still in water.
237	ORE	13.5	194	94.50	Good signal. Dropped still in water.
238	ORE	16	171	111.00	Good signal. Dropped at 4 knots.

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG 24

Date	Site Number	Cruise	Trips	Drill	Core	Stuck Pipe	Mechanical Down Time	In Port Time	Standby	Other	Total Time
5-1-72	In Port							8.50			8.50
5-2-72								24.00			24.00
5-3-72								7.50			7.50
Total								40.00			40.00
5-3-72	231	16.50									16.50
5-4-72	231	23.00	1.00								24.00
5-5-72	231		7.25		16.75						24.00
5-6-72	231				24.00						24.00
5-7-72	231				24.00						24.00
5-8-72			6.75		14.00					1.75	22.50
Total		39.50	15.00		78.75					1.75	135.00
5-8-72	232	1.50									1.50
5-9-72	232	23.00									23.00
5-10-72	232	19.50	4.50								24.00
5-11-72			4.25		19.00						23.25
Total		44.00	8.75		19.00						71.75
5-11-72	232A		.75								.75
5-12-72	232A		5.25	1.75	14.75		2.25				24.00
5-13-72	232A		5.00		16.00						21.00
Total			11.00	1.75	30.75		2.25				75
5-13-72	233	3.00									3.00
5-14-72			7.00		15.00					2.00	24.00
5-15-72			2.00							(fishing)	2.00
Total		3.00	9.00		15.00					2.00	29.00

Time Distribution - Leg 24 (Continued)

Date	Site Number	Cruise	Trips	Drill	Core	Stuck Pipe	Mechanical Down Time	In Port Time	Standby	Other	Total Time
5-15-72	233A		5.25		16.75						22.00
5-16-72	233A		4.75		5.75						10.50
Total			10.00		22.50						32.50
5-16-72	234	13.50									13.50
5-17-72	234	24.00									24.00
5-18-72	234	24.00									24.00
5-19-72	234	14.50	9.00		.50						24.00
5-20-72	234			3.25	20.75						24.00
5-21-72	234		1.75		1.25					1.00 (work pipe)	4.00
Total		76.00	10.75	3.25	22.50					1.00	113.50
5-21-72	234A		10.00	5.75	1.25		1.50 (positioning)				18.50
5-21-72	235	1.50									1.50
5-22-72	235	15.50	8.50								24.00
5-23-72	235		3.75	3.00	17.25						24.00
5-24-72	235			11.00	10.50					2.50 (sand line)	24.00
5-25-72	235			4.00	20.00						24.00
5-26-72	235		10.50		.75					4.50 (severing tool)	15.75
Total		17.00	22.75	18.00	48.50					7.00	113.25
5-26-72	236	8.25									8.25
5-27-72	236	24.00									24.00
5-28-72	236	13.25	6.75				4.00				24.00
5-29-72	236		1.75		19.00		3.25				24.00
5-30-72	236				24.00						24.00
5-31-72	236				24.00						24.00
6-1-72	236		10.50								10.50
Total		45.50	19.00		67.00		7.25				138.75

Time Distribution - Leg 24 (Continued)

Date	Site Number	Cruise	Trips	Drill	Core	Stuck Pipe	Mechanical Down Time	In Port Time	Standby	Other	Total Time
6-1-72	Seychelles	13.50									13.50
6-2-72	Seychelles	13.50							10.50		24.00
6-3-72	Seychelles								24.00		24.00
6-4-72	Seychelles								22.00		22.00
Total		27.00							56.50		83.50
6-4-72	237	2.00									2.00
6-5-72	237	23.75	.25								24.00
6-6-72	237		5.50		18.50						24.00
6-7-72	237				23.25		.75				24.00
6-8-72	237			1.50	22.50						24.00
6-9-72	237		6.50	1.50	7.50		6.75				22.25
Total		25.75	12.25	3.00	71.75		7.50				120.25
6-9-72	238	1.75									1.75
6-10-72	238	24.00									24.00
6-11-72	238	24.00									24.00
6-12-72	238	24.00									24.00
6-13-72	238	11.00									11.00
Total		84.75									84.75
6-13-72	Diego Garcia	13.00									13.00
6-14-72	Diego Garcia	24.00									24.00
6-15-72	Diego Garcia	5.50					.50		1.50		7.50
Total		42.50					.50		1.50		44.50
6-15-72	238	16.50									16.50
6-16-72	238	20.25	2.75				1.00				24.00
6-17-72	238		4.25		18.75		1.00				24.00
6-18-72	238				24.00						24.00
6-19-72	238				24.00						24.00
6-20-72	238				24.00						24.00
6-21-72	238		6.50		3.25		1.50				11.25
Total		36.75	13.50		94.00		3.50				147.75

Time Distribution - Leg 24 (Continued)

Date	Site Number	Cruise	Trips	Drill	Core	Stuck Pipe	Mechanical Down Time	In Port Time	Standby	Other	Total Time
6-21-72	Mauritius	12.75									12.75
6-22-72		24.00									24.00
6-23-72		24.00									24.00
6-24-72		24.00									24.00
6-25-72		24.00									24.00
6-26-72		08:00									08:00
		116.75									116.75
TOTALS		558.5	142.00	31.75	471.00		22.50	40.00	58.00	11.75	1335.50 (55.64 days)

DEEP SEA DRILLING PROJECT
OPERATIONS REPORT
LEG 25

SUMMARY

Leg 25 of the Deep Sea Drilling Project started on June 26, 1972 at the Island of Mauritius. Holes were drilled in various basins and ridges in the West Indian Ocean and the leg was completed 57.1 days later on August 22, 1972 at Durban, South Africa. The Challenger traveled 5,408 miles and drilled 13 holes at 11 sites. Water depths of the drill sites ranged from 944 meters to 5082 meters and averaged 3685 meters (approximately 12,000 feet).

