DEEP SEA DRILLING PROJECT
TECHNICAL REPORT NO. 10
OPERATIONS RESUMES — PART V

PRIME CONTRACTOR

THE REGENTS
UNIVERSITY OF CALIFORNIA

SCRIPPS INSTITUTION OF OCEANOGRAPHY
University of California, San Diego

OPERATIONS RESUMES

LEG 45 through LEG 54

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

August 1977

M. N. A. Peterson
Principal Investigator
Project Manager
Deep Sea Drilling Project
Scripps Institution of Oceanography

F. C. MacTernan
Principal Engineer
Deputy Project Manager
Deep Sea Drilling Project
Scripps Institution of Oceanography

INTRODUCTION

IPOD/DSDP Technical Report Number 10 is the fifth edition of Operations Resumes published since Leg 1 started in the Gulf of Mexico on August 11, 1968.

This Report tells about operational and engineering procedures used aboard D/V Glomar Challenger from Leg 45 through Leg 54.

The same successful and widely-read format established for the first four DSDP Technical Reports citing Operations Resumes was followed in Technical Report Number 10.

This Technical Report, the first covering some of the International Phase of Ocean Drilling (IPOD) cruises, gives performance achievements, drilling and coring results, drill bit performance and improvements, coring equipment modifications, tests of new procedures and equipment, improvement of coring procedures, plus problems encountered and anticipated and the steps taken or proposed to eliminate the trouble.

ACKNOWLEDGEMENTS

Achievements by the technical staff of the International Phase of Ocean Drilling of the Deep Sea Drilling Project, have, to a great extent, been responsible for the success and the resulting contribution to the basic earth research credited to the Deep Sea Drilling Project.

To. V. Larson, Head of Operations, and S. Serocki, Head of Engineering, and their respective staffs, i.e., B. Robson, G. Foss, R. Knapp, P. Thompson, M. Storms, B. Adams, R. Keefe and Patricia Duley, the Project gratefully acknowledges your dediciation, talents and expertise.

Logistics, headed by R. Olivas and his entire staff also have contributed mightily to IPOD/DSDP's success with top-flight support provided for Operations, Engineering and Scientific functions.

IPOD/DSDP extends its most sincere thanks to persons named for their outstanding talent and dedication which are prime requisites for any successful scientific venture.

F. C. MacTernan

F. C. MacTERNAN
Principal Engineer
Deputy Project Manager
IPOD/DSDP/SIO

MNA Peterson

M. N. A. PETERSON
Principal Investigator
Project Manager
IPOD/DSDP/SIO

OPERATIONS RESUMES

Contents

Leg 50 - Funchal, Madeira Islands to Funchal, Madeira Islands
September 12, 1976 to November 10, 1976
Dr. Yves Lancelot, University Parix VI
Dr. E. L. Winterer, Scripps Institution of Oceanography
Cruise Operations Manager:
Mr. Glen N. Foss

Leg 51 - Funchal, Madeira Islands to San Juan, Puerto Rico
November 11, 1976 to January 18, 1977
Dr. Thomas W. Donnelly, State University of New York
Dr. Jean Francheteau, Centre Oceanologique de Bretagne
Cruise Operations Manager:
Mr. Robert R. Knapp

Leg 52 - San Juan, Puerto Rico to San Juan, Puerto Rico
January 22, 1977 to March 9- 1977
Dr. Wilfred B. Bryan, Woods Hole Oceanographic Institution
Dr. Paul T. Robinson, University of California, Riverside
Cruise Operations Manager:
Mr. Robert R. Knapp

Leg 53 - San Juan, Puerto Rico to Cristobal, Canal Zone
March 13, 1977 to April 25, 1977
Dr. Martin F. J. Flower, Imperial College
Dr. Hubert Staudigel, Massachusetts Institute of Technology
Cruise Operations Manager:
Mr. Glen N. Foss

Leg 54 - Cristobal, Canal Zone to Los Angeles, California
April 30, 1977 to June 18, 1977
Dr. Rogert Hekinian, Cen tre Oceanologique de Bretagne
Dr. Bruce R. Rosendahl, Duke University
Cruise Operations Manager:
Mr. Robert R. Knapp

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 45

GENERAL

Leg 45 was the first part of a two leg attempt at Deep Crustal Drilling, the first such effort during the International Phase of Ocean Drilling of the Deep Sea Drilling Project. The voyage began Thanksgiving Day, November 27, 1975 when the ship arrived at San Juan, Puerto Rico and ended 54 days later on January 20, 1976 when the ship returned to San Juan. A site slightly west of the mid-Atlantic Ridge was selected for the first Deep Crustal Drilling attempt and was occupied for 35-1/2 days. A penetration of 664.09 meters below the ocean floor was achieved before unstable hole conditions caused the site to be abandoned.

At this site, a modified re-entry system was used which, for the first time, allowed steel casing to be cemented through the upper soft sediments. Seven core bits were dulled and nine re-entries were made in a water depth of 4485 meters. As recovery in the upper basalt sections was poor, the hole was left open for possible evaluation during Leg 46 with down-hole logging instruments.

When unstable hole conditions forced an early termination of the attempted deep crustal penetration, a site for a second attempt was then selected slightly east of the mid-Atlantic Ridge. To establish its suitability for deep crustal drilling, a single bit pilot hole was drilled. Then the vessel returned to San Juan for resupply, crew change and repairs.

The Deep Sea Drilling Project is managed by Scripps Institution of Oceanography (SIO) under a contract with the National Science Foundation (NSF). Scientific planning is coordinated by SIO through the Joint Oceanographic Institutions For Deep Earth Sampling (JOIDES) organization.

Funds are provided by the American, English, French, German, Japanese and Soviet governments. Coring operations are conducted by Global Marine, Inc. (GMI) under a subcontract with SIO.

PORT CALL - SAN JUAN, PUERTO RICO

The GLOMAR CHALLENGER arrived in San Juan, Puerto Rico at 1610 hours on Thanksgiving Day, November 27, 1975. This marked the end of a three-week Engineering Leg where various new systems which were installed and repairs which were made at a major dry docking at Norfolk, Virginia were tested and evaluated. Only minor faults had been found. On Friday afternoon a critique of the Engineering Leg, chaired by the Deputy Project Manager, was held aboard the ship. Particular emphasis was placed on the various sub-systems which would be needed during Leg 45 if the planned Deep Crustal Drilling was to be accomplished.

The automatic latching mechanisms of both the 11-3/4" and 16" casing hangers, which are a part of the newly designed re-entry hardware, had been found to have only a marginal amount of over-travel to insure engagement. All six hangers aboard were taken to a local machine shop where additional over-travel was provided. When the hangers were returned they were assembled to verify that proper engagement was achieved. In addition, a centering device (marcel ring) for the snap ring of the automatic hangers was given a test. It performed satisfactorily and the ring was guided into the throat of the re-entry cone without difficulty.

Following the crew change on Saturday, the proper engagement of the latching mechanisms were again verified, which provided training for the new crews. Then a re-entry cone was assembled and stowed on the starboard casing rack. Excessive coatings on the throat of the re-entry cones was reported to have created latching problems. Therefore, two of the lower re-entry cone sections were sent to a local shipyard where the internal bore was sandblasted clean.

Only a minor amount of supplies were loaded, mainly those of an emergency nature which had been air freighted from the U.S. Fresh water was taken.

WEATHER

Both sites investigated were located in the area of prevailing northeast to east trade winds. Climatological averages for the area during December-January showed predominant northeast to east wind and waves. Some northerly swells due to the passage of storms over the northern North Atlantic Ocean were anticipated, their severity was not.

While at Site 395, two low pressure systems which formed further south than normal produced northerly swells with a significant height of 15-20 feet. Fortunately the normal northeast-east trade winds did not accompany these swells and stationkeeping was not adversely affected. At times, however, it was necessary to operate with three motors assigned to propulsion to stem accompanying winds which exceeded 33 knots at times.

Of greater impact on operations was the continual presence of a confused sea with as many as three swells from various directions. At times even the optimum heading produced a vessel roll of five degrees. At times the roll was accompanied by an equal amount of pitch. These factors combined to adversely affect tripping operations. On two occasions, one of the two connecting links between the travelling block and the elevators became disengaged while making up a stand of drill pipe. On one occasion it went unnoticed and subsequently when a strain was taken on the drill string, the drill pipe parted due to the eccentric loading placed on it. Fortunately no one was injured. The safety dogs on the dual elevators were found to be worn and were built up by welding. On another occasion, the elevators became unlatched.

Another factor affecting operations was the long period of the northerly swells which gave rise to more vessel heave than normal. Shortened bit life was attributed to this heave and caused three five-foot bumper subs to be employed in the bottomhole assembly for drilling. The heave compensator proved to be effective in minimizing the effect from these long period swells.

Only once were operations suspended because of weather. This was while running 11-3/4" casing. However, at times it appeared that operations were being conducted near the vessel's maximum capabilities. The loss of a scanning sonar tool when the line pulled out of the rope socket can probably be traced to the excessive surge on the drill string at that particular time.

As most of the planned work during IPOD is in the northern hemisphere, it can be expected that weather will continue to play an important role in the success or failure of future voyages. Forecasting facilities were good and in all cases at least 12 to 24 hours accurate advance warning of wind and waves conditions were provided by the weatherman. The use of real time satellite coverage enabled him to enhance the unusually good radio facsimile weather maps from the U.S. This should probably continue throughout the next year as operations are continued in the North Atlantic.

UNDERWAY - SAN JUAN TO SITE 395 - SITE 396 TO SAN JUAN

The first site to be investigated had been designated No. 5 on the Prospectus and was located 1158 nautical miles east of San Juan. Due to the prevailing northeast-east trade winds, average speed enroute was a slow 8.37 knots. During this trip from San Juan, considerable maintenance work was accomplished which helped prepare for the upcoming deep crustal drilling.

The return from the operating area (the two sites were approximately 131 nautical miles apart) was helped by the prevailing trade winds. The average speed during the return to San Juan exceeded 10 knots. Towed surveys were taken at full speed while underway. Both magnetometer and air gun subbottom profilers were operated. The recorder for the subbottom profiler was modified to allow simultaneous recording of both the subbottom profile and the magnetometer readings on the same paper. This should allow more rapid and better use of the magnetometer readings.

OBJECTIVES/STRATEGY

The prime objective of Legs 45 and 46 was a single deep penetration near the crest of mid-Atlantic Ridge to develop an understanding of the origin, structure, and composition of the oceanic crust. Two primary sites had been selected from extensive surveying of an area near 23 degrees north latitude. One site was located just west of the ridge near 46 degrees west longitude; the other, just east of it at 43 degrees west longitude. Both had overlying sediment ponds exceeding 100 meters in thickness to provide needed lateral support to the drilling assembly while spudding in. Alternate sites had been surveyed for contingency purposes.

Previous deep crustal drilling attempts on Leg 34 and 37 had demonstrated that it is not always possible to penetrate the crust in regions of thin sediment cover as found near the ridge crest due to rock fractures and/or other unstable conditions. Therefore, the strategy for Leg 45 called for the drilling of a single bit "pilot" hole when first occupying a site to establish if the upper crust was stable and offered a reasonable opportunity for deeper drilling. The "pilot" hole was to be further used to establish the proper depth for washing-in of the re-entry cone/conductor casing assembly and the selection of a proper setting depth for 11-3/4" casing. This latter casing was to be cemented through the overlying soft sediment layers that normally wash out and prevent effective cuttings removal while drilling underlying hard rocks.

SITE 395 - THE PILOT HOLE

The Leg 45/46 Prospectus called for the investigation of a site (No. 6) east of the mid-Atlantic Ridge first. However, as the westerly site (No. 5) was enroute, the scientific party requested that a single bit pilot hole be drilled there before proceeding further east.

This was accomplished in a routine manner. A site with approximately 100 meters of soft sediment cover was located with the subbottom profiler and a beacon was launched while underway. Water depth, as measured by the Precision Depth Recorder (PDR), was 4494 meters. As has been the practice on the GLOMAR CHALLENGER for several years, the drill string was not measured; only average lengths from previous measurements were used. Later this proved to be a tactical error. A pinger fitted at the core bit was used to establish the sea floor at 4527 meters. The hole was then continuously cored to a total penetration of 184.65 meters below the sea floor, with basalt being encountered at a subbottom depth of 93 meters. No hole problems were encountered. Indications from the pilot hole were that operationally the site offered a good opportunity for a deep penetration. With this information and a review of the cores recovered in the pilot hole with scientific objectives, the scientific party requested that an attempt at deep crustal penetration be made at Site 395 (Prospectus No. 5).

The drill string was pulled above the mud line and then jetted into 82 meters subbottom without rotation. Based on this, a casing point 62 meters subbottom was selected based on the jetability and skin friction bearing capacity of the nannoforam ooze which made up the sediment cover.

HOLE 395A - DEEP CRUSTAL PENETRATION AND RE-ENTRY

The re-entry cone was keelhauled without incident. The basic design shown in Figure No. 1 was used. A mud skirt extension was not required. The cone was fitted with the standard three steel passive reflectors. In addition, between the steel reflectors, spherical, hollow 10" glass balls were fitted on five foot tethers in case the cone should settle.

The five joints of 16" casing were run and hung off on top of the lower guide horn assembly in the moon pool. The buttress threads on the casing made up surprisingly well. All mill joints had been previously tack-welded and the joints made up on the rig floor were locked with epoxy. A bottomhole assembly (BHA) was then run with a lowering tool fitted so that the bit was located approximately six inches inside the 16" shoe. The lowering tool was attached to the casing while hanging in the moon pool with only minor difficulty. The casing was then latched into the re-entry cone and run to bottom. Lowering of the re-entry cone was watched on the PDR. Adjustment of gains allowed an accurate depth reading until the cone was within 45 meters of bottom. At this time, it was discovered that following the drilling of the pilot hole, the drill string had been rearranged on the pipe racker. The pipe actually being used to lower the re-entry cone was of a different length and not measured. As an accurate relationship of the ocean floor to drill string measurements is needed to properly wash-in and set the re-entry cone, cores were taken to provide the needed relationship. This was accomplished without incident and is recommended for future work.

The drill pipe ocean floor depth as established by cores and average lengths of drill pipe was 4485 meters, a major difference of 42 meters from that found on the pilot hole. Subsequent measuring of the drill string indicated that the actual depth should have been 4493 meters which compared favorably with the 4494 meters shown by the PDR. No attempt was made to change previously reported measurements. The same drill pipe was used each time a re-entry attempt was made while working on the site.

The casing was jetted into 4547 meters which placed the re-entry cone base at 4485 meters. The washing-in operations was slower than anticipated and an inner barrel was dropped to provide additional jetting action. Approximately two hours were required to jet-in the casing. A Rotary shifting tool was run while washing in the last joint and release of the casing/re-entry cone from the drill string was made without incident. Later when the 11-3/4" casing was run, the cone was found to have settled an additional three meters which placed the mud skirt at the mud line.

When release was accomplished, a 14-7/8" hole was washed down to 4572 meters and the hole was then continuously cored to 4600 meters to fit the 11-3/4" casing. Coring from 4572-4600 meters was done with a minimum of circulation to avoid the hydraulic opening effect on the bumper subs as the bottomhole assembly was not completely buried. While retrieving the last core from 4600 meters, the bit plugged and the drill string became stuck. It was eventually worked free after five hours by allowing the ship's heave to knock down on the bumper subs.

It was then necessary to pull out to unplug the bottomhole assembly. Cuttings were found lodged as high as 90 meters above the bit. The same drill string was rerun, the hole re-entered, and cleaned out without incident. The plugging/sticking is attributed to the low circulation rates being used and the small annular area provided by the 16" casing lowering tool.

One hundred nine meters of 11-3/4" pipe had been planned which would bring the casing to within six meters of bottom. The casing was made up with a stab-in shoe on bottom and, as with the 16" casing, the buttress threads made up well. The casing was hung off on top of the hcn assembly in the moon pool. The running tool was made up with some difficulty due to rolling of the vessel.

A delay in re-entering the hole with casing was caused by high swells. After securing the drill string and waiting on weather five hours, the drill string with casing attached was again run and the casing stabbed in the hole and hung at 4597 meters. An upwards strain was taken to verify latching and the cone was found to have settled three meters to 4588 meters.

Release from the casing was made by applying 5,000 ft-lbs of torque and slowly allowing the lowering nut to unscrew. When free of the casing, the casing was cemented through the drill pipe and displaced with a latch down cementing plug. The plug failed to bump. Subsequent test of displacement showed, that when using the measuring tanks aboard the ship, that an amount of fluid at least 10% over theoretical is needed to fill the drill pipe.

After the casing was in place and cemented, the drill string was removed and a coring assembly made up. On the first re-entry attempt, the lower seven drill collars were lost when a bumper sub service connection failed. The drill string apparently hit the rim of the re-entry cone while stabbing. No damage to the cone was observed.

Penetration rate in the basalt were higher than that usually found in the deep ocean, however, bit life was far shorter than anticipated. An improvement of over 30% in bit life was noted after the heave compensator was placed in service.

Re-entries (maneuvering the ship and stabbing the pipe) were different from those on previous voyages as the drill string was moving more rapidly. This required that the drill string be closer to the cone while scanning and that the decision for stabbing be made while the drill string was in motion. As experience was gained, the operation became fairly routine (see Figure 2).

Near the end of bit run No. 6, considerable torque was encountered beginning at a depth of 5095 meters. On the following bit, this same interval near 5095 meters continued to give problems. The interval (5095-5103 or bottom) was reamed and normal coring operations were resumed. However whenever circulation was lowered and/or stopped as required for retrieving cores, the core bit would plug and the drill string would become stuck. Rotation would usually stop whenever circulation was first established which suggested that cuttings were packing off against the drill collars and it appeared that the cuttings were not being removed from the hole. To overcome the situation, various methods were tried. Increased sea water circulation rates and increased frequency and volume of mud slugs were used. None seemed to correct the problem. Finally, it was necessary to spot mud on bottom and pull 18 meters off bottom to retrieve cores. Even then there was often temporary sticking of the drill string.

The core recovery in this interval beginning at 5095 meters to be eventual total depth at 5149 meters was good, exceeding 45%. The upper part of the interval was a weathered dolerite and/or doleritic basalt with occasional slickensides, indicating minor faulting. The lower cores were badly brecciated and when cut for sampling would fracture easily. An extremely soft material was cementing the existing fractures.

After reaching a depth of 5149 meters and after the drill string again became stuck, an attempt was made to use cement to stabilize the dolerite section. Approximately twenty barrels of cement slurry were equalized at 5120 meters and a trip was made to change dull bits. Even while pulling out of the cement, the drill string tried to stick and it was necessary to rotate to pull up.

Thirty six hours after the cement was in place, the location of the cement top was felt for. The first hard resistance was encountered at 5093 meters and one and one half hours were required to drill from there to 5101 meters. The hole was then cleaned out to 5134 with no noticeable improvement in hole stability.

The drill string was then pulled above the unstable section and the inner barrel retrieved. No cement was found. In its place were cuttings followed by walnut sized dolerite pebbles and a core sized piece of dolerite in the catcher. Further attempts at stabilizing the hole with cement were considered to have a low probability of success and a sizeable risk factor to the equipment and hole. The hole was left open for possible evaluation by downhole logging instruments during Leg 46.

Before leaving the site an attempt was made to measure the sonic velocity of the cored interval by running a hydrophone on the Schlumberger line through the bit at 5088 meters and measuring the transit time of air gun signals from the ship. Apparently these signals were not strong enough to be heard, although signals had been received earlier when the hydrophone was suspended through the bit slightly above the mud line.

Unfortunately a stop ring, which had been placed on the hydrophone with set screws to prevent it from fully entering the hole, failed to hold. The tool apparently became bent and could not be retrieved. Pump circulation was shut off and after working the wireline approximately thirty minutes, the line parted at the float valve immediately above the bit. It appears that the line parted immediately above the cable head.

SITE 396 - A SECOND PILOT HOLE

After unstable hole conditions were encountered at Site 395, the vessel moved to prospectus No. 6 to drill a pilot hole for a possible deep crustal penetration east of the mid-Atlantic Ridge.

Again, a site was selected which had over 100 meters of soft sediment cover to provide lateral support to the bottomhole assembly. The water depth was 4460 meters both by PDR and drill pipe measurements (the drill string was measured using a steel tape on each section of pipe). Basalt was encountered at 4581 meters after a subbottom penetration of 121 meters. No hole problems were encountered while coring to the total depth of 4681 meters; however, the penetration rates and muddy water associated with the cores recovered suggest that sediments were encountered from 4630 to 4648 meters. No sediment cores were recovered from this interval, however, small samples were obtained for dating purposes and micro fossils were older.

Utilization of this site for deep crustal penetration will require a significant penetration of fairly dense basalt with a 15" core bit. Otherwise, the site appears suitable from an operational standpoint.

While pulling out, the bottom sediments were tested for proper re-entry cone/conductor casing setting depths. The sediments appeared to be quite similar to those at Site 395 and the same depths used there would be recommended at this site.

As sufficient 16" casing was not aboard to set a re-entry cone for Leg 46, the voyage was directed to return to San Juan for extensive repairs to equipment. This decision proved to be correct as a stern thruster motor bearing failed shortly after clearing the mud line. (Weather conditions in the area required that all four thrusters be used to avoid excessive roll)

DRILLING AND CORING

Penetration rates in the basalts were high and on occasion exceeded 10 m/hr. Recovery was low. An increase in recovery was noted whenever penetration rates became slower. With present core bit designs, it is doubtful that increased recovery will occur in the upper, apparently glassy sections.

At Site 395, an increased penetration rate was observed on the second hole while coring the upper basalt section (See Figure 3). This can probably be attributed to an increased circulation rate which was used on the second hole and the inner barrel seal which appears to be effective in improving bottomhole hydraulics. However, near the bottom of Hole 395A, when cuttings were not being removed and the bit was becoming routinely plugged, the seal acted to restrict circulation rates when the jets became plugged.

The weather conditions during the voyage provided considerable vessel heave. It became difficult to keep the two upper bumper subs in neutral while drilling and it became necessary to operate with three upper subs (15 foot total stroke). A modified bottomhole assembly which consists of a core barrel, one stand of 8-1/4" drill collars, bumper sub, one stand of 8-1/4" drill collars, three bumper subs, one stand of 8-1/4" and 7-1/4" drill collars was used during most of the voyage.

As previous attempts at deep crustal drilling had usually resulted in stuck drill pipe, two rotary drilling torque jars were made available to run when conditions warranted. These jars were run early at Site 395 and no problems developed. Later when trying to determine why such extreme short bit lifes were being experienced, it appeared that the torque jars were hitting down on the large swells and were contributing to the shortened bit life.

The use of mud slugs to assist in the removal of cuttings and the spotting of mud to suspend cuttings during trips has been an established practice. As bentonite is used to mix such mud, an adequate supply of fresh water is needed. At Site 395, when unstable hole conditions were encountered, the supply of fresh water was nearly exhausted and the evaporators had difficulty in adding to the supply. To conserve fresh water, the use of fresh water mud mixed with equal parts of sea water and thickened with cement was tried with encouraging results. While the resultant mud will not thicken as it is pumped down the hole and mixes with sea water (as is the case with fresh water mud), the sea water mud appeared effective in suspending cuttings on trips and connections.

CORE BITS

Due to the high penetration rates enjoyed only the extended chisel shaped insert roller core bits were used (Type F94CK). On Hole 395, a single bit penetration, the core bit was totally destroyed after 24.8 hours (all cones and journals were gone). On Hole 396, another single bit penetration, the core bit was totally destroyed after 24.2 hours (even the shanks were gone).

On Hole 395A, six Type F94CK 10 inch core bits were used to penetrate below the 11-3/4" casing. Three of the bits were used with bumper subs to control the weight on the bit; three were used with the heave compensator. It is conservatively estimated that bit life was extended thirty percent when the compensator was in use.

All core bits showed some flaring of the core guide which would then impinge on the cutters. Some additional strengthening is needed along with hard metal to control core diameters allowed to enter the inner barrel. There were occasional outsize cores observed which had jammed the inner barrel.

Two methods were used to judge whether the core bit had become dull. One was the gauging of cores as described by Mr. Edmiston in summarizing Leg 37 operations. The other was close observation of torque readings recorded on the drilling recorder. Both proved effective at times. Both proved misleading at times. On Site 396, full sized cores were obtained until the last. When the bit was pulled, it was found completely destroyed. On Hole 395A, bit No. 7 was pulled when excessive torque was observed. The bearing seals were still effective. The troublesome unstable dolerite section had been penetrated and provided torque readings similar to those of a dull bit.

STATIONKEEPING (DYNAMIC POSITIONING)

Overall the performance was adequate. No major excursions or major lost time can be attributed to the system, however, the system did not perform up to expectations while maneuvering the ship in automatic for re-entry. The display on the bridge control console continued to move in apparent response to vessel roll and pitch making it difficult to judge the vessel actual position (motion was approximately ten feet for each degree of roll and/or pitch). The use of tighter gains during these maneuvers was not possible as it would over drive the thrusters and main propulsion. The result, when tried, was a constant reversal from port to starboard; from ahead to astern. Troubleshooting to find the cause of this fault was unsuccessful.

A total of eight beacons were launched. One, a quad life or 24 day beacon, failed abruptly after reaching the ocean floor. A double life (12 day) beacon was launched at Site No. 396 when leaving and a double life beacon was launched at Site No. 395 while enroute to San Juan. These beacons were set to facilitate navigation during Leg 46 while relocating the sites.

Noise was noted early during the voyage in the No. 2 stern thruster motor bearing. It progressively got worse and failed on the last day at Site No. 396. This bearing and three others were replaced at San Juan.

On several occasions while readying the beacons for service, a plastic screw used to hold a magnet in place broke. This often left the beacon on with no way to shut it off until the defective part was drilled out. The vendor should be notified that this type plug is unacceptable for use on the GLOMAR CHALLENGER.

RE-ENTRY EQUIPMENT

RE-ENTRY CONES, CASING HANGERS AND RUNNING TOOLS

The re-entry cone running procedures that have been developed in the past worked smoothly. The new configuration handled as well as if not better than the previous designs. Latching of the 16" casing to the re-entry cone was accomplished without mishap. A "marcel" ring was installed behind the snap ring in the automatic hanger assembly and apparently took care of the misalignment reported during the Engineering Voyage.

Releasing of the 16" casing once jetted-in was accomplished with the Rotary shifting tool as designed. When recovered, the casing lowering/releasing tool which is run as part of the bottomhole assembly was found to have lost one of the six stop bolt sleeves. As this has been a continuing problem, a modification of the securing mechanism should be undertaken. The 16" lowering tool which in the new design acts as a stabilizing sleeve and carrier for the locking paddles, has only minimal flow by area for cuttings once the casing is released. A modified design is needed to improve cuttings removal after release and to retain a leaky pack-off for jetting purposes.

The 11-3/4" casing lowering tool (hex Kelly and nut with left hand safety joint threads) worked as designed. It would be helpful to include a swivel joint below this hanger so that the entire stinger assembly and stab-in sub need not be rotated during make up of the left hand lowering thread.

Engagement of the 11-3/4" hanger to the 16" casing hanger was accomplished the first time the casing was seated. An upstrain of over 50,000 pounds verified proper engagement and provided a good reference point for the actual final location of the 11-3/4" casing. The re-entry cone had apparently settled three meters from time of initial release.

CEMENTING

The use of a stab-in casing shoe was successful in allowing re-entry operations to be performed successfully. Unfortunately the latch down plug to hold the cement in place did not bump after displacing the drill string with a theorectical volume of sea water plus five percent. Subsequently, a displacement plug was used to determine actual drill pipe displacement as referenced to the measuring tanks on the cementing unit. This work indicated that it will be necessary to overdisplace approximately ten percent on future jobs.

The cementing unit which had been recently modified to include a jet mixer performed as designed, however, additional crew experience will be required before consistent slurry weights can be achieved. It is recommended that selected personnel be given instruction and/or experience on land operations with similar equipment.

For plugging operations, the slurry was batch mixed successfully and it is recommended for future use in this type of operation until crew proficiency in controlling slurry density with the jet hopper is demonstrated.

SCANNING SONAR

The recently overhauled wireline winch (Schlumberger Mohole Unit) performed well. The scanning sonar tool was routinely run to 4479 meters in approximately two and one half hours and retrieved in one and one half hours. Faster speeds are possible, however the potential of overrunning and causing damage to the line maintained this slower pace. It was also found necessary to circulate sea water at all times while lowering the tool to prevent the tool from "floating" and again overrunning the line.

The scanning sonar tool performed reliably with almost no problems experienced with the electronics sections. Many problems were, however, experienced with the cable heads and in particular, the short "pig tail" section which crossed over from the inch and one half Gearhardt-Owens (GO) cable head, which is fitted on the main cable, to the 3-1/2" Schlumberger CIS cable head, that is on the scanning sonar tool. This "pig tail" section was removed on one unit by modifying the Schlumberger head to accept the lower GO Connector directly. This enhanced the reliability of the system a great deal.

Some problems were experienced with poor and/or slow rotation of the scanner. This was apparently caused by the circulation of fluid while scanning. While stopping circulation would help, this was not feasible when close to the cone due to the quickness with which the re-entry had to be made. The problem was solved by proper spacing which in conjunction with the bit seal forced the fluid away from the transducer. When running casing the pump could be shut down as no float valve was in the string to catch the transducer.

Two transducers were lost. One, lost when the first 10" bit was being stabbed, would have been prevented by a closer tool spacing which would have prevented the transducer from hitting the cone. The second was lost when the cable pulled out of a cable head while retrieving the sonar tool. This caused the tool to fall against a closed float valve. This caused the transducer to be lost, the drive shaft to be broken, and the motor housing to be flooded. The failure was probably caused by heavy weather and resultant surges inside the drill pipe which acted against the tool.

Re-entries were made by using both 8° and 45° transducers. The addition of a downhole video gain control during the Engineering Voyage allowed the dampening out of the "mud ring" which normally confused a 45° transducer presentation and allowed sharper images of the reflectors to be presented.

The glass balls which had been fitted on the rim of the cone between the passive steel reflectors gave the cone a distinctive signature when compared to previous re-entries. The return signal was not too strong from the balls and they could be easily removed by gain adjustment. The use of tethered reflectors appears to have merit where there is concern regarding possible settling of the re-entry cone.

Due to the weather experienced and/or water depth at Site 395, considerably more drill string motion was observed than on previous re-entry work during Leg 37. The drill string did not come to rest over the re-entry cone as in the past and it was necessary to make re-entries while the drill string first began its move over the cone. It was found to be helpful to scan and make re-entries from approximately four meters above the cone. This was considerably closer than on previous voyages.

As in the past, the ability to determine whether a valid re-entry had been made was a concern as five to six additional hours are required to trip the scanning sonar tool if a false re-entry has been made. At Site 395, both the 14-7/8" bit and 11-3/4" casing took noticeable weight during the lowering of the first 30 meters after successful re-entries. In retrospect several stabs judged unsuccessful at the time, may have been successful. Four of thirteen attempts were judged unsuccessful with one resulting in the loss of a bottomhole assembly when the drill string apparently hit the rim of the cone. Nine successful re-entries were made which included all seven of the last seven attempts.

Despite the improved ability to re-entry that came with experience, a means was still needed to assist in determining whether valid re-entries were being made. To this end the scanning sonar tools were fitted with hydrophones which provided an audible signal during and after a re-enter attempt. When used, a signal was received which appeared to be in response to the drill string moving inside the casing. The technique cannot be considered proven as it has not as yet been down when an unsuccessful attempt is made, however, it shows promise of providing the additional information needed.

Maneuvering of the vessel for re-entry was somewhat handicapped by the malfunctioning of the dynamic positioning system and the continual heading changes required by weather conditions. Average maneuvering time was two hours ten minutes (See Figure 2). The actual time to approach the target improved and methods for determining the sea floor location are considered adequate.

CORING EQUIPMENT

The overall recovery of cores in the basalt sections was indeed low. It is doubtful that it can be increased significantly with the present core bit design, however, new designs now being built which place the inner barrel closer to bottom should help.

Some improvements should be possible in the present coring system by careful review to remove all enlargements and/or restrictions from the system. Possibly a hard metal application in the throat of the bit would overcome oversize cores from jamming the inner barrel. The entrance to the inner barrel should be restricted to the size of the catchers. Utilization of second hand short pieces of butyrate liner by splicing with glue was used with success. They had formerly been discarded. Necessary tools and techniques had been worked out by the SIO laboratory officer.

The drill pipe pinger/piston corer was used at Site 395, Pilot Hole. Location of the sea bed was seen on the PDR. No core was obtained and the pinger was damaged during handling. The concept of a dual purpose tool is of doubtful validity and it is recommended that the pinger be developed separately as a tool for locating the sea bed only.

On one occasion, a plastic sock came loose while coring soft sediments and plugged the inner barrel check valve. A stronger sock material should be developed to prevent this.

DRILLING EQUIPMENT

Even though 17.5 hours were lost in making repairs of various types, the overall equipment performance was good. Probably the most aggravating and time consuming piece of equipment was the newly installed pipe stabber on which over seven hours of actual downtime was recorded, plus many long trips where hydraulic fluid drenched the rig floor. The problem was in the hydraulic actuator for the gripping head that takes hold of the pipe. Adequate spares were not aboard. The unit was rebuilt by the mechanic and welder several times before sufficient strength was achieved in the actuator head. Once accomplished, the unit performed well and is a decided improvement over the previous equipment.

Early in the voyage the drawworks auxillary electric brake failed to engage several times. The fault was traced to a micro switch in the control mechanism. The underlying fault appears to be the accumulation of moisture in the box. At present, this box is covered by plastic. In the long term, a heater or something similar is indicated.

On the voyage to Site 395 from San Juan, new vibration dampener hoses were installed in the Bowen hydraulic pump unit. Only one failure was noted during the voyage and this was attributed to a faulty union and not vibration, In the past this has been a constant problem area.

On two occasions a connecting link between the travelling blocks and the drill pipe elevators came loose while tripping the drill pipe during times of heavy rolling. The Safety dogs were found to have been trimmed with a torch and were built up with weld material. On one occasion the fault went unnoticed and, when a strain was taken on the drill string, the S-135 drill pipe parted due to the eccentric loading. Close inspection will be required in the future to avoid loss or injury.

Even though the heave compensator had been in use during the Engineering Voyage, considerable troubleshooting was required to isolate an electrical fault in the Ohmstead safety valve closing circuit. Once this was done the compensator was placed in service in the passive mode. Handling of the cylinder was accomplished with ease even in fairly severe weather conditions. The use of the compensator does restrict the amount of head room for making connections. Care was required to insure that each connection was made down fully to avoid plugged bits. A longer heavy wall pup joint beneath the power sub would be worthwhile to improve the compensator's ability to work.

On Site 396, the heave compensator was tested in the active mode and weight fluctuations increased. Gains were reduced and weight fluctuations decreased to that observed in the passive mode. Troubleshooting was not successful in determining the cause and was hampered by inadequate documentation.

Due to engine/generator assignments the port mud pump was used frequently. This apparently has not been the case in the past and the absence of a stroke indicator on this pump made its use awkward. A unit should be secured and installed. The presently installed 6-1/2" liners provided an annular velocity of 125 fpm to carry cuttings out of the hole when the pumps were operated at full speed. Weather considerations did not allow the assignment of sufficient generators to parallel both pumps at full speed. It is therefore recommended that the pumps be equipped with the maximum liner size (or 7-1/4") which would increase the annular velocity to 160 fpm (a twenty five percent increase).

ENGINE ROOM

No major breakdowns occurred which resulted in any downtime until after the decision had been reached to return to San Juan early. Then while pulling drill pipe at Site 396, the motor bearing on No. 2 stern thruster failed and had to be secured to prevent further damage.

The bearing that failed had been noisy and running hot since early in the voyage. The same bearings on stern thruster No. 1 and bow thruster No. 1 are reported to be noisy. All three have been scheduled for replacement in San Juan even though installed new in Norfolk in October.

The port engine room blower required new bearings during the voyage. Generator 9A bearings which were renewed in Norfolk are also reported noisy and will be replaced. The use of considerable amounts of mud to help clean the hole at Site 395 of cuttings depleted the fresh water aboard. Consumption of potable water ran approximately 7,000 gal/day which was nearly 40% higher than normal and the ship's evaporators therefore had difficulty in adding to the drill water supply.

While sea water can be used in mixing muds it is doubtful that they are as effective as the fresh water muds in cuttings removal. Therefore, attention needs to be given to minimizing the consumption of fresh water for other purposes, to assure that the maximum amount of fresh water is aboard when departing port (even if less fuel is taken) and improving the reliability and/or performance of the ship's evaporators. In addition, some fresh water that is now discarded (i.e. photo wash water) could be saved for mud mixing.

A considerable effort had been made during the Engineering Voyage to make the engine room "ship shape" after the major dry dock period in Norfolk. This work continued during Leg 45.

HOUSEKEEPING/STORAGE

The ship had recently been through a major dry docking. A great deal of work was required to return the vessel to "ship shape" condition. With the unusually long time on site, seamen were able to accomplish more than a normal amount of needed maintenance and cleaning. On the return to San Juan they were assisted by the drilling crews.

Many hand rails, guards and walks were improved. Particularly to the newly overhauled cementing unit and Schlumberger Mohole winch. The walkway between the core lab and the rig floor was widened.

Re-entry tools were cleaned and oiled promptly after each use. Scabbards were made to hold the 11-3/4" casing running tools.

COMMUNCATIONS

Excellent. Daily contact was maintained with the SIO radio station WWD and traffic was cleared daily. The volume of traffic appears excessive and both SIO and GMI need to take steps to slow the flow of messages down to a more reasonable level.

Commercial facilities were available for those desiring to send messages to their homes and families. The radio officer assisted by the laboratory officer was able to complete many phone patches to the U.S. which served as a good morale booster to many during the holidays.

ACKNOWLEDGEMENTS

The extension of capabilities demonstrated during Leg 45 took place only through the wholehearted support and hard work of all those aboard. At times when progress was slow or difficulties were encountered, it was gratifying to know that the entire ship was concerned and ready to assist. Many times it was necessary to improvize to overcome the problems at hand and there was always a spirit of helping displayed that went well beyond the normal areas of responsibilities. The dedication of the entire crew of the GLOMAR CHALLENGER and of the Leg 45 scientific party is gratefully acknowledged.

V.F. Larson

V. F. Larson
Cruise Operations Manager
Deep Sea Drilling Project

HOLE 395A

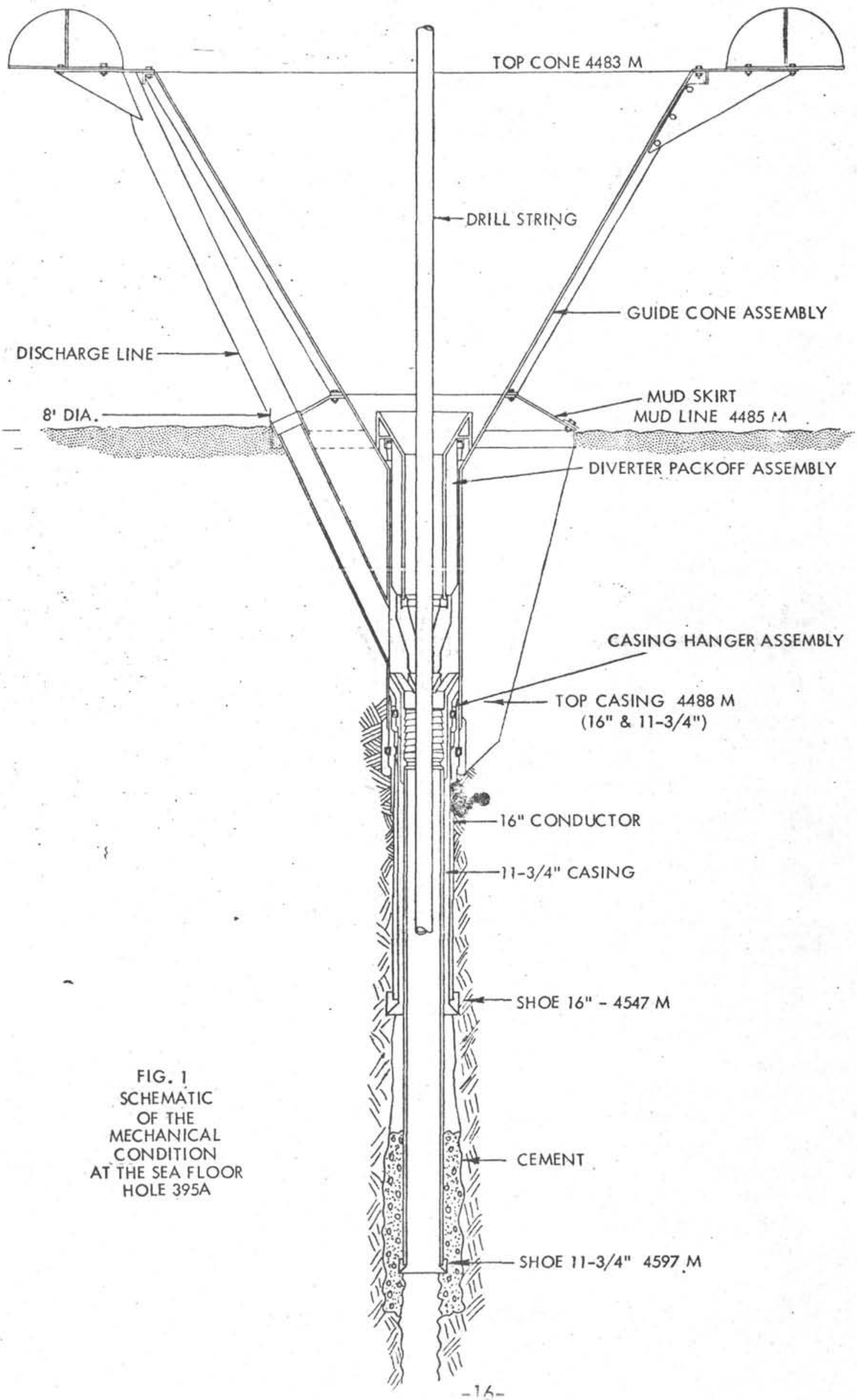


FIG. 1
SCHEMATIC
OF THE
MECHANICAL
CONDITION
AT THE SEA FLOOR
HOLE 395A

FIGURE 2

RE-ENTRY MANEUVERING TIME

SITE 395

Time required once scanning sonar on bottom until re-entry made. (successful re-entries)

Re-entry No.	Time/Date Tool Down	Time Stab Made	Elapsed Time
1	0225 hrs 13 Dec	0532	3 hrs 7 min
2	1935 hrs 16 Dec	2030	55 min
3	1807 hrs 19 Dec	2155	3 hrs 48 min
4	2030 hrs 24 Dec	2117	47 min
5	1920 hrs 27 Dec	2037	1 hr 17 min
6	0610 hrs 30 Dec	0816	2 hrs 6 min
7	2305 hrs 2 Jan	0318	4 hrs 13 min
8	2020 hrs 5 Jan	2250	2 hrs 30 min
9	1434 hrs 8 Jan	1519	45 min
		Average Time	2 hrs 10 min

FIGURE 3

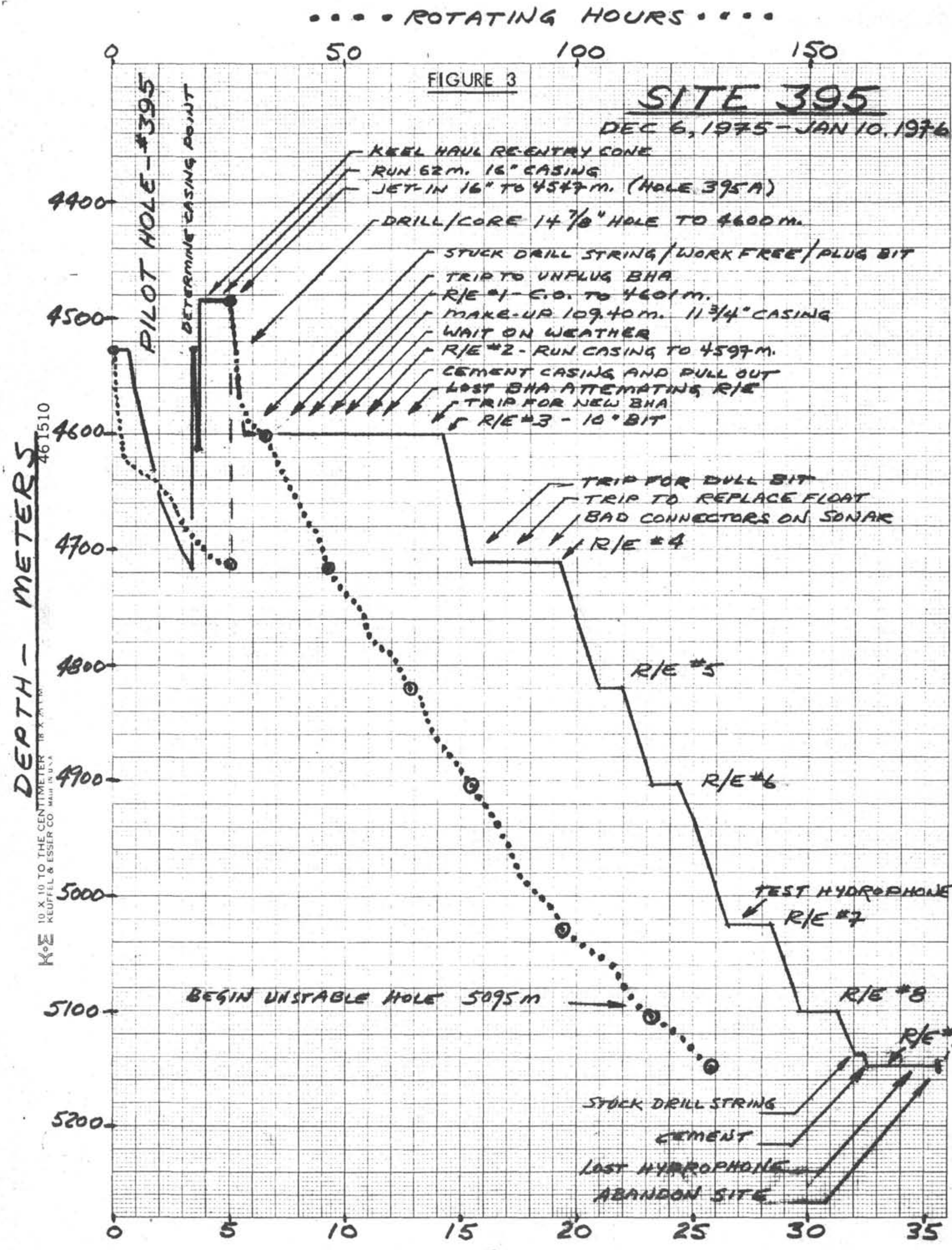
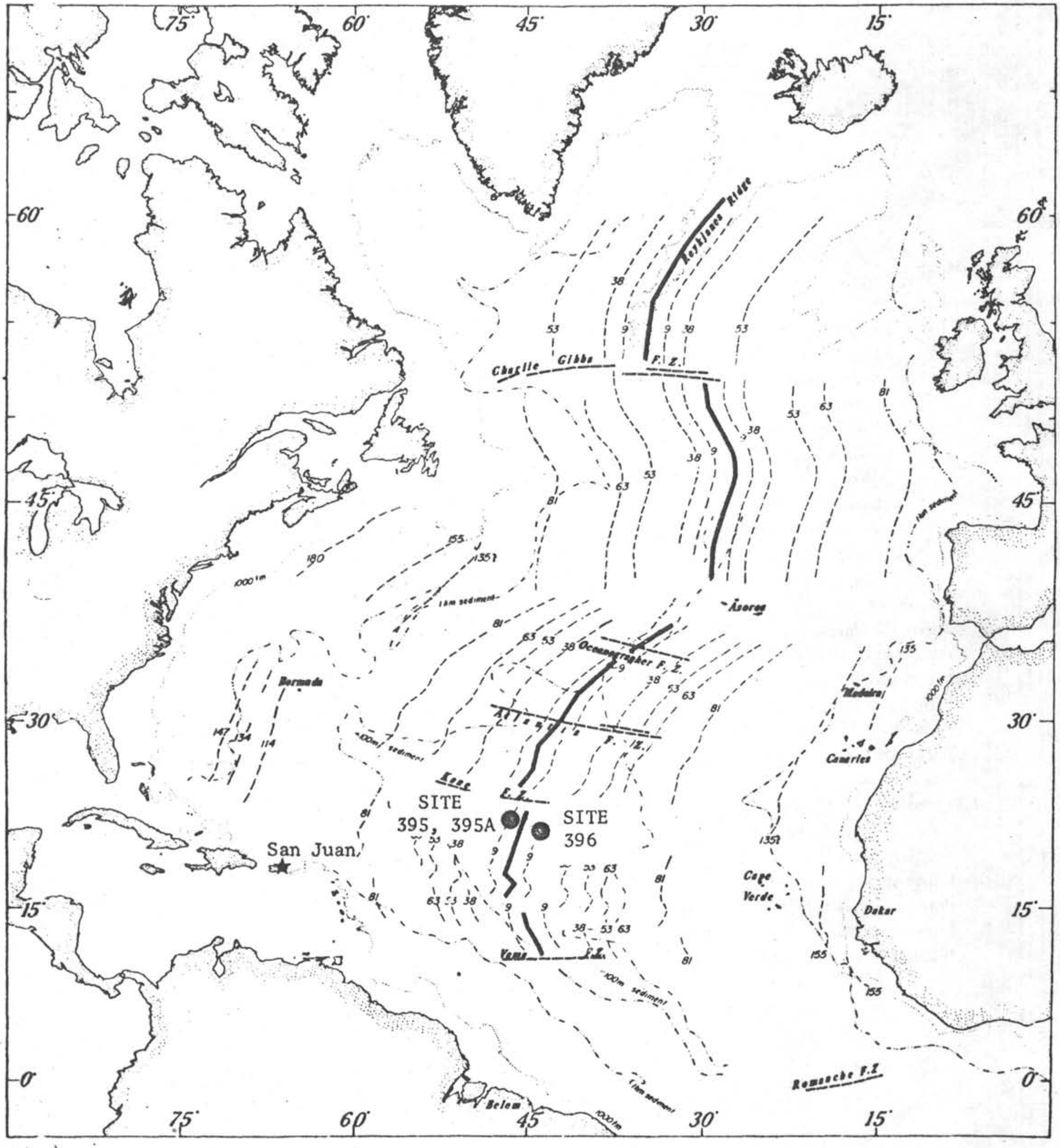