A total of 4253 meters of ocean sediments were penetrated, of which 33% were cored. Drilling depths ranged from 26 to 1174 meters (3,820 feet). The average hole program consisted of taking four cores per 100 meters, with usable recovery obtained on 88% of the 171 cores attempted and total recovery of 57%. No hydrocarbons or gas shows were encountered.

Distribution for the 57.1 days total leg time was 46.3% site time, 49.2% cruising time and 4.5% port time (Fig. I). Total site time of 26.4 days was divided into 17.7% coring, 13.8% drilling, 59.4% trips and 9.1% other (Fig.II). Three of the 13 holes were abandoned soon after spudding and a fourth, after 200 meters of drilling, due to sediment instability and/or excessive hardness at a shallow depth.

Stormy weather was not a major factor on Leg 25 but did cause cancellation of an intermediate hole between Holes 245 and 246. The major problem of this leg was having to position the vessel in confused seas. Nine of the 13 holes were plagued with the sea, wind, swell and/or current from different directions, thus precluding ideal positioning of the vessel and resulting in operations hampered by vessel motion. At one site (Hole 248) a 4-5 knot current was experienced from one direction while swell trains came from three other directions. Understandably, the vessel positioning system was given a severe test during this leg and responded admirably with marginal results arising only at Hole 248. It was noted, however, that even though no major operating problems resulted, frequent attention was required of one or two components of the system.

Downtime due to equipment failure was at a minimum. Loss or damage to bottom hole assemblies was limited to a core barrel, float sub and bit lost at Hole 244 and a bent bumper sub at Hole 247.

The Challenger was almost called upon to perform an act of mercy for a British vessel in which an explosion had disabled the ship and injured several personnel. Through the Amvers system, however, a closer vessel was located and dispatched.

DRILLING AND CORING

The bottom hole assembly used on Leg 25 was the same for all holes and consisted of the following: core bit, float sub, 8-1/4" core barrel, three 8-1/4" drill collars, two Baash Ross bumper subs, three 8-1/4" drill collars, two Baash Ross bumper subs, one 8-1/4" drill collar, one 7-1/4" drill collar, and a joint of 5-1/2", 26 lb/ft drill pipe.

All drill pipe was inspected by Tuboscope while the Challenger was in Port Louis, Mauritius and 58 questionable joints were found. These joints were broken out of the string at the first site and set aside for a more detailed inspection while cruising. Later they were cleaned internally, visually inspected by a Borescope tool, and pit depths determined sonically. Eleven joints were rejected as below acceptable standards. The S-135 pipe is to be admired for its durability and excellent service record during the past several years of severe tension, torsion, and bending loads in a salt water environment.

Scientific objectives of Leg 25 were primarily accomplished at nine of the 13 holes drilled. Objectives were generally sediment sampling and sampling of either basement or prominent sonic reflectors. Three holes were abandoned due primarily to instability shortly after spudding and one hole after 200 meters of drilling. As with other legs, correlation between PDR depths and drill pipe measurements was somewhat of a problem, but can probably be better described as giving one a feeling of apprehension when spudding by not knowing the precise depth at which bottom would be found. At nine sites, drill pipe measurements were "deeper" than the PDR measurements (range 2-43 meters), at one site they were the same, and at one site pipe measurements were "shallower" by two meters. The largest discrepancy of 43 meters occurred at Hole 244 located on the slope of the Zambezi Canyon. At this site, PDR records were quite difficult to interpret due to apparent phantom reflections from the slope. Additionally, at a few sites, precise measurements were made more difficult when vessel movement occurred and soft bottom sediments were present.

The largest factor governing percentage core recovery for Leg 25 was, generally, the sediment being cored with the sands and silty clays being particularly difficult due to their abrasive and unconsolidated nature. Recovery ranged from a low of 9% at Hole 240A to a high of 78% at Hole 249 and averaged 56.7%.

Bits used included both 3 and 4 cutter, non-sealed and sealed bearing types. Core throat segments on several bits were bent when drilling the harder sediments and need strengthening to prevent cutter interference. A heave compensation device would have been a most welcome addition to the Challenger for eliminating those sudden bit shock loads due to vessel motion and should result in increased core recovery. A graphic plot of

Penetration Rates vs Penetrated Depth for the various holes of Leg 25, indicate both increased penetration rates and longer bit life for the sealed bearing type of bit. Intuitively, we feel this to be correct but the graphs were not scientifically valid and the various drilling parameters were not thoroughly analyzed. Preliminary work of Penetration Rate vs Sediment Sonic Velocity was initiated but not enough data are available at this time to draw any conclusions.

A brief resume of each hole is given in the following paragraphs.

Hole 239 (326 meters). Sediments of silty clay, ooze, brown clay and basalt. Seas moderate but confused, causing occasional 10° roll. Inclinometer readings taken. Average coring rate 14 meters/hour.

Hole 240 (195 meters). Sediments of ooze, silty clay, sands and basalt. Seas moderate but confused. Wind and swell in one direction and 1.5 knot current in another induced undesirable but tolerable roll. Inclinometer readings taken. Average coring rate 7.6 meters/hour.

Hole 240A (202 meters). Hole spudded to sample sediments missed in Hole 240. Same formations. Poor recovery due to unconsolidated sediments and extremely poor bit condition from drilling on basalt in Hole 240.

Hole 241 (1174 meters). Deepest penetration on Leg 25. Sediments of ooze, shale, mudstone, and sandstone. Stuck pipe due to heaving shale, but freed all right. 856 barrels mud used for hole stabilization. Moderate but confused seas with long period swells during last two days. Average coring rate 14 meters/hour.

Hole 242 (676 meters). Sediments of nanno ooze and chalk. Seas moderate but confused with wind and current 45° apart resulting in positioning problems. First heat flow measurements taken. Also, inclinometer readings were taken. Beacon malfunction with replacement beacon landing 800 feet from site. Hole abandoned after objectives primarily reached. Low penetration rates from bit balling during latter stages of drilling. Average coring rate 8 meters/hour.

Hole 243 Hole abandoned shortly after spudding due to instability of unconsolidated sand and fine loose gravel (Zambezi Canyon). Seas calm. Moved three miles to Hole 244 with drill pipe suspended above mudline.

Hole 244 Hole abandoned shortly after spudding due to instability of clay and pebbly sands. PDR difficult to interpret due to phantom reflections. Bit and core barrel lost in hole.

Hole 245 (396.5 meters). Sediments of clay, chalk and basalt. Swell in different direction than wind and seas. 50 mph gusts in varying direction required constant heading changes and positioning problems with regular rolls of 4-5 degrees. Beacon malfunction with replacement landing 600 feet from site. Semi-automatic operation used with alternate shifting between two beacons due to poor reception from both. Changed brake bands. Inclinometer readings taken. Average coring rate 9 meters/hours.

Hole 245A (149 meters). Hole intended for cores missed in Hole 245. Sediments of silty clay and ooze. Average coring rate 53 meters/hour.

Hole 246 (203 meters). Sediments of ooze, calcareous sand, and glauconite sand. Poor core recovery due to unconsolidated sediments. Hole instability caused abandonment prior to accomplishing all objectives. Seas calm. Average coring rate 24 meters/hour.

Hole 247 (26 meters). Hole abandoned shortly after spudding due to inability to penetrate hard sediment with 10-20,000 pound weight. One bumper sub bent. Moderate seas.

Hole 248 (434 meters). Sediments of ooze, clay, sand, and basalt. Swells from three directions and a 4 knot current from a fourth. Manual positioning required due to malfunctioning computer and vertical reference gyro. Thruster "wash" interferred with signal to hydrophones. Vessel drift raised drill pipe and gave false indications of drilling "break". Vessel position offset required to reduce drill pipe - horn rubbing. Hole required 430 barrels mud for stabilization. Head flow and inclinometer readings taken. Average coring rate 26 meters/hour.

Hole 249 (412 meters). Sediments of ooze, chalk, siltstone, ash, limestone, and adesite. Manual positioning good in calm seas. Heat flow and inclinometer readings taken. Average coring rate 22 meters/hour.

HEAT FLOW MEASUREMENTS

The number of heat flow measurements possible on Leg 25 was limited. The instrument was not available for service until the fifth hole for reasons outlined below. Of the nine holes available for possible measurements, only three could be utilized. Three holes were abandoned shortly after spudding, another after encountering sand at 203 meters, and two holes were unavailable due to inclement weather and resultant vessel motion. On those holes where measurements were taken (Nos. 242, 248 and 249), acceptable data were obtained.

Originally, it was planned to utilize the new style heat flow instrument package which is run as part of a regular inner core barrel and does not require special wireline runs. Unfortunately, the electronics package for the new instrument was not available at the time of departure. The older model heat flow equipment then had to be prepared for service and consequently, was not available until Hole 242.

Running procedure for the older model heat flow instrument requires locking the instrument into an inner barrel with the core catcher dogs (to prevent downward travel) and a pipe spacer with baffle plate installed above the instrument (to prevent upward travel). The inner barrel is lowered to the bit by wireline and locked into the outer barrel. The bit is then lowered to bottom and approximately 10,000 pounds bit weight maintained during periods of temperature recording. Maximum time delay for the instrument prior to initiation of temperature recordings was 25 minutes. This posed no problem for shallower water depths but in deeper waters of 5000 meters, temperatures recordings were initiated prior to the instrument being inserted into the formation. This situation was not entirely without merit as it did allow bottom water temperatures to be recorded and provided another point on the buildup curve for heat flow data.

Heat flow equipment functioned satisfactorily except on the initial run in Hole 242, where the bottom lock assembly (aluminum sleeve with steel washer on top) was lost above the bit. Fortunately, the steel washer was recovered as a portion of the succeeding core after an inner barrel with center bit had been run in an attempt to push the junk through the bit.

INCLINOMETER MEASUREMENTS

Inclinometer measurements (hole drift) were taken as conditions permitted and were made in six of the 13 holes. The two readings on each target normally varied by several degrees and required averaging except in those cases where drill pipe motion was negligible, which occurred only once. Although these measurements are satisfactory as approximate indicators, precise measurements would require some means of immobilizing the drill string, such as a heave compensating device.

Measurements were taken by using either the instrument in a regular inner barrel with readings taken just prior to a regular core (thereby sacrificing approximately one meter of core for instrument space) or taking readings simultaneously with heat flow measurements. In the latter case, the inclinometer was installed in the top portion of the same core barrel containing the heat flow instrument. Although either method is acceptable, readings taken just prior to cutting a core are more desirable from an efficiency standpoint if a one meter loss of core is not considered excessive. It does, however, have the disadvantage of providing a target that is "scuffed" from apparent contact with the plump bob, making it more difficult to read. Additional work will be required to reduce or eliminate this particular undesirable feature.