ROTATING HOURS
0
50
100
150
SITE 395
DEC 6, 1975 – JAN 10, 1976
PILOT HOLE – #395
DETERMINE CASING POINT
KEEL HAUL RE-ENTRY CONE
RUN 62 m. 16" CASING
JET-IN 16" TO 4547 m. (HOLE 395A)
DRILL/CORE 14 7/8" HOLE TO 4600 m.
STUCK DRILL STRING / WORK FREE / PLUG BIT
TRIP TO UNPLUG BHA
R/E #1 – C.O. TO 4601 m.
MAKE-UP 109.40 m. 11 3/4" CASING
WAIT ON WEATHER
R/E #2 - RUN CASING TO 4597 m.
CEMENT CASING AND PULL OUT
LOST BHA ATTEMPTING R/E
TRIP FOR NEW BHA
R/E #3 - 10" BIT
TRIP FOR DULL BIT
TRIP TO REPLACE FLOAT
BAD CONNECTORS ON SONAR
R/E #4
R/E #5
R/E #6
TEST HYDROPHONE
R/E #7
R/E #8
R/E #9
BEGIN UNSTABLE HOLE 5095 m
STUCK DRILL STRING
CEMENT
LOST HYDROPHONE
ABANDON SITE
DEPTH – METERS
4400
4500
4600
4700
4800
4900
5000
5100
5200
0
5
10
15
20
25
30
35
DAYS

FIGURE 4



LEG 45 DRILL SITES

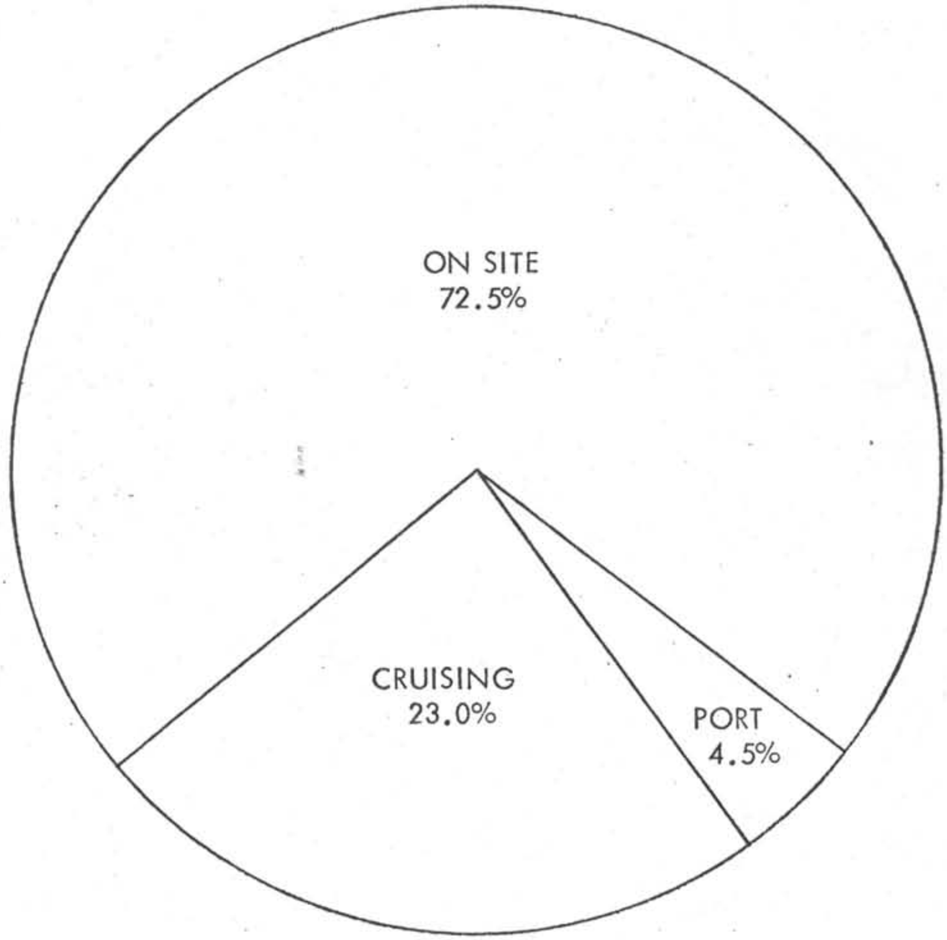
FIGURE 5

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS SUMMARY
LEG 45

Total Days (November 27, 1975 - January 20, 1976)		53.9
Total Days In Port		2.4
Total Days Cruising		12.4
Total Days On Site		39.1
Trip Time	13.1	
Drilling Time	0.1	
Coring Time	14.1	
Stuck Pipe	1.0	
Wait On Weather	0.2	
Position Ship	0.3	
Mechanical Downtime	0.7	
Re-entry Time	6.1	
Other	3.5	
Total Distance Traveled (Nautical Miles		2613
Average Speed		9.12
Number of Sites		2
Number of Holes Drilled		3
Number of Cores		112
Percent of Cores With Recovery		96.4
Total Penetration		1070.23
Total Meters Drilled		76.15
Total Meters Cored		994.08
Total Meters Recovered		327.61
Percent of Core Recovered		32.96
Percent of Total Penetration Cored		92.9
Maximum Water Depth (Meters)		4527.0
Minimum Water Depth (Meters)		4460.0

FIGURE 6

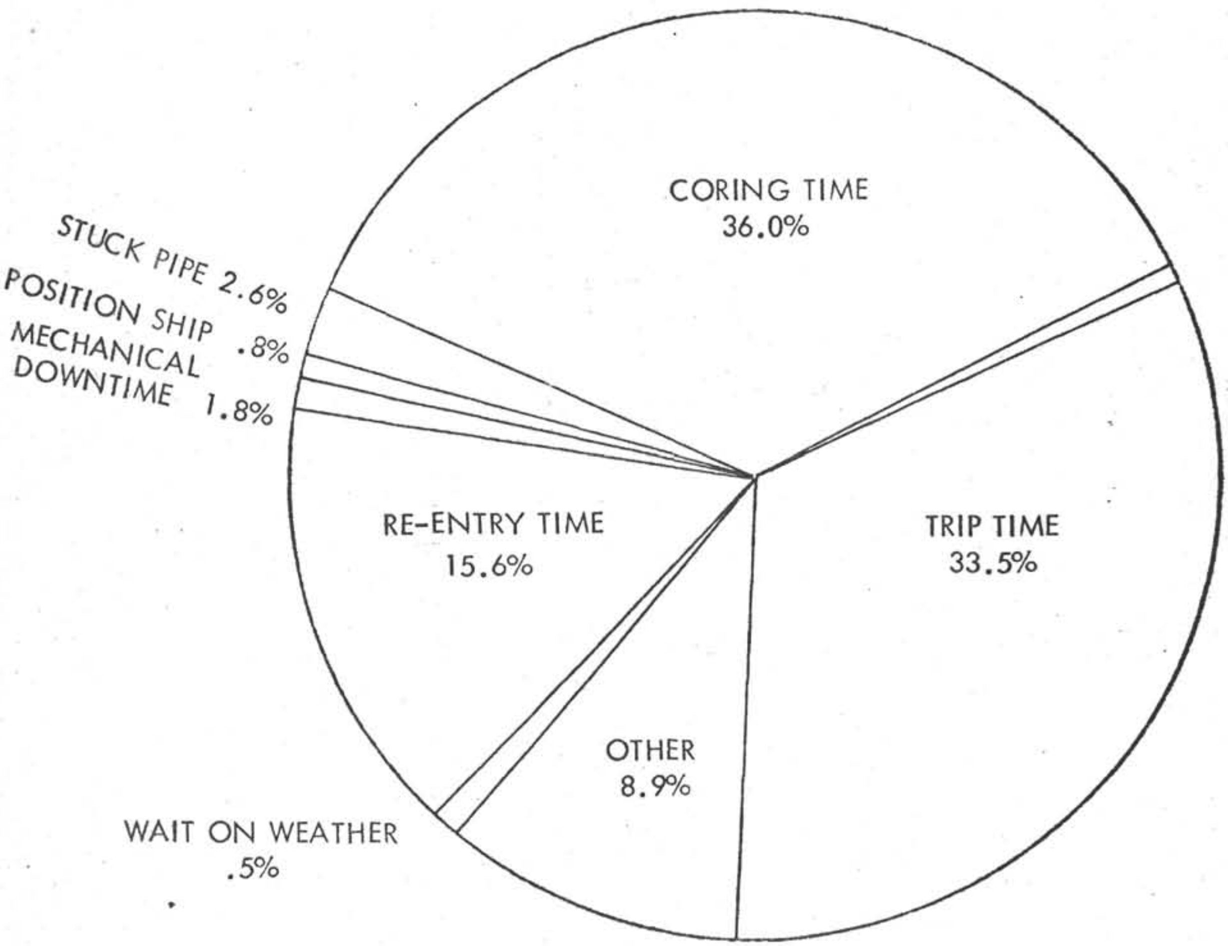
DEEP SEA DRILLING PROJECT
TOTAL TIME DISTRIBUTION
LEG 45



START LEG: November 27, 1975
FINISH LEG: January 20, 1976
TOTAL TIME: 53.9 Days

FIGURE 7

DEEP SEA DRILLING PROJECT
ON SITE TIME DISTRIBUTION
LEG 45



TOTAL TIME ON SITE: 39.1 Days
TOTAL SITES: 2
TOTAL HOLES: 3

FIGURE 8

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 45

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 M/Hr	Time On Hole Days	Time On Site Days
395	22° 45.35'N	46° 04.90'W	4528	20	20	100.0	184.65	88.36	47.85	0	184.65	7.54	3.7	
395A	22° 45.35'N	46° 04.90'W	4485	67	66	99.0	587.94	105.97	18.02	76.15	664.09	6.37	31.7	35.4
396	22° 58.88'N	43° 30.95'W	4460	25	22	88.0	221.49	133.28	60.17	0	221.49	9.13	3.7	3.7
	Totals		4491*	112	108	96.4	994.08	327.61	32.96	76.15	1070.23	6.98	39.1	

* Average

FIGURE 9

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 45

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
395	Smith	10"	F94CK	CC010	184.65	0	184.65	24.8	All cones & journals gone.	4527.69 - 4712.34
395A	Smith	14-7/8"	F94CK	697AN	39.27	76.15	115.42	7.6	BT-O, SE, O	4485 - 4600.42
395A	Smith	10"	F94CK	CA012	0	0	0	0		Lost with BHA on ocean floor.
395A	Smith	10"	F94CK	CA752	113.92	0	113.92	13.5	T-1, B-8, 0	4600.42 - 4714.34
395A	Smith	10"	F94CK	CA753	106.72	0	106.72	17.7	T-8, B-8, 0	4714.34-4821.06
395A	Smith	10"	F94CK	CA765	84.34	0	84.34	13.4	T-8, B-8, Cones Locked Skidded	4821.06 - 4905.40
395A	Smith	10"	F94CK	CA741	124.11	0	124.11	19.4	T-8, B-8, o	4905.40 - 4029.51, Heave Compensator
395A	Smith	10"	F94CK	CA282	74.12	0	74.12	19.1	18 BT, SE, 0	5029.51 - 5103.63, Heave Compensator
395A	Smith	10"	F94CK	KK987	45.46	0	45.46	13.7	BT-0, SE, 0	5103.63 - 5149.09, Heave Compensator
395A	Smith	10"	F94CK	CA768	0	0	0	0	T-1, B-1, 0	Clean out bit - suitable for rerun.
395A	Total of 9 Bits		F94CK		487.94	75.15	664.09	104.4		
396	Smith	10"	F94CK	CA766	221.49	0	221.49	24.2	All cones & journals gone	4460 - 4681.49

FIGURE 10

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 45

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours					
395	ORE	16.0	S/N 338	15 Days	Single Life	-	1153 Hrs	5 December	1975
395	ORE	13.5	S/N 314	10 Days	Double Life	-	1200 Hrs	21 December	1975
395	ORE	16.0	S/N 299	1-1/2 Hrs	Quad Life	-	0700 Hrs	31 December	1975
395	ORE	16.0	S/N 333	10 Days +	Double Life	-	0900 Hrs	31 December	1975
395	ORE	13.5	S/N 311		Double Life	-	0800 Hrs	10 January	1976
395	ORE	16.0	S/N 336		Double Life	-	1900 Hrs	15 January	1976
396	ORE	13.5	S/N 365		Single Life	-	0200 Hrs	11 January	1976
396	ORE	13.5	S/N 368		Double Life	-	2220 Hrs	14 January	1976

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 46

GENERAL

Leg 46 was the second part of a two Leg attempt at deep crustal drilling near the Mid-Atlantic Ridge. On Leg 45, the first attempt (west of the ridge) was terminated after making nine re-entries, due to unstable hole conditions. Recovery was poor. On Leg 46 a second attempt (east of the ridge) was again terminated after seven re-entries and again due to unstable hole conditions. Recovery was again poor. However, an extensive suite of wire-line logs were obtained to assist evaluation. This marked the first successful wire-line logging since Leg 6.

The ship departed San Juan, Puerto Rico on 28 January 1976 and arrived in Las Palmas, Canary Islands on 10 March 1976, after 42 days at sea. During this time two holes were drilled in a sediment pond just east of the Mid-Atlantic Ridge. The first of the two was a pilot hole to establish the amount of 16" casing needed for re-entry that could be washed or "jetted" into the ocean bottom. The second hole penetrated 405.5 meters in 24 days before it had to be abandoned because of unstable hole conditions. As on the Leg 45 attempt, 16" casing was attached to the re-entry cone and washed in until the re-entry cone was resting on the sea floor. A 14-7/8" hole was then drilled, below the shoe of the 16" casing, into the underlying basalt, 11-3/4" casing was then run and cemented through the upper sediments with the shoe firmly placed in the basalt. A ten inch hole was then drilled to total depth.

Six core bits were used to drill the hole and seven successful re-entries were required in nearly 4500 meters of water. When the unstable hole conditions caused an early termination of drilling, a suite of downhole logging instruments was run successfully.

Plans to drill a single bit hole about 1000 feet away from the re-entry hole, logging of the Leg 45 hole and a rendezvous with the research vessel *Knorr* for geophysical experiments were cancelled when the derrick was damaged. One of the guide rails which restrains the traveling blocks broke loose and bent the derrick to such an extent that it was unsafe to operate. The vessel then steamed to port at Las Palmas for repairs, resupply and crew change.

The Deep Sea Drilling Project is managed by Scripps Institution of Oceanography (SIO) under a contract with the American National Science

Foundation. Scientific planning is coordinated by SIO through the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES).

Funds for these operations are supplied by the United States, Germany, Russia, Japan, England and France. Drilling and coring operations are conducted by Global Marine Inc., under a subcontract with SIO.

PORT CALL - SAN JUAN, PUERTO RICO

The *Glomar Challenger* arrived in San Juan, Puerto Rico at 13:18 hours on 20 January 1976, at which time Leg 45 ended. Extensive mechanical repairs were required. These were well beyond the normal routine and the ship was in port for over eight days. The ship departed San Juan at 14:45 hours, 28 January 1976.

The main project was bearing replacements on all four thruster motors. An attempt to make the heave compensator operable in both the passive and active mode was not successful. During Leg 45 one thruster motor bearing had failed and one bearing was noted to be noisy. When the failed bearing was removed it was discovered that the new bearings installed during the recent dry dock period were the wrong type. Steps were immediately taken for bearing replacement on all thruster motors. Extensive check-out and tests of the heave compensator lasted five days. Brown Bros. representatives in attendance were confident that the system could be relied upon to operate in either the passive or active mode when they had finished. This did not prove to be the case, subsequently.

In addition, all of the drill pipe had a tuboscope inspection. Two joints were found suspect. The engine room had the opportunity to tear down and overhaul both #9 and #11 generators.

An abnormally large supply of meat and other food was loaded and 200,000 gallons of fuel was taken on. Special supplies consisting of 42 boxes of Schlumberger equipment and 1-1/2 tons of geophysical equipment was also loaded. Over one fourth of the meat could not be loaded aboard the vessel due to insufficient storage space.

The longer than usual port call gave the drilling crew and welder the opportunity to check-out and put together a complete re-entry cone on the dock. It was then placed on the casing rack for use at the first site.

OBJECTIVES

The prime objective of combining Leg 45 and Leg 46, to drill one hole as deep as possible into the ocean crust was lost when it became necessary to abandon Site 395A on Leg 45 because of unstable hole conditions. However, the objective of Leg 46 continued to be maximum penetration of the basalt near the Mid-Atlantic Ridge. There the ship headed, to an area east of the ridge, where a pilot hole had been drilled on Leg 45. A re-entry cone and 16" casing would be washed in, a 14-7/8" hole would be drilled into the basalt, and casing would be cemented through the overlying sediments. This would prevent the upper sediments from washing out which would in turn provide for effective cuttings removal of the basaltic rocks.

A rendezvous had been arranged with the research vessel *Knorr* to allow for some geophysical experiments which required shooting explosives at a considerable distance from the vessel and measuring the travel time of sound to geophones in the hole. Therefore, the plan was to drill as deeply as possible until three days before the arrival of the *Knorr*. Then pull the bit and re-enter to record a series of downhole logs through the drilled interval. These logs would include gamma/sonic, gamma/neutron/density and gamma/dual induction. Following this a clamped geophone experiment would be conducted using the *Knorr* to supply and shoot the explosive charges required. Then both ships would move back to Site 395A on Leg 45, re-enter, run logs, and conduct the clamped geophone experiment again. If all was successful, the *Knorr* would then photograph the re-entry cone and the surrounding ocean floor. Heat flow measurements would be taken during the drilling operation and just before start of the downhole logging program at both locations.

SITE 396-HOLE A

As discussed above, the revised prospectus called for drilling near Site 396, a pilot hole drilled on Leg 45. While enroute to this site the ship passed Site 395A and dropped a beacon to assist in locating it when ready for logging.

After arriving in the vicinity of Site 396 additional profiling of the sediment pond was done to determine the best location for drilling. A minimum of 100 meters of sediments was needed to support the BHA while spudding. A new beacon was dropped, but an unexpected narrowing of the pond caused the beacon to land in outcropping basalt. Due to this unfortunate incident the Co-Chief Scientists decided to return to the vicinity of Site 396 for coring. The beacon left there on Leg 45 was still operating.

The water depth as measured by the Precision Depth Recorder (PDR) at this location was 4463 meters. The drilling assembly was made up and the drill string was measured while running in to drill the pilot hole. The drill string located bottom at 4465 meters by coring. The pilot hole was washed in to determine the amount of 16" casing to attach to the re-entry cone. Three heat flow measurements were taken at different depths as the hole was washed-in without rotation to 123.5 meters. Based on this a casing point of 120 meters was selected for the site.

HOLE 395B

The re-entry cone which had been assembled in San Juan was picked up and keel hauled with no problems. The cone used was the basic IPOD design without the mud skirt extension.

Eleven joints of 16" casing, totaling 120 meters, were made up and locked with epoxy. This string was then lowered and hung off in the moon pool. The bottom hole assembly was made up and run with the lowering tool located so that the bit was flush with the 16" casing shoe. The lowering tool was attached to the 16" casing, and the casing was then lowered into the cone to latch it in place. On the first attempt the snap ring would not engage. When the casing head was pulled up to the deck, the snap ring was found sprung about 3/4". It had apparently jumped out of its groove on the casing head while lowering and then slid back into the groove when pulled up. The snap ring was changed and would not engage when lowered again. When again pulled to the deck the snap ring was gone. Repeated attempts were made to re-engage or retrieve the ring without success. After many hours the ring was finally retrieved using a homemade fishing hook. When measured on deck the distance between the ends of the ring was found to be 27". When new the distance is 3". A new ring was then installed and this time successfully latched into the cone. After latching the casing into the cone, lowering of the casing cone was delayed seven hours until repair was made to the bow thrusters. This thruster problem was due to over heating of some relays in the engine room. This was cleared up by directing ventilation to the relays. The casing was then lowered and washed in to 4585 meters and released. This placed the base of the re-entry cone at 4465 meters.

After releasing the casing a 14-7/8" hole was washed for 2 meters and then continuously cored to 4631.5 meters. The top of the basalt was located at 4616.5 meters. At 4631.5 meters the hole was flushed with 50 BBLS. of 9.2 ppg. 68 second viscosity mud and the pipe was pulled to the shoe of the 16" casing. After waiting 30 minutes, it was run back to bottom. No fill was then found. Then 120 BBL. of 9.0 ppg. mud was spotted and the pipe was pulled out of the hole.

163.10 meters of 11-3/4" casing was made up which would place the shoe about 3 meters off bottom. This operation was delayed for 10 hours because of a computer memory power supply failure. The problem was found, resolved, the program reloaded and normal positioning operations resumed. A total of 15 joints of 11-3/4" casing were needed. Collars were tack welded. The cementing stinger and running tools were made up and then latched into the casing. The casing was then lowered to 4452 meters, on the drill string, or 9 meters above the top of the cone which was at 4461 meters. The scanning sonar equipment was then rigged, and run to the bottom of the casing. After 53 minutes of maneuvering re-entry was accomplished. The casing was then run to bottom and hung at 4628.0 meters. A check was made to assure that the casing was latched on and then released from the drill string. The mud was then circulated out and the cementing lines were hooked up. After the 275 sacks of cement were mixed, the wiper plug was inserted and pumped down and bumped with 1000 psi. When the pressure was released, two stands of drill pipe were pulled and an attempt was made to circulate out the residual cement. Pressure up to 2000 psi was unsuccessful in establishing circulation. It was finally necessary to pressure up to 3000 psi before circulation was established. After completing this the drill pipe was pulled out of the hole to make up the conventional coring equipment set up.

Penetration rates in the basalt were slower than rates enjoyed on Leg 45, while using more or less the same drilling weight, pump pressure and rotary speed. The average bit life was 12.2 hours and the average penetration was about 50 meters per bit while drilling the basalt.

Re-entry never became a routine procedure even though 7 re-entries were made while at this site. Re-entry was similar to those described in the Leg 45 summary and different from previous experiences in that the drill string was apparently moving faster and required the sonar tool to be closer to the cone in order to stab while the drill string was in motion.

Following re-entry #5 the core recovery began to decrease quite markedly. This was attributed in part to the deteriorating weather conditions. The drill string was pulled after cutting only 4 cores and 5-3/4 rotation hours on the bit. Increased torquing was observed during drilling and the bit also plugged occasionally during recovery of the inner core barrel. The main reason the string was pulled however, was because the ship was rolling 5-7° and frequently 9-11°. When the weather calmed, and a new re-entry was made it was necessary to ream 38 meters to bottom before coring could be started. Total core recovery for the first 3 cores after the new bit was reamed to bottom was 0.08 meters. After the third core barrel was retrieved the hole was conditioned for approximately 3 hours. The first core cut following the conditioning was from 4842-4847, required only 7 minutes to cut and recovered 1 meter of loose glassy basaltic sand. Before coring the next 4.5 meters 15 BBLS. of mud were spotted. This core required only 12 minutes to cut but recovery was zero (in both of the last two cores a plastic sock was used with the upper core catcher). While the last core was being cut a leak appeared in the stem of the National Swivel. The Bowen Unit was set back and the swivel replaced. After replacing the swivel, 2 more cores were cut to a total depth of 4870.5 meters. While retrieving the last core, the drill string became stuck and circulation was lost. It required over 50 minutes to free the pipe and regain circulation. It was decided at this point that further attempts to core would unnecessarily endanger the drill string with almost no chance of successfully deepening the hole. As in Leg 45 the hole was abandoned because of unstable hole conditions. However, the hole was filled with mud to assist the downhole logging program.

The logging program involved running four different logs, gamma/sonic, gamma/density/neutron, gamma/dual induction and will be discussed later in this report. Following the logging, a clamped geophone experiment was tried inside the drill pipe, and then a hydrophone was lowered into the open hole. However, neither experiment could be considered successful, apparently the sound source used could not override the noise from the drill pipe inside casing.

HOLE 396C

After completing the logging at Site 396B it was decided that a one bit hole drilled approximately half way between 396 and 396B would add considerably to the data gathered so far in the area. Also there would be sufficient time to accomplish the drilling before the scheduled rendezvous with the *Knorr*.

The ship was moved into position and the drill string was made up and run in to 4455 meters which was 10 meters off bottom. The Bowen Unit was picked up and as the torque arm was being installed it was observed that the starboard guide rail was approximately 2 feet lower than the one on the port side. An inspection of the crown revealed that the pad eye holding the guide rail to the water table had broken. Repair operations began immediately, but as daylight occurred it became evident that damage had been done to the derrick itself. The two cross members at station 17 and 19 as well as the diagonal bracing had been badly bent. The aft starboard leg was also bent and slightly twisted as well as being pinched in about 1-1/2" at and above station 17.

There was a great deal of concern that the derrick would not be safe to pull the 4400 meters of drill pipe hanging in the slips. However, after about 12 hours, and consultation by radio with people on shore, it was decided to try and carefully pull the string. It was further decided that when the pipe was on board, that the ship should go to Las Palmas and have the necessary repairs made on the derrick. Over 30 hours were spent on this site and no cores were taken.

DRILLING AND CORING ASSEMBLY

The standard DSDP bottomhole assembly which consists of a bit, bit sub, (with float valve), core barrel, top sub, latch sub, three 8-1/4" drill collars, one five foot stroke Baash-Ross bumper sub, three 8-1/4" drill collars, two 5' bumper subs, two 8-1/4" drill collars, one 7-1/4" drill collar, one 5-1/2" heavy wall drill pipe, was used while drilling 396A and on 396B until the heave compensator was placed into operation. The modification that was then made consisted of adding another stand (3) of 8-1/4" drill collars between the lower and upper bumper subs. This was done to allow more weight to be exerted on the bit without the danger of exerting too much weight on the drill pipe. For logging operations the top two bumper subs were removed. This was done to reduce the possible restrictive action created by the mandrel. The standard bottomhole assembly had been made up and run at Site 396C before the hole was aborted.

CORING AND DRILLING EQUIPMENT

The standard inner core barrel was used for all the coring on this Leg and proved quite satisfactory even though the recovery was low. The only variation was the addition of the soft core catcher and plastic sock to the upper catcher in the bottom portion of Site 396B. This modification contributed to the recovery in two cores of extremely loose, coarse, angular glassy basalt.

Only one major equipment failure occurred (other than the guide rail dropping) and that was in the swivel assembly. Core 31 had been nearly cut when a stream of water appeared to spray from the packing of the swivel, however on closer observation, it was found to be a crack in the stem of the swivel. The water would only spray when the full weight of the string was on it and not when pipe was placed on the elevators. It was necessary to change the swivel assembly for the new one put on board in San Juan. The whole operation took about four hours.

The newly installed pipe stabber again caused trouble as it did on Leg 45 with hydraulic fluid again leaking out and drenching the floor. This problem was eventually solved when the rig mechanic found that the head seals were not quite thick enough and the body was sealing off before the seals. To overcome this, one layer of teflon tape was placed under the seals and all leaks stopped. These repairs were made while the operation was waiting on the weather to improve.

The heave compensator was not picked up and put into the drilling string until after re-entry No. 3 however, the bypass valve on the heave compensator could not be made to operate so it was set back to correct this problem. Following re-entry No. 4 the heave compensator was again used to cut cores 19 and 20 after reaming three meters. During this time the heave compensator did not operate with 100% efficiency. Strokes were irregular and at times would lift the weight off of the bit. The air and hydraulic pressure were adjusted and it seemed to operate better with 2240 lb air pressure and 2310 lbs hydraulic pressure, however, these pressures are lower than prescribed on the chart for a 360,000 lb load, but this has been normal in the past. After making the connection to cut core No. 21, an attempt was made to scope the heave compensator and the piston bottomed out on the down stroke. At the same time the shear relief valve on the hydraulic line stand pipe released. This valve had also released just prior to picking up the compensator from the racker. The hydraulic pressure was regained and the system circulated to remove any possibility of air. Each attempt to put the compensator in operation resulted in the piston bottoming out on the down stroke. The pressure on the anti-slingshot valve was raised from 50 lbs to 150 lbs with nitrogen. It continued to appear that the anti-slingshot valve was not operating properly, so it was decided to set the compensator back for reasons of safety. Each time the shear relief valve released it resulted in a loss of hydraulic fluid and as there was a minimum amount of fluid, it was considered advisable to continue to troubleshoot and save what fluid was left for the downhole logging program, particularly the clamped geophone experiment. The heave compensator was not used for the logging at Site 396A because the sea conditions did not require its use and the clamped geophone experiment was not attenuated at this site.

CORE BITS

During the drilling of Site 396A and B one 14-7/8" and five 10" bits were used. The 14-7/8" bit was a rerun which was used for 16.93 hours and can still be used for a re-entry operation for drilling hole for the 11-3/4" casing. Four of the 10" bits were F94CK and one was a F99CK. The average bit life of the five bits was 12.2 hours and when recovered four of the five were 1/8"-1/4" out of gauge. The average penetration rate for these bits to cut 33 cores was 8.35 meters/hour.

The heave compensator was used only while cutting cores #19 and 20, so a comparison of the bit life while using the compensator as opposed to when not using it could not be made.

The one F99CK bit which was used had a life of 11.86 hours which was about the average and cut 38 meters of core. The F94CK which followed it also cut 38 meters but lasted only 5.75 hours and the bearings were loose when the bit was recovered. Both bits were pulled when the core diameter had decreased to 4 cm. This has been established as a fairly accurate appraisal of bit condition and proved to be quite valid in the drilling on Leg 46. In all cases the decrease in diameter appears to relate to the flaring of the core guides.

Variations in torque did not seem to relate to the bit wear so it was used only as a plus value when core diameter had decreased and it was decided to pull the bit.

BEACONS

Four ORE beacons were dropped on this Leg, three double life and one single. However, another beacon (13.5 double life) was also used which had been dropped by the previous Leg to assist in returning to that particular drill site.

One beacon (13.5 double life) was dropped at Site 395A enroute to the area of Site 396. This was done so the ship could return and hopefully re-enter to carry out a downhole logging program. Another double life was dropped but not used because it landed in an unfavorable location. It did create some positioning problems later.

The beacon that was dropped 14 January 1976 on the previous Leg was a double life and was used for positioning until 13 February 1976. A truly great beacon. When this beacon weakened a 16.0 single life was dropped and worked fine for 14 days until the gains had to be turned up and then the double life 16.0 kHz that had been dropped and not used, caused interference and required an additional beacon to complete the hole. In general, all the beacons performed very well.

POSITIONING

Positioning on this Leg was generally good. Some problems were encountered but all of these were resolved with a minimal effect on the drilling operation. The problems that developed and their solutions are listed in chronological order.

1. The ship started moving off position slowly because the bow thrusters were not operating. This turned out to be due to an overheating of relays in the engine room. As soon as proper circulation was established, the problem was corrected.

2. The computer memory power supply failed. It was found that PT-17 circuit breaker CB-1 popped off and would not stay reset. All possible problems were investigated in this area before looking elsewhere. Then a neg 8-volt fuse in PT-16 was found to have blown, this was replaced and the system came up. Then all voltages were aligned to the proper voltage, gain changes were made and the program reloaded. The normal operation was resumed after 10 hours of downtime.

3. Incoming signals from 2-16 kHz beacons caused the computer to become confused and tried to position on both at once. This problem was corrected when a 13.5 kHz beacon was dropped.

4. The last problem resulted from radio transmission causing erroneous heading error, which in turn caused the thrusters to operate maximum rpm, bow and stern in opposite directions. This caused the ship to move off position 400 feet. The problem was a filament voltage ground in the radio transmitter. This was fixed and no more problems developed.

RE-ENTRY

Re-entry enjoyed a high degree of success in that seven out of ten re-entry attempts were successful. The first re-entry stab was successful, then the second attempt was not completed when the 8 degree transducer was lost and the tools had to be changed. On the third attempt, after stabbing, the string started taking weight when the first joint in the second stand was being lowered. The fourth re-entry attempt was not successful in that soft mud was recovered in the core barrel when the stab was verified. The fifth attempt at re-entry was successful (2nd) when a verification core was taken and recovered cement which had equalized inside the 11-3/4" casing. Each of the re-entry attempts after this were successful until the site was abandoned.

The sonar tool was lowered to 4445 meters in about two and one half hours which was considered fast enough. Even at this speed, with pumps circulating sea water, the cable was found to be kinked above the connector four times and required reheading before it could be run again. The tool was retrieved in about one and one half hours.

The scanning sonar performed very well and the only malfunction was the loss of the 8 degree transducer on the second re-entry attempt.

As experienced on Leg 45, the depth of water, the weather and sea conditions contributed to a great deal of string motion. Again, it was necessary to attempt re-entry when the drill string started over the cone and the 25 foot range was in use. The sonar tool usually was held about five meters above the cone until the targets could be identified, then was lowered to three meters for final positioning and stabbing. The rapid and eccentric motion of the drill pipe required that the tool be this close to the cone.

Most of the difficulty in re-entering was the difficulty of maneuvering the ship over the cone after the targets were identified at about 40 feet. The repositioning when using the 50 foot range finder seemed to amplify the excursions and eccentricities of the pipe motion. Another thing that created a problem was the poor presentation of the targets on the 25 foot range toward the end of the site drilling. It appeared that a sediment cone had built up and was masking the targets. Possibly the tethering of targets on rope or light cable as was done on Leg 45 would help to correct this problem. As each re-entry attempt was made, it seemed that there were more and more objects that were being reflected. It would be worthwhile on future Legs to see if these same things are observed. The belief on this Leg was that these reflectors are objects thrown from the vessel and sink to the bottom near the area of the cone.

LOGGING

One of the objectives of the IPOD program was to have a deep penetration of the ocean crust with hopes that the rocks penetrated could be documented with downhole logging equipment. This was to be accomplished by Legs 45 and 46. A double Leg penetration was not possible due to unstable hole conditions developing on the Leg 45 drill sites. However, through the cooperation of Schlumberger Well Logging Services both the logging tools and an engineer were provided at no cost other than freight charges and transportation for the engineer to attempt to log any hole drilled on Leg 46 and possibly the site on Leg 45. This would be the first downhole logging attempted since Leg 8 in 1969.

Site 396B was drilled to a depth of 405.5 meters below the ocean floor and then had to discontinue drilling due to the same unstable hole conditions that terminated drilling on Leg 45. The drill string was pulled and a modified bit assembly replaced the regular drilling bit and bit sub.

The logging tools to be run were the same as those used every day for logging wells in the petroleum industry. The hole was re-entered and the first tool to be run was the gamma/sonic. It was run in the hole and a log recorded. When the second log, a gamma/density/neutron, was made up and run it appeared unable to leave the bottom of the drill pipe which was hanging about 50 meters above the shoe of the 11-3/4" casing. A centralizing spring was removed and the tool rerun. Again the tool seemed to stop but more cable was run off and the tool came out of the drill pipe. A partial malfunction in the tachometer gear box showed more cable run than had actually been unspooled. This defect was corrected and the log was run and recorded. Due to the tachometer malfunction the gamma/sonic was rerun to the proper depth. When the two gamma sonic logs were compared it could be observed that the first run had actually logged the casing from the shoe to the bottom of the drill pipe.

The third log run was the gamma/dual induction and it was run with no trouble. A fourth log, the temperature log, was not run because the bottomhole temperatures were too low to be recorded with that particular tool.

Each log was run over the same interval twice for repeat comparison. Also each tool did not reach the same total depth probably because of hole conditions plus the difficulty of determining when the tool had bottomed. In addition, each log was digitized on tape which will undoubtedly help in the final interpretation of the logs. The logs were logged in feet because the equipment had been assembled in the U.S. where all recorders are in feet.

The rigging up of the first logging tool began at 10:00 on 28 February 1976 and the last tool came on deck at 20:00 on 29 February 1976, for a total logging time of 34 hours. It took this long because additional trips were made to relog the gamma/sonic and also to remove the bottom centralizer spring on the gamma/density/neutron log. It is estimated that if the same logs are run in the future it would probably only require fifteen to eighteen hours.

The initial interpretive comparisons that have been made by the scientists to the recovered rocks has met with a great deal of enthusiasm. It appears that the logs can supply many answers where core recovery is low.

HEAT FLOW

There were six heat flow measurements taken on this Leg. Three were taken while washing with a 14-7/8" bit through the sedimentary section with the fourth being taken just one meter above the contact with the basalt through the 14-7/8" bit. The fifth reading was made with the 10" bit and covered the interval 4739.0 meters to 4767.5 after the fifth re-entry had been confirmed. The last reading was taken after the down-hole logging had been completed.

The heat flow measuring tool was made up and lowered on the sandline in the inner core barrel usually reserved for the center bit. In the first three attempts it was lowered after a certain depth had been reached. The fourth took three measurements as a stand was lowered without circulating. The last reading was obtained after the core barrel was allowed to free fall.

There are two tool set-ups depending on whether a 14-7/8" or a 10" bit is being used. When using a 14-7/8" bit the make-up from top to bottom is as follows: Top 15' section with pulling neck, a 12' section, a baffle inside turned up, 3' pup joint, 7-7/16" landing sub, 14-7/8" sub, 8-1/4" core catcher sub. With this assembly a 8" spring should be placed at the top of the tool, a 8" spring at the bottom, then the steel retainer plate which rests on the shoulder of the core catcher sub through which the probe extends below the core barrel. For the 10" bit the changes required are, turn the baffle plate around, change out the 14-7/8" with a 9-3/4" sub and replace the 8" springs with 4". A 56" plastic liner should be placed in the assembly below the baffle plate in both cases.

COMMUNICATIONS

Generally, communications with WWD in La Jolla were very good. Messages were sent and received twice daily except when atmospheric conditions made this impossible. WWD was using the 17 MHZ transmitter due to technical problems with their 12 MHZ transmitter, however, one problem did arise due to using only the 17 MHZ frequency. Radio IRM in Italy uses the same frequency and caused heavy interference to WWD when it was in use, therefore, WWD could only be copied when IRM signals began to fade.

Commercial communication was possible daily but was not used to any great extent. Most messages sent by the foreign participants on the cruise were sent to WWD for rerouting to their desitnation, however, a few messages were sent direct.

Personal radio telephone calls were made through amateur radio operators and the results were very satisfying. On one occasion when commercial radio could not be contacted, the amateur operators made it possible to complete a very important call.

ACKNOWLEDGMENTS

Although all the objectives of Leg 46 were not accomplished due to the unexpected termination of drilling, a fairly high degree of enthusiasm was generated.

The Global crew attempted to the best of their ability to achieve the maximum success both in core recovery and re-entry. The same can be said for the enthusiastic support supplied by the SIO technicians. In addition, the success of the logging program was realized only through the diligence of Rudy Aguilar the Schlumberger logging engineer. He not only prepared his tools but was a great deal of assistance to the electronic technicians.

The scientific party, again represented by many countries of the world, retained an enthusiastic attitude and a great deal of pleasure was derived from their dedication.

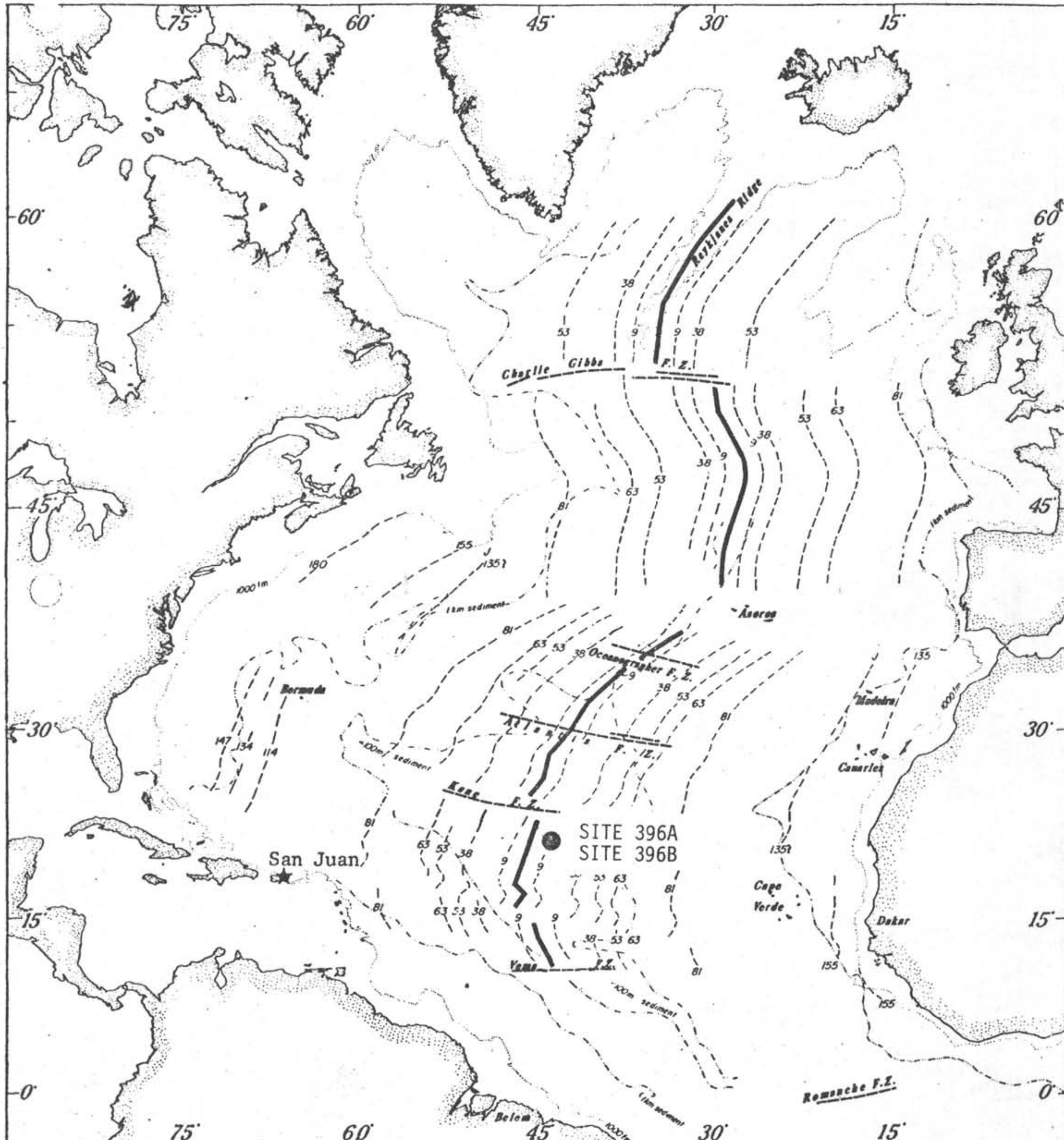
R.R. Knapp

R.R. Knapp
Cruise Operations Manager
Deep Sea Drilling Project

DEEP SEA DRILLING PROJECT
IPOD
OPERATIONS RESUME
LEG 46

TOTAL DAYS (20 January 1976 - 10 March 1976)			50.05
TOTAL DAYS IN PORT			8.05
TOTAL DAYS CRUISING INCLUDING SITE SURVEY			14.6
TOTAL DAYS ON SITE			27.4
Trip Time	196.45 hrs.	8.3 days	
Drilling Time	24 "	1.0 "	
Coring Time	109.45 "	4.5 "	
Positioning	11.8 "	.5 "	
Mechanical Downtime	41.0 "	1.70 "	
Re-entry	77.7 "	3.24 "	
W.O.W.	15.55 "	.66 "	
Other	183.55 "	7.5 "	
TOTAL DISTANCE TRAVELED (Nautical Miles)			2934.8
AVERAGE SPEED (knots)			8.4
NUMBER OF SITES			0*
NUMBER OF HOLES DRILLED			2
NUMBER OF CORES ATTEMPTED			35
NUMBER OF CORES WITH RECOVERY			32
PERCENT OF CORES WITH RECOVERY			91.4%
TOTAL METERS CORED			283
TOTAL METERS RECOVERED			64.2
PERCENT RECOVERY			22.6%
TOTAL METERS DRILLED			356.5
TOTAL METERS OF PENETRATION			529.0
PERCENT OF PENETRATION CORED			53.4
MAXIMUM PENETRATION (meters)			405.5
MINIMUM PENETRATION (meters)			123.5
MAXIMUM WATER DEPTH (meters)			4465
MINIMUM WATER DEPTH (meters)			4465

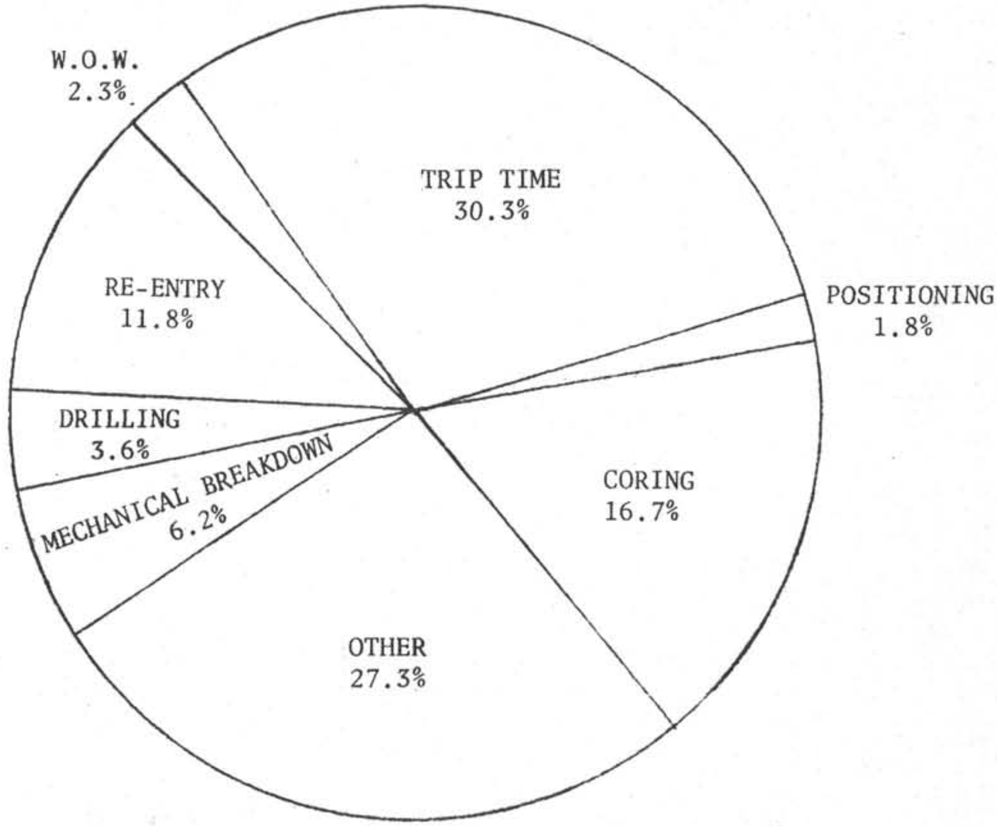
* Returned to previous site drilled on Leg 45.