BEACONS

A total of 13 ORE beacons were used with frequencies and beacon life as indicated below:

Frequency (kHz)	Rated Life (Days)	No. Used
13.5	6	3
13.5	12	4
16.0	6	3
16.0	12	3
	Total Beacons Consumed	13

Ten of the 13 beacons were dropped while underway at 5 knots. Two of these malfunctioned after 10-12 hours requiring replacement beacons to be dropped. Interestingly enough, but of unknown significance, both failures were 16 kHz 12-day beacons and both returned to almost normal signal output prior to departure from the site. Another coincidence is that both replacement beacons landed some 600-800 feet from the original beacons rather than the anticipated 200-300 feet (Holes 242 and 245).

VESSEL OPERATION

The typical operational procedure used on Leg 25 for site selection and vessel positioning was as follows: make one profile over an area looking for the most promising site; return to that site and launch the beacon while traveling at 5 knots; retrieve the electronic gear, make a 180° turn, return to the site once again, and home-in on the beacon. Vessel response during these maneuvers was quite good with the final 180° turn being made in about five minutes once the electronic gear had been retrieved. Total distances for site surveys during the leg was 297 miles or 5.5% of total leg mileage.

Environmental conditions dictated speeds at which the Challenger could travel. Rolls of 20° and 30 foot swells were experienced while steaming between some sites. During steaming distances of appreciable length, speeds ranged from 6.6 to 9.4 knots (not including site profiling), with an average of 8.5 knots. An important point which should always be brought to the attention of the Chief Scientists when planning the number of possible sites, is the influence of environmental conditions, particularly relating to vessel speed. Programs otherwise may be based upon (published) speeds of 10-11 knots, obtainable only under certain conditions.

Performance of the dynamic positioning system was quite good with average positioning errors ranging from 0.2% to 1.3% of water depth and an overall average of 0.6%. Positioning difficulties did exist, however, at Hole 248. Problems with the Digital-Analog converter precluded using the Automatic mode at this site. Also, partial loss of command to the thrusters made Semi-Automatic unreliable, therefore, Manual mode had

to be used under the most severe environmental conditions of a 4-knot current and 3 swell trains, each from a different direction. Twice, vessel drift was sufficient to lift (or raise) the drill pipe enough to give false indications of a "drilling break" while cutting cores. Drill pipe rubbing against the horn was also quite noticeable.

Other problems with the positioning system occurred during the leg but had only a minor affect on operations. The two vertical reference gyros seemed to be rather tempermental throughout the cruise. Switching back and forth between the two was not uncommon to obtain some degree of reliability. As indicated above for Hole 248, false commands to the thrusters occurred several times. The roll stabilization system was taken out of service between Sites 247 and 248 due to a malfunctioning valve but, again, operations were not adversely affected.

Power assignments of the various generators are to be modified during drydocking at Durban, South Africa, which will further enhance the flexibility of the present system.

COMMUNICATIONS

During Leg 25 radio communications to and from the United States on Project business were handled via the U.S. Naval Communication Station, Asmara, Ethiopia (NKA), and they did an excellent job. The ship was in almost constant radio telegraph communication with NKA and no delays were encountered on any traffic. Volume of traffic was normal - about four outgoing messages daily plus approximately the same volume of outgoing weather messages. The incoming volume was average.

Radiotelephone communications with the U.S.A. were somewhat spotty due to the remote area. It was possible to communicate directly through Radio Station WOO (New York) for about an hour daily on the 13 MHZ band during the first six weeks. During the last two weeks, it was frequently possible to work directly through KMI (Oakland) for about an hour daily on the 13 MHZ band at about 1400 GMT.

Equipment reliability was good; the power amplifier tube on TMC required replacement upon failing after several thousand hours. The Marconi radar was used throughout the voyage, except for brief periods and worked well. The receiver crystal required replacement early in the voyage.

The radio antenna system was improved by the addition of: 1) a vertical trapped whip receiving antenna atop the derrick; 2) connection of an antenna switching system so that any receiver may be instantly connected to any antenna desired.

The TMC receiver and the ship's entertainment receiver were overhauled, realigned, and are working well.

PERSONNEL

A few minor bumps and bruises occurred during Leg 25 but nothing of a major nature that entailed lost time. All personnel, including Marine, Drilling and Scientific party were quite safety conscious and contributed to the fine record during the eight week period.

Global Marine's personnel are to be highly commended not only for skill in drilling and marine operations but also for their cooperation, helpfulness, and especially their fine attitude during trying times imposed by the environment.

Additionally, a brief word concerning the Scientific Group, who were not only highly professional, conscientious, and enthusiatic, but also a real delight for their cooperation, sense of humor, and understanding nature, particularly when technical problems precluded fulfillment of scientific objectives.

J. R. Shore
Cruise Operations Manager
Deep Sea Drilling Project

DEEP SEA DRILLING PROJECT
SUMMARY OF OPERATIONS
LEG 25

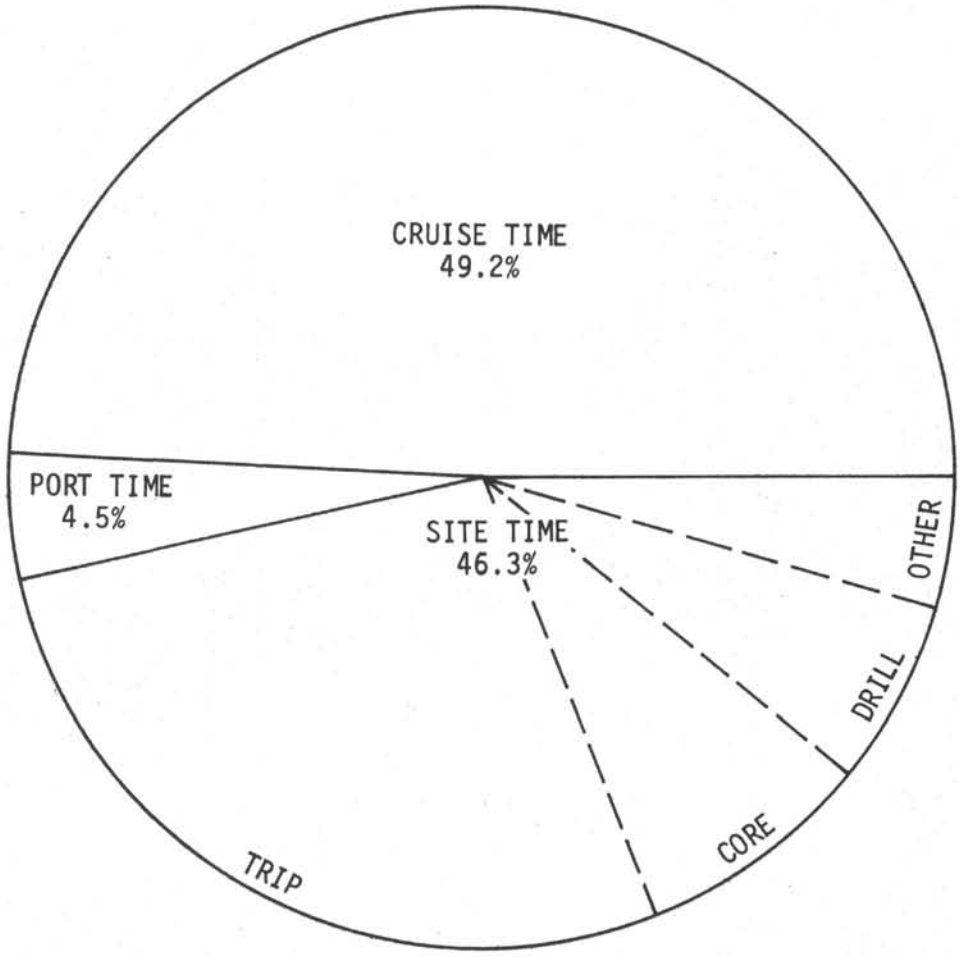
Total Days (June 26 - August 22, 1972)		57.1
Total Days In Port		2.6
Total Days Cruising		28.1
Total Days On Site		26.4
Coring Time	4.7	
Drilling Time	3.6	
Trip Time	15.7	
Mechanical Downtime	0.3	
Other Miscellaneous Time	2.1	
Total Distance Traveled (Nautical Miles)		5,408
Average Speed (Knots)		8.5
Sites Investigated		11
Holes Drilled		13
Number of Cores Attempted		171
Number of Cores With Recovery		151
Percent of Cores With Recovery		88.4
Total Meters Cores		1,394
Total Meters Recovered		790.3
Percent of Core Recovered		56.7
Total Meters Penetrated		4,253
Percent of Penetration Cored		32.8
Total Meters Drilled		2,859
Maximum Penetration Per Hole (Meters)		1,174
Minimum Penetration Per Hole (Meters)		26
Average Penetration Per Hole (Meters)		327.5
Maximum Water Depth (Meters)		5,082
Minimum Water Depth (Meters)		944
Average Water Depth (Meters)		3,685