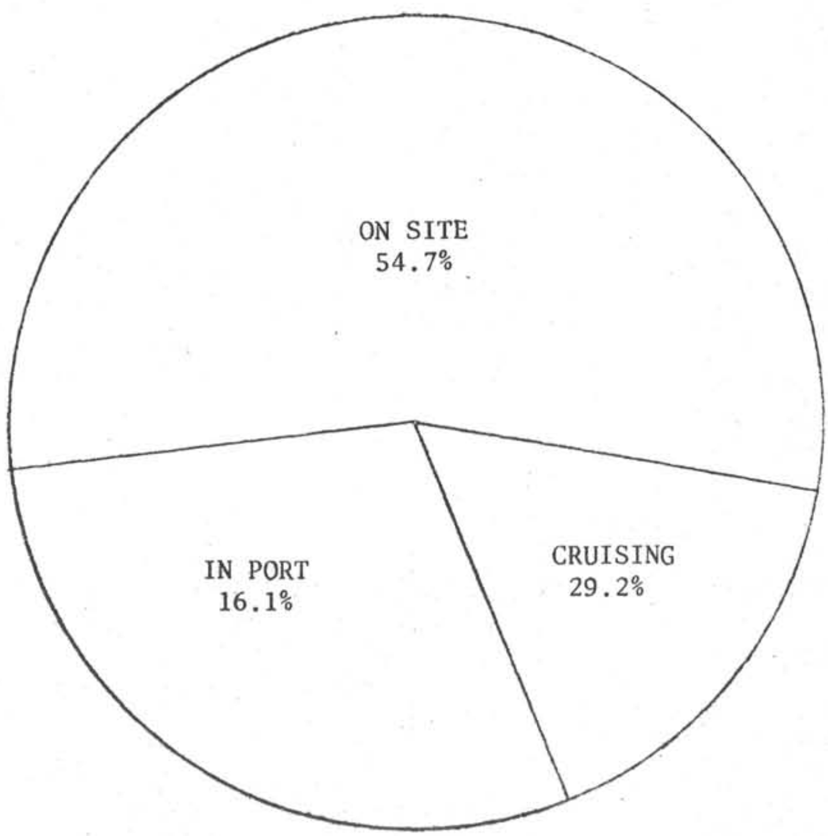
75°
60°
45°
30°
15°
Reykjanes Ridge
Charlie Gibbs F. Z.
Açores
Oceanographer F. Z.
Atlantis F. Z.
Kane F. Z.
Vema F.Z.
Bermuda
Madeira
Canaries
Cape Verde
Dakar
Belem
Romanche F.Z.
SITE 396A
SITE 396B
San Juan
1000 fm
1 km sediment
100m sediment
0°

LEG 46

IPOD
DEEP SEA DRILLING PROJECT
LEG 46
ON SITE TIME BREAKDOWN



TOTAL TIME DISTRIBUTION
LEG 46



DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 46

HOLE	LATITUDE	LONGITUDE	WATER DEPTH (m)	NUMBER OF CORES	CORES WITH RECOVERY	PERCENT OF CORES WITH RECOVERY	METERS CORED	METERS RECOVERED	PERCENT RECOVERED	METERS DRILLED	TOTAL PENET. (m)	AVG. RATE PENET. (m/hr.)	TIME ON HOLE (hrs.)	TIME ON SITE
396-A	22°59.14'N	43°30.90'W	4465	2	2	100.0	13.0	.64	4.9	110.5	123.5	72.6	42.7	
396-B	22°59.14'N	43°30.90'W	4465	33	30	90.9	270.0	63.56	23.3	246.0	405.5	5.9	574.7	
396-C			4465	--	--	--	--	--					30.3	647.7
TOTAL:			4465	35	32	91.4	283.0	64.2	22.6	356.5	529.0	39.3	647.7	

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG 46

DATE	HOLE NO.	CRUISE	TRIPS	DRILL	CORE	STUCK PIPE	W.O.W.	POSITION SHIP	MECH. REPAIR	PORT TIME	RE-ENTRY	OTHER	TOTAL TIME	REMARKS
1-21-76					- IN PORT SAN JUAN -					10.7			10.7	
1-21										24.0			24.0	
1-22										24.0			24.0	
1-23										24.0			24.0	
1-24										24.0			24.0	
1-25										24.0			24.0	
1-26										24.0			24.0	
1-27										24.0			24.0	
1-28										14.7			14.7	
										193.4			193.4	
1-28		9.3		- EN ROUTE SITE 395-A & 396-A -									9.3	
1-29		24.0											24.0	
1-30		24.0											24.0	
1-31		24.0											24.0	
2-1		23.0											23.0	
2-2		24.0											24.0	
2-3		21.8						2.2					24.0	
2-4		15.7						8.3					24.0	
2-5								1.3					1.3	
		165.8						11.8					177.6	
2-5	396A		18.3	3.1	1.0							.3	22.7	
2-6			9.8	2.9	.5							6.8	20.0	Heat flow experiments.
			28.1	6.0	1.5							7.1	42.7	

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG 46

DATE	HOLE NO.	CRUISE	TRIPS	DRILL	CORE	STUCK PIPE	W.O.W.	POSITION SHIP	MECH. REPAIR	PORT TIME	RE-ENTRY	OTHER	TOTAL TIME	REMARKS
2-6-76	396B											4.0	4.0	
2-7												24.0	24.0	Making up csg. & cone. Also fishing snap ring.
2-8			11.0	.5					2.5			10.0	24.0	
2-9				11.5	9.5							3.0	24.0	Heat flow measurement.
2-10			8.3		6.5				2.5			6.7	24.0	Work on comp.
2-11			10.3						10.0			3.7	24.0	Make up 11-3/4" csg.; repair comp.
2-12			7.5						1.5		5.0	10.0	24.0	Re-enter & lmtd. 11-3/4" csg.
2-13			9.0						3.0		11.0	1.0	24.0	
2-14											17.0	7.0	24.0	
2-15				6.0	2.0						5.0	11.0	24.0	
2-16			3.3		20.7								24.0	
2-17			13.0								3.7	7.3	24.0	Heave compensator operation trouble.
2-18					21.0							3.0	24.0	
2-19			17.0		5.0						.5	1.0	24.0	
2-20					9.0						7.0	8.0	24.0	
2-21			12.0		9.25							2.75	24.0	
2-22			5.0		3.0						9.5	6.5	24.0	
2-23			9.7		8.5		5.8						24.0	
2-24			11.25				9.75				1.0	2.0	24.0	
2-25					7.5				2.5		3.5	10.5	24.0	
2-26			10.0		6.0				7.0			1.0	24.0	
2-27			12.0								12.0		24.0	
2-28											2.5	21.5	24.0	Heat flow & logging.
2-29												24.0	24.0	Logging & geophone experiments.
3-1			10.7									8.0	18.7	Hydrophone experiments.
			150.55	18.0	107.95		15.55		29.0		77.7	175.95	574.7	

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG 46

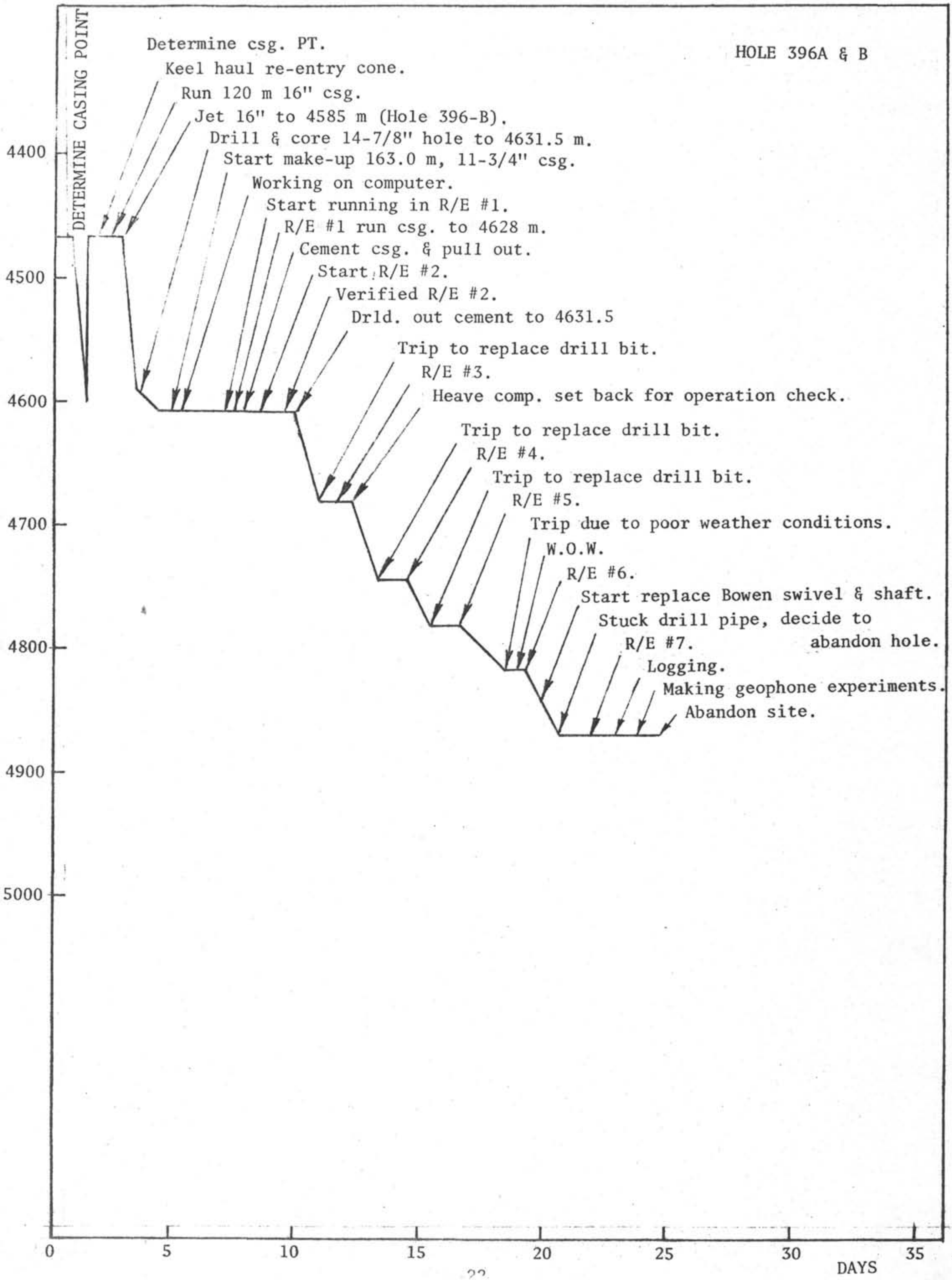
DATE	HOLE NO.	CRUISE	TRIPS	DRILL	CORE	STUCK PIPE	W.O.W.	POSITION SHIP	MECH. REPAIR	PORT TIME	RE-ENTRY	OTHER	TOTAL TIME	REMARKS
3-1-76	396C		5.3										5.3	
3-2			12.0						12.0				24.0	Pad eye on stbd. guide rail broken; derrick damaged.
3-3			.5									.5	1.0	
			17.8						12.0			.5	30.3	
3-3		23.0											23.0	
3-4		24.0											24.0	
3-5		23.0											23.0	
3-6		24.0											24.0	
3-7		24.0											24.0	
3-8		23.0											23.0	
3-9		24.0											24.0	
3-10		17.5											17.5	
		182.5											182.5	

HOLE 396-A

DATE (Midnight)	METERS CORED	METERS REC.	% REC.	CUM. TIME CORING	METERS DRLD.	CUM. TIME DRLG.
FEBRUARY						
5	9.5	.6	6.0	1.0	47.5	3.1
6	3.5	.04	.5	.5	63.0	2.9
TOTAL:	13.0	.64	.5	1.5	110.5	6.0

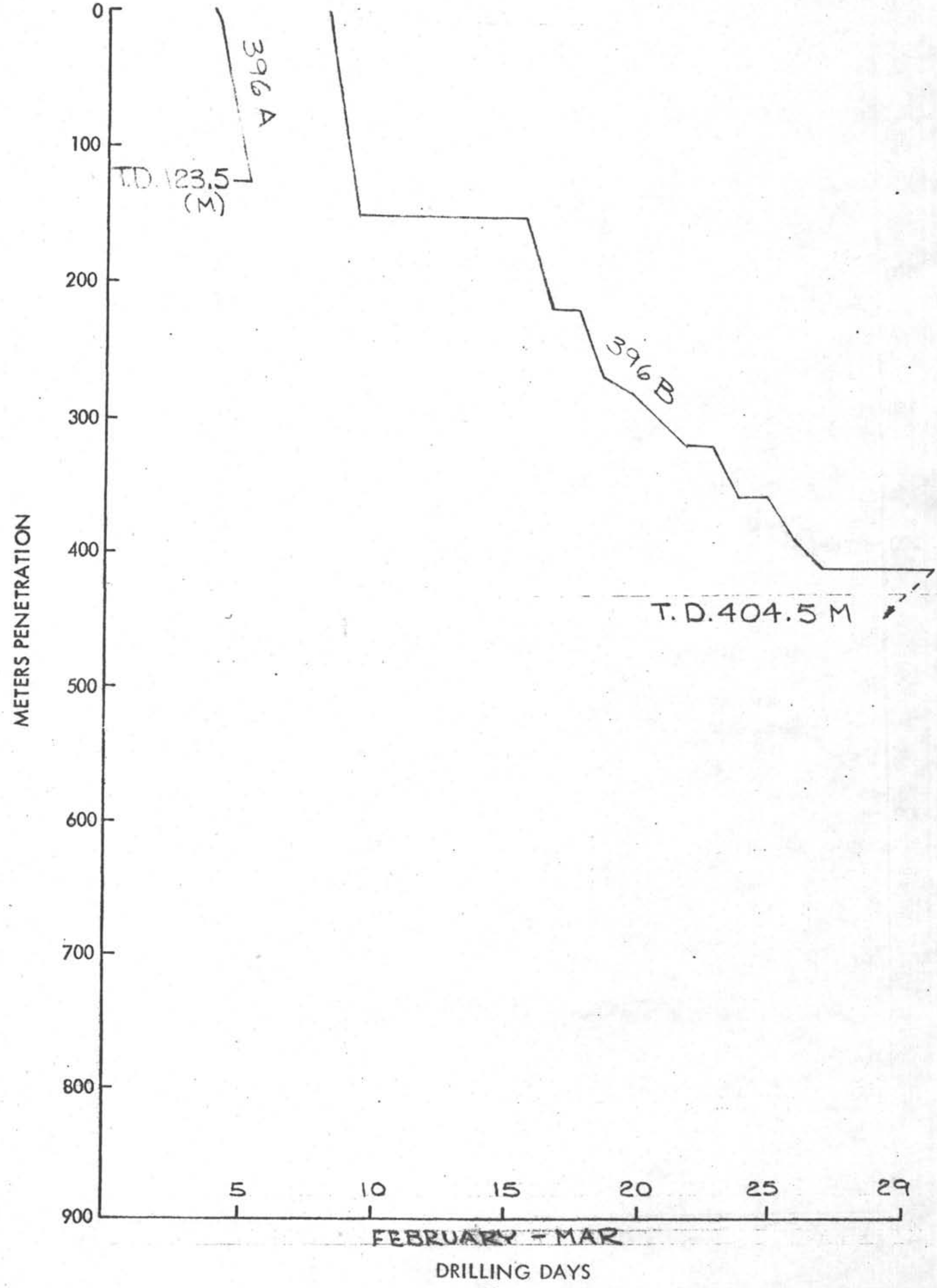
HOLE 396-B

DATE (Midnight)	METERS CORED	METERS REC.	% REC.	CUM. TIME CORING	METERS DRLD.	CUM. TIME DRLG.
8					14.5	.08
9	35.0	6.6	18.8	4.9	107.5	4.8
10	9.5	2.23	23.4	4.0		
11						
12						
13						
14						
15	7.5	.85	.8	1.0	110.5	4.5
16	42.0	12.09	28.7	12.9		
17						
18	38.0	18.0	47.3	9.25	13.5	4.8
19	9.5	6.55	68.9	3.63		
20	19.0	6.65	35.0	6.15		
21	19.0	5.95	31.3	5.71		
22						
23	38.0	1.84	4.8	3.7		
24						
25	33.5	1.08	3.2	4.1		
26	19.0	1.72	9.0	3.65		
27						
28						
29						
TOTAL:	270.0	63.56	23.3	58.99	246.0	14.18

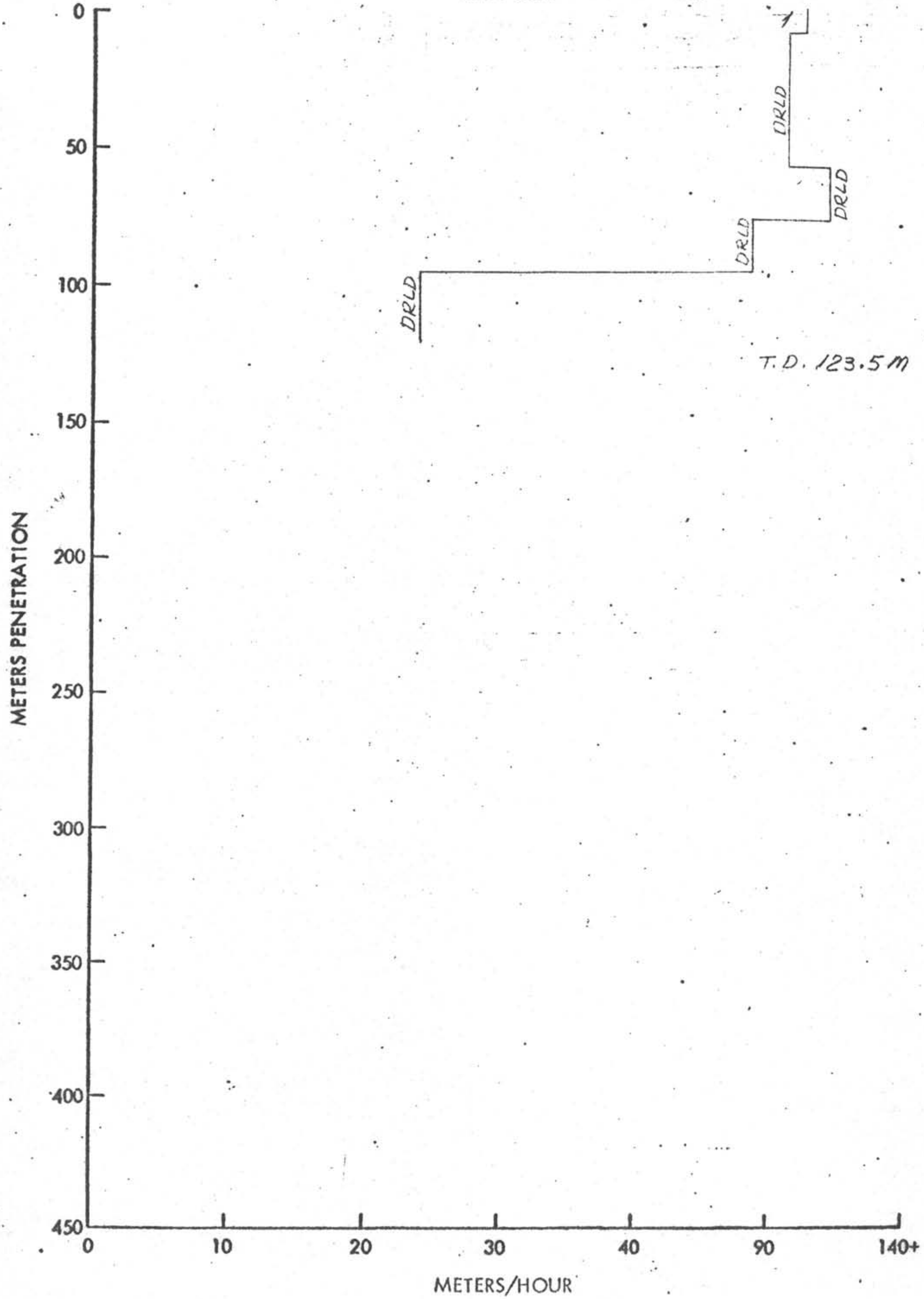


HOLE 396A & B
DETERMINE CASING POINT
Determine csg. PT.
Keel haul re-entry cone.
Run 120 m 16" csg.
Jet 16" to 4585 m (Hole 396-B).
Drill & core 14-7/8" hole to 4631.5 m.
Start make-up 163.0 m, 11-3/4" csg.
Working on computer.
Start running in R/E #1.
R/E #1 run csg. to 4628 m.
Cement csg. & pull out.
Start R/E #2.
Verified R/E #2.
Drld. out cement to 4631.5
Trip to replace drill bit.
R/E #3.
Heave comp. set back for operation check.
Trip to replace drill bit.
R/E #4.
Trip to replace drill bit.
R/E #5.
Trip due to poor weather conditions.
W.O.W.
R/E #6.
Start replace Bowen swivel & shaft.
Stuck drill pipe, decide to abandon hole.
R/E #7.
Logging.
Making geophone experiments.
Abandon site.
4400
4500
4600
4700
4800
4900
5000
0
5
10
15
20
25
30
35
DAYS

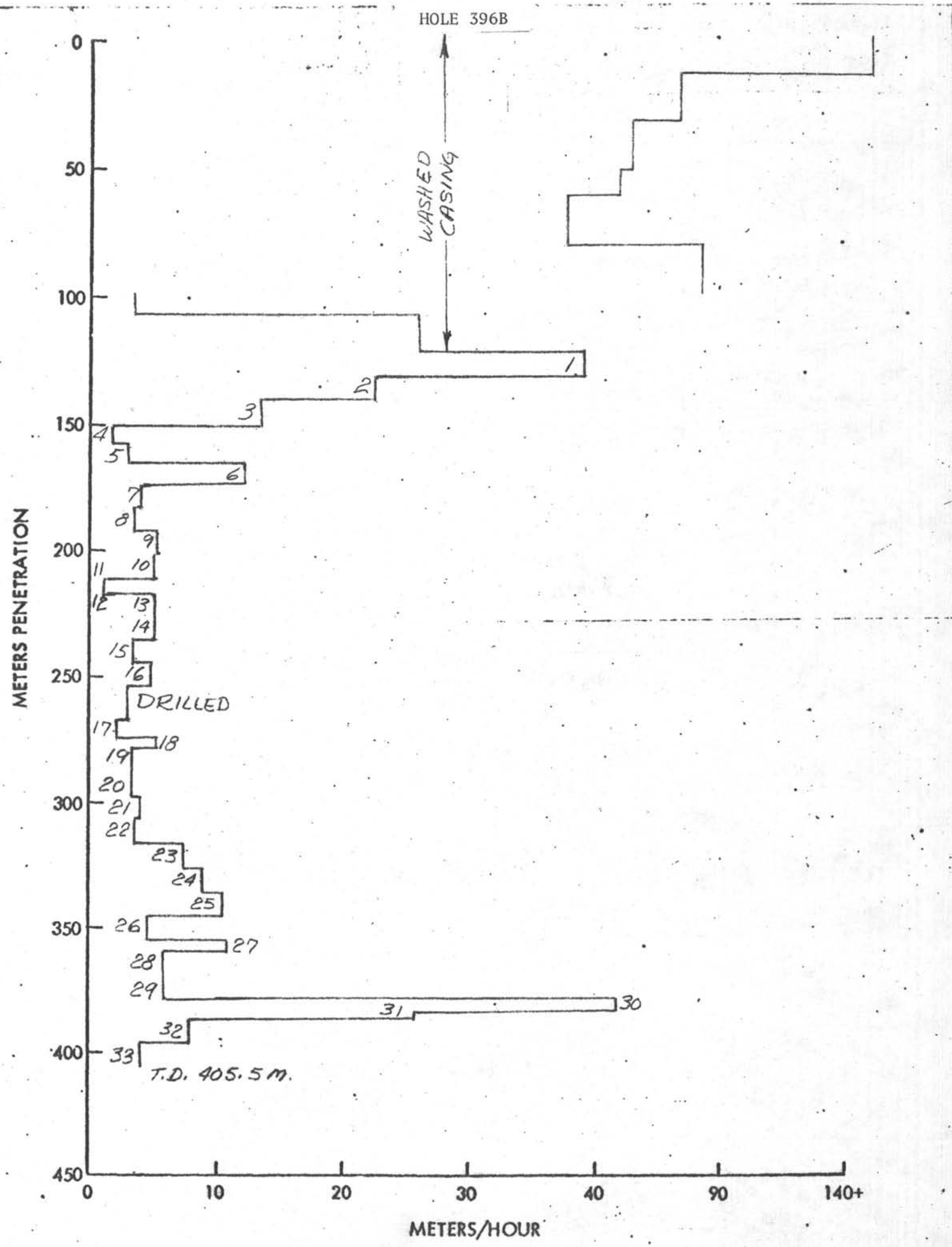
HOLE 396 - A & B


0
100
200
300
400
500
600
700
800
900
METERS PENETRATION
396 A
T.D. 123.5 (M)
396 B
T. D. 404.5 M
5
10
15
20
25
29
FEBRUARY - MAR
DRILLING DAYS

HOLE 396A



METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
DRLD
DRLD
DRLD
DRLD
T.D. 123.5 m
0
10
20
30
40
90
140+
METERS/HOUR


HOLE 396B
WASHED CASING
DRILLED
T.D. 405.5 M.
METERS PENETRATION
METERS/HOUR
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33

RE-ENTRY MANEUVERING TIME
HOLE 396B

Time required to re-enter once scanning sonar is on bottom (successful re-entries):

RE-ENTRY NO.	TOOL DOWN	STABBED	ELAPSED TIME
1	0522-2/12	0613	51 mins.
2	0738-2/15	0911	1 hr., 33 mins.
3	1605-2/17	1657	52 mins.
4	0123-2/20	0557	4 hrs., 34 mins.
5	0739-2/22	1427	6 hrs., 48 mins.
6	0120-2/25	0233	1 hr., 13 mins.
7	1501-2/27	0123-2/28	10 hrs., 22 mins.
	AVERAGE TIME:		3 hrs., 36 mins.

DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 46

HOLE	MFG.	SIZE	TYPE	SERIAL NUMBER	METERS CORED	METERS DRILLED	METERS TOTAL PENET.	HOURS ON BIT	CONDITION	REMARKS
396-A	Smith	14-7/8"	F94C	AN697	13.0	110.5	123.5	2.18	T1-B1-SE	Re-run
396-B	Smith	14-7/8"	F94C	AN697	44.5	122.0	166.5	13.75	T1-B1-SE	Re-run
396-B	Smith	10"	F94CK	KK986	49.5	110.5	160.0	18.4	T2BT-B4-0	0= 1/8" (drld. footage is cement).
396-B	Smith	10"	F94CK	CA767	47.5	13.5	61.0	17.7	T3BT-B8-0	0= 1/8"
396-B	Smith	10"	F99CK	SV857	38.0		38.0	11.86	T1BT-B1-0	0= 1/8"-1/4"
396-B	Smith	10"	F94CK	CA281	38.0		38.0	5.75	T1BT-B6-0	0= 1/8"+
396-B	Smith	10"	F94CK	CA761	52.5		52.5	7.7	T3BT-B4-I	

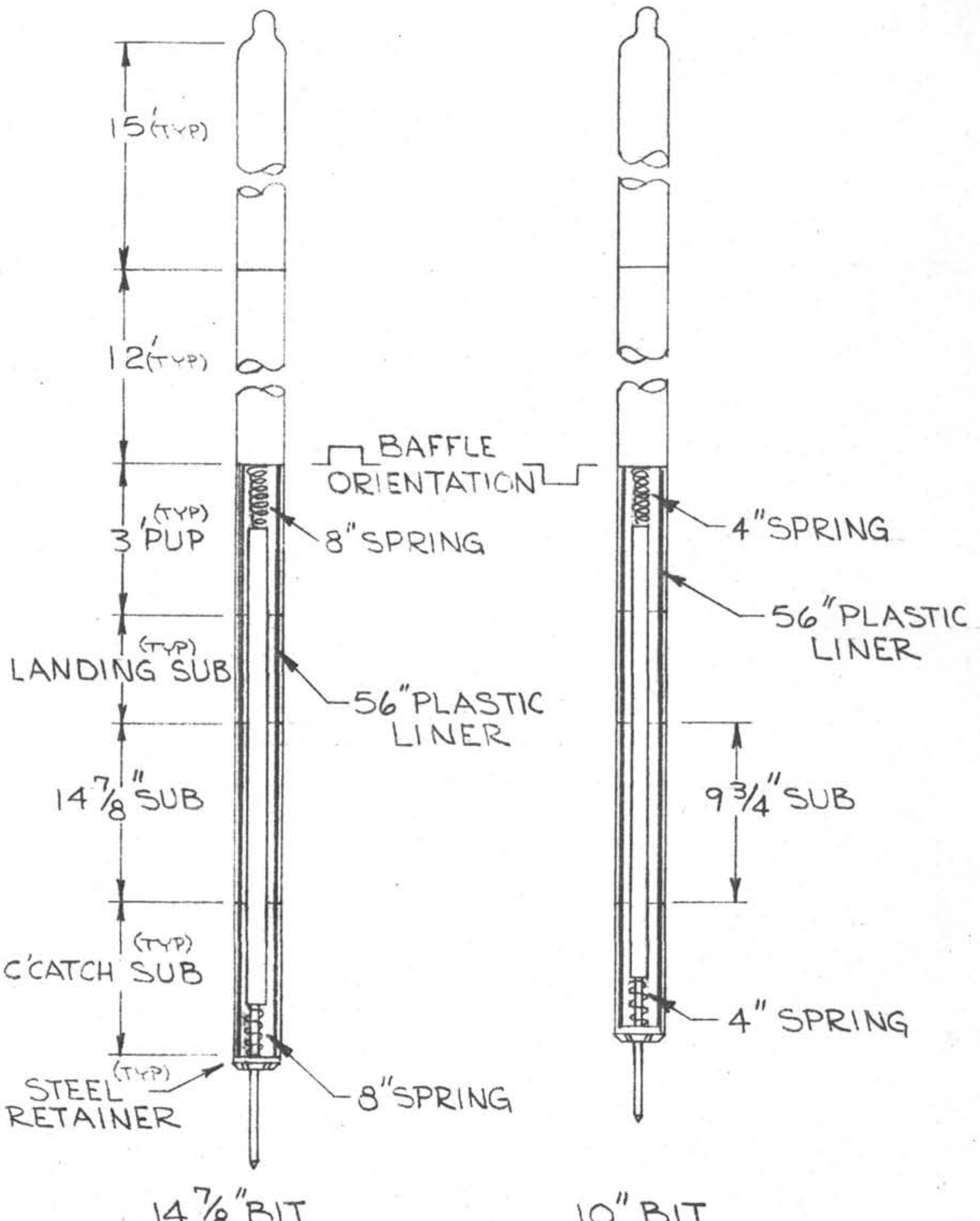
DEEP SEA DRILLING PROJECT

BEACON SUMMARY

LEG 46

HOLE NO.	MAKE	FREQ. kHz	SERIAL NUMBER	SITE TIME DAYS	
395A	ORE	13.5	369	--	Dropped 1910 2/3/76 double (dropped for possible re-entry later in Leg.
397	ORE	16.0	335	--	Dropped 2046 2/4/76 double (after dropped site not drilled).
396	ORE	13.5	368	30	Dropped 2220 1/14/76 double (dropped on Leg 45).
396B	ORE	16.0	342	14	Dropped 0716 2/13/76 single.
396B	ORE	13.5	271	6+	Dropped 2148 2/26/76 double.

HEAT FLOW TOOL MAKE UP
(USING CENTER BIT INNER BARREL)



DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 47

Leg 47 was the first voyage of the International Phase of Ocean Drilling where the entire emphasis was on deep continental margin drilling. The leg was divided into two parts allowing for one site to be investigated on the northwest African continental margin and another on the western margin of the Iberian subcontinent. Each site was drilled to a record depth and nearly all scientific objectives were achieved.

The leg commenced on March 10, 1976 at Las Palmas, Canary Islands and terminated May 12 at Brest, France. Brief interim port calls were made at Las Palmas to disembark an ill scientist and at Vigo, Spain for a scientific crew change.

Many voyages of the Deep Sea Drilling Project have broken operational records and Leg 47 was no exception. New milestones reached include the following:

Deepest Single Bit Penetration - - - - - - - - -	1453 Meters, Hole 397A
Deepest Multiple Bit Penetration - - - - - - - -	1740 Meters, Hole 398D
Most Time Spent On-Site In One Leg - - - - - - -	42.5 days

The total core recovery, 1812.5 meters, has been exceeded only by the Leg 42 total from somewhat shallower Mediterranean and Black Sea drilling.

Total length of the leg was 62.5 days, of which 42.5 days were spent on site, 9.8 days under way and 10.1 days in port. 2.7 days of operating time were lost due to mechanical difficulties and 1.4 days of delay due to weather were experienced.

LAS PALMAS PORT CALL

Emergency derrick repairs were necessitated by the failure of a guide rail pad-eye that effectively terminated Leg 46. In addition, extensive repairs and maintenance were performed in the engine room. This work included a major overhaul on No. 4 engine, a top overhaul and piston replacement on No. 9 engine, rear oil seal replacement on No. 6 engine and replacement of No. 5 D.C. generator with a spare unit carried on board.

As key personnel and materials had not arrived, derrick repairs did not commence until about three days after the ship's arrival in port. All lines and drilling equipment were rigged down from the upper portion of the derrick. The crown block and gin pole assemblies were removed and set on the pier by a large shipyard crane. The top 39 feet of the derrick, including the water table, was then set on the pier and both starboard legs (two sections each) and associated bracing were replaced while the yard crane supported the structure.

New supporting pad-eyes were installed at the top of the guide rails and fittings were installed to provide a backup sling support in case of future pad-eye failure.

Active mode pressure transducers removed in Norfolk, Virginia were reinstalled for the heave compensator and repairs were made to the heave compensator racker arm bracket where a large crack had been found. Repairs were also made to engine room ventilation ducting and the drill pipe stabber. The fuel oil holding tanks (29 and 30) were cleaned by a shipyard crew.

In addition to routine supply functions, about 600 feet of 16 inch casing for future re-entry operations were onloaded. Fresh water and lube oil tanks were topped off while the derrick and engine room repairs were in progress. On the morning March 19, the CHALLENGER moved to the bunkering pier and began taking on fuel. Fueling and the last of the scheduled engine room work were completed at about the same time. After tugs were alongside, consecutive problems with electrical assignment of No. 5 generator to propulsion and with the failure of the newly installed governor on No. 4 engine delayed sailing for over 15 hours. During this time it was necessary to move from the bunkering pier to an anchorage outside the harbor. At 1415 hours on March 20, the vessel weighed anchor and departed for Site 397.

SITE 397

The beacon was dropped at Site 397 only 9-1/2 hours after getting under way from Las Palmas. The site was located about 55 miles south of Grand Canary Island and about 55 miles west of Cape Bojador on the African Coast. While the drill string was being run to the sea floor, an intermittent malfunction developed in which electrical power to the bow thrusters was lost. A mudline punch core was taken, but continuous coring operations did not commence until troubleshooting was completed and the problem resolved. A delay of 8-1/2 hours resulted.

The hole was then continuously cored to 1000 meters below the sea floor with generally excellent rates of penetration and core recovery. After about 700 meters penetration (75 cores), backflow was noted as the core barrels were removed from the drill pipe indicating that the float valve above the bit was not closing properly. After cutting Core No. 82, it was necessary to pump down the core breaker center bit to dislodge material plugging the throat of the bit. Plugging problems began again after Core No. 99. Repeated occurrences eventually forced termination of drilling at 1000 meters subbottom when core could no longer be recovered.

Due to the presence of minor amounts of natural gas which persisted from very shallow depths to total depth, the hole was filled with weighted mud before it was abandoned. The drill string was then pulled and the bit was on deck at 1600 hours on March 28.

HOLE 397A

While the drill string was on deck, about three hours were taken to pick up the heave compensator cylinder and bleed air from its hydraulic system in preparation for its employment on the ensuing hole. Inspection of the coring equipment revealed both the flapper valve and the core barrel latch sleeve to be suspect of contributing to the bit plugging problem. These were replaced, as was the bit. The bit appeared to be in excellent condition but had accumulated too many rotating hours to be run again.

The drill string was run to the seabed and spud-in of Hole 397A occurred at 0140, March 29. Since Hole 397 had been continuously cored, the new hole was drilled nearly to the previous total depth before the coring program was resumed. A center bit was employed to a depth of 707 meters subbottom, where it was replaced with an inner core barrel. Spot coring was done at depths where low recovery was realized on Hole 397 and continuous coring was resumed at 964 meters subbottom. Due to the greater rate of penetration achieved while drilling as opposed to coring and the elimination of time-consuming wireline trips, 1000 meters (total depth of Hole 397) was reached in 1.9 days instead of the 6.4 days required on 397. The new bit had only about 22 hours rotating time at this depth while its forerunner of the same model had accrued 33 hours.

Coring continued routinely to a depth of 1302 meters subbottom, where a highly indurated Cretaceous shale was encountered. The rate of penetration dropped sharply from about 13 meters per hour in the overlying mudstones to about 2.4 meters per hour in the shale. 65 rotating hours were consumed in coring from 1302 meters to the total depth of 1453 meters. Although the diameter and condition of the core indicated that bit failure was imminent, fairly good core recovery was attained through the final core. Scheduling considerations necessitated terminating operations at a depth that was apparently just short of the ultimate Jurassic objective.

Small amounts of natural gas were encountered to total depth with a notable decrease in quantity in the lower shale section. The hole was filled with weighted mud to about 450 meters subbottom. A 20 barrel cement plug was spotted at the top of the mud.

The drill string was on deck and the ship was under way at 0330 hours on April 7.

SITE 397 TO VIGO

Shortly before the departure of the ship from Site 397, a member of the scientific party was stricken with a severely infected tooth. The ship's surgeon reported that the man was in need of prompt dental care and the vessel was detoured slightly. He was then put ashore at Las Palmas for required treatment. Arrangements for treatment, transportation and lodging were handled through the vessel's Las Palmas agent. The CHALLENGER was at anchor for one hour outside Las Palmas harbor while the man was transferred to a small boat and the necessary documents were exchanged with the agent's representative. The total difference in time between the action taken and proceeding directly to the Moroccan Basin survey site was about five hours. The man did not rejoin the scientific party.

Geophysical surveys requiring course changes and reduced speed were conducted as the vessel crossed the Moroccan Basin. About nine hours were required in excess of the direct steaming time from Las Palmas to Vigo.

Shortly after departure from Las Palmas, metal fragments were found in the lube oil filters of No. 2 engine. Inspection revealed that the main and connecting rod bearings required replacement. Adequate spares were not on board and it was necessary to make the remainder of the transit to Vigo on five propulsion engines. This resulted in a reduction in speed of 3/4 to one knot and a time loss of approximately 12 hours.

Good weather prevailed and an unexpectedly high speed was maintained until the ship was about 200 miles from Vigo. Gale force head winds were then encountered that reduced headway to about two knots at times and delayed arrival at Vigo by about 12 hours.

VIGO PORT CALL

The GLOMAR CHALLENGER dropped anchor in the harbor estuary of Vigo, Spain at 2300 April 12 and remained there until 0600 the following morning. Parts for No. 2 engine were received and the engine was reassembled and test run before the ship's departure. Twelve members of the scientific staff and three GMI personnel departed the ship in Vigo while 12 scientists, two Scripps technical personnel and two GMI personnel embarked. Fresh vegetables, mail and a small amount of air freight were also onloaded.

SITE 398

The cruise to the site of Leg 47B operations was uneventful and the beacon was dropped less than 14 hours after departure from Vigo. Site 398 was located just south of Vigo Seamount, about 95 miles west of Porto, Portugal.

As re-entry operations were planned at this site, the first hole (398) was an exploratory penetration primarily intended to determine the water depth and casing point for the main re-entry hole. To keep the re-entry area as undisturbed as possible, the ship was offset 200 feet from the beacon before spudding the exploratory hole.

The corrected precision depth recorder water depth was 3920 meters (derrick floor to the sea bottom). A punch core was attempted at 3915.5 to 3925 meters (drill pipe measurement). No weight indicator fluctuation was noted, but the drill string was pulled clear of bottom by an additional joint while the core barrel was retrieved. Only a handful of sediment was recovered from the core catcher and it was inferred that the sea floor was at or slightly below PDR depth. The bit was again lowered to 3925 meters without pumping and this time indication of bottom was noted by weight indicator at 3917 meters. In the interest of saving time and of obtaining a full core, another joint was added and the bit was lowered to 3934.5 m. 3917 meters was recorded as the official water depth, but was later found to be in error.

A third consecutive punch core was taken. At this point the sediment became too firm for penetration with neither circulation nor rotation.

The shallow sediment was determined to be a relatively firm calcareous ooze suitable for supporting a re-entry cone with casing. The bit was then jetted without rotation to a depth of 103 meters subbottom to confirm the feasibility of washing in a casing string. The plan was for an additional core to a depth of 109.5

meters, a run of a new sampler designed to recover pore water and a run of the heat flow tool. Then the bit would be pulled clear of the mudline and a second exploratory hole spudded to provide a complete core record of the upper stratigraphic section. The downhole operations had been completed successfully and the heat flow tool was being retrieved when the sandline suddenly parted, leaving the tool and about 5000 feet of line in the drill pipe. It was considered unlikely that time would be saved by fishing for the broken line and a pipe trip was made to the surface to recover line and tool.

HOLE 398A

After retrieving the drill string, the ship moved off station about two miles and jettisoned the damaged sandline. As the line on the independent hydraulic sand reel was now too short, the overshot and sinker bars were switched over to the new line on the drawworks sand reel.

Weather conditions had deteriorated to a marginal state while the drill string was being pulled. Running into the hole was delayed until the next weather satellite forecast was received. After a wait of three hours, a forecast calling for steady or slightly improving conditions was received. Operations were considered feasible under existing conditions and the pipe trip to the seabed was made. Because of weather conditions and the possibility of excursions, the bottomhole assembly was washed in as quickly as possible with no coring or attempts to confirm water depth. The wind did not moderate and a deep short period swell developed which caused the vessel to pitch in a sharp, violent manner. The guide rails and suspended drilling equipment were subjected to considerable battering and connections were made with difficulty. Due to the hazard to personnel and equipment, operations were halted after two cores and a total penetration of 210.5 meters. The drill string was pulled clear of the sea floor and an additional 30.5 hours were spent waiting for improved weather conditions.

HOLE 398B

The drill pipe had been pulled at the rate of one stand per hour during the weather shutdown. When operations were resumed, it was necessary to run pipe some distance back to the sea floor. As the sea conditions were still far from optimum, the bottomhole assembly was again washed in with dispatch.

Hole 398B was yet another attempt at a relatively deep exploratory penetration to core the soft, rapidly penetrated upper stratigraphic section and to employ the various special tools before setting the re-entry hardware. After washing to 229.5 meters subbottom and cutting one core, pore water and heat flow runs were to be made.

The sandline parted upon pickup of the pore water tool, leaving the tool and about 12,000 feet of line in the hole. It was necessary to pull the drill string to recover the line and tool. The line inside the pipe was found to be badly kinked and twisted and only a few short pieces could be salvaged. At that point, approximately 13,000 to 14,000 feet of line remained on each reel and both were too short for further operations at Site 398. An attempt was made to long splice the free ends of the two lines but it was unsuccessful. The lays did not match as one line was new and the other had been somewhat stretched through repeated use. A second attempt at splicing these two half lines was made after reeling off the line from the hydraulic sand reel and exposing the opposite end of the line which was still in new condition. (As no takeup reel for this amount of line was available, two stands of drill pipe were hung off through the moon pool and the line was spooled off below the ship). A successful long splice was made and about 3,000 feet of line had been added to the drawworks sand reel when a snarl in the line was encountered which would not pass through the drill pipe. It was then necessary to cut and clamp the line and lay down the drill pipe. After two or three hundred feet of badly kinked and twisted line was recovered, it became evident that none of the remaining line would be salvageable. The ship was again offset from the location and the damaged line was cut loose. At this point the total spare sandline aboard was comprised of three pieces totaling about 12,000 feet. An urgent request was relayed to GMI San Diego to have a new reel of line delivered to the ship while on location as soon as possible. The drawworks sand reel now held about 17,000 feet and, as weather conditions were favorable, it was decided to rig the re-entry hardware and commence operations on the deep penetration hole without further delay.