FIGURE I

DEEP SEA DRILLING PROJECT

TOTAL TIME DISTRIBUTION

LEG XXV



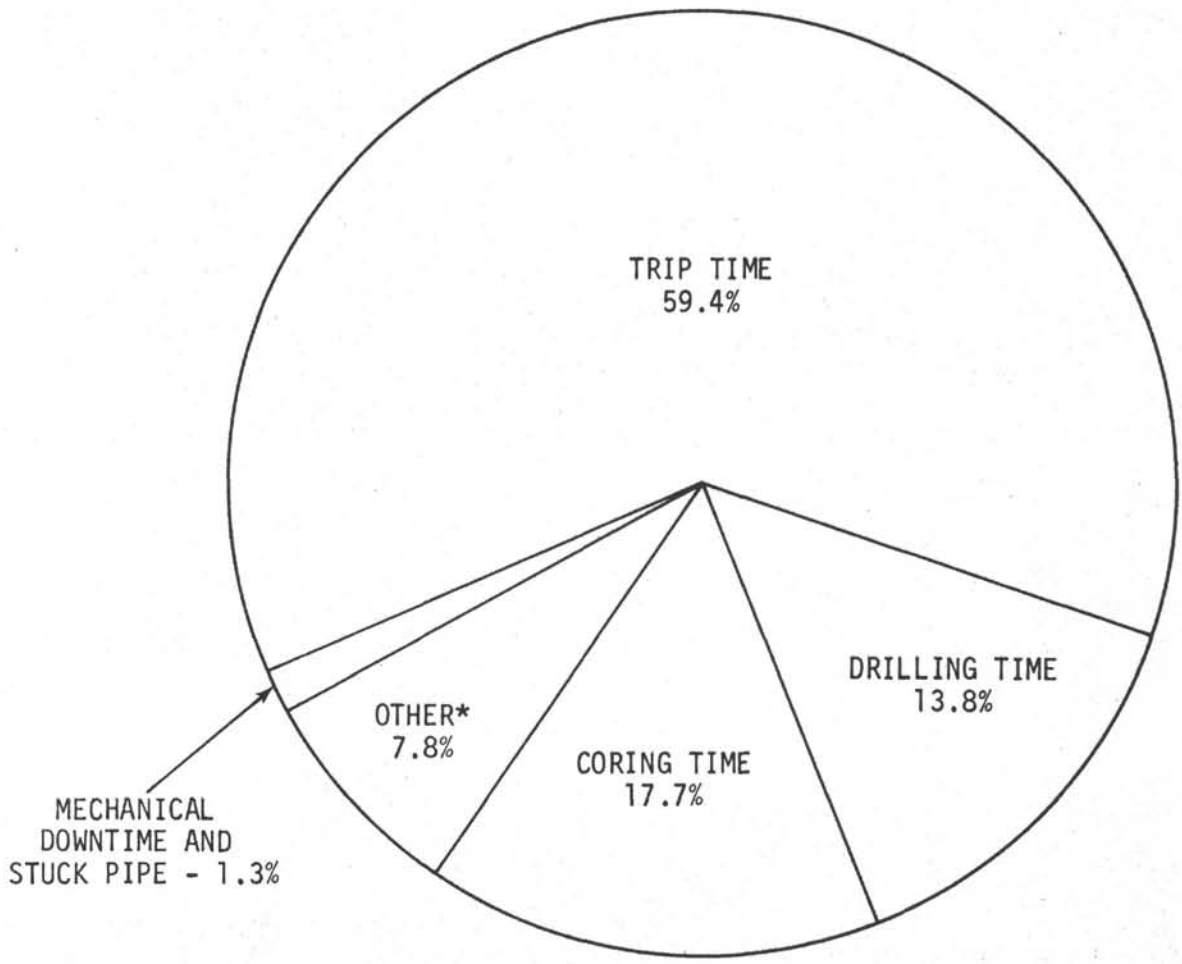
START LEG: 0400 GMT, 26 JUNE 1972, PT. LOUIS, MAURITIUS
COMPLETE LEG: 0628 GMT, 22 AUGUST 1972, DURBAN, SOUTH AFRICA
TOTAL TIME: 57.1 DAYS
TOTAL SITES: 11
TOTAL HOLES: 13

FIGURE II

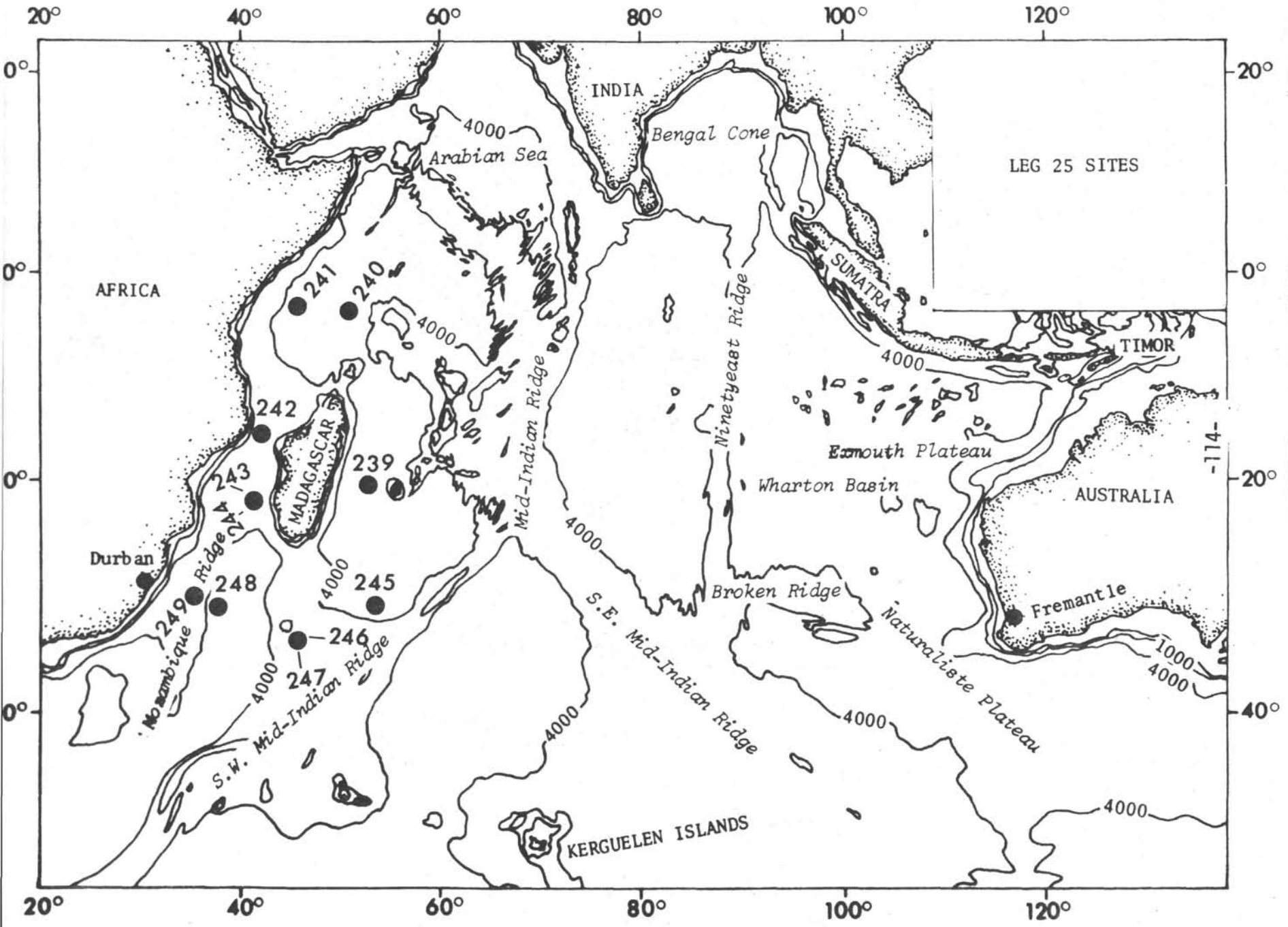
DEEP SEA DRILLING PROJECT

ON-SITE TIME DISTRIBUTION

LEG XXV



TOTAL LEG TIME:	57.1 DAYS
TOTAL TIME ON SITE:	26.4 DAYS
TOTAL SITES:	11
TOTAL HOLES:	13
*INCLUDES:	Segregating drill pipe
	Magnafluxing drill collars
	Downtime for ship positioning
	Misc. other items


20°
40°
60°
80°
100°
120°
0°
20°
40°
INDIA
Bengal Cone
Arabian Sea
4000
LEG 25 SITES
AFRICA
241
240
SUMATRA
Mid-Indian Ridge
Ninetyeast Ridge
TIMOR
242
MADAGASCAR
239
Exmouth Plateau
Wharton Basin
AUSTRALIA
243
244
Ridge
Durban
248
245
Broken Ridge
Fremantle
249
Mozambique
246
247
Naturaliste Plateau
1000
S.W. Mid-Indian Ridge
S.E. Mid-Indian Ridge
KERGUELEN ISLANDS

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 25

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	Remarks
239	ORE	13.5 kHz	192	76.5	6 day beacon life. Beacon drop at 5 knots 1130 hours 6/30/72. Water depth 4971 m (PDR). Good performance.
240	ORE	16 kHz	185	35.0	6 day beacon life. Beacon drop at 5 knots 1300 7/9/72. Water depth 5082 m (PDR). Good performance
240A	ORE	16 kHz	185	29.5	
				64.5	
241	ORE	13.5 kHz	199	116	12 day beacon life. Beacon drop at 5 knots 1830 hours 7/13/72. Water depth 4054 m (PDR). Good performance.
242	ORE	16 kHz	178	13.7	12 day beacon life. Beacon drop at 5 knots 0230 hours 7/23/72. Water depth 2275 m (PDR). Replaced due to faulty signal, however giving strong signal as departed site.
	ORE	13.5 kHz	206	60.3	Dropped at 1615 hours 7/23/72. Landed 800 feet from first beacon 6 day beacon life. Good performance.
243	ORE	16 kHz	183	12.5	12 day beacon life. Beacon drop at 5 knots 1200 hours 7/28/72. Water depth 3879 m (PDR). Good performance. Hole abandoned early due to instability.
244	ORE	13.5 kHz	190	15.0	6 day beacon life. Beacon drop standing still at 0330 hours 7/29/72. Water depth 3847 m (D.P.). Good performance. Hole abandoned early due to instability.

(Continued)

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 25

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	Remarks
245	ORE	16 kHz	179	77.5	12 day beacon life. Beacon #179 dropped at 5 knots 8/2/72. Water depth 4857 m (PDR). Replaced after 10-1/2 hours with #200 (12 day beacon life) due to faulty signal. Beacon #200 landed 600 feet south. During later stages (heavy swells) switched back and forth between two beacons for maintaining position.
245A	ORE	13.5 kHz	200	21.5	
				99.0	
246	ORE	16 kHz	187	22.5	12 day beacon life. Beacon dropped at 5 knots 8/9/72. Water depth 1030 m (PDR). Good performance. Hole abandoned early due to instability.
247	ORE	13.5 kHz	197	11.5	12 day beacon life. Beacon dropped at 5 knots 8/10/72. Water depth 944 m (PDR). Good performance. Hole abandoned early due to instability.
248	ORE	16 kHz	186	81.0	6 day beacon life. Beacon dropped at 5 knots 8/13/72. Water depth 4994 m (PDR). Adequate performance.
249	ORE	13.5 kHz	203	62.0	12 day beacon life. Beacon dropped at 5 knots 8/17/72. Water depth 2088 m (PDR). Good performance.

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 25

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
239	Smith	10-1/8	4 CTR	GR569	175.0	151.0	326.0	14.0	T-1, B-8	Bearings loose, one cone locked, out of gauge, core throat bent. Drilled on basalt approx. 6 hrs.
240	Smith	10-1/8	3 CTR, 94C	HC755	53.0	142.0	195.0	9.5		
240A	Smith	10-1/8	3 CTR, 94C	HC755	34.0	168.0	202.0	3.6	T-8, B-8	All 3 cones missing. Water causes partially plugged
								13.1		Drill on basalt approximately 6 hours.
241	Smith	10-1/8	4 CTR, 93CJS	JK950	252.0	922.0	1174.0	51.6	T-2, B-6	1 tooth missing; 1 tooth chipped; 3 seals gone; 1 bearing appears broken; in gauge.
242	Smith	10-1/8	4 CTR, 94CJS	JZ252	134.0	542.0	676.0	32.3	T-1, B-2	Bit bald but good for rerun.
243	Smith	10-1/8	4 CTR, 94CJS	JZ252	6.0	26.0	32.0	0.5		Reran bit from Site #242. Site #243 abandoned early due to hole instability.
244	Smith	10-1/8	4 CTR, 94CJS	JZ252	3.0	24.0	27.0			Punch cores washed only. No rotation. Bit lost in hole.
								32.8		
245	Smith	10-1/8	4 CTR, 94CJS	JZ255	150.5	246.0	396.5	20.0		
245A	Smith	10-1/8	4 CTR, 94CJS	JZ255	63.0	86.0	149.0	1.6	T-5, B-4	Bearing fair. 19 teeth either missing or badly chipped.
								21.6		
246	Smith	10-1/8	3 CTR, 94CJS	JZ243	94.0	109.0	203.0	4.5	T-1. B-2	In gauge. Good for rerun.
247	Smith	10-1/8	3 CTR, 94CJS	JZ243	8.0	18.0	26.0	0.5	T-1, B-2	In gauge. Good for rerun.
248	Smith	10-1/8	3 CTR, 94CJS	JZ243	136.0	298.0	434.0	8.5	T-2, B-8	Out of gauge.
								13.5		
249	Smith	10-1/8	4 CTR, 94C	HC759	285.0	127.0	412.0	17.4	T-1, B-3	In gauge. Good for rerun.