HOLE 398C

The last remaining first generation re-entry cone had been assembled and stowed in the starboard casing rack area. It was now transferred to the port main deck bulwark, reslung and keelhauled into place beneath the moon pool without significant difficulty. The only irregularity was the need to reweld a sonar reflector brace at the last moment before keelhauling.

Based on the exploratory holes, 80 meters of 11-3/4 inch casing were made up and hung off below the rig floor. The bottomhole assembly was made up and latched into the casing and the entire string was lowered and latched into the cone. The cone was then cut loose from its slings and the drill string was run to just above the seabed.

The power sub was rigged and the casing string was washed into the sea floor. Unexpected resistance to further washing came at a drill string depth of 3980 meters. The inability to wash deeper cast considerable doubt on the accuracy of the 3917 meter water depth determined earlier. The casing and drill string were then pulled well clear of the mudline, the inner core barrel was replaced, and a punch core was attempted. On this attempt, the weather was nearly flat calm, rendering the weight indicator more sensitive than during times of greater vessel motion. Bottom was "felt" at 3900 meters. As this confirmed the apparent depth to sea floor noted on the previous wash-in attempt, 3900 meters was established as the official water depth.

HOLE 398D

The casing was washed in to the depth reached on the previous attempt and the inner core barrel was retrieved (with no core recovery). The Rotary shifting tool was made up on an inner core barrel and pumped to the bottom of the drill string. Upon retrieval of the tool with the sandline, the sleeve in the casing running tool was shifted. The casing/cone assembly was then released without difficulty.

Because of previous spot coring, it was possible to wash to 271 meters and bury the bottomhole assembly before taking the first core. Intermittent coring then continued to 527.5 meters where continuous coring was initiated.

The requested spare sandline was shipped by air to Vigo and then transported to Site 398 on the deck of the Spanish motor tug Vulcano. The tug made its rendezvous with the CHALLENGER on the morning of April 26 and the reel of line, along with a quantity of fresh vegetables, was transferred without incident. While it was necessary to change the heading of the drill ship to provide a lee for the tug, the transfer was accomplished during a wireline trip and coring operations were not interrupted.

Two failures of the dynamic positioning system's vertical reference gyro occurred in the earlier stages of drilling. While it was known that an excursion off the location of the beacon had occurred, the distance off station was not known as this type of failure caused loss of the positioning display. After drilling was resumed, the amount and direction of bias of the replacement gyro was unknown and it was felt that a constant error of unknown magnitude existed in the display. The effect of this excursion of a sizeable magnitude and the lateral forces of the drill string acting against the casing/cone assembly was not known. It was considered quite possible that the casing had been kinked or broken just below the cone and that re-entry might be difficult or impossible. For this reason the first bit was run somewhat longer than under normal circumstances to assure penetration of a known seismic reflector and to accomplish one of the scientific objectives before pulling out of the hole. At a depth of 974 meters and after 48 rotating hours, coring operations were interrupted for the first round trip for bit change and re-entry attempt.

After the hole was filled with gel mud, the drill string was pulled to replace the bit and to return the bottomhole assembly used for lowering the re-entry cone to its normal configuration. A circulating head was installed and the pump was run while the bit was pulled clear of the re-entry cone in an effort to clear cuttings from the cone and reflectors.

The first re-entry attempt was an exceptionally smooth operation. The logging line was rigged and the sonar tool was run to bottom without incident. A strong sonar target was acquired upon commencement of scanning and the ship was maneuvered to close it. After a net movement of 150 feet forward on the spud-in heading, the stab was made. Total scanning time was one hour and forty five minutes.

The second round trip was made after only 26.7 rotating hours and was occasioned by a coring equipment malfunction rather than the condition of the bit. The inner barrel core catcher sub had loosened and backed off while Core No. 93 was being retrieved and the barrel was recovered open ended. The core catcher assembly, plastic liner and core remained somewhere in the drill string. One unsuccessful attempt was made to fish for the liner with a spear. As chances of recovering all the material in the string were considered extremely slim, it was decided to make a round trip and spend no more time fishing. 400 barrels of gel mud was displaced to the level of the sea floor and the trip began. Unfortunately the mud and suspended cuttings began to flow back (the flapper valve was later found to be held open by the core catcher sub) and completely filled the outer core barrel with cuttings and plugged all passages through the bit. This resulted in a very wet and muddy trip. The buytrate core liner and 8.9 meters of core were recovered from about 230 meters above the bit and the core catcher assembly from the bit sub. Fortunately, this incident occurred in a re-entry hole as the bit neared the end of its run and the only operational time lost was the two hours spent on the fishing attempt. The same situation would almost certainly have resulted in the loss of a single-bit hole or could easily have necessitated an additional round trip and re-entry.

After the bit and bit sub assembly were changed, the string was run to just off the sea floor for the second re-entry attempt. The operation of the sonar tool was tested on deck and inside the drill pipe on the run to bottom. The tool was seated at the bit in the normal manner with the mud pump engaged to hold the flapper valve open. When the tool was energized, it operated apparently in the normal mode for ten seconds or less. Power regulation to the tool was then lost and could not be regained, necessitating retrieval of the tool. When the tool was recovered, it was found that the rotating shaft had broken cleanly at the top of the extender section causing the loss of extender and transducer.

A standby sonar tool was assembled and ready, but when the cable was connected and final on-deck checkout was attempted, the conductor carrying power to the drive motor was found to be shorted. The short was traced to the cable connection box on the forward bulkhead of the logging unit cab. Salt water falling from the packoff assembly during the wireline trips had entered the connector.

After the connection box had been cleaned and sealed, the replacement sonar tool was lowered and seated in the bit (this time with extra pump pressure). A strong target (apparently the re-entry cone) was detected within fifty feet when scanning commenced. Each subsequent sweep of the scanning beam showed better resolution of the target configuration and a reduction in range. After about five minutes the display indicated that the bit was directly over the cone and a successful stab was made. No maneuvering of the vessel was required.

Due to time constraints, no further re-entries were planned. The third bit was to be run until basement was reached, until scheduling forced termination of the hole or until the bit failed. It became evident that the major scientific objectives could not be attained if the ship were to depart the site in time for its scheduled arrival in Brest. A cruise extension of up to three days was requested by the scientific party and was granted by DSDP management. An additional development of operational significance was the loss of two of the ship's D.C. generators. This limited the vessel's stationkeeping ability while drilling and permitted drilling operations to continue only in relatively good weather.

Although it became evident that the basement objective was not within reach, the goal of penetration into the oldest overlying sediment unit had apparently been attained on the morning of May 8. By this time rising winds had begun taxing the positioning capabilities of the ship nearly to the limit and it was necessary to terminate drilling operations.

The hole was plugged in the same manner as Hole 397A. All equipment was on deck and secured for sea and the ship was under way for Brest at 0530 hours on May 9.

SITE 398 TO BREST

Because of D.C. generator failures and limited flexibility of electrical power assignments, propulsion was again limited to five motors. Strong head winds with gusts to 40 miles per hour were encountered the first day but decreased slowly, allowing an overall speed of advance of 7.1 knots.

HYDROCARBONS

Due to increased concern over the risk of uncontrolled hydrocarbon escape from reservoir rocks attendant to deep continental margin drilling, safety and instrumentation procedures aboard the CHALLENGER were upgraded prior to Leg 47. A combination of three gas chromatographs was utilized during the leg for compositional gas analysis and equipment for measuring the fluorescence of soluble liquid and solid hydrocarbons was also available. Stringent procedures were set up for monitoring each core for changes in gas quantity or composition and for the presence of liquid hydrocarbons. Gas samples were collected through the plastic liner from almost every core.

At site 397, hydrocarbon gas was present in the cores from about 80 meters subbottom to the total depth of 1453 meters subbottom. The gas composition was very closely monitored and each core was checked for fluorescence and oil staining. Though variable, the volume of gas escaping from the cores was relatively low. No signs of petroleum or indications of migratory hydrocarbon accumulations were detected.

Although some gas was anticipated at Site 398, only minute traces were found. The quantity was too small for detection by the standard Exploration Logging chromatograph or for meaningful analysis by the more sensitive Hewlett-Packard instrument.

DRILLING AND CORING EQUIPMENT

The standard DSDP bottomhole assembly was utilized for the majority of operations. This consisted of a bit, bit sub (with flapper valve and inner core barrel support bearing), outer core barrel, three 8-1/4" drill collars, one 5' stroke Baash-Ross bumper sub, three 8-1/4" drill collars, two 5' stroke bumper subs, two 8-1/4" drill collars, one 7-1/4" drill collar, and one joint 5-1/2" heavy wall drill pipe. Total length of the assembly was 120 meters. On Hole 397, where use of the heave compensator was not planned, a fourth bumper sub adjacent to the lowermost bumper sub was employed. For re-entry operations (Holes 398C and 398D - first bit), a casing running tool was placed between the seventh and eighth drill collars. No drilling tools were lost.

The standard DSDP wireline coring assembly was employed. Overall core recovery was quite good. Instances of low recovery were attributed mostly to plugged bits and (on Site 397) to intervals of unfavorable lithology. On one or two occasions, the inner barrel apparently did not latch into place and little or no core was recovered. A piece of core falling from the previous core barrel and lodging in the bit or bit sub is the suspected cause.

After approximately 75 cores had been cut on Hole 397, back flow through the drill pipe on recovery of core barrels indicated that the flapper valve was not closing completely. This was the apparent cause of repeated bit plugging and the eventual loss of the hole. When the assembly was recovered, the flapper valve spring was found to be too weak to close the valve completely against gravity. It apparently had been fatigued by the repeated shock and cycling of seating and retrieving inner core barrels.

On three occasions core barrels were sufficiently stuck at the bit to cause shearing of the overshot pin on the first retrieval attempt. All three were recovered on the second wireline run. The primary cause is believed to be the packing tendency of the shale/claystone lithologies being penetrated, possibly aggravated by insufficient fluid pressure at the bit.

A core catcher sub came unscrewed and was lost upon retrieval of a core on Hole 398D, necessitating a somewhat premature trip for bit and re-entry. Upon review of the malfunction, it was noted that core catcher subs and other inner barrel connections had been found to be loose or easily broken on several occasions after retrieval from downhole. This is believed to be due to wear of the threaded connections themselves attendant to repeated assembly and disassembly. Provisions should be made for "retirement" of inner barrel assemblies after a certain amount of use.

SANDLINES

Some doubt remains as to the exact cause of the two sandline failures on Site 398. Both breaks occurred upon retrieval of a core barrel (with special tool) which had been lowered on the sandline without circulation. Both breaks were located about 1000 feet below the surface. Very similar circumstances accompanied the breakage of a line on Leg 44A when a shifting tool was being retrieved. In none of these cases was there a pronounced increase reported on the weight indicator before the failure. "Overrunning" or excessive slack and kinking due to flotation of the tool on the run in is considered the most logical cause. In all cases, however, competent operators were involved and great care was taken to avoid this situation. It is also difficult to explain how enough slack could be introduced to kink the line several thousand feet above the tool. An alternative factor could be the inability of the line to untwist normally on the run to bottom with a core barrel attached, although the overshot assembly is designed to provide for rotation.

The practice of running tools into the hole on the sandline without circulation has been discontinued.

BITS

As evidenced by the penetration records set, excellent service was rendered by the tungsten-carbide roller cone core bits utilized.

Although the stratigraphic section at Site 397 was primarily chalk, mudstone and shale, intermediate length insert F94CK bits were used on both holes. The occurrence of hard limestones and cherts had been anticipated and damage to longer inserts was feared. Excellent penetration rates were enjoyed until well-indurated Cretaceous shale was encountered in the lower part of Hole 397A. The rate of penetration then fell to about 2.4 meters per hour. In retrospect, it is felt that a longer insert F93CK bit would have given a much better shale penetration rate and would have put the ultimate Jurassic objective within reach.

Long insert F93CK bits were used exclusively on Site 398 and provided excellent penetration rates throughout, including the tough shales. Although considerable limestone was encountered in the lowermost part of Hole 398D, it was relatively soft and did no damage whatever to the cutting structure of the bit.

None of the bits failed catastrophically and the failure mode common to all was bearing wear.

Bit "balling" was suspected in shale and claystone intervals at both sites. In the slower claystone coring in Hole 398D, abrupt drilling breaks would occur with up to a threefold increase in penetration rate for as much as an entire core. Examination of cores revealed no variation in lithology or physical properties and the faster drilling was interpreted as temporary "cleaning" of the bit. Unfortunately the hydraulic power sub is quite limited in its RPM range and a standard rotary drilling technique of spinning the bit at high speed to clear it is not possible.

SPECIAL TOOLS

The drill pipe pinger was modified prior to Leg 47 and now run without the piston coring feature. The new design provides for greater ease of handling and, hopefully, less maintenance. The echo from the pinger was watched carefully on the precision depth recorder during the initial drill pipe trip on Hole 397. Although sensitive gain adjustments were required, the pinger reading was in good agreement with the PDR value until the power sub/swivel assembly was rigged. As soon as the assembly was made up, the mud pump was engaged and test run as per standard procecure. At this point, the pinger signal was lost. Upon recovery it was found that the rubber face of the transmitter had been separated from the metal housing. It is now believed that this failure may have been caused by a differential pressure which developed across the bit (and transmitter) during pumping. No spares were on board and pinger capabilities were lost for the remainder of the leg, however, the results of the test were promising for the employment of the pinger in the future.

A total of four heat flow measurements were attempted. Two of the three measurements attempted on Site 397 were successful and a geothermal gradient was determined. The other attempt at this site failed due to the breakage of a solder wire connection in the electronics package. The single attempt at Site 398 was also technically successful except that the tool had to be retrieved by tripping the pipe after the sandline parted. Good thermal data were recovered, however. No further runs were made as the risks involved to both the sole remaining sandline and the high investment re-entry hole were considered too great. Recent design changes in this tool should continue to provide greater durability and ease of handling.

The in situ pore water sampler received on board at Vigo represented a type of downhole instrumentation new to the Project. It basically consists of a sampling probe which extends through the core bit and is forced into the undisturbed sediment below the bit. A sampling tube runs from the tip of the probe through a timer operated valve, into a pre-evacuated sample chamber. The entire assembly is run inside and attached to a standard diameter inner core barrel. The very first run of the sampler in Hole 398 was an unqualified operational success and a usable sample was obtained. The second attempt, on Hole 398B, resulted in the second sandline failure. When the tool was finally recovered after tripping the pipe, it was discovered that the sampling valve had not closed fully and that sea water had displaced the sample from its chamber. In situ sampling attempts were discontinued at this point for the same reasons as were the heat flow measurements.

Extender shoes for the cutting of small diameter cores had been designed by the Project's Development Engineering Section and were on board for testing and for the evaluation of small diameter coring for pressure core barrel and other programs. Unfortunately, scheduling considerations and the overall coring program relegated these tests to fairly low priority and only one test run was made. The firm marly chalk cored was apparently too hard for this operation, as the cutting structure of the shoe was almost completely worn away. In addition, the core obtained was too firmly packed into the shoe and aluminum liner to be removed. Further testing was deferred until more favorable conditions can be arranged.

BEACONS

The performance of the ORE sonar beacons was more than adequate with the exception of two occurrences.

The original 13.5 kHz single life beacon dropped on Site 397 performed well for nearly eight days and began to fail on the final day of Hole 397 operations. As soon as the mudline was cleared with the drill string, a 16 kHz single life replacement was dropped. The signal strength of this beacon was unacceptably low and the frequency was too far off specification to be accepted by the positioning system's filter. Positioning was switched back to the original beacon while a second single life 16 kHz replacement was dropped. This beacon remained strong for the duration of site occupancy (over ten additional days).

A 16 kHz double life beacon was dropped on arrival at Site 398. The beacon had been running for three days due to the fact that the plastic activation plug had broken when the beacon was tested on rigging it up. Signal strength remained high until the 25th day of operation (the final day on site) when the signal dropped abruptly to a very low level. A 13.5 kHz single life replacement was dropped immediately. The replacement signal was unstable with the pulse breaking up and drops in the signal level. On switching back to the original beacon, it was found that it had regained its strength. Positioning remained on the original beacon for the final day of site time. On departure from the site, both beacons were emitting strong, stable pulses.

One beacon, which had been rigged up in the mud room, was found to have been damaged. The rubber transmitter diaphragm had been punctured and oil was escaping. The beacon was boxed for shipment from Brest to ORE for repairs.

DYNAMIC POSITIONING SYSTEM

Although no major excursions, equipment losses or inordinately long operational shutdowns were attributed to dynamic positioning failures on Leg 47, several situations arose in which serious consequences were averted only through the skill and vigilance of bridge personnel. A total of 12-3/4 hours of operating time was lost due to problems with the positioning system.

Probably the most serious shortcoming of the system, in terms of persistence, potential for disaster and difficulty of corrective action is chronic vertical reference gyro failure. Four such failures occurred on Leg 47. The standard corrective action in such cases is to switch over to the standby gyro but in one instance this was done and the standby was found to be defective. Gyro failure is particularly serious in view of the fact that the positioning display is lost. Even if manual control is assumed immediately, it is necessary to operate "blind" and rely on the attitude of the drill pipe in the guide horn for positioning until gyro function is restored. The extent of the excursion taken is never known. The gyros are subject to a constant error or "bias" which is relatively unimportant if the same gyro is used for the duration of a site, but which becomes significant in the event gyros are interchanged. Another shortcoming of the gyros currently in use appears to be their susceptibility to error introduced by the acceleration of vessel motion. During the rough weather period on Site 398, positioning was quite erratic. At one point, the display dot was noted to move continuously though a range of plus or minus 15 to 20 feet in the Y axis in perfect coordination with the roll of the ship. The reliability of vertical reference gyros has been poor since the inception of the Project.

During one period of several days duration, the system's heading control feature developed the habit of abrupt failure and "locking up" the thrusters at full rpm, driving the ship off its preset heading. These failures were found to be triggered primarily by radio frequency interference caused by keying the vessel's powerful TMC transmitter on certain frequencies. Investigation of the problem revealed it to be more complex than originally thought, as the lockups were occasionally triggered by other means and (rarely) for no apparent reason. The problem was not fully rectified until all the following actions had been taken:

A. All parts of the bridge console and chassis were provided with RF ground straps to the ship's hull.

B. Additional shielding was provided from the ship's transmitting radio antennas.

C. The heading encoder module in the bridge console was replaced.

D. An intermittently defective relay, also in the bridge console, was located and replaced.

One or more "ghost" problems persist in the electronics of the system and cause unpredictable "excursions" off the beacon. Some of these are real and require corrective action while others are bogus displays. Because of the extremely transient nature of these problems and because major troubleshooting cannot be done during on-site operations, the causes are virtually impossible to ascertain. Loss of acoustics was experienced during heavy weather on Site 398 and was apparently caused by water entering the preamplifier boxes on the hydrophone trunks when seas swept over the main deck. The location and/or method of sealing of these boxes should be subject to review.

HEAVE COMPENSATOR

The ship's vertical motion compensator continued to be plagued by peripheral mechanical and electrical problems but was successfully employed on the latter portion of Hole 397A and for virtually all coring operations on Site 398. Its effective maintenance of uniform hook load is credited with being a factor in the long and productive bit lives on both sites. Considerable heave was experienced at times on Site 398 from both seas and swells. Although lithology was probably the prime factor, heave compensation was, without a doubt, instrumental to a degree in the remarkable 72.2% core recovery rate over the 1298 meters cored in Hole 398D.

The most serious and perplexing problem encountered was the tendency of the system to dump its hydraulic fluid through some part of the maze of valves, vents and solenoids in the hydraulic control system into a holding tank. This would cause the compensator cylinder to "bottom out" over a period of a few seconds and would require recharging of the system before operations could be resumed. The malfunction was transient in nature and would usually rectify itself before troubleshooting could be done. A leaky pilot spool valve and possible intermittent electrical problems have been identified as the most likely culprits.

The compensator piston stroke indicator was repaired on three or four occasions for both electrical and mechanical faults. A great many man hours were spent on this component alone to say nothing of the great effort expended on the former problem.

HOLE PROBLEMS

The deep penetrations at both sites were remarkably free of hole problems but some tendencies were observed which might become important factors on future deep penetrations.

Some sticking and torquing were experienced just below 1300 meters in the upper portion of the Cretaceous shale section in Hole 397. The appearance of the cores suggested that these might be the effects of heaving shale. Just as the effects appeared to be developing into a significant problem, however, they simple ceased and no further difficulties were encountered on that hole.

Coincident with a period of heavy swells and considerable heave while coring Hole 398D, some concern was generated by fill in the hole. As much as eight or nine meters of fill would accumulate while the wireline trip was being made and it was necessary to stand back a single joint to keep the bit off bottom. This phenomenon ceased when the heave decreased and is now believed to have been caused by the rubbing of the drill string on the wall of the hole while the heave compensator was locked out during the wireline trip.

The problem of plugged bits was a continuing, frustrating and expensive one. Nearly 30 hours of operating time were consumed in clearing bits on Hole 398D alone and at times it appeared that a pipe trip would be necessary. The plugging occurred in a variety of situations and at the slightest provocation. Without a doubt the plastic, packing character of the shale and claystone lithologies was a major factor but other ramifications, possibly depth related, may be involved.

Final inclinometer readings in deep holes 397A and 398D were 28° and 23° respectively. These deviations from vertical, if true, did not cause any drilling problems aside from possibly a slight increase in torque. It may be advisable, however, to employ a stabilizer assembly on future deep penetrations. The bits recovered from total depth on both holes were measurably out of gauge and "steps" were cut into the stabilizer pads. It is felt that the drag of these pads may contribute to the hole deviation.

ENGINEERING

The vessel's power generating and propulsion machinery suffered a nearly unbelievable sequence of calamities from the very beginning of the leg. Steaming from Las Palmas was delayed for 15 hours after tugs were already alongside by two unrelated breakdowns. A microswitch failure in an overload trip prevented the assignment of No. 5 and No. 7 engines to propulsion. As soon as this problem was solved, the newly installed governor in No. 4 engine failed and had to be replaced.

This was only the beginning. During the course of the voyage, the crankshaft bearings (main and rod) of No. 1 Caterpillar engine failed. They were replaced in Vigo. Shortly thereafter bearing metal was found in the oil filters of No. 2 engine. The crankcase was cleaned and the engine operated through the leg. No. 4 D.C. generator developed a ground in the armature on April 29 and was lost for the duration of the leg. On May 4, No. 6 D.C. generator shorted internally, caught fire and was damaged beyond shipboard repair. By the first week in May ominous noises had developed in the bearings of No. 3 D.C. generator, No. 5 propulsion motor and the "B" drawworks motor. (All these generators and motors were overhauled during the November 1975 drydock period).

On April 15, sea water was reported leaking into both stern thrusters through failed seals. Back pressure was required to check the rising level of emulsified oil and water in No. 1 stern thruster. Lesser amounts of water were later discovered to have entered both bow thrusters. All four somehow continued to function for the remainder of the leg.

Other incidents included a generator flashover which incapacitated the "B" drilling switchboard for 2-1/2 hours, the failure of one main sea water circulating pump and the loss of No. 1 evaporator due to a badly corroded tube nest.

DECK DEPARTMENT

Deck Department personnel figured directly in the coring operation in that they were required to make four long splices in sandline cables and to pour several wire rope sockets. The task of straightening and spooling salvageable sandline sections also fell to the seaman gang.

The routine duties of cleaning and preservation of the ship were complicated by spillages of drilling mud and cement. Stiff headwinds during coring operations resulted in the repeated cleaning of oily residue from the deck house and casing rack areas. A blown gasket in the heave compensator caused pydraul to be sprayed over a large newly painted area, necessitating repainting. As pydraul is an efficient paint remover, even normal leakage from the heave compensator system results in increased requirements for paint and topside maintenance.

COMMUNICATIONS

Radio communications were handled directly with Scripps Station WWD for the first few days of the cruise while the vessel was in the Canary Islands area. Very poor signal quality made communications extremely difficult, however, and it was necessary to shift to the Navy system. Nearly all messages for the remainder of the leg were sent through Naval Communications Station Nea Makri, Greece. Most messages were received via the Mercast system. Equipment failures and material requirements resulted in a relatively large volume of GMI traffic with commercial European stations. Radio telephone communications with the U.S. on commercial channels was fair to good and easily attained. No amateur radio communications were conducted.

NAVIGATION

The satellite navigation system was out of commission for about two days with a power supply problem while the ship was in transit from Site 397 to Vigo. Navigation by celestial fixes and LORAN A lines of position was entirely adequate during this period. The Scripps electronics technician had effected repairs and the unit was functional on arrival in Vigo. A technical representative was on hand to board the ship and thoroughly check out the unit while the ship was at anchor in Vigo.

A great deal of time and effort was spent by the radio officer in troubleshooting and repairing the ship's LORAN receiver. Good LORAN A lines were obtained consistently and the LORAN C mode is apparently operational. Leg 47 operations were in fringe areas of LORAN C coverage and only intermittent sky waves were received. Ground wave reception should provide good fixes on forthcoming North Atlantic legs.

The recently installed Lemkuhl true bearing module was a valuable asset in the radar plotting of ship contacts. Due to the CHALLENGER's restricted maneuverability while under way, profiling and her complete immobility while on station, ship traffic was a matter of concern throughout the leg. Site 398 was located in a major seaway and heavy traffic was encountered on the transit to Brest.

The location of drilling sites was accomplished without great difficulty, despite the fact that the track of one of the reference profiles was found to be in error by about five miles. Satellite navigation was used to its best advantage by first copying alerts of scheduled satellite overflights and then adjusting the ship's speed to time arrival at the immediate site area coincident with or shortly following the receipt of a reliable satellite fix.

WEATHER AND CURRENTS

Weather was generally quite good during Site 397 occupancy and did not hamper operations. Anticipated northeast trade winds were not encountered on the transit to Vigo and better than expected speed was realized with the five available propulsion engines until the ship was about 200 miles from Vigo. Gale force (up to 60 mph) head winds were then encountered from the passage of a storm front, slowing the ship to as little as 2.4 knots and causing rolls up to 16 degrees.

Shortly after the commencement of operations at Site 398, circulation from a strong high pressure area in the northeast Atlantic produced steady northerly winds across the Bay of Biscay with sustained velocities of 35 to 42 mph. The strong winds and relatively short fetch resulted in short period swells up to 16 feet high. These produced the "snap pitch" of the vessel which resulted in the delay of drilling operations for 33 hours. The weather for the remainder of site occupancy was, in general, unpleasantly cloudy, cool and breezy but did not interfere with operations. Several storms which would have been likely to halt operations were forecast for the area by weather maps but all changed course or "stalled" in the Atlantic. The overall weather conditions at Site 398 were somewhat better than normal for the geographic area and time of year. Weather conditions became extremely critical during the final few days on site in view of the ship's drastically reduced stationkeeping capabilities. Frontal winds gusting to 35 mph were a decisive factor in the termination of operations at this site. They would not have had a significant effect had the ship been at full power.

Currents were not a significant operational factor but they were observed, at times, on both sites. They are believed to be eddies or tongues of the prominent longshore currents located landward of the sites. The currents encountered were intermittent and variable in both direction and speed. At times, the drill pipe was offset from vertical enough to cause rig floor personnel to notify the bridge of a possible positioning excursion. Ironically, the strongest and most persistent current was experienced during the final days on site. Its direction was opposite that of the wind and the current "assisted" the single propulsion engine in holding position.

PERSONNEL

With the exception of the dental infection which necessitated removal of the patient from the ship, no medical situations arose that could not be treated adequately by the ship's surgeon. In addition to colds and minor injuries, about 20 cases of influenza were treated. Engine room personnel were particularly hard hit and a severe shortage of watchstanders existed for a few days.

Global Marine personnel performed in a competent and efficient manner for the duration of the cruise. They were resourceful in overcoming numerous technical disadvantages to achieve the objectives of the drilling program. Frustrating equipment problems, prolonged unpleasant weather and the eleventh hour extension of an already long expedition combined to bring crew morale to an abnormally low level during the final days of the leg. Their professionalism, however, did not allow this factor to affect performance.

Glen N. Foss

Glen N. Foss
Cruise Operations Manager
Deep Sea Drilling Project

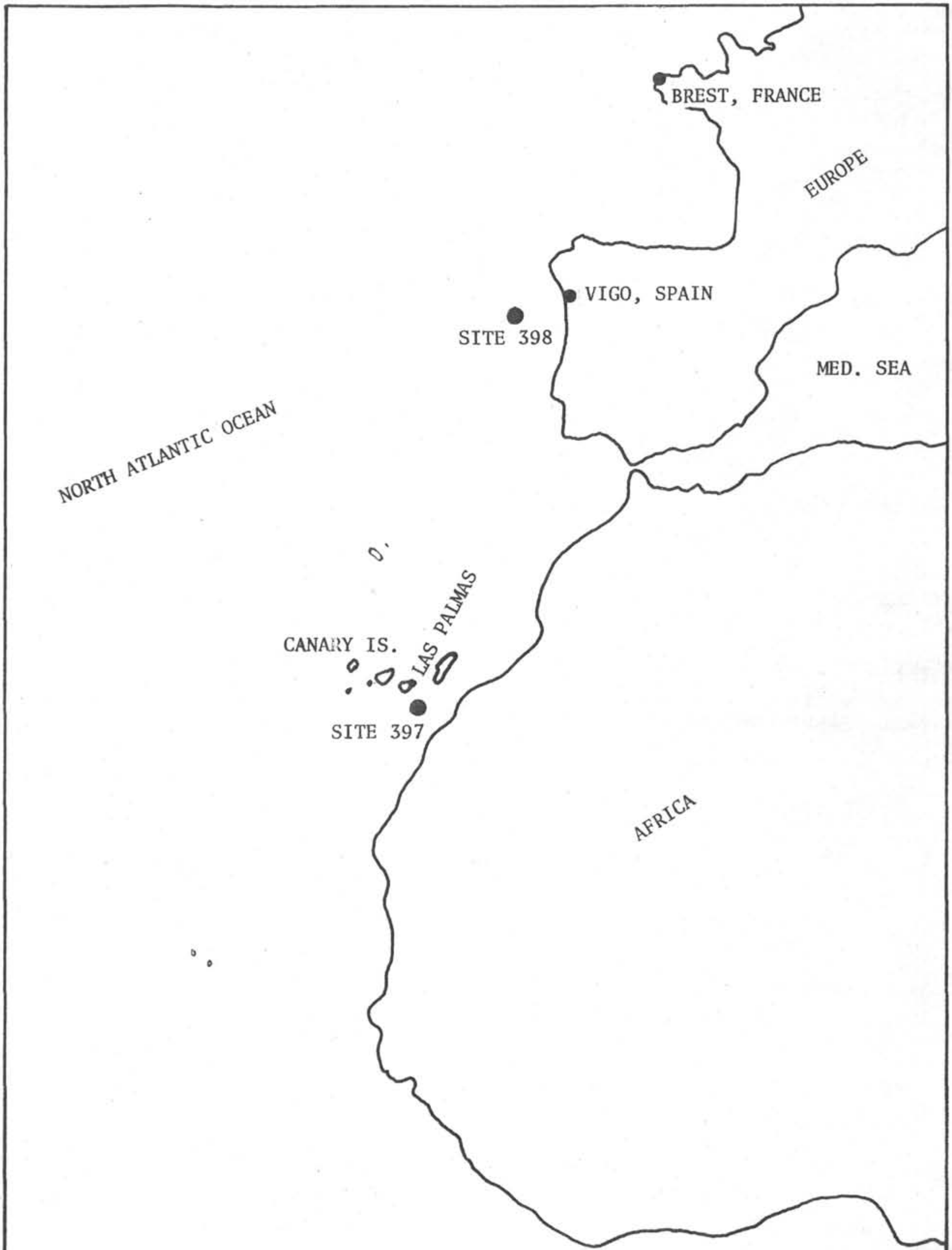
DEEP SEA DRILLING PROJECT

OPERATIONS RESUME

LEG 47

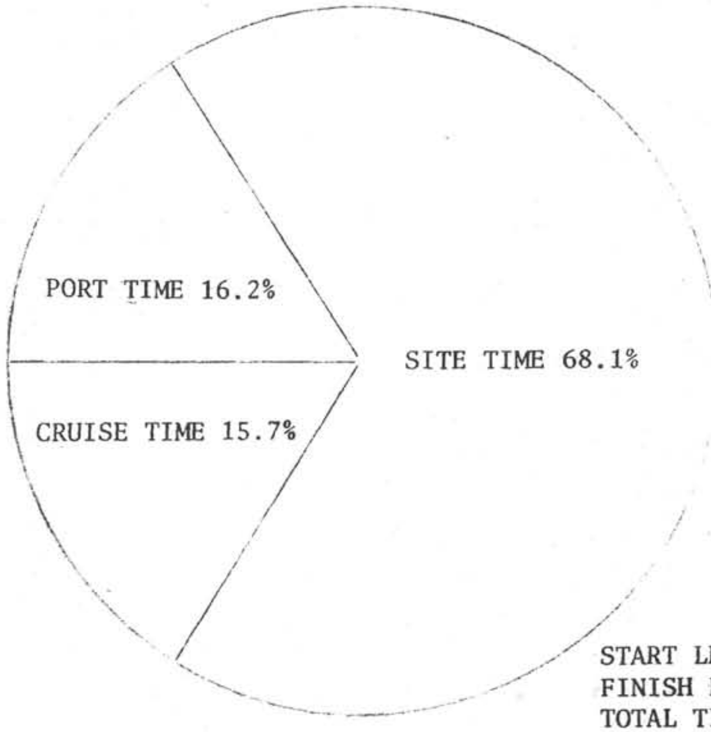
Total Days (March 10, 1976 - May 12, 1976)		62.50
Total Days In Port		10.14
Total Days Cruising		9.81
Total Days On Site		42.55
Trip Time	5.3	
Drilling Time	2.2	
Coring Time	26.0	
Mechanical Downtime	2.6	
Position Ship	0.2	
Re-entry and Related Operations	1.3	
Wait On Weather	1.4	
Other	3.6	

Total Distance Traveled (Nautical Miles)	1824
Average Speed (Knots)	8.6
Sites Investigated	2
Holes Drilled	7
Number of Cores Attempted	301
Number of Cores With Recovery	292
Percent of Cores With Recovery	97.0
Total Meters Cored	2809.5
Total Meters Recovered	1812.5
Percent Recovery	64.5
Total Meters Drilled	2040.0
Total Meters Penetration	4849.5
Percent Penetration Cored	57.9
Maximum Penetration (Meters)	1740.0
Minimum Penetration (Meters)	79.0
Maximum Water Depth (Meters)	3900.0
Minimum Water Depth (Meters)	2910.0



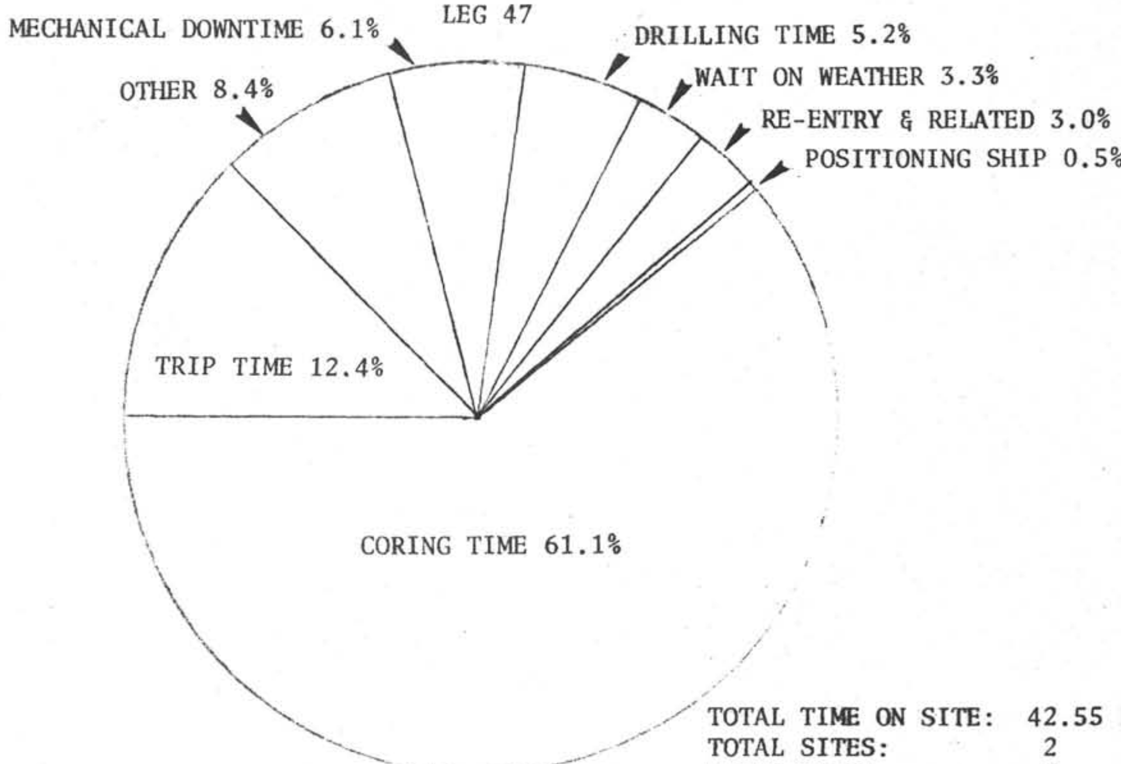
LEG 47 DRILL SITES

TOTAL TIME DISTRIBUTION
LEG 47

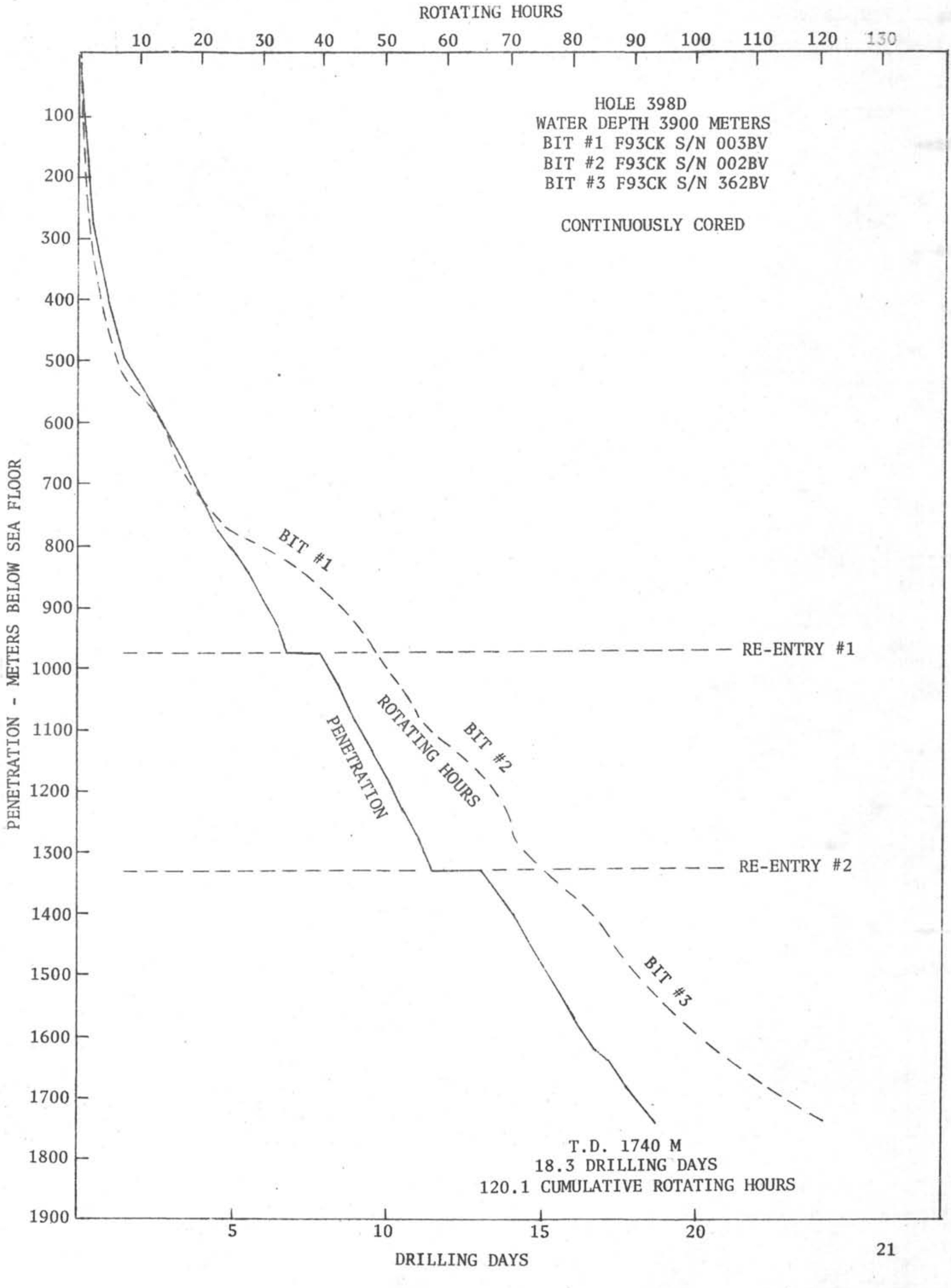


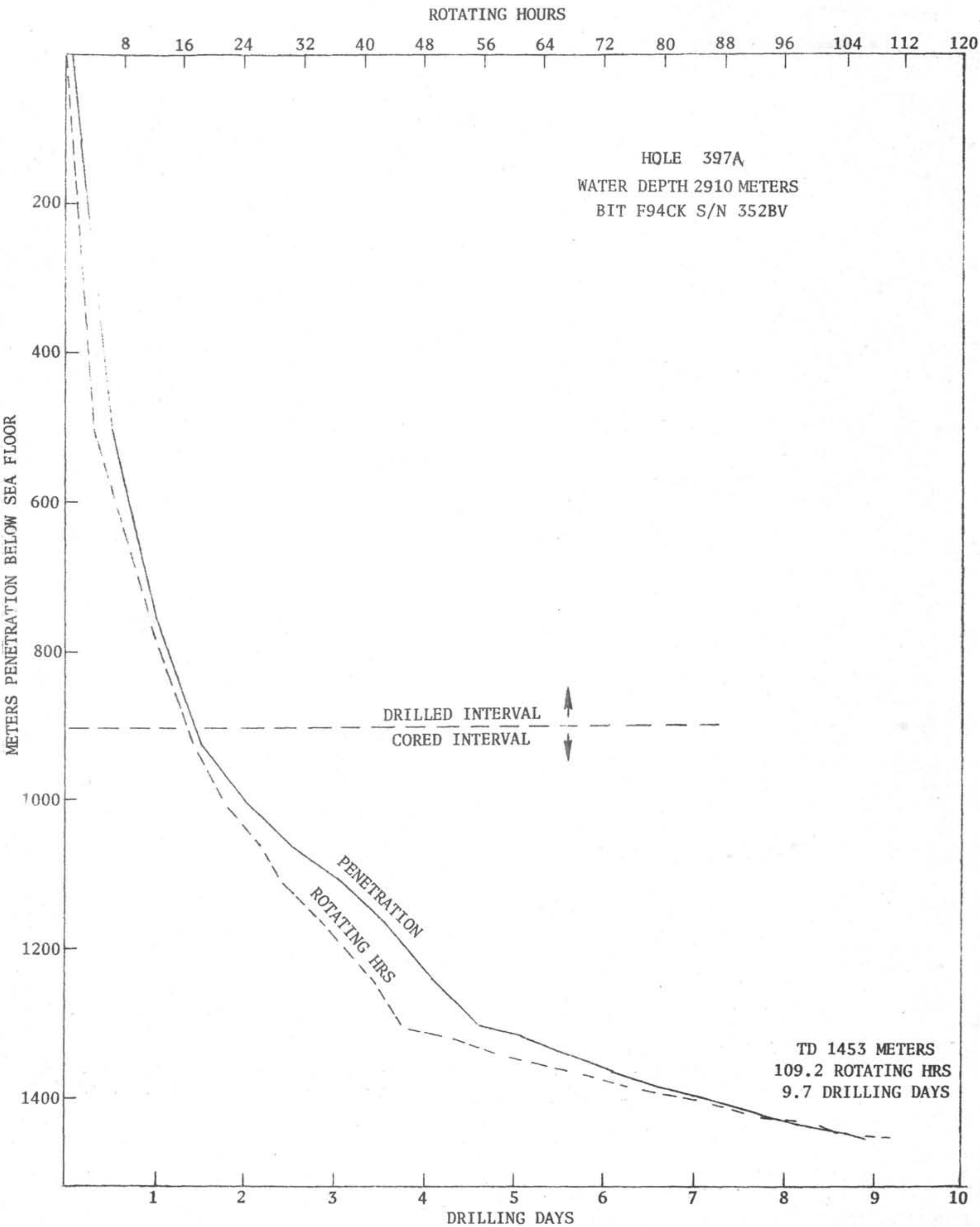
START LEG: March 10, 1976
FINISH LEG: May 12, 1976
TOTAL TIME: 62.50 Days

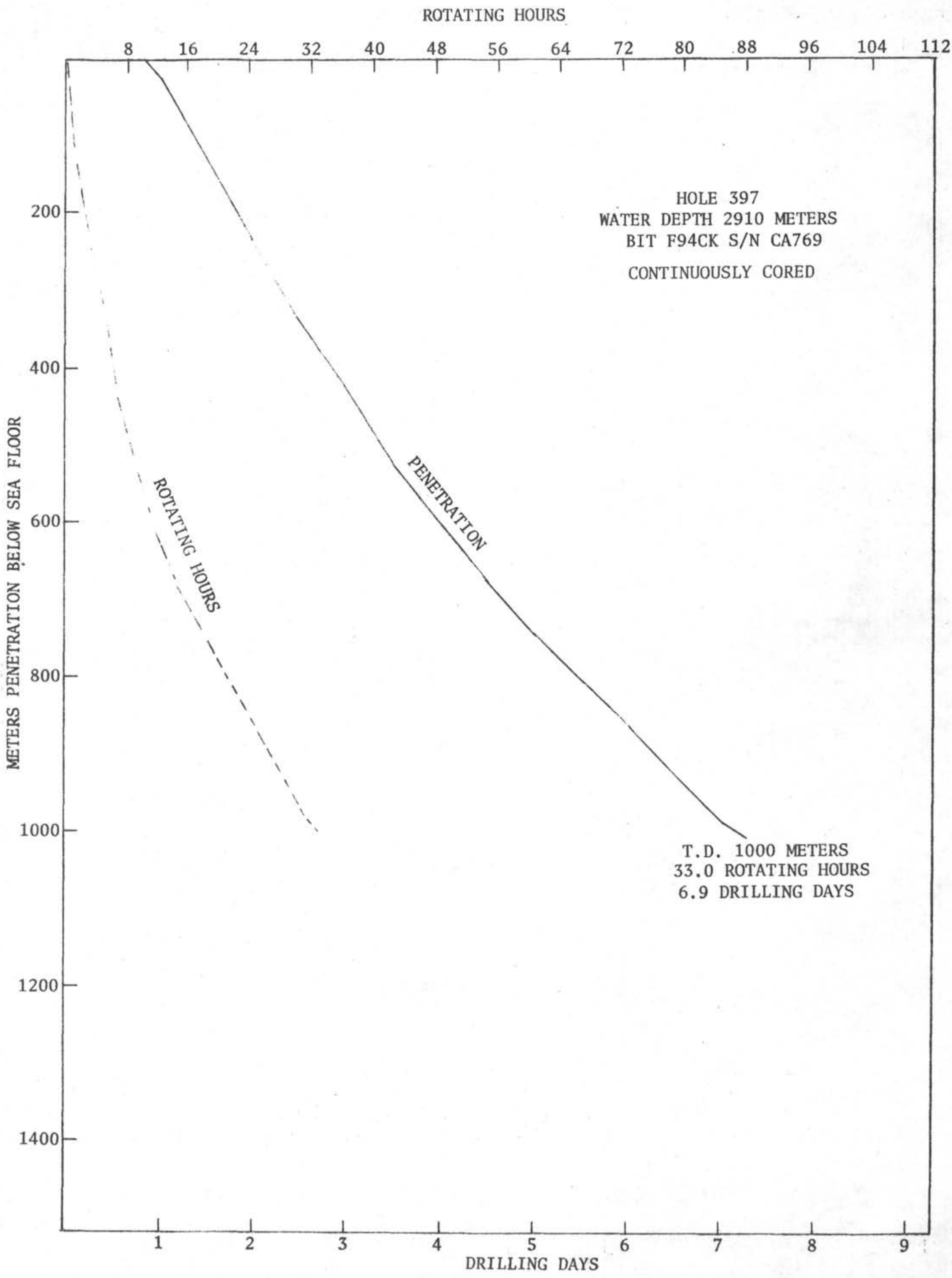
ON-SITE TIME DISTRIBUTION
LEG 47



TOTAL TIME ON SITE: 42.55 Days
TOTAL SITES: 2
TOTAL HOLES: 7


ROTATING HOURS
10
20
30
40
50
60
70
80
90
100
110
120
130
HOLE 398D
WATER DEPTH 3900 METERS
BIT #1 F93CK S/N 003BV
BIT #2 F93CK S/N 002BV
BIT #3 F93CK S/N 362BV
CONTINUOUSLY CORED
PENETRATION - METERS BELOW SEA FLOOR
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
BIT #1
RE-ENTRY #1
PENETRATION
ROTATING HOURS
BIT #2
RE-ENTRY #2
BIT #3
T.D. 1740 M
18.3 DRILLING DAYS
120.1 CUMULATIVE ROTATING HOURS
5
10
15
20
DRILLING DAYS


ROTATING HOURS
8
16
24
32
40
48
56
64
72
80
88
96
104
112
120
HOLE 397A
WATER DEPTH 2910 METERS
BIT F94CK S/N 352BV
METERS PENETRATION BELOW SEA FLOOR
200
400
600
800
1000
1200
1400
DRILLED INTERVAL
CORED INTERVAL
PENETRATION
ROTATING HRS
TD 1453 METERS
109.2 ROTATING HRS
9.7 DRILLING DAYS
1
2
3
4
5
6
7
8
9
10
DRILLING DAYS


ROTATING HOURS
8
16
24
32
40
48
56
64
72
80
88
96
104
112
HOLE 397
WATER DEPTH 2910 METERS
BIT F94CK S/N CA769
CONTINUOUSLY CORED
METERS PENETRATION BELOW SEA FLOOR
200
400
600
800
1000
1200
1400
ROTATING HOURS
PENETRATION
T.D. 1000 METERS
33.0 ROTATING HOURS
6.9 DRILLING DAYS
1
2
3
4
5
6
7
8
9
DRILLING DAYS

DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 47

SITE NO	MAKE	FREQ. kHz	SERIAL NUMBER	SITE TIME HOURS	REMARKS
397	ORE	13.5	217	186.9	Single life, failing on final day.
397A	ORE	16	305	- - -	Very weak signal; defective envelope.
397A	ORE	16	345	224.5	Single life; strong for duration.
398	ORE	16	372		Double life; started for test 1600 10APR plug broke-
398A	ORE	16	372		could not shut off. Total running time 28.6 days.
398B	ORE	16	372		Sharp drop in signal strength for few minutes final
398C	ORE	16	372		day on site but regained strength.
398D	ORE	16	372	609.9	
398D	ORE	13.5	358	22.3	Single life; signal weak and broken shortly after landing on bottom. Regained strong, stable signal within hours.

DEEP SEA DRILLING PROJECT

BIT SUMMARY

LEG 47

HOLE	MFG	SIZE	TYPE	SERIAL NUMBER	METERS CORED	METERS DRILLED	METERS TOTAL PENET	HOURS ON BIT	CONDITION	REMARKS
397	Smith	10"	F94CK	CA769	981.0	19.0	1000.0	33.0	TO,B1,SE-I	Throat plugged with mudstone.
397A	Smith	10"	F94CK	352BV	467.0	986.0	1453.0	109.2	TD,B6,SF,0 1/4	Moderate to high shirttail wear. All cones loose-none locked-1/4" "step" in stabilizer pad
398	Smith	10"	F94CK	CA769	35.0	93.0	126.5	1.1	TO,B1,SE-I	Total 34.1 hours.
398A	Smith	10"	F94CK	CA769	19.0	191.5	210.5	1.2	?	Total 35.3 hours, 1576 m.
398B	Smith	10"	F94CK	CA769	9.5	229.5	239.0	1.0	TO,B2,SF-I	Total 36.3 hours.
398C	Smith	10"	F93CK	003BV	- - -	79.0	79.0	0.6	- - - - -	Jet in only.
398D	Smith	10"	F93CK	003BV	551.0	423.0	974.0	48.0	TO,B3-SF,I	Total 1053 m, 48.6 hours.
398D	Smith	10"	F93CK	002BV	332.5	19.0	351.5	26.7	TO,B1-SE,I	Suitable for rerun.
398D	Smith	10"	F93CK	362BV	414.5	- -	414.5	45.4	TO,B5-SF/0 1/16	Two cones somewhat loose-drilled some limestone

DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 47

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
397	26° 50.65'N	15° 10.75'W	2910	104	98	94.2	981.0	584.8	59.6	19.0	1000.0	30.3	186.9	
397A	26° 50.65'N	15° 10.75'W	2910	52	52	100.0	467.0	242.7	52.0	986.0	1453.0	13.3	224.5	411.4
398	40° 57.6'N	10° 43.1'W	3900	4	4	100.0	35.0	22.1	63.1	93.0	126.5	115.0	36.4	
398A	40° 57.6'N	10° 43.1'W	3900	2	2	100.0	19.0	17.2	90.7	191.5	210.5	175.4	56.5	
398B	40° 57.6'N	10° 43.1'W	3900	1	1	100.0	9.5	8.3	86.9	229.5	239.0	239.0	26.5	
398C	40° 57.6'N	10° 43.1'W	3900	0	-	- -	0	0.8	- -	79.0	79.0	197.5	32.0	
398D	40° 57.6'N	10° 43.1'W	3900	138	135	97.8	1298.0	936.6	72.2	442.0	1740.0	14.5	458.5	609.9
				301	292	97.0	2809.5	1812.5	64.5	2040.0	4848	18.2		1021.3

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 47

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
3 10 76 3 21 76		9.8	.	.	.	.	.	.	.	235.8	.	.	245.6	IN PORT LAS PALMAS
. . .		.	.	.	.	.	.	.	.	.	.	.	.	O/W TO SITE 397
3 21 3 28	397	.	15.5	1.1	141.1	.	.	1.8	16.1	.	.	11.3	186.9	
3 28 4 7	397A	.	14.5	31.1	155.7	0.8	.	.	2.3	.	.	20.1	224.5	
4 7 4 12		137.0	.	.	.	.	.	.	.	1.0	.	.	138.0	397A TO VIGO LAS PALMAS STOP
4 12 4 13		13.6	.	.	.	.	.	.	.	6.5	.	.	20.1	VIGO TO SITE 398
4 13 4 15	398	.	19.4	1.8	5.1	.	.	1.3	4.4	.	.	4.4	36.4	
4 15 4 17	398A	.	10.8	3.0	2.3	.	33.5	.	6.0	.	.	0.9	56.5	
4 17 4 18	398B	.	10.3	2.0	1.2	.	.	.	11.7	.	.	1.3	26.5	
4 18 4 20	398C	.	8.0	2.3	.	.	.	.	8.5	.	13.2	.	32.0	
4 20 5 9	398D	.	48.6	10.2	319.4	.	.	0.8	14.4	.	16.7	48.4	458.5	
5 9 5 12		75.0	.	.	.	.	.	.	.	.	.	.	75.0	SITE 398 TO BREST
TOTAL		235.4	127.1	51.5	624.8	0.8	33.5	3.9	63.4	243.3	29.9	86.4	1500.0	

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 48

Leg 48 of the IPOD program was designed to drill in two areas of the northeastern Atlantic Ocean. These two areas were the Bay of Biscay and the Rockall Plateau.

The leg started May 12, 1976 in Brest, France and ended 61.86 days later in Aberdeen, Scotland on July 13, 1976. During this leg the CHALLENGER traveled 1935.4 nautical miles and drilled ten holes at eight sites. Water depths ranged from 4414 meters to 2317 meters and averaged 3099 meters. Hole depths ranged from 72.5 meters to 831.5 meters and averaged 399.2 meters. A total of 2995.5 meters were cored and 1230.22 meters of core were recovered for a recovery of 41.06%.

Time distribution for the leg was 9.65 days in port, 11.41 days cruising and 40.8 days on-site. The on-site time consisted of 8.6 days tripping, .09 days drilling, 20.9 days coring, .6 days positioning the ship, .57 days for mechanical downtime, .54 days in re-entry operations, 1.8 days waiting on weather, and 7.7 days in miscellaneous activities such as picking up a new drill string and running downhole logs.

PORT CALL AND DRY DOCK - BREST, FRANCE

The GLOMAR CHALLENGER arrived in Brest, France at 0830 on May 12, 1976 at which time Leg 47B ended and Leg 48 began. The vessel was required to initially anchor and wait for high tide before entering dry dock.

At 1500 on May 12, the ship had entered dry dock primarily for repair of a stern thruster, which had developed a leak during Leg 47. After water was removed from the dry dock the stern thruster motors were landed and the drive shafts and casings were pulled. On one of the stern thrusters it was found that the gear box bolts had loosened and allowed water to enter. This unit was replaced and both units were reassembled with new seals. The bow thrusters were inspected and new seals were installed. They were not removed. While this work was being done, the main and connecting rod bearings were replaced on engines No. 1 and No. 12. Also No. 4 and No. 6 generators were replaced. The alignment of these two generators took longer than was anticipated and particularly No. 6 which was not completed until 2000 hours on May 21.

The cap of the heave compensator accumulator cylinder was removed and the cylinder inspected. In addition, a general inspection of the entire system was made, however, final checking out of the operation had to wait until the ship was on location and drilling.

The No. 2 drawworks motor was removed, repaired and replaced. In addition, the drill pipe was inspected by Tuboscope. All joints were found to be in acceptable condition. A new sandline was spooled onto the coring winch using a newly reconditioned wireline tensioner. It worked smoothly.

While in dry dock cracks were found in the hull on the port side (Frame No. 10 third plate from the keel and first plate from the stem). There was one crack two inches long, 20" from the bottom of the plate and one crack 10" long, 22" from the bottom of the plate and a few inches abaft of the first crack. This area was sanded and the cracks welded and repainted to the satisfaction of the ABS surveyor.

Normal supplies were taken on including two re-entry cones. Fuel was not taken.

The additional port time, required for repairs, allowed the drilling crew and welder the opportunity to assemble a re-entry cone on the dock and then place it on board for use at the first site to be drilled.

In addition, new sea strainers were installed. They were sandblasted and coated with Axexior No. 3 before installation.

SITE 399

The initial site chosen for Leg 48 was to be located in the Biscay-Meriadzek Terrace area and was planned to be a deep-penetration re-entry site. After only 25.7 hours of travel from port, the first beacon was dropped at Site 399. This time included the necessary profiling to ascertain that the site would be located as close as possible to the approved site. A 16 kHz beacon was dropped and positioning was begun; however, within an hour, it was necessary to drop a 13.5 kHz beacon because of the poor signal being received from the initial beacon. While attempting to position on the second beacon, it was discovered that the signal from the first beacon became stronger. Offsets were dialed in and the first beacon was used for positioning. During the time that the positioning problem was being worked on, drill string was made up. Finally, 20 hours after the second beacon was dropped, the hole was spudded. One core was cut and retrieved from 4414-4422 meters then an additional three and one half hours were spent positioning the ship and working with the computer. The hole was then washed without rotation to 4477 meters and another core cut from 4477-4486.5 meters. The drill string was then pulled with the idea of running casing and the re-entry cone to 4477 meters; however, as preparations were being made to accomplish this, sea conditions worsened and the marginal beacon signal became unusable. It was then necessary to move approximately one mile and start all over again with the preparations for drilling a re-entry hole.

SITE 400

After moving approximately one mile in an east southeasterly direction away from the beacon signal of Site 399, a 16 kHz double life beacon was dropped. The final offsets from the beacon were 990' north and 180' west on a heading of 288°. These offsets were made in an attempt to have the same water depths as at Site 399; however, the PDR indicated a water depth of 4399 meters or 15 meters shallower than at Site 399. The drill string was then made up to wash a pilot hole to determine the amount of casing that should be attached to the cone. A core was cut from 4399-4408 meters and recovered 9 meters which then verified the PDR reading. The hole was then washed as deep as possible without rotation and reached 4478 meters which would allow 79 meters to be washed in with the cone assembly. It required 29 hours to pull the drill pipe, keelhaul the cone, make-up and latch the 16" casing and run back to bottom.

HOLE 400A

This re-entry site was spudded at 1745 and required three hours to wash in the 74.5 meters of casing to 4473.5 meters. After washing in the shifting tool was run and the 16" casing was released at 2200. The core barrel and shifting tool were recovered and a new core barrel dropped. It then required 4-1/2 hours to set back the Bowen unit, pick up the heave compensator, circulate air out of the system and recharge the system, again pick up the Bowen sub and adjust the heave compensator before the coring program could begin. Cores No. 1 through No. 34 (4473.5-4796.5 meters) were cut using the heave compensator. After Core No. 34 was recovered, the float valve in the core barrel was found to be broken. Core No. 33 had 0.0 recovery and Core No. 34 had 0.1 meter recovery. It was felt that the bit may be plugged and plans were to drop a center bit and clear the obstruction; however, after finding the broken check valve, it was decided to cut Core No. 35 without the heave compensator. Core No. 35 recovered 4.5 meters and the heave compensator was used until Core No. 48 and was then locked out of the system because of a power unit problem.

After removing the heave compensator, recovery was good for four cores then the amount of recovery decreased. Twenty barrels of mud were spotted after Core No. 55 with no improvement; however, after another 20 barrels were spotted following Core No. 60, recovery improved. After Core No. 73, 20 barrels of mud were again spotted. The circulating pressure was 1300 psi after dropping the inner barrel. It was retrieved and a center bit dropped in an attempt to clear the bit. When trying to recover the center bit the pin sheared in the overshot. This was replaced and the center bit was recovered. Core No. 74 recovered only 0.45 meters so 228 barrels of 9.4 ppg 40 sec viscosity mud was pumped into the hole and a round trip was made to see what the problem was. When the string was recovered one cone in the bit (F93CK) was found that would not turn so the bottomhole assembly was made up with a F94CK core bit and spaced out with a bit release sub as part of the assembly. The drill string was run in and hung off at 4389 meters to start re-entry. The sonar re-entry tool was started in the hole at 0725 hours and the tool took weight at 0928 at 3289 meters. The vessel was maneuvered and re-entry made in one hour and 23 minutes. After retrieving the sonar tool, 23 stands of pipe were run in to 5044.5 meters. Then for the next 2-1/2 hours, the heave compensator and Bowen sub were picked up. The drill string was then washed to bottom (5176.5 meters) and was hanging in the hole when the pin end of the pup joint attached to the Bowen sub broke and dropped 528 joints of drill pipe plus the bottomhole assembly to the ocean floor. There was 5056 meters of drill pipe lost when the pin broke. Following this the Bowen unit and heave compensator was set back and a new string of drill pipe was picked up.

During the coring operation three inclination surveys were made. Number one on Core No. 56 had no reading because the clock stopped; Number two on Core No. 58 (5015-5024.5 meters) with 6^{o} angle (good record) ; and Number three on Core No. 68 (5100.0-5119.5 meters) with 7^{o} 45' (good record).

SITE 401

The loss of the drill string at Site 400 delayed departure for Site 401 approximately 50 hours while the balance of drill pipe stored on board could be picked up and racked. In addition, all the subs on the Bowen sub from the swivel on down were magnafluxed as well as the two 20 foot pup joints, which were to replace the unit that failed.

Authorization was received from La Jolla on June 5 to proceed to an alternate location not previously approved by the Safety Panel, as the amount of drill pipe remaining aboard restricted the depth of operations. It required only about four hours of travel from the time the ship left Site 400 until the beacon was dropped at Site 401 in 2460 meters of water as shown on the PDR; however, after the ship had been positioned to the desired location, the depth of water to the derrick floor was calculated to be 2504 meters.

The drill string was made up with the heave compensator in the drilling assembly and a mudline core was attempted from 2504-2508 meters and recovered only water. Six core attempts were made until a 8.5 meter core was recovered in the cored interval 2547.0-2555.5 and the mudline was considered to be at 2547.0 for all depth measurements at this site. After Core No. 1, the hole was washed to 2631.5 meters and was then continuously cored to Core No. 11 (2717-2726.5 meters). At this point, the heave compensator was closed because pydraul was being lost. This problem was remedied when it was found that a stop for a swash plate had fallen out and was replaced. After cutting three more cores, coring was discontinued when it became necessary to secure No. 2 Gyro due to a power failure. It required 2-3/4 hours to determine the cause of the failure and make repairs. Burned out brushes were found in the motor generator for No. 1 Gyro. Coring was then continued with the heave compensator working until the end of Core No. 20. After cutting this core, it took 15 minutes to close the cylinder. The problem was in some wiring behind the instrument panel and was corrected so the heave compensator could be used again while cutting Core No. 23. Recovery had been poor from the time the gyro was repaired (Core No. 15) and when Core Nos. 25, 26 and 27 came up with no recovery, 15 barrels of mud were spotted to attempt to clean up the hole and find out if cuttings in the hole were the problem. Pump pressure during the low recovery period was normal, so bit plugging was not felt to be a problem. When Core No. 28 also had no recovery, it was decided to discontinue drilling and attempt to release the bit for the first time and run a downhole logging program.

Preparation began by laying down 2-1/2 doubles, setting back the Bowen sub, setting back the heave compensator and picking back up the Bowen sub. Then four more doubles were layed down and then the bit was doubled back to bottom to clean up the hole with a 20 barrel slug of 45 sec viscosity mud. The releasing tool was then lowered to release the bit; the release of the sub was shown by weight pick up, then loss on the sandline weight indicator. To further assure that the bit was released, a center bit was dropped and recovered. Then 80 barrels of 45 sec viscosity mud was spotted and preparation for logging begun. The bottom of the drill pipe was pulled to 2666 meters so that the upper two bumper subs would have hole support.

Because of the calm seas, the sheaves were rigged in the normal manner when running the Schlumberger winch. An attempt was not made to use the heave compensator.

The first tool rigged was the gamma/sonic/caliper log which has two sets of springs for centralizing the tool and for measuring the hole diameter. The tool started in the hole at 1400 hours and came out of the drill pipe without any problem. The tool went to 2869 meters or 17 meters from total drilled depth. This log was recorded up to 2666 or the bottom of the drill pipe. A rerun of the logged section was made and then a variable density log was run using the same tool. It was then pulled to the surface with no trouble coming back into the drill pipe. Following this, the gamma induction and gamma/density/neutron logs were run without complication. As each log was run, the pick up point (depth to which logging tool went) was shallower indicating that cuttings were probably filling the bottom. Another interesting fact was that the gamma detected the interface of water and sea bottom at 2550 meters and not what the PDR indicated by about 45 meters. From the time the sheaves were picked up until the last tool was on-deck required less than 15 hours and all logs were of good quality.

The drill string was picked up and gear secured for the move to Site 402.

SITE 402

This site was the second of two new sites proposed for the Bay of Biscay drilling; the first being Site 401. It was close to Site 401 as it took only 4.5 hours to travel to the proposed site, do the necessary profiling and drop the beacon.

It was not possible to start making up the drill string at this site for four hours due to adverse weather conditions. After the drill string was made up, a mudline core was attempted at the depth indicated by the PDR (2335 meters); however, as at Site 401, the mudline core found bottom deeper (2355.5 meters) or 20 meters deeper than the PDR measurement. A possible answer to the problem is that the site was located in a small valley and possibly the PDR could be producing multiples rather than true ocean bottom reflective data.

After the mudline core was recovered, the heave compensator was picked up and the hole was washed 42 meters to 2397.5 meters. Core No. 2 was cut and then a heat flow measurement was taken. A stand was then washed and then Core No. 3 cut and recovered followed by a second heat flow measurement. Again, 28.5 meters were washed and Core No. 4 cut, followed again by the third heat flow measurement. Core No. 5 (2483.0-2492.5 meters) was then cut and recovered, but when the core was recovered, a piece of metal was observed at the top of the core. The metal object proved to be about 1/3 of the seal on the float valve and after some discussion, it was decided to pull the string and replace the float valve. This was done because of the possible complications that could develop.

HOLE 402A

The necessary round trip was made to replace the float valve and the drill string was back on bottom in about nine hours. The hole was washed to 137 meters which was the total depth reached in Hole 402. Three cores were then cut and a heat flow measurement made. After this, the hole was continuously cored to Core No. 19 (2663.5-2673.5 meters) where a drift shot was taken and showed only a 2° hole angle. Continuous coring continued to a total depth of 2825.0 meters.

During the drilling of this hole, the heave compensator was in the string at all times, however, it was taken out occasionally to see if there was any effect on core recovery. At times, it appeared there was and then again the opposite was true. One thing that did seem to be consistent was that more time was required to cut a core when the heave compensator was being used. Sea conditions were ideal for drilling with a pitch and roll of about 2^{o} as an average. The active mode was tried only once and could not be truly evaluated because of the calm sea conditions.

After the coring was completed, preparations were made to log the hole. The Bowen sub and heave compensator were set back; the Bowen sub picked up; and a wiper run was made by pulling 2 doubles and 11 stands. The string was then run back to the bit release point and 20 barrels of 9.0 ppg 60 sec viscosity mud was circulated. The bit release shifting tool was then run and the release was attempted. The sandline weight indicator picked up to 6000 lbs and then decreased to a normal weight of 3500 lbs. When the pump was opened to 50 spm the pressure read from 500-550 lbs, so it was felt that the bit had been released. This was further substantiated when the tool was returned to the surface and the pipe disconnected. There was a constant heavy back flow of water indicating no float valve. The hole was then filled with mud using 150 barrels of 9.0 ppg 60 sec viscosity mud and the drill string pulled to the logging depth (2466.5 meters).

The Schlumberger sheaves were again used without the heave compensator because of the smooth seas. The gamma/sonic/caliper tool was made up and run in the hole. It stopped at 2538 meters, but after picking it up and lowering it (gently spudding) three times, it broke through and stopped at 2801 meters (24 meters off bottom). The hole was then logged back to the drill pipe with no problem. (Incidentally the gamma tool picked the sea floor at about 2353-2355 meters which again confirms drill pipe measurement but does not agree with PDR) When the tool was lowered again for a relog of the interval it would not go through an apparent bridge at 2540 meters. It was thought that the large diameter of the centralizing and caliper springs may be the problem, so the tool was pulled and the gamma/induction tool, which has no springs, was made up and run in the hole. It too stopped at 2546 meters and could not be spudded through the bridge. The tool was pulled to the deck and it was decided to run in drill pipe and attempt to wash through the bridge. This would have to be done very carefully because only the top connector of the bit release remained on the bottom of the string. The Bowen unit was connected and the pipe washed successfully through the bridged area and to 2793.5 meters. It was not washed deeper because of concern as to the nature of the material at 2801 where the gamma/sonic tool stopped. The pipe was again pulled to 2466.5 and the gamma/induction tool was made up and run in to 2804 meters with no indication of the bridge problem. This tool made two logging runs followed by the gamma/dnesity/neutron log. It too went to bottom with no trouble and made two runs through the logged interval. The tools were layed down and the drill string was laid down and the rig secured for departure to Site 403. Including the clean out run, the complete logging program was completed in 15 hours. While logging, the drill pipe was hung at 2466.5 meters to make sure that the top two bumper subs were below the mudline.

SITE 403

This site was the first hole to be drilled in the southwest Rockall Plateau and was approximately a two and one half day trip northwest from the Bay of Biscay.

A beacon was dropped in 2317 meters (PDR) of water which was confirmed with Core No. 1 (2317-2321.5 meters) which recovered 4.83 meters of soft sediments. The hole was then continuously cored to a total depth of 2806 meters or a subbottom penetration of 489.0 meters. During the drilling, heat flow measurements were taken following Cores Nos. 5, 11, 16, 21, 26 or until the sediments became too firm for the heat probe to function properly.

Core recovery dropped markedly following Core No. 46 and the drill rate increased three to four times. The only recovery consisted of loose, fine sand and some small rounded pebbles when using a plastic sock in the core catcher. Due to the apparent loose nature of the sediments, drilling was stopped because of the possible hazard to the drill string.

An attempt was made to log the hole. The rotary shifting tool was run and the bit was released at 2802 meters. The hole was filled with 175 barrels of 8.9 ppg 67 sec vis mud and the bottom of the drill string was positioned at 2432 meters.

The first log to be run was the gamma/sonic/caliper. The tool started in the hole at 1420 hours and cleared the bottom of the pipe (2432 meters) at 1450 hours. A calibration check was made while running in the hole. The tool stopped at 2746 meters because of an apparent bridge. The hole was logged from 2740 meters and the tool brought back inside the drill pipe while the film was being developed. (The sea bed appeared to be at 2312 meters based on the gamma curve) After developing the film, the tool was run back in the open hole and again stopped at 2761 meters. It was pulled up and then run to bottom with a pick up at 2794 meters. while logging up, the tool stuck at 2778 meters and was dropped back to 2815. While logging up, it stopped again at 2779 meters. When an attempt was made to drop back the tool did not move so some slack was put in the cable. They logging up was tried again; the tool cleared the stuck point; and the rest of the hole was logged up to 2450 meters. The tool had picked up an additional 1500 lbs which gradually was reduced to 600 lbs. After reaching 2450 meters, the tool was dropped down in an attempt to lose the extra weight, however, this could not be accomplished, so the balance of the hole was logged and the tool brought back on deck. There was no additional material on the tool so the weight measurement was apparently no accurate. The gamma/induction log was made up but could not be run because the weather had deteriorated so badly. In fact, the induction tool was damaged while trying to insert it in the drill string. The ship waited on weather for 40 minutes and then the drilling crew started pulling the drill string slowly. The ocean floor was cleared at 1900 hours on the 23rd and it was not until 1100 hours on the 24th that the drill string was secured on deck. The ship then stood by waiting on the weather before moving to Site 404.

SITE 404

After retrieving the drill string from Site 403, it was necessary to wait more than 21 hours before the ship could be moved about five miles to drill Site 404.

The drill string was made up and run in to bottom. A mudline core verified the corrected PDR depth of 2322 meters. Following the mudline core, the hole was washed to 2343.5 meters where some resistance to drilling was encountered. A core was cut but recovered nothing unusual so the hole was then washed to 2426 meters. Core No. 3 was cut as a check on lithology and also to ascertain if any hydrocarbons could be detected for safety reasons. The hole was then washed to 2492.5 meters and then cored continuously to the suddenly terminated total depth of 2711.0 meters (389 meters sea bottom penetration).

While cutting the last core, winds increased suddenly with gusts to 40 and 45 mph. The seas also increased rapidly to 10-12 feet. With the ship positioning in semi-automatic, it was decided that the drill string should be pulled. Fortunately, the heave compensator was not in the string so that it was possible to clear the mudline quickly by being able to pull and lay down doubles instead of singles. Just as the string cleared the mudline, the ship moved off location 800-1200 feet. The drill string was then pulled until the bottomhole assembly was nearby to the ship, but it was not possible to maintain a steady safe heading, so the bottomhole assembly was hung off until weather conditions improved. It required about ten hours of standby before the bottomhole assembly could start to be brought aboard.

Unfortunately, because of the sudden worsening of weather conditions, it was not possible to log this hole.

SITE 405

After retrieving the bottomhole assembly on Site 404, it was necessary to wait an additional three and one half hours for the weather to improve before departing for Site 405. After about 12 hours of travel, profiling and positioning was dropped at Site 405.

Due to the fact that the bottomhole assembly had hung just below the ship for about ten hours at Site 404, it was magnafluxed while making up the drill string at drill Site 405.

A mudline core was taken which verified the PDR depth of 2974 meters. The hole was cored continuously from there to a total depth of 3381.0 meters. Coring was good until approximately 3130 meters and then recovery dropped sharply. The drill rate had also increased markedly indicating a soft formation. Recovery consisted mainly of soft mud with some rather large cobbles located near the top of almost every core. Mud was spotted twice to aid in improving recovery but had little effect. At about 3250 meters, the formation became firmer and recovery was good from there to total depth.

When total depth was reached, the bit was released and the hole filled with 8.9 ppg 62 sec vis mud preparatory to logging the hole from 3092 meters to total depth. The first tool run was the gamma/sonic/caliper. While running in, the tool stopped at about 3212-16 meters. Four attempts were made to penetrate the bridge and were unsuccessful. The hole was therefore logged from the bridge point to the bottom of the drill string. This bridging point was coincidentally in the area of fast drilling and poor recovery mentioned earlier. After pulling the tool, the hole was carefully cleaned out to total depth. This was done carefully because the bit had been released and only the top connector of the bit release assembly remained at the bottom of the drill string. The hole was then filled with 200 barrels of 8.9 ppg 62 sec vis mud and logging started again. This time the complete set of logs, gamma, sonic, neutron, density and induction were run with no problems, however, the logs did show an area of very soft material where drilling difficulties had been encountered. The pipe was pulled in preparation for the short move to Site 406.

SITE 406

Site 406 was located only about five miles from Site 405, therefore, we were able to start making up the drill string within 2-1/2 hours after leaving Site 405. After making up the drill string, a mudline core was taken and bottom was determined to be 2911 meters (the PDR indicated a water depth of 2907 meters.) The hole was cored and drilled to 3334 meters and then continuously cored to a total depth of 3742.5 meters. At this depth the water flow at the surface, when the core barrel was removed, indicated that the float valve was probably stuck open. A center bit was dropped to try and unplug the bit but, when it was recovered, the back flow of water continued. A core barrel was then dropped and 15 barrels of mud was pumped, however, the surface pressure indicated that the inner barrel was not seating properly. The core barrel was pulled and center bit with a longer tip was dropped. When retrieved, back flow continued so a core barrel was again dropped. The pump pressure gauge again indicated that the barrel was not seating properly. Because of the time factor involving our departure for Aberdeen, it was decided to discontinue drilling and attempt to log the hole. The core barrel was recovered and a center bit dropped for the wiper run prior to releasing the bit and filling the hole with mud.

Following the wiper run, the overshot was lowered to retrieve the center bit so the shifting tool could be lowered and the bit released. However, it came back to the surface without the center bit and again the same way on the second attempt. It was decided that apparently the bit had been released in some unknown way, so logging would be attempted. The hole was filled with mud and the pipe pulled to logging depth. The first tool, the gamma/sonic/caliper, had no trouble in going out of the pipe and the rest of the logging tools were also run successfully.

When the drill string was recovered the bit, release sub, float valve and support bearing were gone but the tool appeared not to have been shifted. The possible answer as to how the release was accomplished is that probably the segments which hold the release sub had broken due to hard drilling and allowed the bit to come off during the wiper run. Another possibility is the failure of the "C" ring or sleeve keeper.

DRILLING AND CORING ASSEMBLY

The bottomhole assembly used on this leg was the standard DSDP assembly with the exception of those holes which were to be logged with downhole logging equipment. The standard assembly consisted of a bit, bit sub (with float valve, core barrel, three 8-1/4" drill collars, one 5-foot stroke Baash-Ross bumper sub, three 8-1/4" drill collars, two 5-foot stroke bumper subs, two 8-1/4" drill collars, one 7-1/4" drill collar and one heavy wall 5-1/2" drill pipe. When the hole was to be logged the bit was attached to the bit disconnect assembly which in turn was attached to the bottom drill collar. During drilling operations, this bit disconnect assembly is held in place by removable lugs which are held in place by a shifting sleeve. When logging depth has been reached a shifting tool is lowered and when pulled up, shifts the sleeve from behind the lugs allowing them to fall in and thus freeing the bit. This operation was successful on four of five holes. The one exception was at Site 406 where the bit released before the shifting tool had been used. There are several possible answers to the question of how this happened. They were discussed above under the Site 406 summary.

A major loss occurred at Site 400A following the first re-entry. The re-entry had been verified and the pipe washed to bottom. During a connection and while just hanging in the hole, the pup joint below the Bowen unit broke at the pin and dropped the entire drill string composed of 528 joints of drill pipe and the bottomhole assembly to the ocean floor. This left 469 joints of pipe on board the ship.

On Site 404 drilling was terminated because of a sudden build up in wind and seas. The drill string was laid down but the bottomhole assembly hung for ten hours before the weather had subsided enough to bring it on board. Therefore, before running in to drill Site 405, the bottomhole assembly was magnafluxed.

BITS

Two F93CK bits were used on this leg; one on Holes 399, 400 and 400A; the other was used on Hole 406. The balance of the holes were drilled using F94CK bits. The penetration rates for the two different type bits was quite similar. The F93CK averaged 25.7 meters/hour while the F94CK averaged 24.0 meters/hour. It was not possible to determine the bit condition of the bits except for one because the balance were released for the logging program.

BEACONS

Nine beacons were used on this leg and all performed very good with the exception of those used at Site 399. A 16 kHz was dropped initially but after an hour of positioning, the signal deteriorated so much that a 13.5 kHz beacon was dropped. While attempting to position on this second beacon, it was discovered that the original beacon was coming in stronger. Offsets were dialed in and the first beacon was used for positioning. However, weather conditions worsened and this marginal signal became unusable so the ship was moved about a mile and another beacon was dropped.

POSITIONING

Positioning on this leg could be considered excellent except for the problems encountered at the first site and described in the section on beacons. The only other time that the ship moved off position was on Site 404 where extreme weather conditions made it impossible to hold position and therefore, the pipe was pulled and had just cleared the mudline when the ship moved off location about 800 feet. One other problem developed on Site 401 when it was necessary to secure the gyro compass due to a power failure. The ship was held on location in manual and then semi-automatic mode until repairs had been made. This took about an hour and a half and was due to burned out brushes in the motor generator for No. 1 gyro.

HEAVE COMPENSATOR

The heave compensator was not used on Sites 399 and 400 because they were strictly pilot holes to find out how much casing would be necessary to attach to the re-entry cone. It was put in the system as soon as the casing and cone had been washed in at Hole 400A. Following Core No. 49, it was locked up because of a power unit problem. It was still out of the system until Core No. 74 was cut and it was decided to come out of the hole and see if there was some problem with the bit due to poor recovery. It was set back until re-entry had been accomplished and was then put back in the string. The string was washed to bottom and was hanging free when the pin broke on the pup joint connected to the Bowen unit.

The heave compensator was used again in Hole No. 401 and was used until a swash plate plug fell out. As soon as it was replaced and container refilled with fluid, it was put back in the system. After taking Core No. 20, 15 minutes were required to close the cylinder. The heave compensator was finally taken out when total depth had been drilled and logging was to start. The seas were so calm that the Schlumberger engineer did not feel that the heave compensator would be necessary. The heave compensator was put in the string for Site 402 and was out for two cores while a check valve was being repaired. It was pulled again when logging started. Between Sites 402 and 403 Mr. Lockman, GMI's Project Engineer on the heave compensator, was transferred to an offshore drilling vessel (Neptune No. 7), so he could return home. Another engineer was not sent to replace him. The heave compensator was used on Site 403 as a check to see if a difference in recovery and penetration rate could be detected when it was used or locked out. It was decided to stop drilling and log this site so the heave compensator was set back. After running one log the weather had become so bad that the string was pulled.

The heave compensator was not used for the balance of the leg because of the rapidly changing weather conditions and the need to be able to quickly clear the mudline. The use of the heave compensator requires that the drill pipe be handled one joint at a time. Without the heave compensator two joints can be handled at one time.

The passive mode was used at all times except for one core taken in the active mode. Weather conditions during this period were too smooth to make a good test.

RE-ENTRY

Re-entry was scheduled for only one hole on this leg. This was Hole 400A, drilled after determining the amount of casing that could be washed in with the cone (Hole No. 400). The hole was drilled to 5176.5 meters (sea floor depth was 4399.0) when recovery became so poor it was decided to pull the string and see of something was wrong with the bit.

The string was recovered and the bit changed and run back with the pipe hanging five meters above the top of the cone. The sonar tool was on bottom at 0928 and at 4389 meters the cone was stabbed after positioning one hour and 23 minutes. Re-entry was verified but while the drill string was hanging after cleaning out to bottom, the pup joint pin in the Bowen unit broke and dropped the drill string to the bottom. No additional re-entries were attempted on this leg.

HEAT FLOW

Fourteen heat flow measurements were made on this leg. Ten of these were run using the heave compensator when it was in the drill string. Of these ten, nine were successful. The one failure was when the tip of the probe was broken off during the run. The last five were run at Site 406 without the heave compensator because of uncertain weather conditions. They too proved to provide satisfactory data.

The measurements were taken using the tool set up which was developed by Al Erickson on Leg 46. Each measurement required about 1-1/2 hours to run from the time the tool started in the hole until it was back on deck.

HYDROCARBONS

Although this leg drilled through many meters of sediments, no evidence of hydrocarbons was detected. The voyage was staffed with a scientist responsible for monitoring any gases which might have been encountered.

LOGGING

This leg again enjoyed the opportunity of having downhole logging capabilities. The money for the program was provided by the Institute of Oceanographic Sciences of the National Environmental Research Council for the Department of Energy, located in Wormley, Godalming, Surrey, United Kingdom.

In addition to having the capability of using the re-entry technique where a cone and casing have been washed in, it was also possible to log single bit holes by releasing the worn out bit and then running logs in the same manner as in re-entry. Using this piece of equipment logs were run in five holes.

The logs which were run included the gamma/sonic/caliper, the gamma/neutron/density and the gamma/induction.

These logs were run by a very capable logging engineer, Mr. Lamb, from Schlumberger Well Services.

The results of the logs were met with a great deal of enthusiasm by the scientists on board because it aided them in their interpretation of the part of the section where core recovery had not been complete.

COMMUNICATIONS

All of the project's communications were handled by the Navy's secondary circuit which sends outgoing traffic via the Navy station in Makri, Greece and the incoming traffic by means of Mercast System. This involves sending traffic blind, three times a day. As a rule, the traffic placed in San Diego by closing time would be received at 1000 hours on the ship the next day.

A few personal telephone calls were made via the French and English coast stations. Many personal calls were made by the amateur (ham) station, also with the help of another amateur radio operator on board. The total volume of traffic was rather light as compared with previous legs. No effort was made to contact WWD directly in San Diego as we were out of his range during his working hours. We will be in WWD's range by the middle of the next leg.

ACKNOWLEDGEMENTS

As has been true since the program began, all of Global Marine's personnel were extremely helpful and their performance was outstanding.

The Scripps' technicians also performed to their normal high degree of efficiency, particularly making sure things were accomplished on time and in an orderly manner.

The scientific group should be commended for their professional approach, cooperation and attitude throughout the leg. It was a great pleasure to be associated with such a dedicated group during this cruise.

Robert R. Knapp
Cruise Operations Manager
Deep Sea Drilling Project

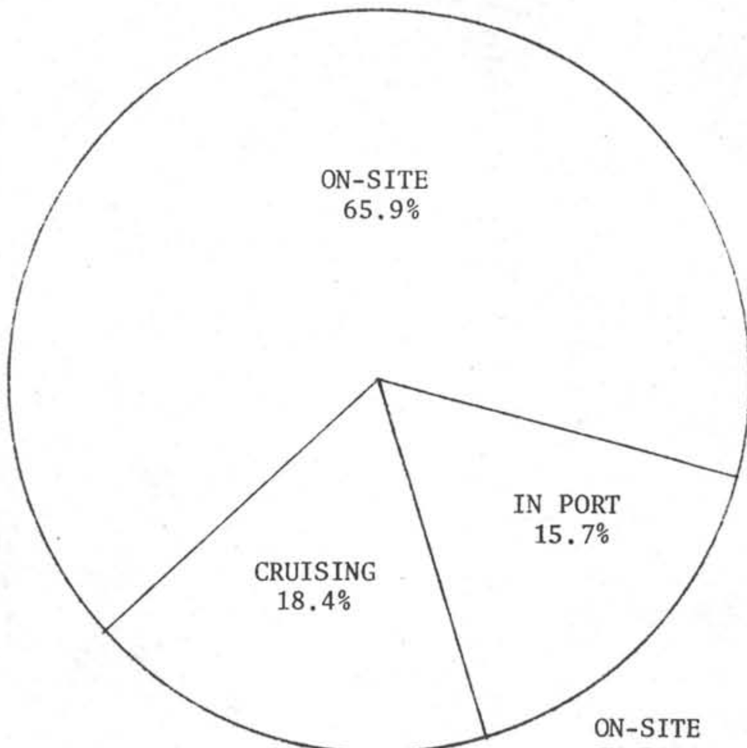
INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 48

Total Days (May 12, 1976 - July 13, 1976)	61.86
Total Days In Port	9.65
Total Days Cruising Including Site Survey	11.41
Total Days On-Site	40.8

Trip Time	8.6
Drilling Time	.09
Coring Time	20.9
Positioning	.6
Mechanical Downtime	.57
Re-entry	.54
Wait On Weather	1.8
Other (Includes Logging)	7.7

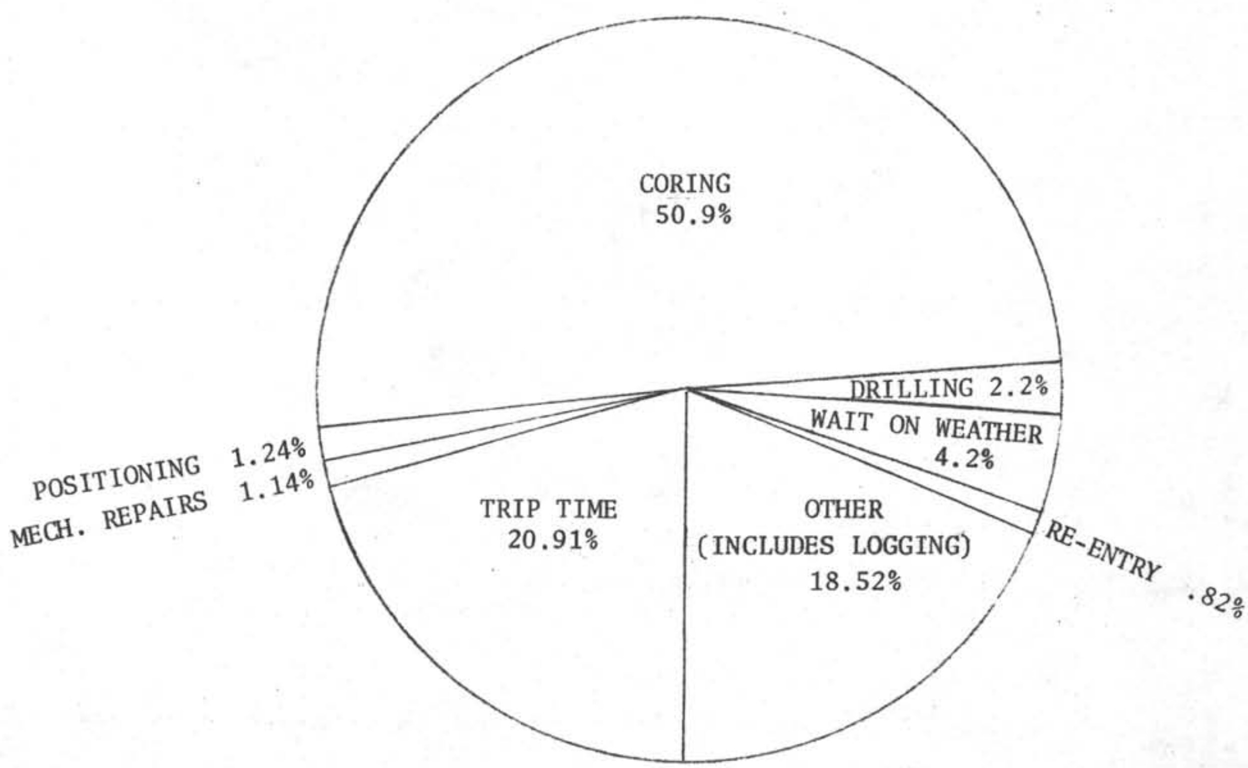
Total Distance Traveled (Nautical Miles)	1935.4
Average Speed (Knots)	8.7
Number of Sites	8
Number of Holes Drilled	10
Number of Cores Attempted	318
Number of Cores with Recovery	308
Percentage of Cores with Recovery	96.8%
Total Meters Cored	2995.5
Total Meters Recovered	1230.22
Percent Recovery	41.06%
Total Meters Drilled	910.5
Total Meters of Penetration	3992.0
Percent of Penetration Cored	75.03%
Maximum Penetration (Meters)	831.5
Minimum Penetration (Meters)	72.5
Maximum Water Depth	4414
Minimum Water Depth	2317

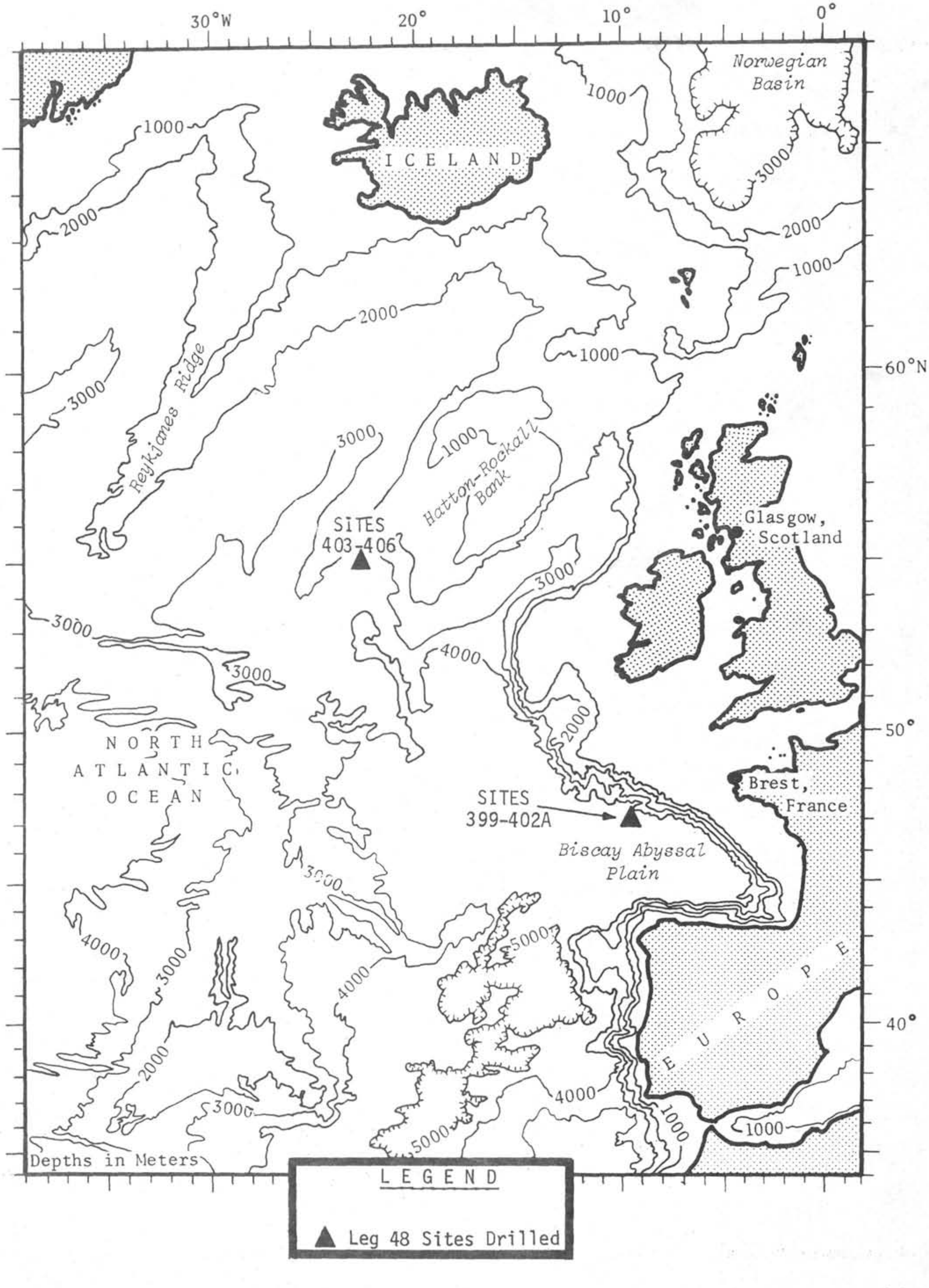
IPOD
DEEP SEA DRILLING PROJECT
LEG 48
TOTAL TIME DISTRIBUTION



ON-SITE	40.8	=	65.9%
IN PORT	9.65	=	15.7%
CRUISING	11.41	=	18.4%

ON-SITE TIME BREAKDOWN




30°W
20°
10°
0°
60°N
50°
40°
ICELAND
Norwegian Basin
Reykjanes Ridge
Hatton-Rockall Bank
SITES 403-406
SITES 399-402A
Glasgow, Scotland
Brest, France
Biscay Abyssal Plain
NORTH ATLANTIC OCEAN
EUROPE
Depths in Meters
1000
2000
3000
4000
5000
LEGEND
Leg 48 Sites Drilled

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 48

Site No.	Make	Freq. kHz	Number	Site Time Hours	Remarks
399	ORE	16.0 S.L.	344	1	Poor signal so dropped 13.5 D.L. #393.
399	ORE	13.5 D.L.	393	34	Signal made for poor positioning - moved about one mile.
400 & A	ORE	16.0 S.L.	376	286.75	Beacon performed well but site abandoned when drill string lost.
401	ORE	13.5 S.L.	355	100.25	Beacon output outstanding with 1000' offset.
402 & A	ORE	16.0 S.L.	337	141.18	Beacon performance very good.
403	ORE	13.5 S.L.	362	103.7	Beacon performance very good.
404	ORE	16.0 S.L.	349	83.25	Beacon performance very good.
405	ORE	13.5 S.L.	320	93.25	Beacon performance very good.
406	ORE	16.0 S.L.	339	132.25	Beacon performance very good.