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 25

Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent of Cores With Recovery	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet. Meters	Avg. Rate Penet.	Time On Hole	Time On Site
Southern Mascarene Basin														
239	21° 17.67'S	51° 40.73'E	4971	21	19	90.5	175.0	106.1	60.6	151.0	326.0	23.3	76.5	76.5
Somali Basin														
240	03° 29.28'S	50° 03.42'E	5082	8	5	62.5	53.0	25.1	47.5	142.0	195.0	20.5	35.0	35.0
240A	03° 29.28'S	50° 03.42'E	5082	4	3	75.0	34.0	3.2	9.4	168.0	202.0	56.2	29.5	64.5
241	02° 22.24'S	44° 40.77'E	4054	29	29	100.0	252.0	136.7	54.2	922.0	1174.0	22.8	116.0	116.0
Mozambique Channel														
242	15° 50.65'S	41° 49.23'E	2275	19	18	95.0	134.0	103.1	77.0	542.0	676.0	20.7	74.0	74.0
Zambezi Canyon														
243	22° 54.49'S	41° 23.99'E	3879	1	1	100.0	6.0	0.3	5.0	26.0	32.0	64.0	12.5	12.5
244	22° 55.87'S	41° 25.98'E	3847	1	0	0	3.0	0	0	24.0	27.0	36.0	15.0	15.0
Madagascar Basin														
245	31° 32.02'S	52° 18.11'E	4857	19	17	89.0	150.5	81.6	54.2	246.0	396.5	19.0	77.5	77.5
245A	31° 32.02'S	52° 18.11'E	4857	7	7	100.0	63.0	47.4	75.1	86.0	149.0	83.0	21.5	99.0
Madagascar Ridge														
246	33° 37.21'S	45° 09.60'E	1030	11	6	54.5	94.0	23.8	25.4	109.0	203.0	41.5	22.5	22.5
247	33° 37.53'S	45° 00.68'E	944	1	0	0	8.0	0	0	18.0	26.0	17.3	11.5	11.5
Mozambique Basin														
248	29° 31.78'S	37° 28.48'E	4994	17	13	76.5	136.0	40.8	30.0	298.0	434.0	49.4	81.0	81.0
Mozambique Ridge														
249	29° 56.99'S	36° 04.62'E	2088	33	33	100.0	285.0	222.2	78.0	127.0	412.0	23.6	62.0	62.0

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG 25

Date	Site Number	Cruise Hours	Trips Hours	Drill Hours	Core Hours	Stuck Pipe Hours	Mechanical Down Time Hours	In Port Time Hours	Other Hours	Total Time Hours
6/26 - 6/28								61.6		61.6
6/28 - 6/30		37.9								37.9
6/30 - 7/03	239		52.0	1.5	14.0		1.0		8.0	76.5
7/03 - 7/09		141.0								141.0
7/09 - 7/11	240		22.0	2.5	8.0				1.5	35.0
7/11 - 7/12	240A		15.0	2.0	2.6		2.0		8.9	29.5
			37.0	4.5	10.6		2.0		10.4	64.5
7/12 - 7/13		37.0								37.0
7/13 - 7/18	241		56.3	34.1	18.5	0.5			6.6	116.0
7/18 - 7/23		109.0								109.0
7/23 - 7/26	242		31.5	21.6	17.2				3.7	74.0
7/26 - 7/28		55.5								55.5
7/28 - 7/29	243		10.8	0.6	1.1					12.5

(Continued)

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG 25

Date	Site Number	Cruise Hours	Trips Hours	Drill Hours	Core Hours	Stuck Pipe Hours	Mechanical Down Time Hours	In Port Time Hours	Other Hours	Total Time Hours
7/29		3.0								3.0
7/29	244		11.0	0.9	1.2				1.9	15.0
7/29 - 8/02		100.0								100.0
8/02 - 8/06	245		45.8	6.4	18.7		5.0		1.6	77.5
8/06 - 8/07	245A		17.6	1.1	2.2				0.6	21.5
			63.4	7.5	20.9		5.0		2.2	99.0
8/07 - 8/09		65.5								65.5
8/09 - 8/10	246		12.8	3.5	5.2				1.0	22.5
8/10 -		3.0								3.0
8/10 - 8/11	247		9.0	1.0	1.5					11.5
8/11 - 8/13		60.0								60.0
8/13 - 8/17	248		55.3	6.3	6.9				12.5	81.0
8/17		10.5								10.5
8/17 - 8/20	249		37.2	6.3	15.4				3.1	62.0
8/20 - 8/22		51.9								51.9
TOTALS		674.3	376.3	87.8	112.5	0.5	8.0	61.6	49.4	1370.4