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 48

Hole	Mfg	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet	Hours On Bit	Condition	Remarks
399	Smith	10"	F93CK	996-BS	17.5	55.0	72.5	1.2	No Wear	Will rerun on Site 400.
400	Smith	10"	F93CK	996-BS	9.0	70.0	79.0	.56	No Wear	Rerun from Site 399.
400A	Smith	10"	F93CK	996-BS	701.0	2.0	777.5	38.18	TO-B1*-1	*One cone very tight.
400A	Smith	10"	F94CK	359-BV	0	0	0	.25	New Bit	Washed in two singles; prepared to start coring; string dropped.
401	Smith	10"	F94CK	300-BV	265.0	76.0	340.0	15.26	Bit Released	Logged hole using bit release sub.
402	Smith	10"	F94CK	326-BV	42.0	95.0	137.0	1.73	TO-BO-1	
402A	Smith	10"	F94CK	326-BV	332.0	137.5	469.5	42.23	Bit Released	Rerun from Hole 400.
403	Smith	10"	F94CK	356-BV	489.0	- - -	489.0	13.23	Bit Released	
404	Smith	10"	F94CK	303-BV	243.5	145.5	389.0	7.8	TO-BO-I	Bit not released for logging - will be able to be rerun.
405	Smith	10"	F94CK	305-BV	407.0	- - -	407.0	12.6	Bit Released	Rerun
406	Smith	10"	F93CK	997.BS	489.5	342.0	831.5	28.4	Bit Released	

INTERNATIONAL PHASE OF OCEAN DRILLING

DEEP SEA DRILLING PROJECT

SITE SUMMARY

LEG 48

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
399	47° 23.40'N	09° 12.31'W	4414	2	2	100.0	17.5	11.77	67.3	55.0	72.5	60.4	1.2	1.5
400	47° 22.90'N	09° 11.90'W	4399	1	1	100.0	9.0	9.0	100.0	70.0	79.0	138.5	.6	.95
400A	47° 22.90'N	09° 11.90'W	4399	74	73	98.6	701.0	329.39	46.9	2.0	777.5	20.4	38.2	10.98
401	47° 25.65'N	08° 48.62'W	2547	28	24	85.7	265.0	103.22	38.95	76.0	340.0	22.3	100.25	4.17
402	47° 52.48'N	08° 50.44'W	2355.5	5	5	100.0	42.0	12.19	29.0	95.0	137.0	79.2	32.5	5.9
402A	47° 52.48'N	08° 50.44'W	2355.5	35	34	97.1	332.0	167.5	50.4	137.5	469.5	11.1	109.3	
403	56° 08.36'N	23° 17.63'W	2317.0	52	51	98.0	489.0	160.83	32.9	- -	489.0	34.3	103.7	4.32
404	56° 03.13'N	23° 14.95'W	2322.0	26	26	100.0	243.5	74.87	30.7	133.0	389.0	49.8	82.25	3.42
405	55° 20.18'N	22° 03.49'W	2974.0	43	40	93.0	407.0	172.05	42.27	- -	407.0	32.3	93.25	3.88
406	55° 15.53'N	22° 05.25'W	2911.0	52	52	100.0	489.5	189.42	38.69	342.0	831.5	29.2	137.25	5.71
				318	308	96.8	2995.5	1230.22	41.06	910.5	3992.0	47.75	698.5	40.83

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 48

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
5 12 76										15.5			15.5	DRYDOCK
5 13 76										24.0			24.0	"
5 14 76										24.0			24.0	"
5 15 76										24.0			24.0	"
5 16 76										24.0			24.0	"
5 17 76										24.0			24.0	"
5 18 76										24.0			24.0	"
5 19 76										24.0			24.0	WET DOCK
5 20 76										24.0			24.0	
5 21 76										24.0			24.0	
5 22 76										.3			.3	
TOTAL										231.8			231.8	
5 22 76		23.7											23.7	
5 23 76		2.0						6.75					8.75	
TOTAL		25.7						6.75					32.45	
5 23 75	399		10.75		.25			3.75	.5				15.25	
5 24 75			11.25	1.0	3.0			4.5	.75				20.50	
TOTAL			22.00	1.0	3.25			8.25	1.25				35.75	
5 24 75								3.5					3.5	POS. FOR SITE 400
TOTAL								3.5					3.5	

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG -48

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
5.25.75	400	.	16.25	.	2.5	.	.	.5	2.25	.	.	1.5	23.0	
TOTAL		.	16.25	.	2.5	.	.	.5	2.25	.	.	1.5	23.0	
5.25.75	400-A	.	1.00	.	.	.	.	.	.	.	.	.	.	
5.26.75		.	17.25	3.0	.	.	.	.	.5	.	.	3.25	24.0	
5.27.75		.	.	.	19.5	.	.	.	.	.	.	4.5	24.0	
5.28.75		.	.	.	24.0	.	.	.	.	.	.	.	24.0	SPOT 20 BBLS MUD
5.29.75		.	.	.	24.0	.	.	.	.	.	.	.	24.0	AFTER CORE 34 FOUND INNER BBL CHECK VALVE BROKE.
5.30.75		.	.	.	24.0	.	.	.	.	.	.	.	24.0	
5.31.75		.	.	.1	23.9	.	.	.	.	.	.	.	24.0	SPOT 20 BBLS MUD AFTER CORE #55
6.1.75		.	.	.03	23.97	.	.	.	.	.	.	.	24.0	
6.2.75		.	11.0	.	1.0	.	.	.	3.0	.	.	9.0	24.0	
6.3.75		.	12.25	.	.	.	.	.	.	.	5.0	6.75	24.0	AFTER RE ENTRY FOLLOWING WASH TO BOTTOM DRILL STRING LOST.
6.4.75		.	.	.	.	.	.	.	.	.	.	24.0	24.0	PICK UP NEW DRILL STRING
6.5.76		.	.	.	.	.	.	.	.	.	.	22.75	22.75	PICK UP PIPE MANNFLOW DUP JTS.
TOTAL		.	41.5	3.13	140.37	.	.	.	3.5	.	5.0	70.25	263.75	
6.5.76		1.25	.	.	.	.	.	.	.	.	.	.	1.25	
6.6.76		1.0	.	.	.	.	.	4.0	.	.	.	.	5.0	
TOTAL		2.25	.	.	.	.	.	4.0	.	.	.	.	6.25	
6.6.76	401	.	5.0	.	2.5	.	.	.	1.0	.	.	10.5	19.0	
6.7.76		.	.	1.0	23.0	.	.	.	.	.	.	.	24.0	

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 48

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
6.8.76	401	.	.	.	21.25	.	.	.	2.75	.	.	.	24.0	
6.9.76		.	.	.	3.0	.	.	.	.	.	.	21.0*	24.0	*LOGGING
6.10.76		.	5.0	.	.	.	.	.	.	.	.	4.25	9.25	
TOTAL		.	10.0	1.0	49.75	.	.	.	3.75	.	.	35.75	100.25	
6.10.76		5.2	.	.	.	.	.	1.05	.	.	.	.	6.25	
TOTAL		5.2	.	.	.	.	.	1.05	.	.	.	.	6.25	
6.10.76	402	.	5.5	.	.	.	3.0	.	.	.	.	.	8.5	
6.11.76		.	7.0	4.0	8.0	.	.	2.0	.	.	.	3.0	24.0	
TOTAL		.	12.5	4.0	8.0	.	3.0	2.0	.	.	.	3.0	32.5	
6.12.76	402-A	.	6.0	2.0	15.0	.	.	.	.	.	.	1.0	24.0	
6.13.76		.	.	.1	23.9	.	.	.	.	.	.	.	24.0	TOOK HOLE SURVEY 2°
6.14.76		.	.	.	24.0	.	.	.	.	.	.	.	24.0	
6.15.76		.	.	.	11.0	.	.	.	.	.	.	13.0	24.0	LOGGING & HOLE CLEAN OUT
6.16.76		.	4.8	.	.	.	.	.	.	.	.	8.5	13.3	AS ABOVE
TOTAL		.	10.8	2.1	73.9	.	.	.	.	.	.	22.5	109.3	
6.16.76		10.7	.	.	.	.	.	.	.	.	.	.	10.7	
6.17.76		24.0	.	.	.	.	.	.	.	.	.	.	24.0	
6.18.76		25.0	.	.	.	.	.	.	.	.	.	.	25.0	
6.19.76		24.0	.	.	.	.	.	.	.	.	.	.	24.0	
6.20.76		1.4	.	.	.	.	.	1.9	.	.	.	.	3.3	

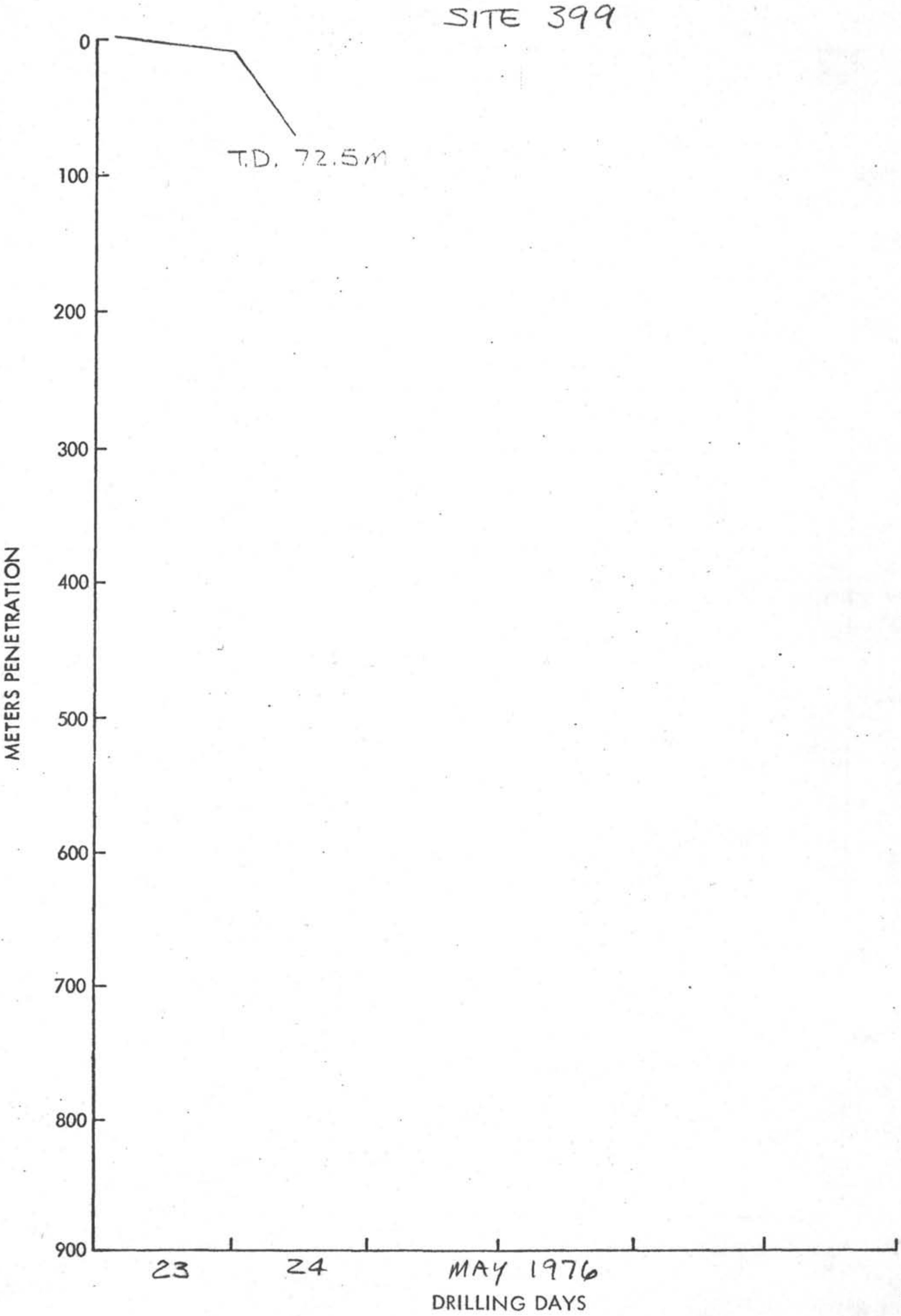
DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 48

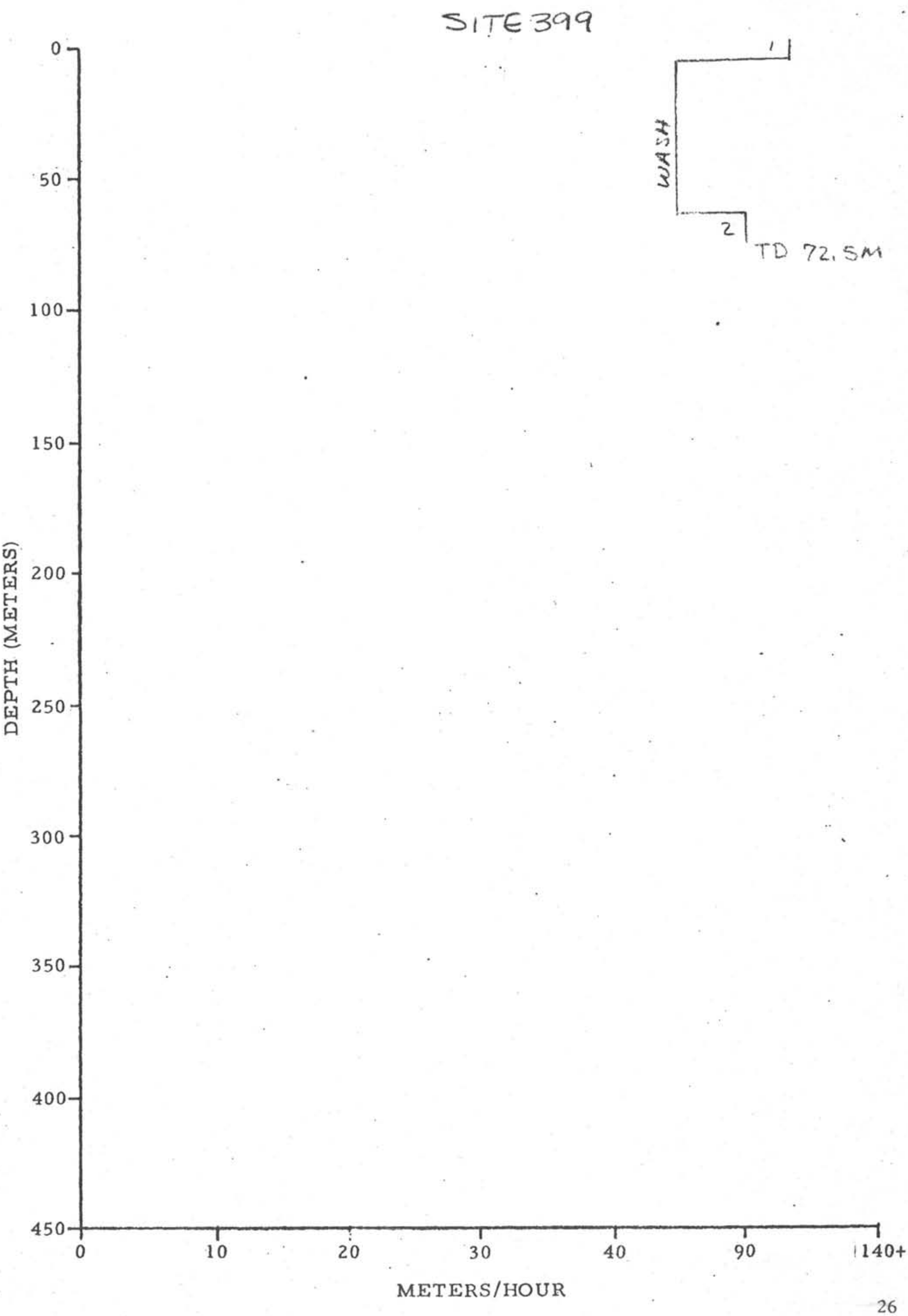
Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
TOTAL		85.1						1.9					87.0	
6.20.76	403		7.2		10.5			1.0				2.0	20.7	HEAT FLOW MEASUREMENT
6.21.76					19.5			.5				4.0	24.0	HEAT FLOW MEASUREMENT
6.22.76					24.0								24.0	
6.23.76			13.4		6.0		.6					4.0*	24.0	* LOGGING
6.24.76			11.0										11.0	
TOTAL			31.6		60.0		.6	1.5				10.0	103.7	
6.24.76							13.0						13.0	
6.25.76		1.05					8.8	.9					10.75	
TOTAL		1.05					21.8	.9					23.75	
6.25.76	404						13.25						13.25	
6.26.76			7.3	1.7	1.0		14.0						24.0	
6.27.76				2.0	22.0								24.0	
6.28.76			5.75		5.25		10.0						21.0	
TOTAL			13.05	3.7	28.25		37.25						82.25	
6.28.76							3.0						3.0	
6.29.76		12.3					3.5	.95					16.75	
TOTAL		12.3					6.5	.95					19.75	
6.29.76	405		7.25										7.25	RUN IN AND MAGNAFLUX BHA
6.30.76			4.0		20.0								24.0	

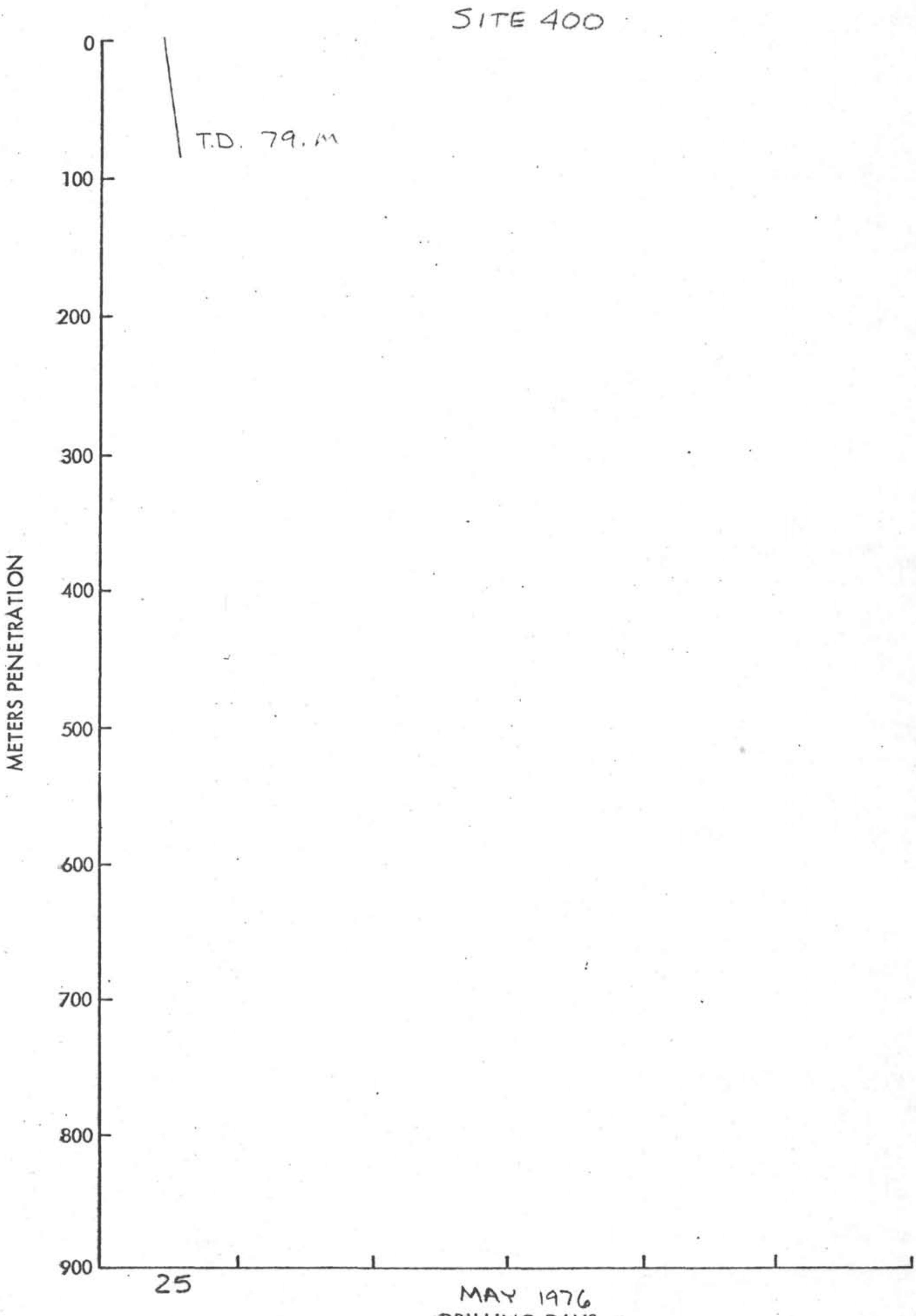
110.85

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 48

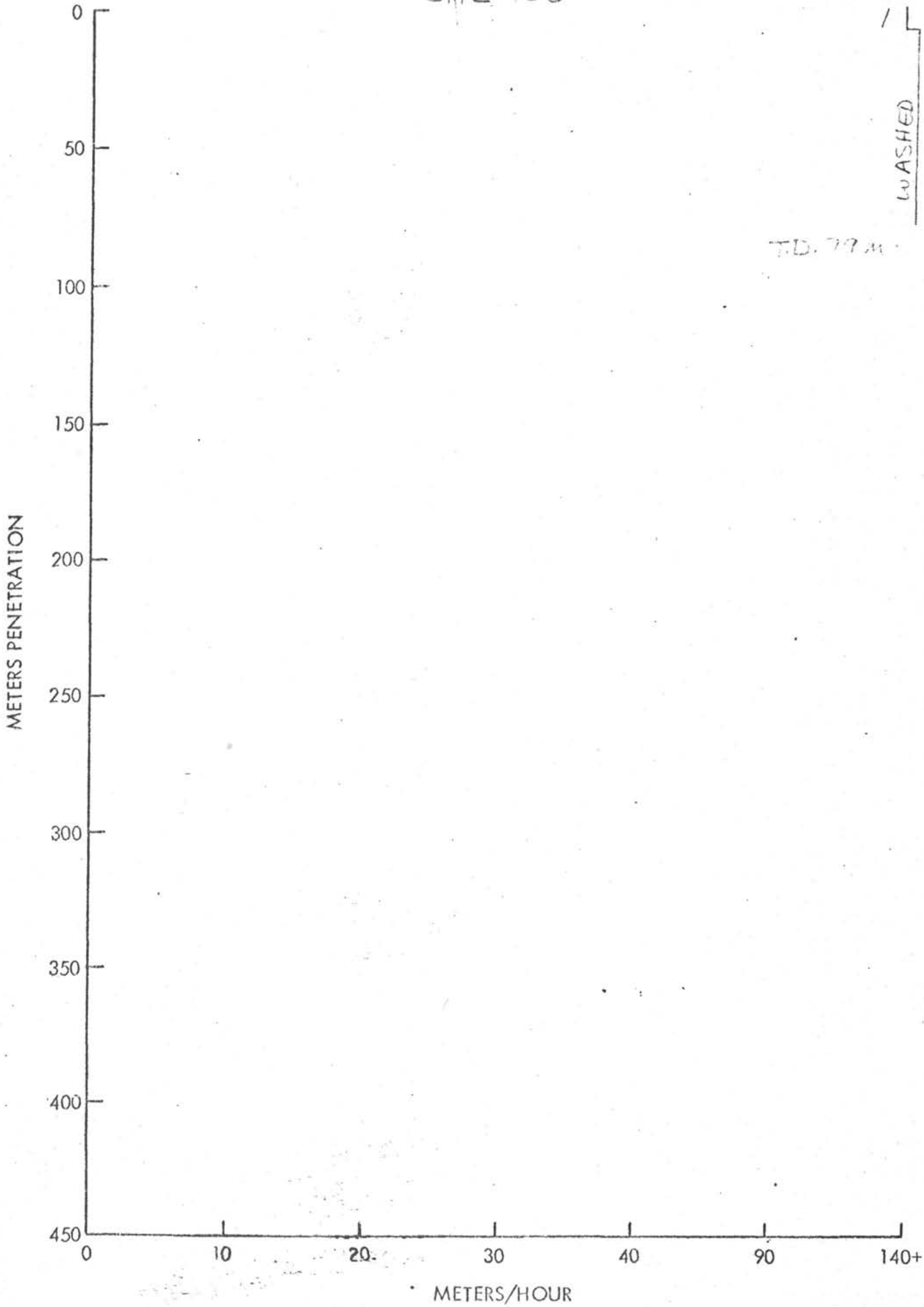
Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
7.1.76	405	.	.	.	24.0	.	.	.	.	.	.	.	24.0	
7.2.76		.	8.25	.	11.0	.	.	.	.	.	.	4.75	24.0	LOGGING
7.3.76		.	5.5	.	.	.	.	.	.5	.	.	8.00	14.0	LOGGING
TOTAL		.	25.0	.	55.0	.	.	.	.5	.	.	12.75	93.25	
7.3.76		1.4	.	.	.	.	.	1.1	.	.	.	.	2.5	
TOTAL		1.4	.	.	.	.	.	1.1	.	.	.	.	2.5	
7.3.76	406	.	6.5	.	1.0	.	.	.	.	.	.	.	7.5	
7.4.76		.	.	6.75	11.0	.	.	.	.	.	.	6.25	24.0	5-HEAT FLOW MEASUREMENTS
7.5.76		.	.	.	24.0	.	.	.	.	.	.	.	24.0	
7.6.76		.	.	.	24.0	.	.	.	.	.	.	.	24.0	
7.7.76		.	.	.	19.0	.	.	.	.	.	.	5.0	24.0	
7.8.76		.	11.0	.	.	.	.	.	.	.	.	13.0	24.0	LOGGING
7.9.76		.	5.0	.	.	.	.	.	.	.	.	4.75	9.75	FLUSH [illegible], SLIP DRILLLINE DRAIN H.C.
TOTAL		.	22.5	6.75	79.0	.	.	.	.	.	.	29.0	137.25	
7.9.76		14.25	.	.	.	.	.	.	.	.	.	.	14.25	
7.10.76		24.0	.	.	.	.	.	.	.	.	.	.	24.0	
7.11.76		24.0	.	.	.	.	.	.	.	.	.	.	24.0	
7.12.76		24.0	.	.	.	.	.	.	.	.	.	.	24.0	
7.13.76		4.3	.	.	.	.	.	.	.	.	.	.	4.3	
TOTAL		90.55	.	.	.	.	.	.	.	.	.	.	90.55	

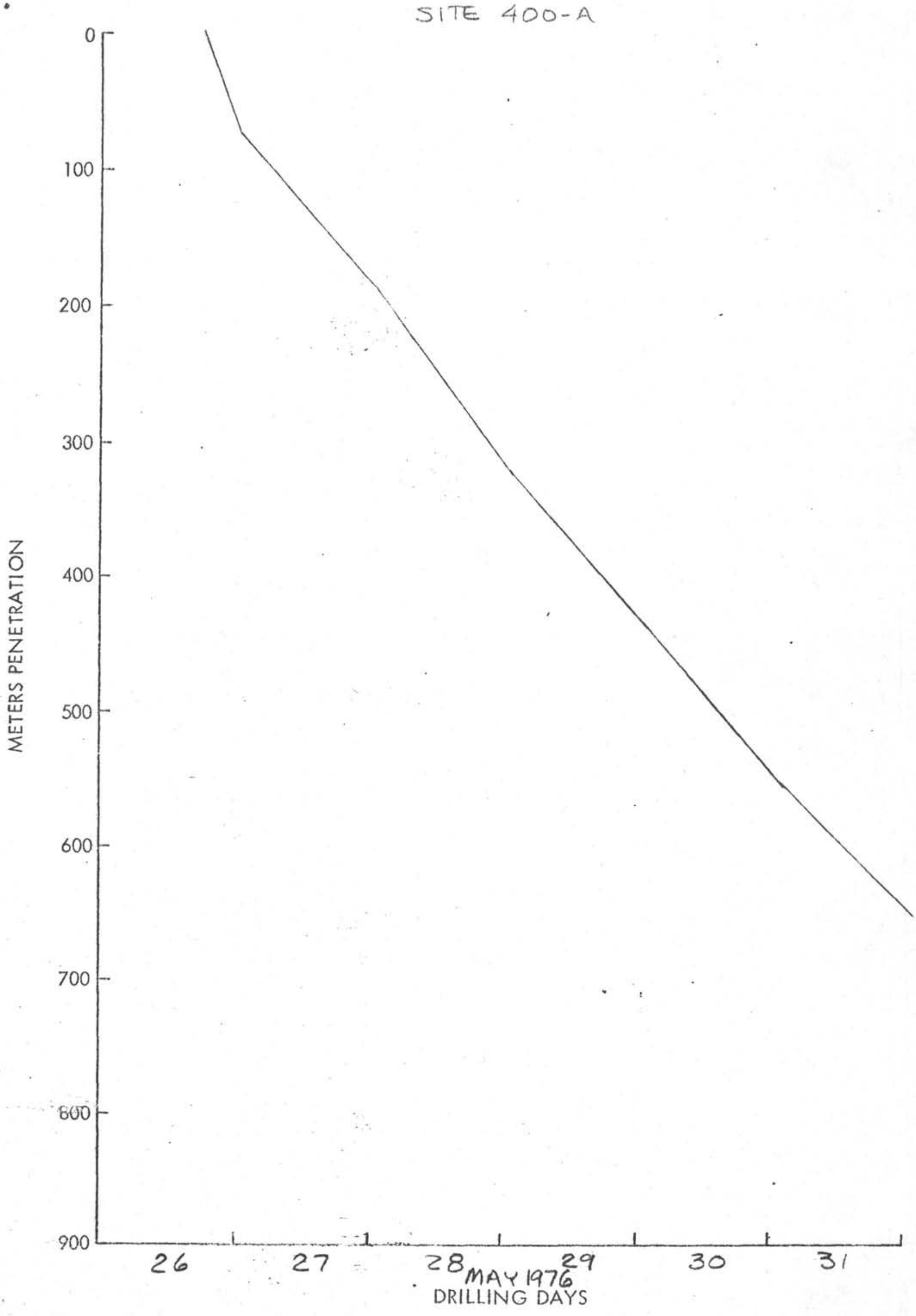

SITE 399
T.D. 72.5m
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
23
24
MAY 1976
DRILLING DAYS


SITE 399
WASH
1
2
TD 72.5M
DEPTH (METERS)
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
METERS/HOUR

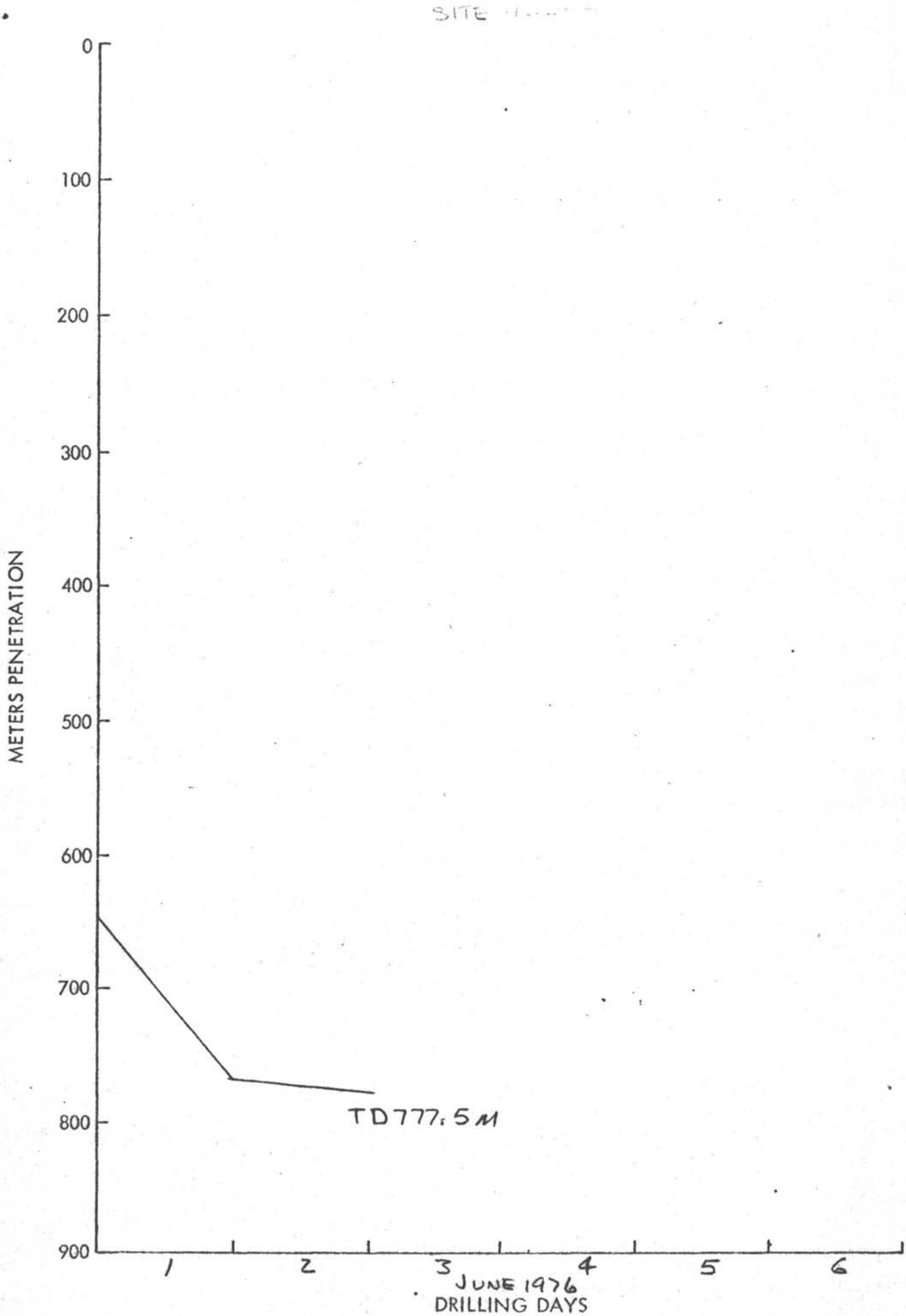

SITE 400
0
100
200
300
400
500
600
700
800
900
T.D. 79.m
METERS PENETRATION
25
MAY 1976
DRILLING DAYS

SITE 400

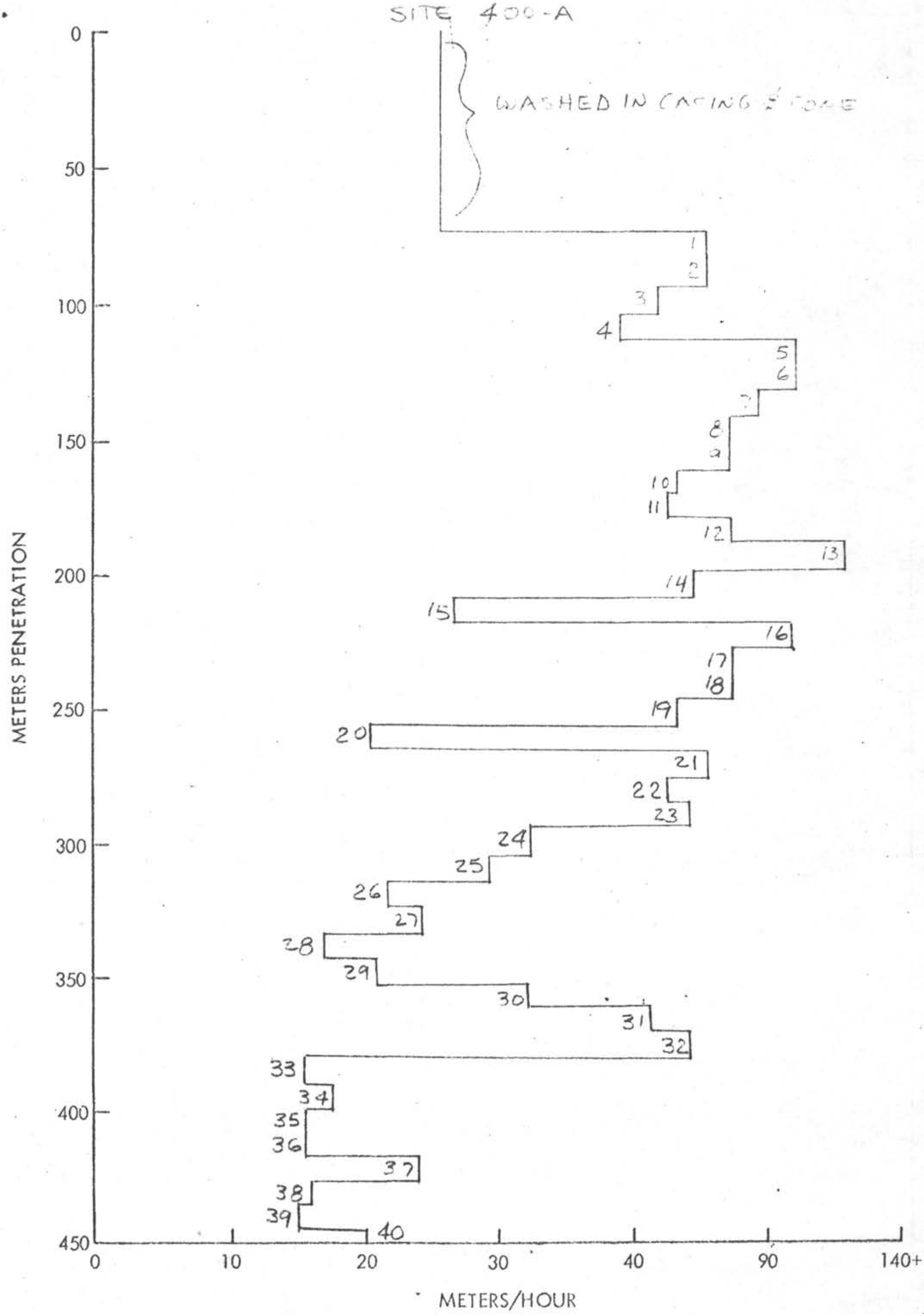

WASHED
T.D. 79 m
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
METERS/HOUR

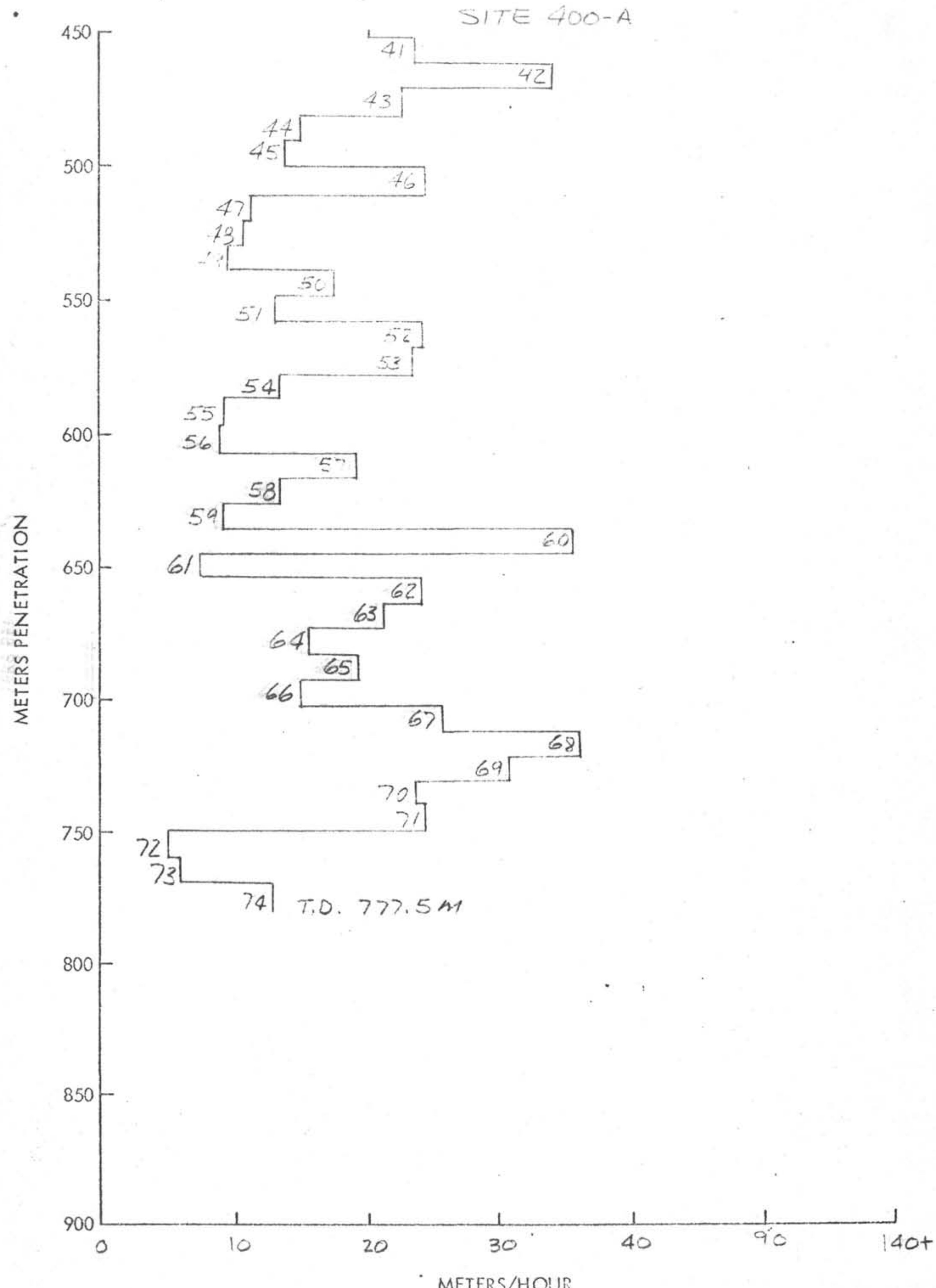


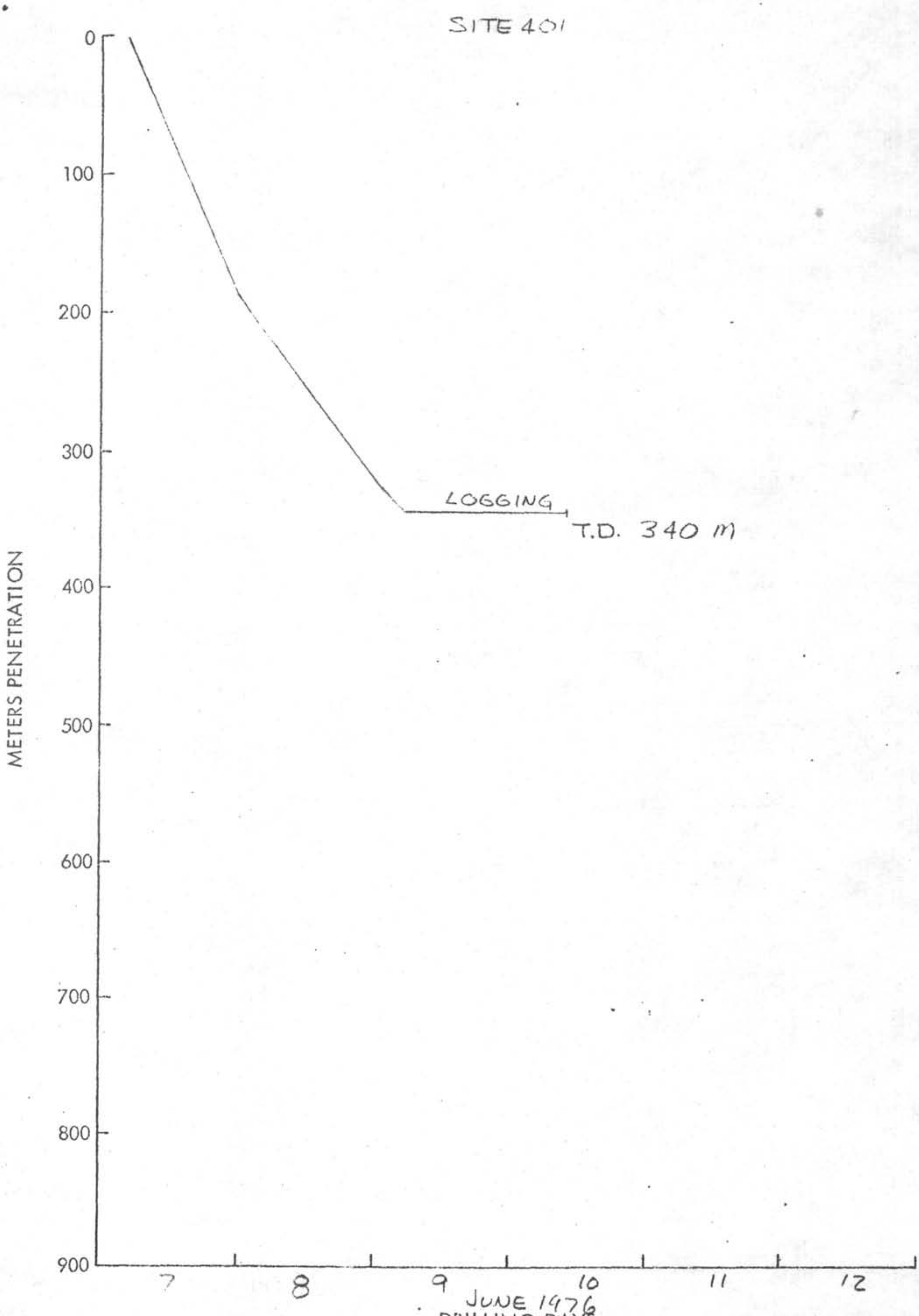
SITE 400-A
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
26
27
28
29
30
31
MAY 1976
DRILLING DAYS

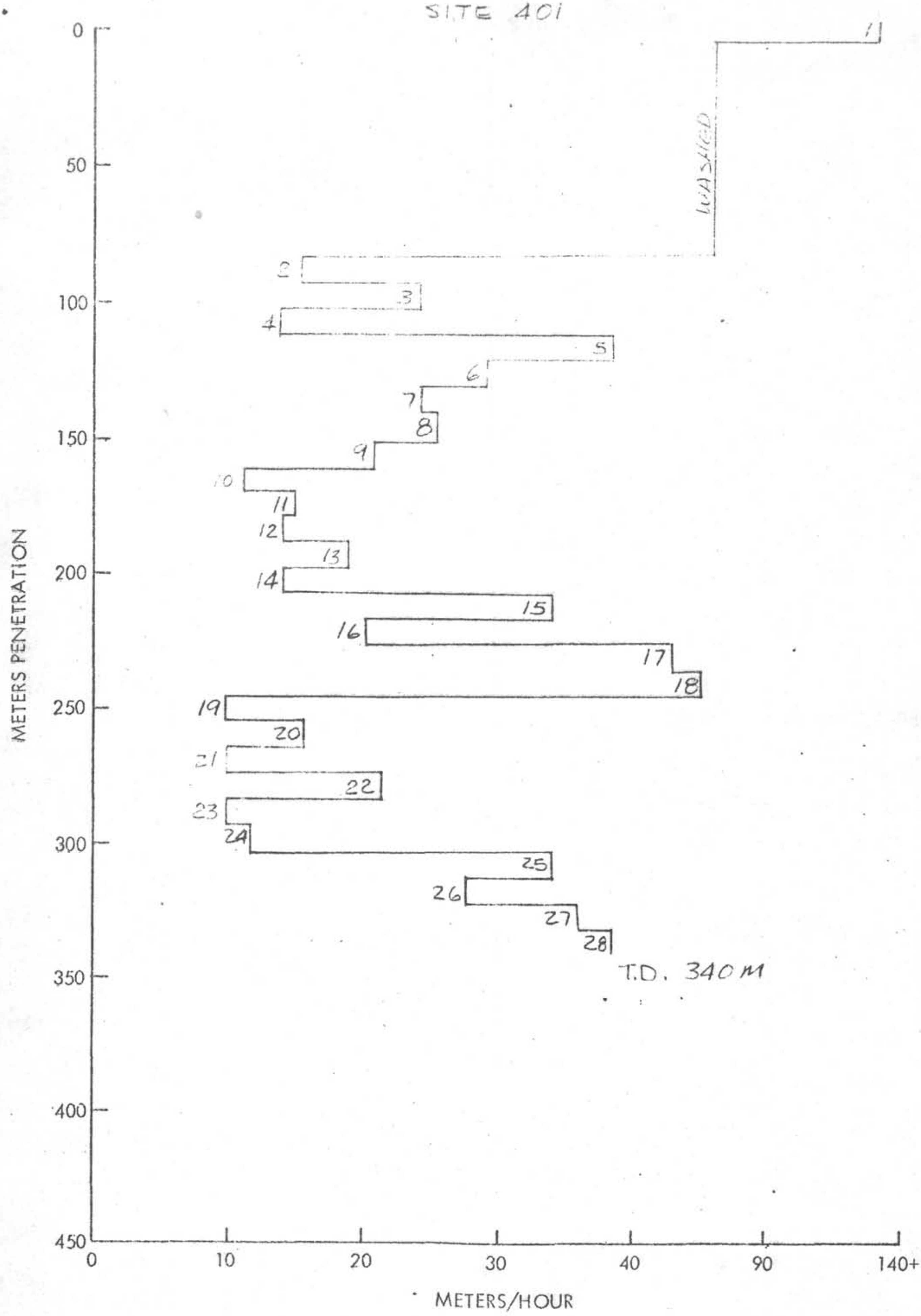


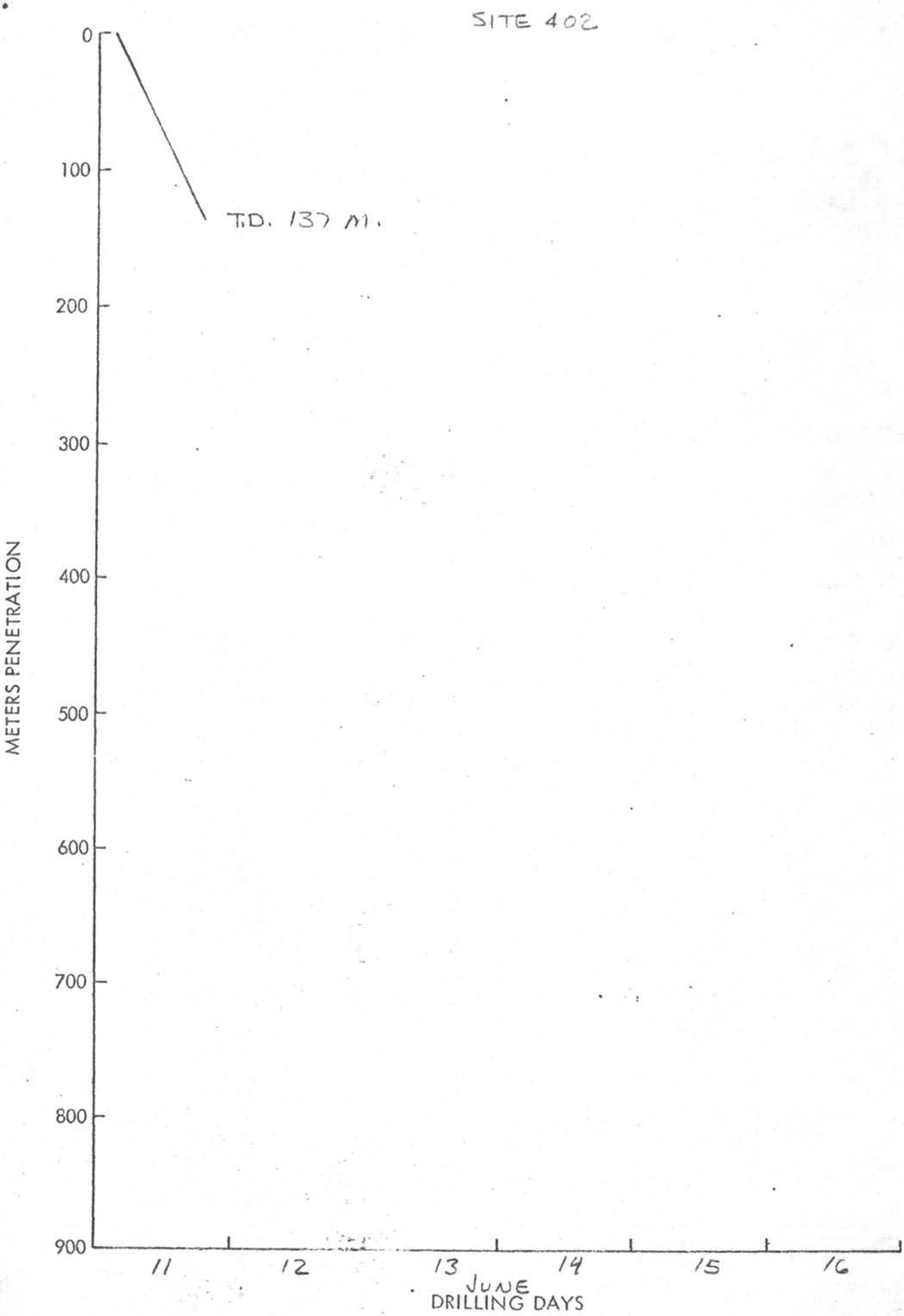
SITE
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
TD777.5M
1
2
3
4
5
6
JUNE 1976
DRILLING DAYS


SITE 400-A
WASHED IN CASING & CORE
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
METERS/HOUR
0
10
20
30
40
90
140+
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

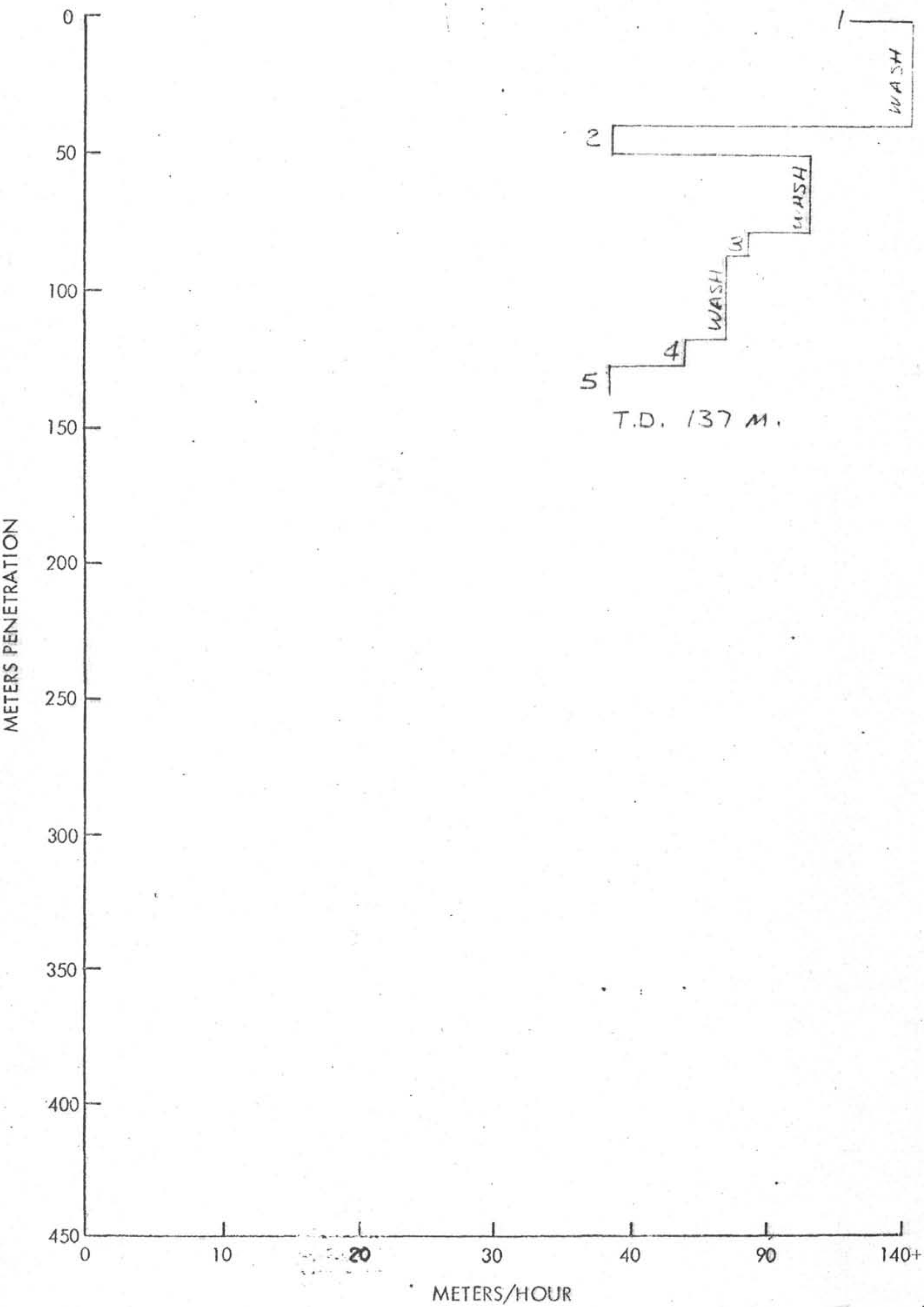

SITE 400-A
METERS PENETRATION
450
500
550
600
650
700
750
800
850
900
41
42
43
44
45
46
47
48
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
T.D. 777.5 M
0
10
20
30
40
90
140+
METERS/HOUR

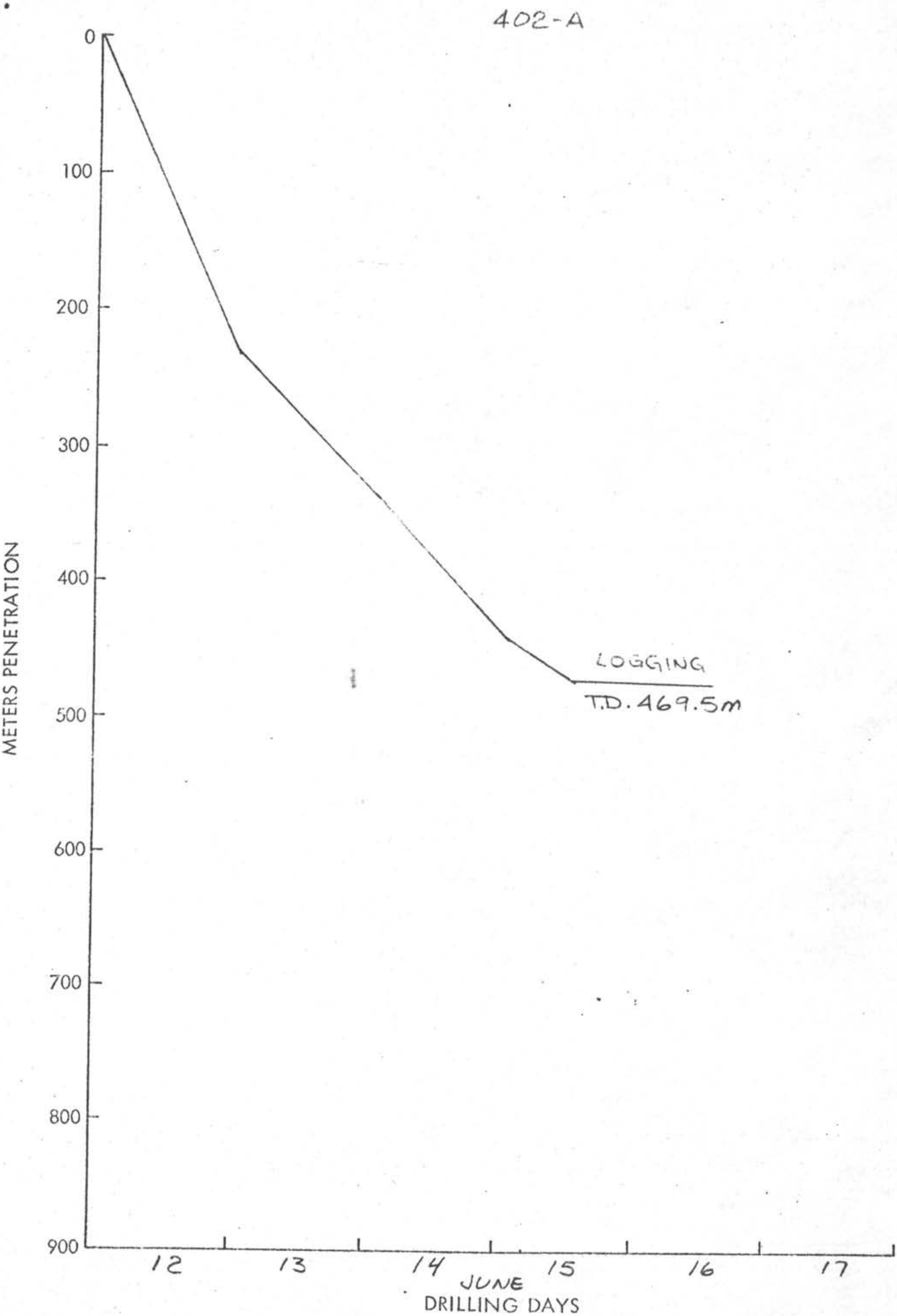

SITE 401
LOGGING
T.D. 340 m
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
7
8
9
10
11
12
JUNE 1976
DRILLING DAYS

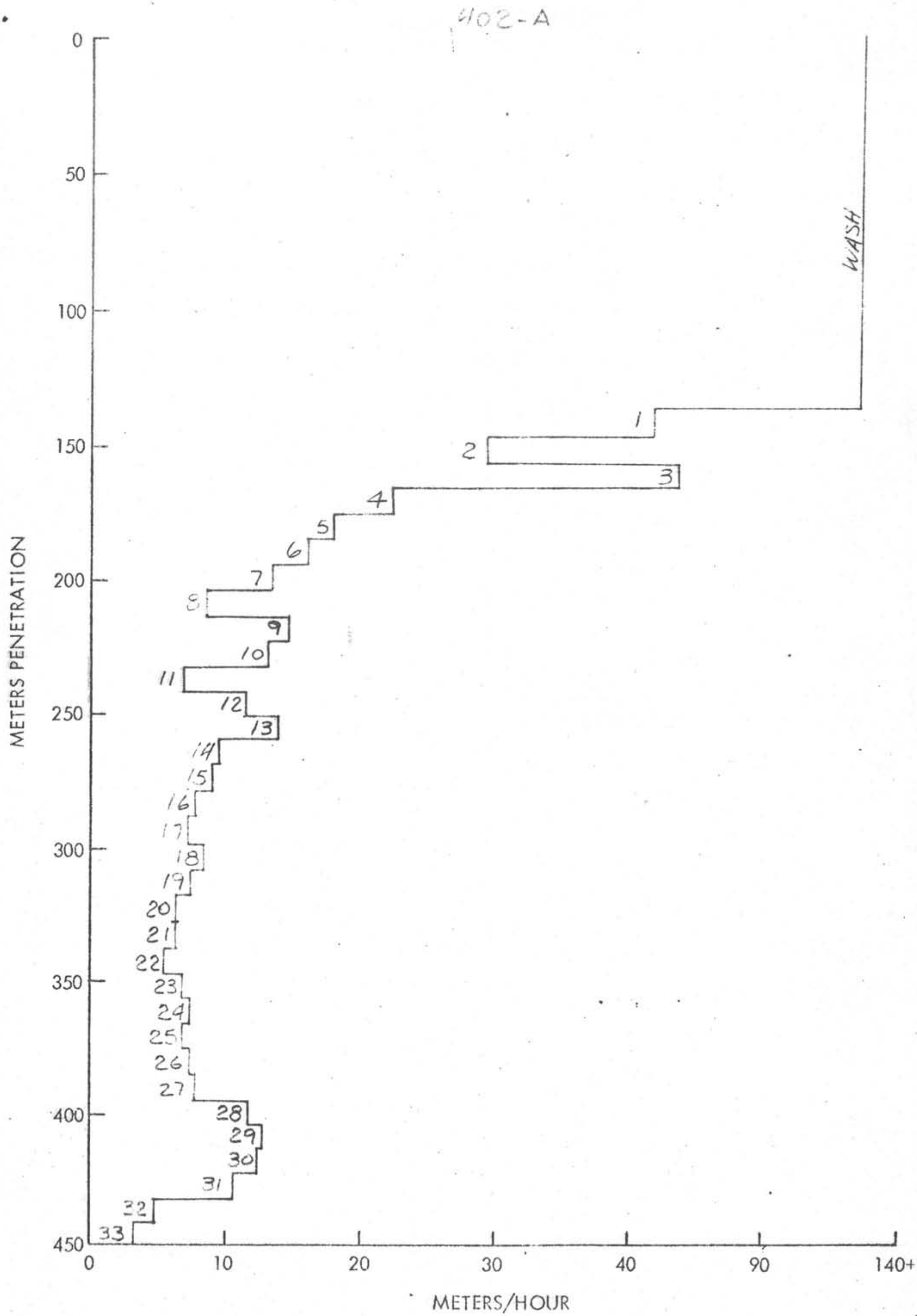

SITE 401
METERS PENETRATION
METERS/HOUR
WASHED
T.D. 340 M
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28



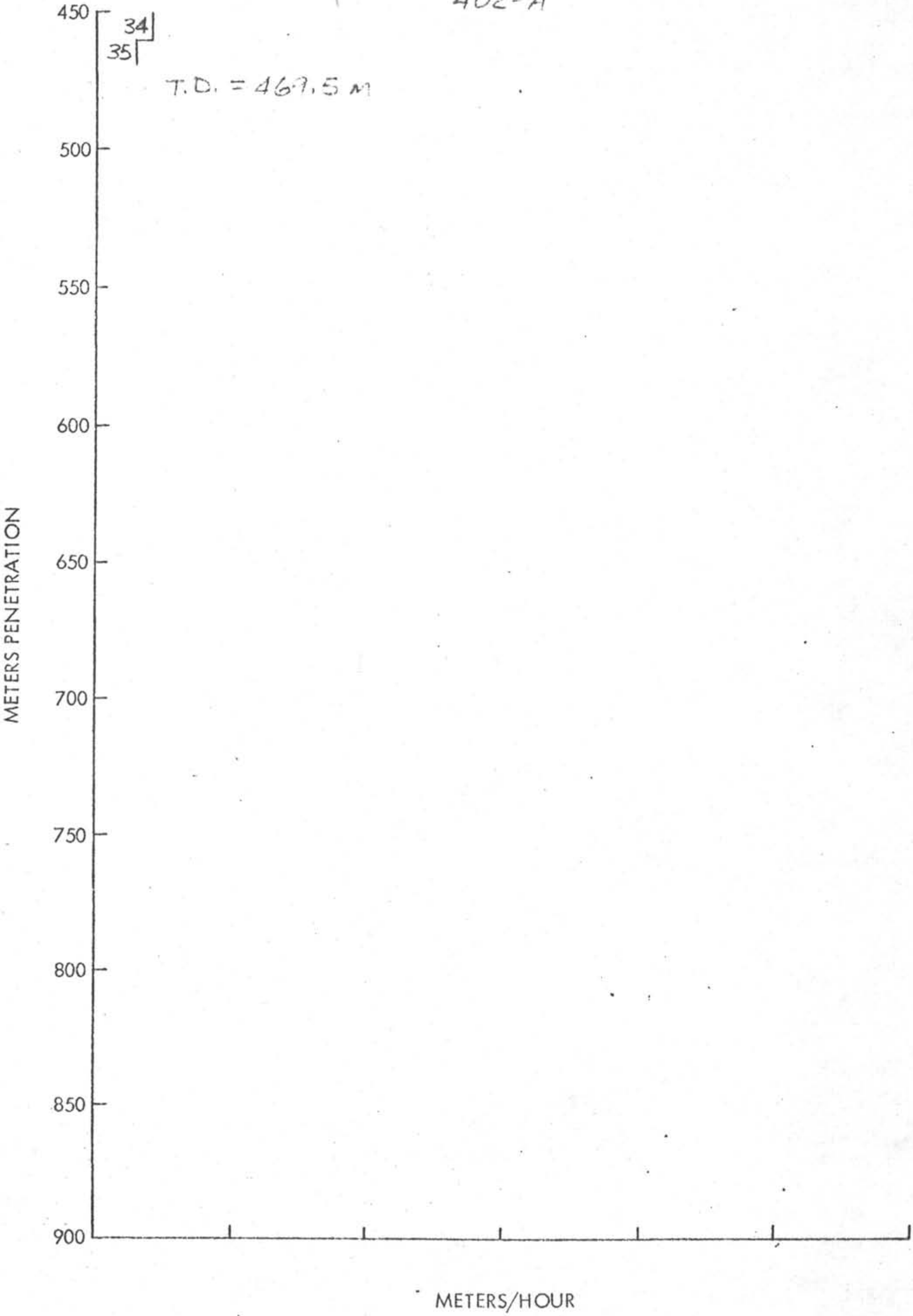
SITE 402
T.D. 137 M.
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
11
12
13
14
15
16
JUNE
DRILLING DAYS

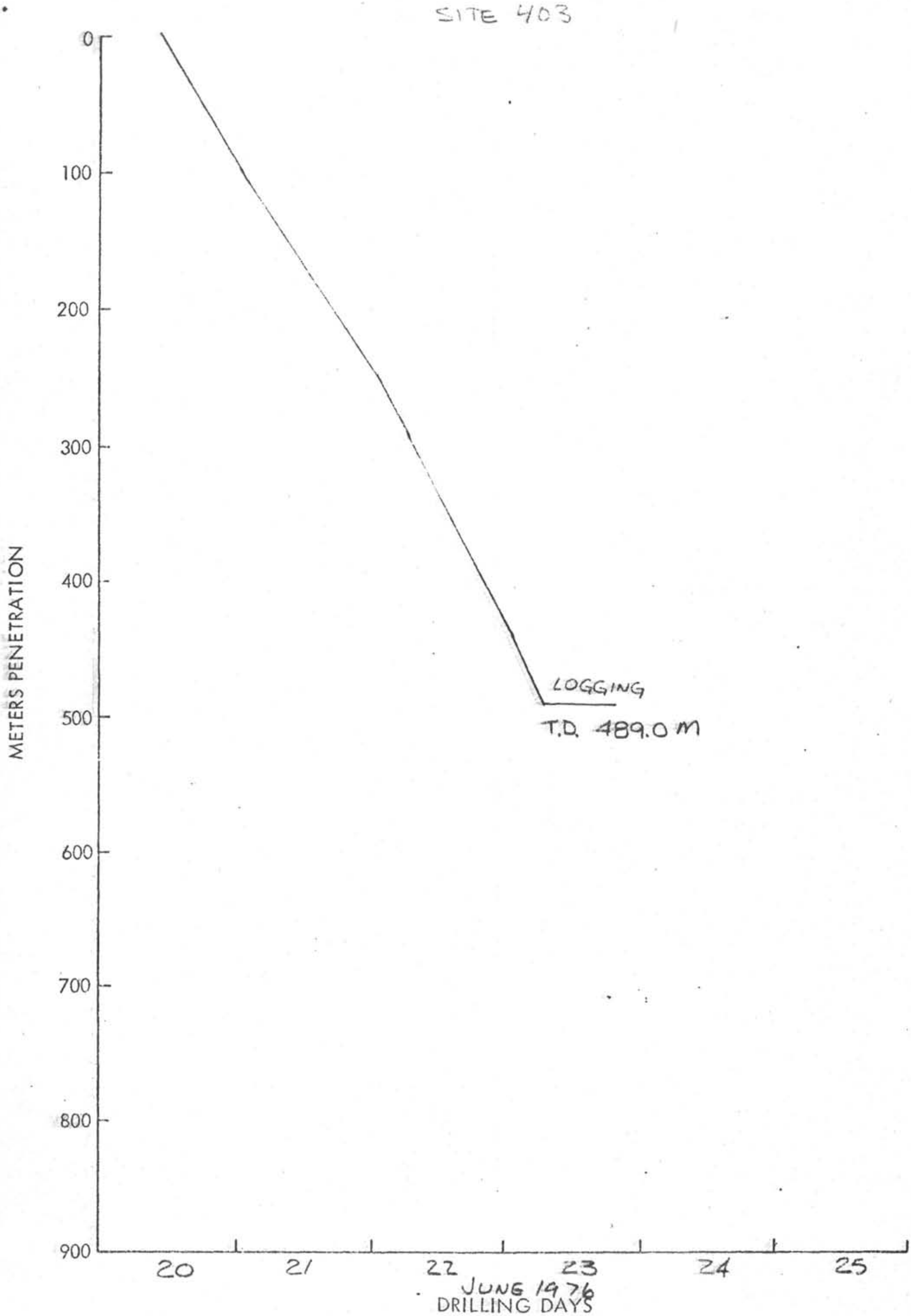

METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
METERS/HOUR
1
2
4
5
WASH
WASH
W
WASH
T.D. 137 M.

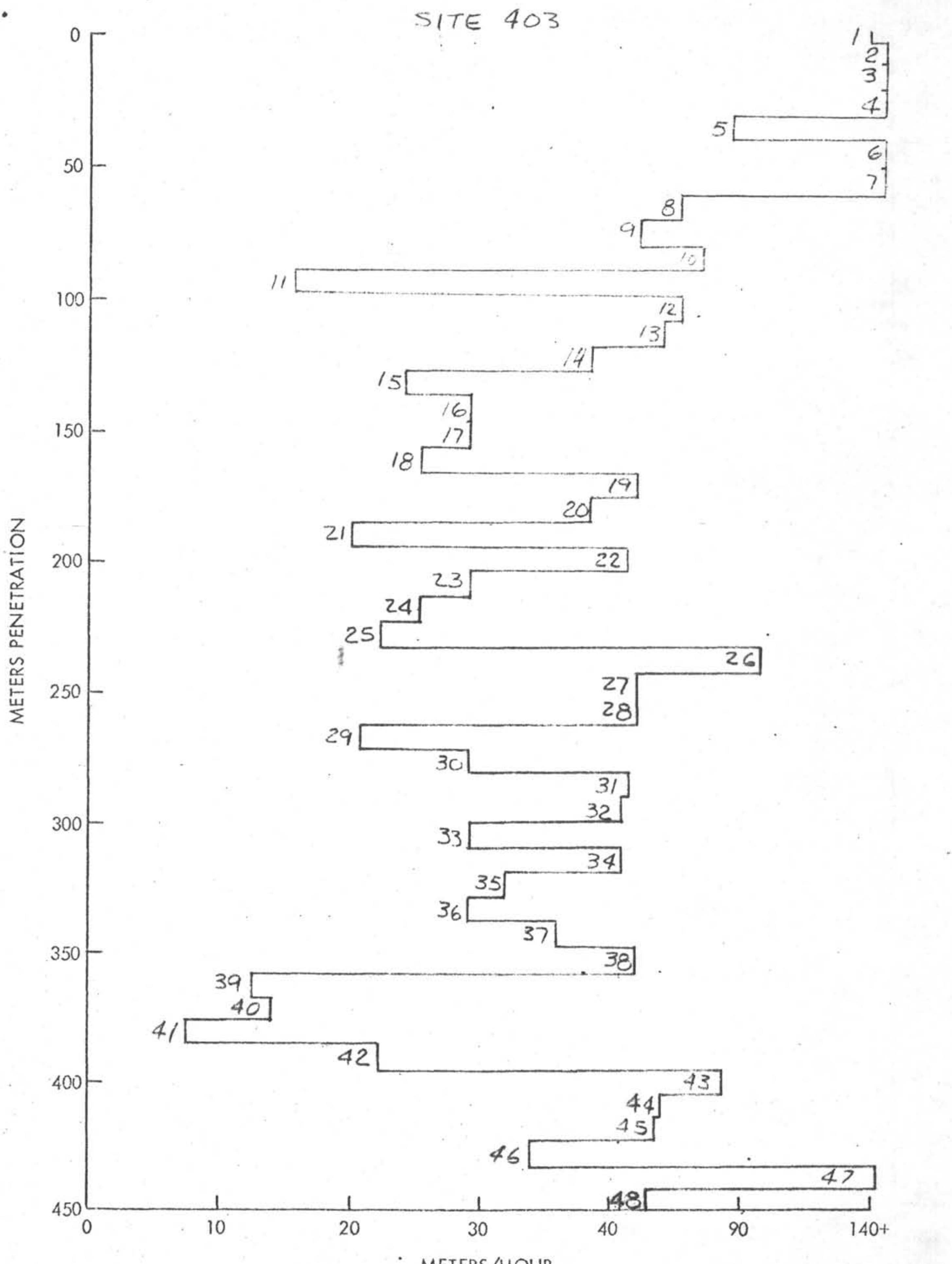

402-A
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
LOGGING
T.D. 469.5m
12
13
14
15
16
17
JUNE
DRILLING DAYS


402-A
METERS PENETRATION
METERS/HOUR
WASH
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33

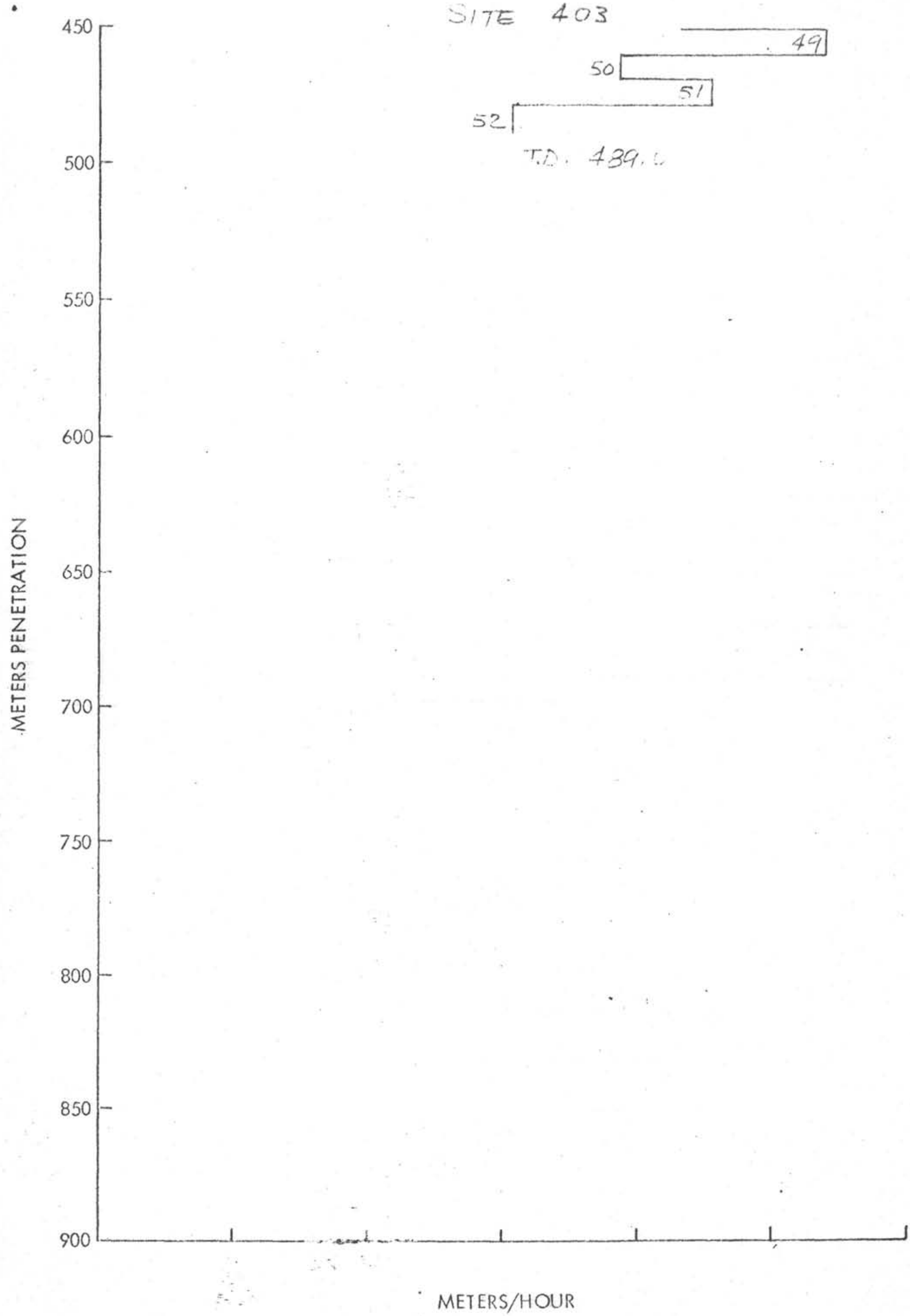
402-A

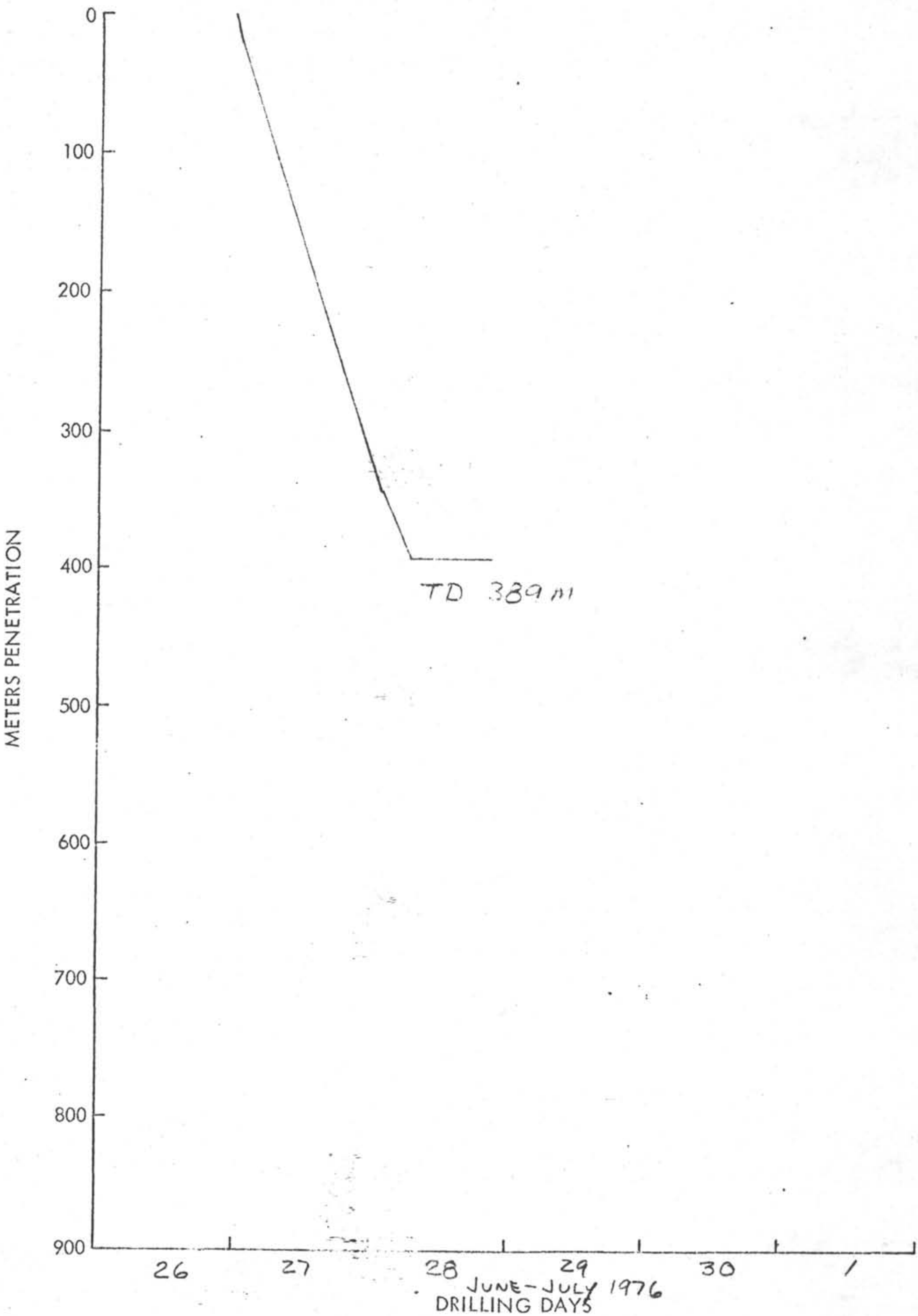

34
35
T.D. = 467.5 M
450
500
550
600
650
700
750
800
850
900
METERS PENETRATION
METERS/HOUR


SITE 403
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
LOGGING
T.D. 489.0 M
20
21
22
23
24
25
JUNE 1976
DRILLING DAYS

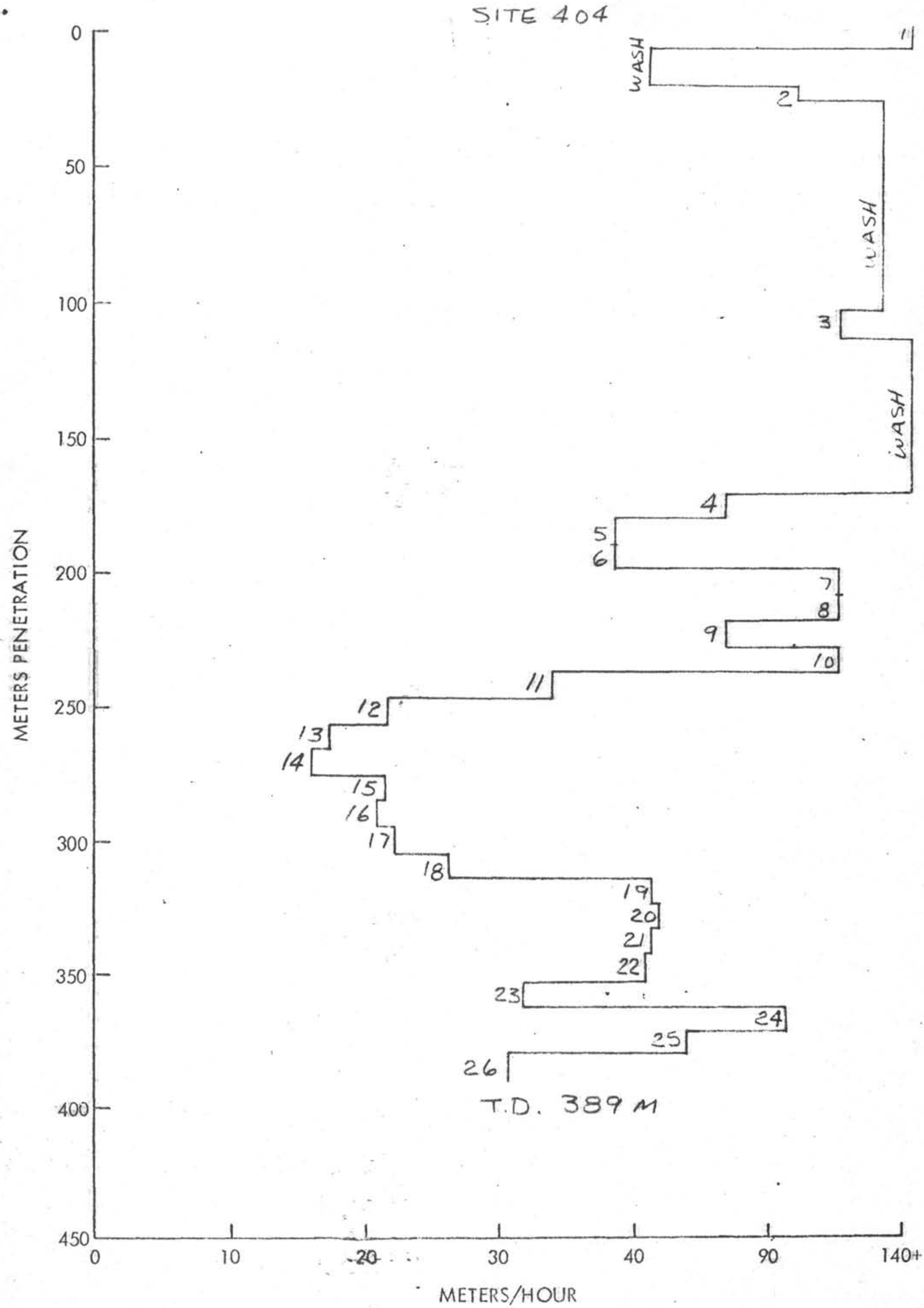


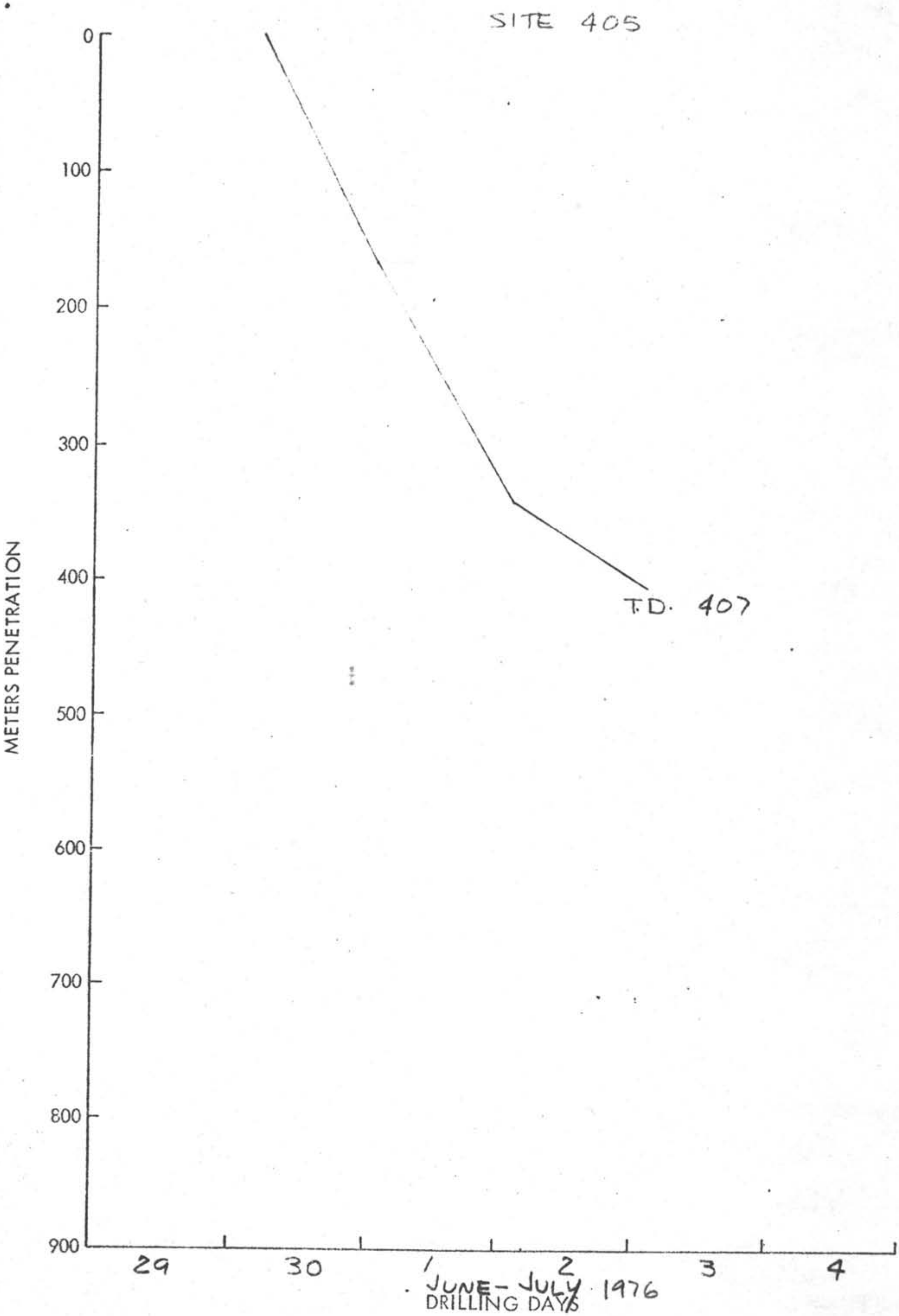
SITE 403
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
METERS/HOUR
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48


SITE 403
49
50
51
52
T.D. 489.0
450
500
550
600
650
700
750
800
850
900
METERS PENETRATION
METERS/HOUR

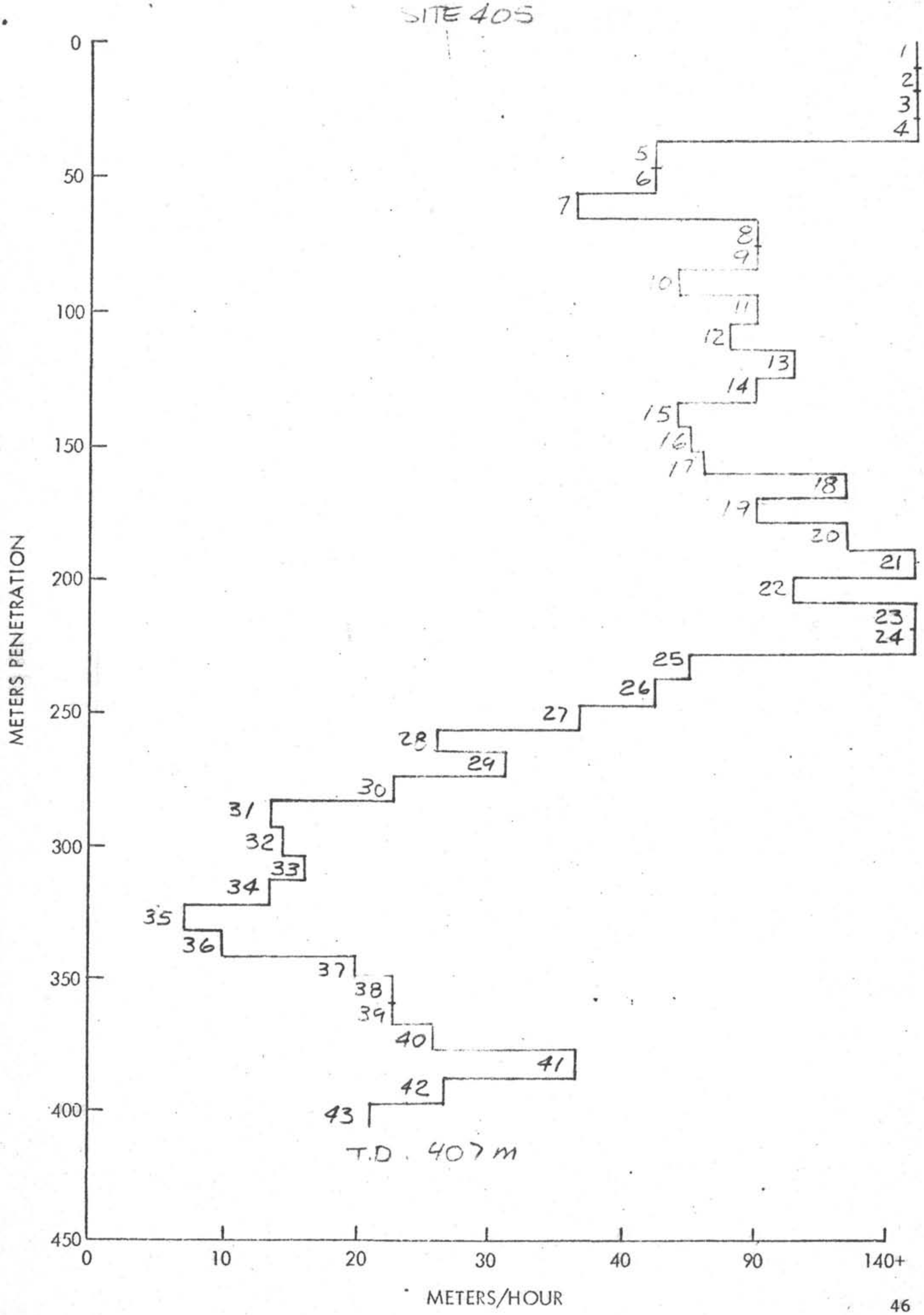


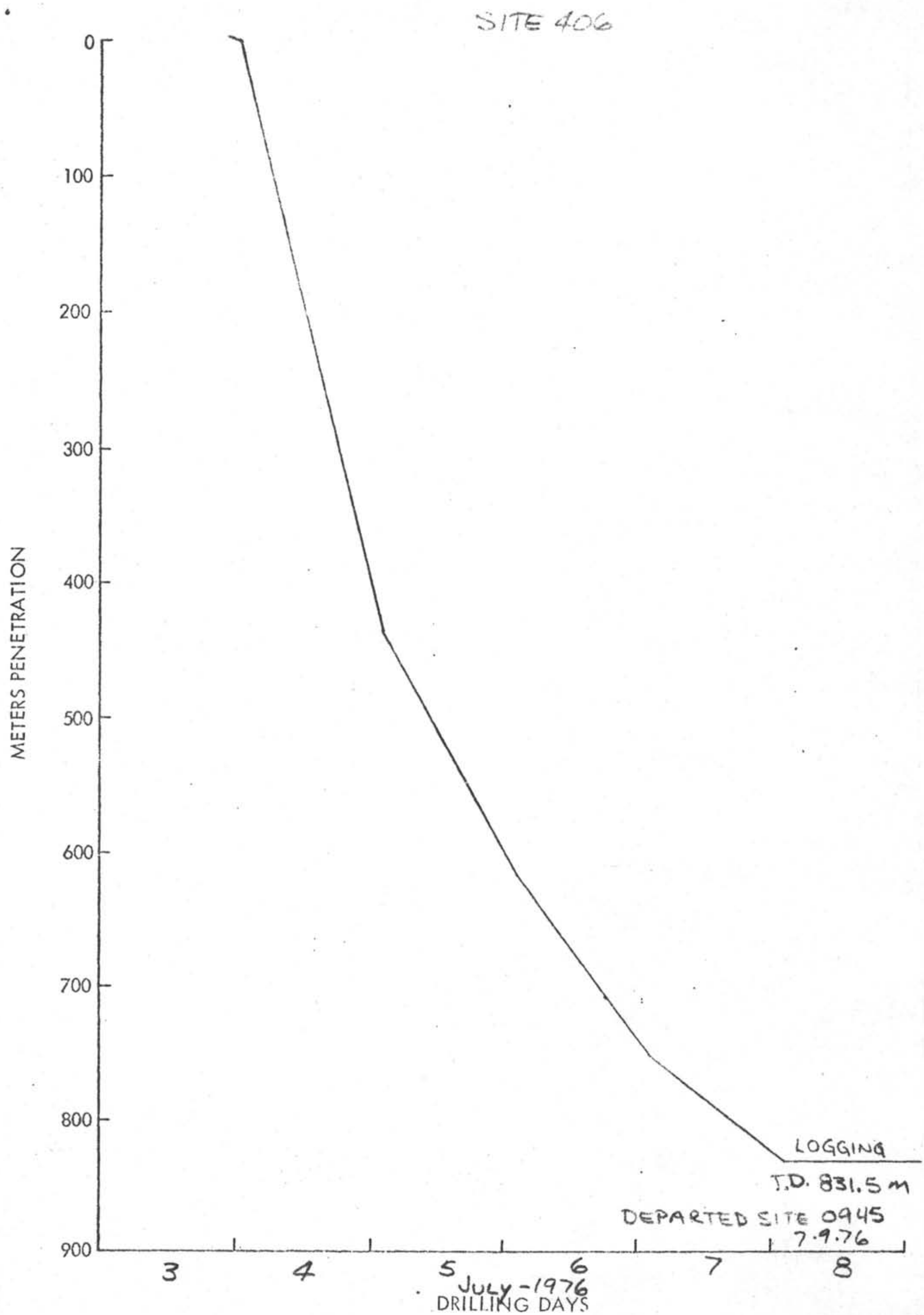
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
TD 389 M
26
27
28
29
30
1
JUNE-JULY 1976
DRILLING DAYS

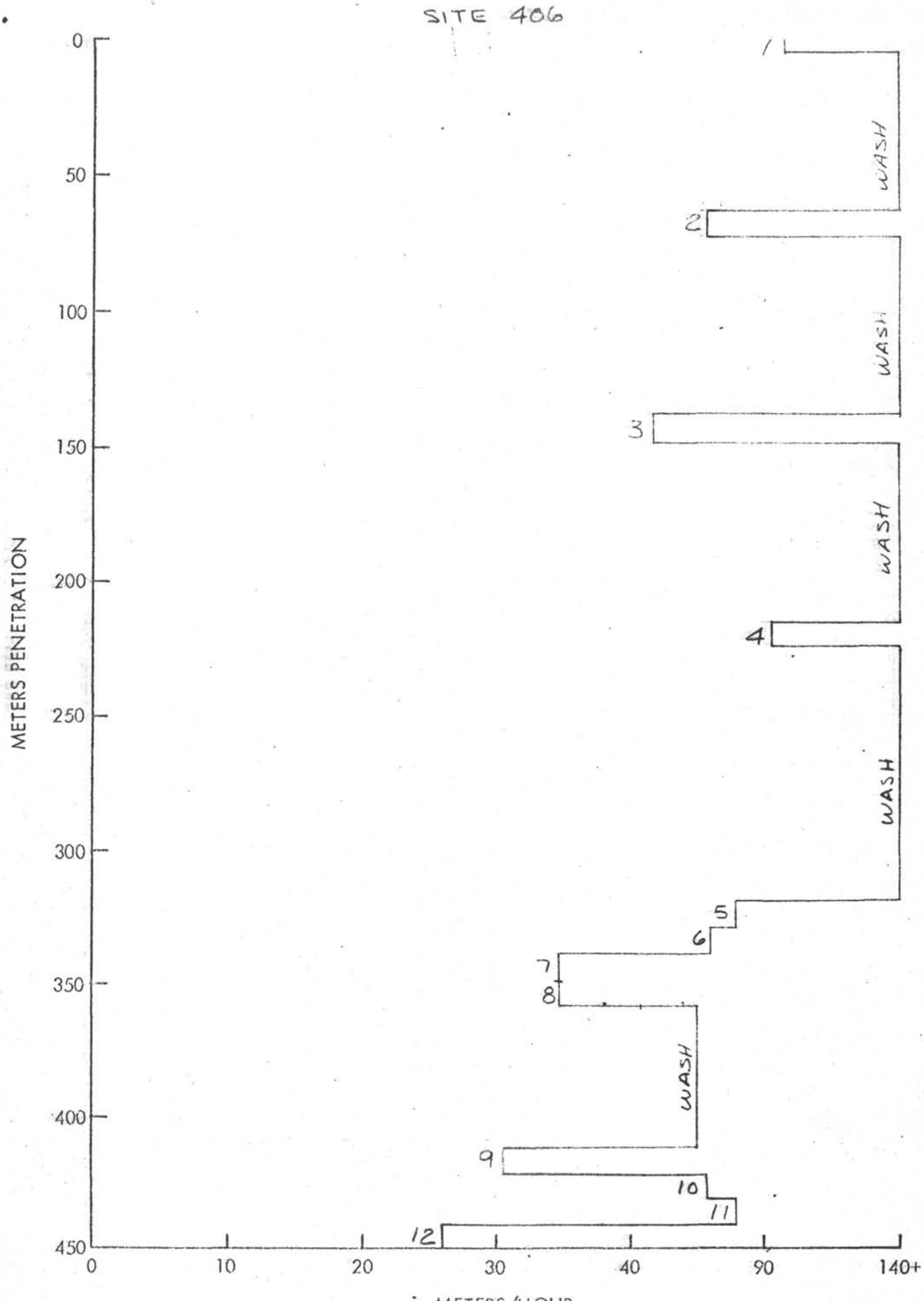

SITE 404
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
METERS/HOUR
0
10
20
30
40
90
140+
WASH
WASH
WASH
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
T.D. 389 M

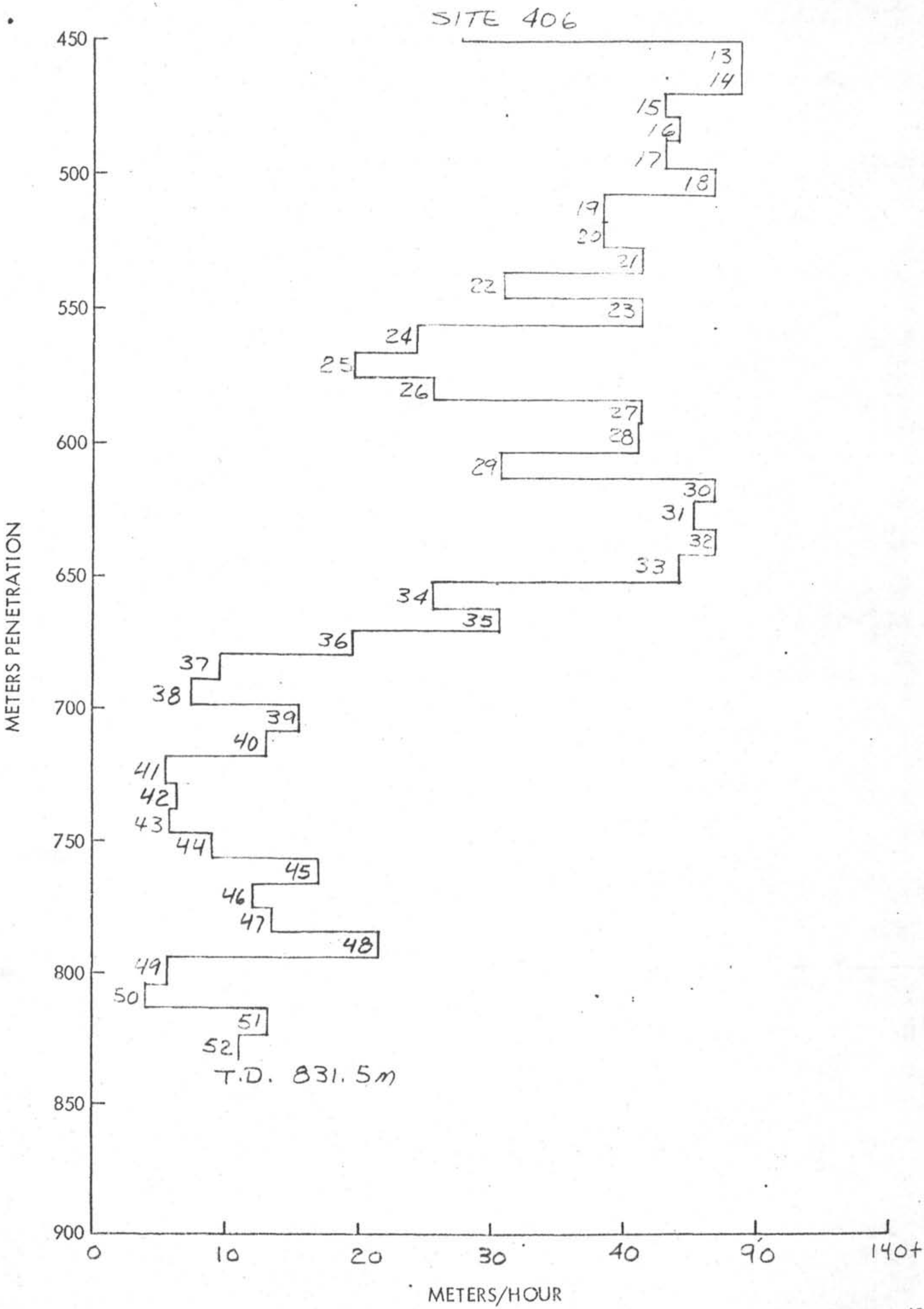


SITE 405
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
T.D. 407
29
30
1
2
3
4
JUNE-JULY 1976
DRILLING DAYS


SITE 405
METERS PENETRATION
METERS/HOUR
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
T.D. 407 m


SITE 406
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
LOGGING
T.D. 831.5 m
DEPARTED SITE 0945
7.9.76
3
4
5
6
7
8
JULY-1976
DRILLING DAYS


SITE 406
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
METERS/HOUR
WASH
WASH
WASH
WASH
WASH
1
2
3
4
5
6
7
8
9
10
11
12


SITE 406
METERS PENETRATION
450
500
550
600
650
700
750
800
850
900
0
10
20
30
40
90
140+
METERS/HOUR
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
T.D. 831.5m

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 49

Leg 49 of the IPOD Program was designed to drill in two regions of the North Atlantic Ocean, the Reykjanes Ridge and the Mid Atlantic Ridge.

The leg started July 13, 1976 in Aberdeen, Scotland and ended 53.47 days later at Funchal in the Madeira Islands. During this voyage the GLOMAR CHALLENGER traveled 4717.6 nautical miles and drilled 10 holes at 8 sites. Water depths ranged from 842 meters to 2987 meters and averaged 2241 meters. Hole depths ranged from 37 meters penetration below the mud line to 458.5 meters and averaged 268 meters. A total of 1943.5 meters was cored and 881.43 meters were recovered, a recovery percentage of 45.

Time distribution for the leg was 6.92 days in port, 23.8 days cruising, and 22.75 days on-site. The on-site time consisted of 11.36 days coring, 5.16 days tripping, 0.47 days drilling or washing, 0.33 days with stuck pipe, 0.66 days waiting on weather, 0.97 days positioning the ship, 1 day downtime, 0.47 days on post site surveys, and 2.33 days miscellaneous, such as heat flow measurements, pore water sampling, deviation surveys, probing the ocean bottom for enough sediment thickness to commence coring, etc.

A tragic rig floor accident that took the life of a rotary helper occurred while operating on Site 409. The pin in the starboard skate of the Bowen power sub torque arm broke and allowed a 600 lb. ± assembly to fall from the derrick. It struck and instantly killed Mr. Meadows.

Weather became a problem in the area of the leg where least expected, the Mid Atlantic Ridge. It caused the termination of three holes and eventually caused the length of the voyage to be shortened.

The port call that terminated the leg was changed from Las Palmas in the Canary Islands to Funchal on Madeira Island only three days before entering port. Many last minute arrangements were required.

PORT CALL - ABERDEEN, SCOTLAND

Leg 48 ended and Leg 49 began when the GLOMAR CHALLENGER arrived in Aberdeen, Scotland at 0420 hours on July 13, 1976. Loading of all ordinary supplies and stores was accomplished while we were moored port side to Pacific Deep Water Pier. A major amount of time was taken in loading drill pipe to replace a complete string lost during Leg 48. A total of approximately 6360 meters of drill pipe and four drill collars were taken aboard. The rules at the port of Aberdeen required the use of the large, slower dockside gantry cranes instead of the cranes aboard the vessel. Stevedores were a requirement in loading nearly all supplies and there were numerous minor disputes to clarify the work rules. Bulk gel, barite, and cement were loaded to completely fill available storage. A total of 228,692 gallons of fuel oil and 42,222 gallons of drill water were taken on after moving to the fuel pier.

A major overhaul was performed on engine No. 6 and new connecting rod and main bearings were installed in engine No. 11.

The entire heave compensator system was inspected and tested by Global Marine and the manufacturer's representatives.

At 0554 hours on July 18, 1976, the CHALLENGER got underway to begin her trek northwest to the Reykjanes Ridge area. However, less than two hours after getting underway, the ship reversed course and returned to Aberdeen to disembark a seriously ill seaman for hospitalization. A local able-bodied seaman (United Kingdom) was signed on to replace him and the vessel was again underway at 1005 hours to resume the voyage.

SITE 407

The first site of Leg 49 was located on the west flank of the Reykjanes Ridge and was a single bit entry. The beacon was dropped after over five days of travel from Aberdeen. A 16 kHz beacon was used and 1.7 hours were spent positioning the ship at a location approximately 1000 feet south and 1300 feet east of the beacon. The water depth at the drill site, as recorded by the Precision Depth Recorder (PDR), was 2482 meters corrected to the rig floor. The drill string was made up and measured by steel line as it was run to bottom. A mud line core established bottom at 2492.5 meters. The hole was cored continuously from the mud line to total depth. Some minor sticking was experienced and the hole was flushed with mud at 2821.5 meters, 2850 meters, and 2897.5 meters, each time completely freeing the tight hole. Heat flow measurements were recorded at 2688.5 meters, 2736 meters and 2783.5 meters. A hole deviation survey taken at 2935.5 meters recorded 2-1/2°. Penetration ceased and the hole was terminated at 2951 meters drill pipe measurement (DPM) from the rig floor, or 458.5 meters of penetration below the mud line.

The hole was plugged with 150 barrels of 11.2 pounds per gallon mud. When the bit was pulled it was found to have two cones with the bearing life completely gone, two cones locked, and the bit out of gauge by 7/8 inch. The inserts showed very little wear. Approximately 65% of the total penetration was in sediment and the remainder in basalt lava. As the bearings became worn and the core diameter decreased, the core recovery increased notably. Cutting a smaller diameter core in the basalt apparently reduced the jamming at the core catcher. If this observation holds true on other sites, it might be worthwhile to redesign the bits to cut a smaller core and keep the dimensions of the core barrel assembly the same as they presently are.

No problems were encountered at this site. The towed survey gear was streamed and a post site survey was made.

SITE 408

This site like Site 407 was also a single bit entry on the west flank of the Reykjanes Ridge. However, it was necessary to make a port call in Reykjavik, Iceland to disembark an ill seaman for hospitalization and the first assistant engineer for compassionate leave and to sign on replacements for each before work could begin. This resulted in a loss of 63.5 hours between Sites 407 and 408. A 13.5 kHz beacon was dropped and 0.8 hour was spent positioning the ship over the beacon. The water depth at the drill site was 1634 meters by PDR corrected to the rig floor. The drill string was run to bottom and on this site the drill pipe pinger was put into use. The pinger and the drill string weight indicator both confirmed the PDR reading of 1634 meters. When the drill pipe pinger was retrieved it was found to be leaking oil from both ends of the transducer. The hole was cored continuously from the mud line to total depth without any problems. Heat flow measurements were taken at 1729 meters, 1805 meters, and 1881 meters.

The hole was prematurely terminated at 1995 meters DPM, or 361 meters of penetration below the mud line, because of the necessity to again take a seriously ill seaman into Reykjavik, Iceland for hospitalization. The hole was plugged with 100 barrels of 11.2 pounds per gallon mud. The bit from this hole still had effective seals, was in gauge, and indicated very little wear on the inserts. Approximately 91% of the total penetration was in sediment and the remainder, in basalt.

SITE 409

The third site was a single bit entry on the crest of the Reykjanes Ridge. There was a loss of 50.6 hours between Sites 408 and 409 because of the emergency trip into Reykjavik with the seriously ill seaman. A 16 kHz beacon was dropped and 1.1 hours were spent positioning the ship over the beacon. The water depth at the drill site was 841 meters as measured by the PDR and corrected to the rig floor. The bottom was found at 842 meters with the bit (DPM) and coring was begun at the mud line. The bottom was found to be very firm and spudding was very difficult. After coring one meter and recovering a small amount of sand, the hole was washed 23.5 meters and then continuously cored. Tight hole was experienced at 1037.5 meters and 50 barrels of mud was pumped to flush the hole. After retrieving core No. 30 at 1142 meters, the bit became plugged. The core barrel was retrieved, dropped again, and retrieved. This slight swabbing action apparently unplugged the bit. The hole was then flushed with 50 barrels of mud and coring continued. While making a connection to continue coring after retrieving core No. 32 at 1161 meters, the pin connecting the starboard skate to the Bowen power sub torque arm broke allowing the 600 pound skate to fall to the rig floor. It struck and killed instantly one of the rotary helpers. The hole was immediately terminated and the drill string pulled. The vessel then proceeded to Reykjavik where the body was removed and repairs were made to the failed torque arm. Total penetration from the mud line was 319 meters. The bit from this hole had effective seals when pulled, was in gauge, and showed little insert wear. Approximately 25% of the total penetration was in sediment and the remainder in vesicular basalt.

SITE 410

The fourth site was on the Mid Atlantic Ridge, one week's travel time from Reykjavik. A 16 kHz beacon was dropped and 1.3 hours were spent positioning the ship to commence operations. The water depth, as measured by the drill pipe, was 2984 meters. Coring was begun at the mud line and progressed through 340 meters of sediment to the top of the basalt. The pore water sampler was run successfully at 3029.5 meters, 3077 meters, 3191 meters, 3248 meters, and 3276 meters. Heat flow measurements were taken at 3058 meters, 3105.5 meters, 3162.5 meters and 3219.5 meters. No problems were encountered in running either instrument. At 3343 meters, the next connection after reaching the basalt, 100 barrels of gel mud was spotted in the hole to aid in preventing possible sticking and the heave compensator was picked up and put into operation. This was the first time that the heave compensator was used on Leg 49 and it worked very well in the passive mode. It was not operated in the active mode on this hole. After coring only 47.5 meters of basalt, the inner core barrel became stuck in the outer barrel. Three runs were made with the sandline but the pin sheared in each case. The bit had plugged at the same time the core barrel became stuck, so there was also no circulation. Another inner core barrel was then run in on the sandline and pulled rapidly out to effect swabbing in an effort to unplug the bit and also free the stuck inner barrel, all to no avail. A "wet" drill string was pulled in order to unplug the bit and recover the inner barrel. When recovered, the core barrel and bit were tightly packed with coarse grained "sand" or cuttings. The last two 9.5 meter cores had cut very quickly; faster in fact than the previous two and the very last one in only 32 minutes. This, coupled with rounded corners on the cuttings/"sand", led the author to think that the fast coring had been actually a "sand". Core recovery had been poor on these last two cores so no conclusive case could be built to identify the source of the plugging. The bit was in excellent condition (T1-B1-I) and was run in the hole twinning this lost one.

HOLE 410A

This hole was located 350 feet away from Site 410 on a course of 020°. The mud line was found by the bit at 2987 meters and washing down was begun. A total of 325 meters was washed before continuous coring was begun. The top of the basalt was found at 330 meters penetration. The heave compensator was not picked up at this hole in order to save time. Because of previous lost time, a maximum penetration was desired in the shortest possible time. Bit life was not a consideration. While making a connection at 3369 meters (382 meters penetration) after pulling core No. 6, the pipe became stuck and plugged. It was not possible to circulate or rotate. This sticking followed the same pattern as in Site 410 in that the penetration rate had increased on the last two cores; the very last one being cut in only 30 minutes. After two and one half hours the pipe was pulled free and circulation was restored. A mud flush of 100 barrels was pumped to clear the hole and several attempts were made to continue coring ahead. Each time the connection was made to core deeper the same sticking problem recurred. It was felt that permanent sticking and loss of a bottomhole assembly was imminent if the attempt to core ahead was continued. It was thought that the hole from the mud line to the top of the basalt at 330 meters was probably enlarged and funnel shaped. This would make it impossible to circulate the cuttings/"sand" through this enlarged portion because of the loss of annular velocity. If deep penetration was desired at this site, or any one similar to it, it is believed that this would require setting of a re-entry cone and running casing to the top of the basalt. This would then provide a "gauge" hole with optimum annular velocity in which cuttings or "sand" could be circulated out to the sea floor and the hole kept clean and free of sticking.

This hole was terminated and preparations made to get underway to the next site.

SITE 411

This site presented much difficulty from two standpoints: (1) finding enough sediment to stabilize the bottomhole assembly so that basement could be cored without a connection failure in the BHA; (2) keeping the sediments clear of the hole to prevent sticking of the drill string.

The first problem took considerable time; over 24 hours. The procedure was to position the ship at the desired site, run the bit to bottom, and wash down as far as possible. The sediment cover ranged from 0 to 74 meters. On the eleventh attempt the 74 meters were found and coring operations began. The water depth was 1950 meters as measured by the drill string. After coring on 17 meters of basalt to a subbottom depth of 91 meters, the second problem became known. The sediment, which was foram sand, was apparently flowing into the hole when pumping was stopped to make a connection and trying to stick the pipe. The hole was flushed with mud to clear it and coring progressed another 19 meters. Again, on the connection, the sticking problem occurred and a mud flush made it possible to continue. At 119.5 meters of penetration, the pipe became stuck on a connection and after two and one half hours it was worked free. After several attempts to continue coring, even with a mud flush of 11.2 pounds per gallon mud, it was deemed impossible to get any deeper. Each time a connection was made the sticking problem reappeared. This hole was terminated to begin Hole 411A.

HOLE 411A

This hole was a 50 foot offset to Site 411 and was drilled in order to examine some of the sediment that caused the sticking problems on Site 411. Here, just 50 feet away, the mud line was found at 1985 meters, 35 meters deeper than Site 411. Total penetration here was only 37 meters, 27.5 meters by coring and 9.5 meters by washing. Very unstable foram sand was encountered as expected and the hole was abandoned as planned.

SITE 412

This hole on the Mid Atlantic Ridge was chosen to test a new style core bit. It was to have a good thickness of sediment most of which was to be cored and basalt which would be continuously cored. The bit was a Smith F44C and is discussed under core bits. The water depth, as measured by the drill string, was 2624 meters. There were 160 meters of sediment and of this, 38 meters were washed and 122 meters cored. The sediment was penetrated without problem and core recovery was average. After cutting 11.5 meters of basalt, the bit failed and penetration ceased. When the bit was pulled it was found to have lost its two drilling or outside cones by failure of the journals. The heave compensator was operated satisfactorily throughout operations at this site in the active mode with 8,000 to 10,000 pounds on the bit, with maximum weight variation ± 1,000 pounds. With exception of the premature bit failure, there were no other problems on the hole.

HOLE 412A

This hole was a twin to 412 and drilled to continue deeper at this site after the premature bit failure. The mud line was found at the same depth, 2624 meters, and the hole was washed down 156 meters, where continuous coring began. The top of the basalt was at 163 meters penetration. Tight hole was experienced at 203.5 meters of penetration on a connection. A 75 barrel mud flush cleared the hole and coring continued. After core No. 8, at 232 meters penetration, the pipe was stuck for one hour and while pulling on it, 75 barrels of mud was pumped. Once freed, the pipe was stuck again for two hours after core No. 9 at 241.5 meters. After freeing the pipe the second time it became a practice to spot 75 barrels of mud in the hole each time a core was cut and ready to retrieve. This alleviated the sticking problem associated with shutting the pump down to start core retrieval and/or to make connections. The tight hole seemed to be caused by fractured basalt and aggravated by cuttings and/or soft sediment flowage. Coring continued to a total penetration of 294 meters below the mud line where penetration ceased. There was no recovery on the last 5 meters of penetration. A deviation survey was run before tripping out and it measured 1-3/4°. When the bit was pulled it had all four cones missing.

SITE 413

This site was 1.3 miles south of Site 412 in 2608 meters of water. The hole was washed to basement which was at 110 meters below the mud line where continuous coring was begun. A tight hole problem, similar to Hole 412A, began at a penetration of 134 meters or 24 meters into the basalt. It, like Hole 412A, seemed to be caused by fractured basalt and also cuttings and/or soft sediment flowage. Mud flushes were begun at each core retrieval and allowed continued penetration. At 149.5 meters penetration the hole was terminated because of weather. A small nearby low pressure area gave rise to winds gusting to 50 miles per hour. All pipe was pulled and the operation began waiting on weather to improve prior to starting Hole 413A.

HOLE 413A

After waiting on the weather 10.8 hours, pipe was run to bottom to commence 413A. After tripping in for three hours, the weather began to worsen and it was necessary to again wait on weather to improve. In addition to the wind and sea, a problem developed with one of the bow thrusters. Between the weather and the thruster being down we could no longer stay on station and the hole was abandoned without ever spudding.

SITE 414

After abandoning Site 413, the ship got underway for Cruiser Seamount 407 miles southeast and hopefully, for better weather. A beacon was dropped, the ship positioned, the pipe run and no soft sediment to stabilize the bottomhole assembly was present. After repositioning the ship and attempting to find sufficient sediment, it became obvious that Hurricane Emmy would become a threat within a matter of a few hours. So, again, without ever spudding, the site was abandoned.

WEATHER

From an operational standpoint, the weather was somewhat reversed from what was anticipated in the two general areas of the North Atlantic ocean. The three sites in the Reykjanes Ridge area were drilled without any weather related problems whatsoever. However, beginning with Site 413 on the Mid Atlantic Ridge, the weather became a problem. Winds to 50 miles per hour caused Site 413 to be terminated early. A small intense low pressure area formed northeast of the ship giving rise to these winds and associated sea and swell.

After terminating Hole 413 and waiting on the weather to moderate for 10.8 hours, the drill string was started to bottom for Hole 413A. The weather, coupled with a thruster problem, prevented the hole ever being spudded.

The immediate forecast for the area was not good and a decision was made to travel southeast to the Cruiser Seamount and core there in a more pleasant meterological clime. However, Hurricane Emmy, which was advancing, was the immediate consideration.

After arriving and dropping the beacon at Site 414, the drill string failed to find sufficient soft sediment to operate and even here Hurricane Emmy became an immediate threat. Plots and forecast of her position for the next 24 hours were such as to render our position untenable. Site 414 was abandoned before ever spudding and the vessel headed east. Emmy eventually was to move further east than any other hurricane had been recorded in the past at these latitudes.

DRILLING AND CORING ASSEMBLY

The bottomhole assembly used on this leg was the standard DSDP assembly in three variations. On the sites where the heave compensator was not used, the BHA consisted of a bit, bit sub with float valve, core barrel, three 8-1/4" drill collars, two 5-foot stroke bumper subs, three 8-1/4" drill collars, two 5-foot stroke bumper subs, two 8-1/4" drill collars, one 7-1/4" drill collar, and one joint heavy wall 5-1/2" drill pipe. On the first site where the heave compensator was used, one of the lower bumper subs was left out. On the remaining sites with the heave compensator in use, both of the lower bumper subs were left out.

CORE BITS

Throughout the leg Smith 10" F94CK bits were used in every hole with the exception of Site 412, where the new style bit F44C was used. The 99CK bits adequately cored soft sediment, limestone, and basalt. This bit has medium length tungsten carbide inserts with a chisel shape which seem ideal for all coring which was done on Leg 49. The sealed journal type bearings give reasonable life. Overall bit life was determined in every case by the bearings. When the drilling bit industry is able to improve the seals and bearings, longer bit runs and deeper single bit holes will be possible.

Another possibility for improving overall bit life would be to go to a large bit size resulting in larger cones and larger bearings. Use of a larger bit such as a 12-1/4 inch would also improve the clearance between the 8-1/4 inch drill collars and the hole. Presently, with the 10 inch bit, there is only 7/8 inch clearance around the 8-1/4 inch collars. Some "tight hole" conditions occasionally experienced might be alleviated with a bigger hole.

The new style core bit, F44C, was essentially a two-cone bit in that only two of the four cones actually drilled. The other two cones were reversed and only helped trim the core to size. These cones did not come in contact with the bottom of the hole. This arrangement allowed the inner core barrel shoe to come deeper into the bit and closer to the cones. This closeness of core barrel and cones was to give fractured rock a better chance of getting into the barrel without jamming.

The recovery of soft sediment with the F44C was comparable with the F94CK. When the bit penetrated basalt it failed quickly. After only 5.5 meters penetration, the drilling cones were pinched and after only 6 meters more, the cones were lost by the leg journals actually breaking off.

HEAVE COMPENSATOR

The heave compensator was not used on Sites 407, 408, and 409 because of the possibility of bad weather. If a site had to be abandoned quickly, handling of the heave compensator would have slowed down the clearing of the mud line.

The heave compensator was, however, used on the remaining sites; performance is being evaluated in both passive and active modes.

BEACONS

Eight single life beacons, four each of 16 kHz and 13.5 kHz, were used on this leg and all worked perfectly. The signals remained strong through abandonment of each site. The longest use of a beacon was at Site 410 where a 16 kHz was used 122.5 hours.

When the first beacon to be used on Leg 49 was turned on for test by removing the magnetic plug, it could not then afterwards be turned off. A new style brass plug with magnet was substituted for the plastic plug and the beacon would not switch off. The plastic one was then tried, but to no avail. A possible explanation was that the two different plugs, brass and plastic, had their magnets installed with different polarity and somehow damaged the magnetically operated switch in the beacon. This beacon was used on Site 407 without any problems, even after operating in air for approximately two days before drop.

DRILL PIPE PINGER

The drill pipe pinger was run only once on the leg at Site 408. It worked very well and indicated bottom at the same depth as the PDR and at the same time that the drill pipe weight indicator showed bottom. When the pinger was retrieved, the transducer was leaking oil from both ends. Before the transducer was made up to run on Site 408, it showed evidence of very rough treatment from pipe wrenches. The case was somewhat distorted and even though the instrument had been overhauled, this distortion probably caused the seal leaks.

There was only the one transducer aboard so we were unable to run the drill pipe pinger on any more of the sites.

HEAT FLOW

There were ten heat flow measurements taken on this leg; three on Hole 407, three on Hole 408, and four on Hole 410.

The heat flow measuring probe was lowered on the sandline after being made up in the inner core barrel. It took approximately one hour each time a measurement was made for the total operation.

No problems were encountered on any of the runs and data was recorded on each.

DYNAMIC POSITIONING

Positioning on this leg was basically good and the entire system operated reliably, however, one hole was abandoned when a leak developed in a lubricating oil line to one of the bow thrusters. When the thruster was secured to repair the line it was necessary to abandon the hole.

The vessel was required to secure for weather due to positioning capabilities before the rig floor operations were secured due to safety concerns. The maximum weather conditions in which the vessel was able to maintain position was approximately 35 mph winds.

COMMUNICATIONS

Much of the communications on Leg 49 were difficult. Because of the geographic location of the leg, it was not feasible to work WWD San Diego directly. The distance from NGR Greece made use of this only remaining Naval Radio traffic station in the Atlantic difficult.

The Navy Mercast System was very satisfactory for incoming traffic. This net has several stations and its coverage of the Atlantic area is very good.

When the ship was on the northern sites near Iceland, U. S. commercial stations were not in usable range and much of our communications were via Radio Reykjavik.

On the Mid-Atlantic Ridge sites, considerable commercial traffic was sent through WSL New Work and WCC Chatham. No amateur (ham) contacts were attempted on Leg 49.

ACKNOWLEDGEMENTS

The scientific group was made up of several nationalities who all worked together enthusiastically, professionally, and cooperatively. It was a very enjoyable experience to be associated with such a fine group of dedicated scientists.

The Scripps' technicians are a marvelous band of miracle workers. I was amazed, on a daily basis, at the amount of work these highly-qualified professionals did cheerfully and efficiently. Their abilities are unlimited. It was a great pleasure to work with them all.

For an old "oil field hand" it was a rewarding experience to work with the Global Marine Drilling Department aboard the Challenger. Their know-how and performance was outstanding. Without these professionals the accomplishments of DSDP would be impossible.

Donald N. Collins

Donald N. Collins
Cruise Operations Manager
Deep Sea Drilling Project

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 49

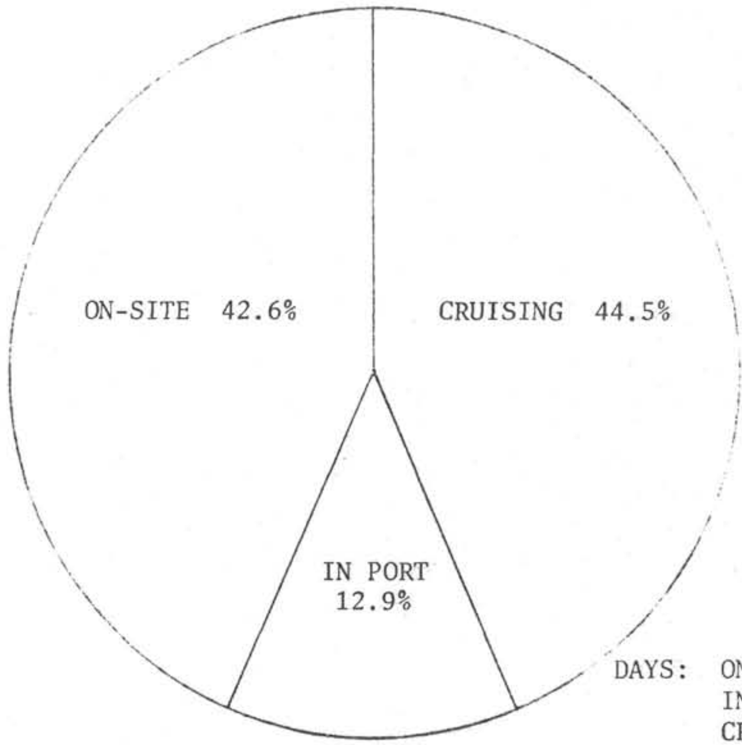
Total Days (July 13, 1976 - September 4, 1976	53.47
Total Days In Port	6.92
Total Days Cruising Including Site Survey	23.8
Total Days On-Site	22.75

Trip Time	5.16
Drilling Time	0.47
Coring Time	11.36
Positioning	0.97
Mechanical Downtime	1.0
Wait On Weather	0.66
Post Site Surveys	0.47
Stuck Pipe	0.33
Miscellaneous	2.33

Total Distance Traveled (Nautical Miles)	4717.6
Average Speed (Knots)	8.3
Number of Sites	8
Number of Holes Drilled	10
Number of Cores Attempted	207
Number of Cores with Recovery	202
Percentage of Cores with Recovery	97.58%
Total Meters Cored	1943.5
Total Meters Recovered	881.43
Percent Recovery	45.35%
Total Meters Drilled	736.0
Total Meters of Penetration	2679.5
Percent of Penetration Cored	72.50%
Maximum Penetration (Meters)	458.5
Minimum Penetration (Meters)	37.0
Maximum Water Depth	2987.0
Minimum Water Depth	842.0

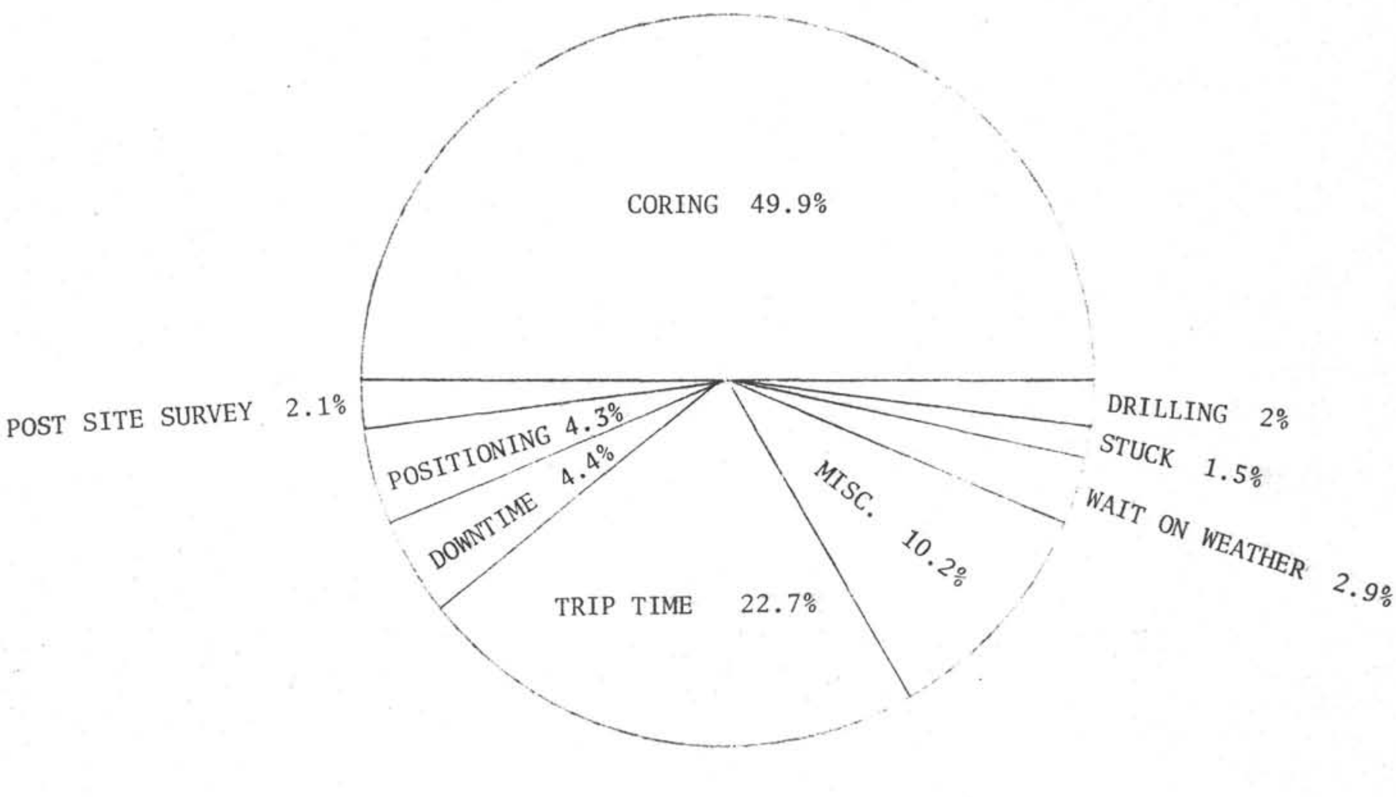
INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
LEG 49

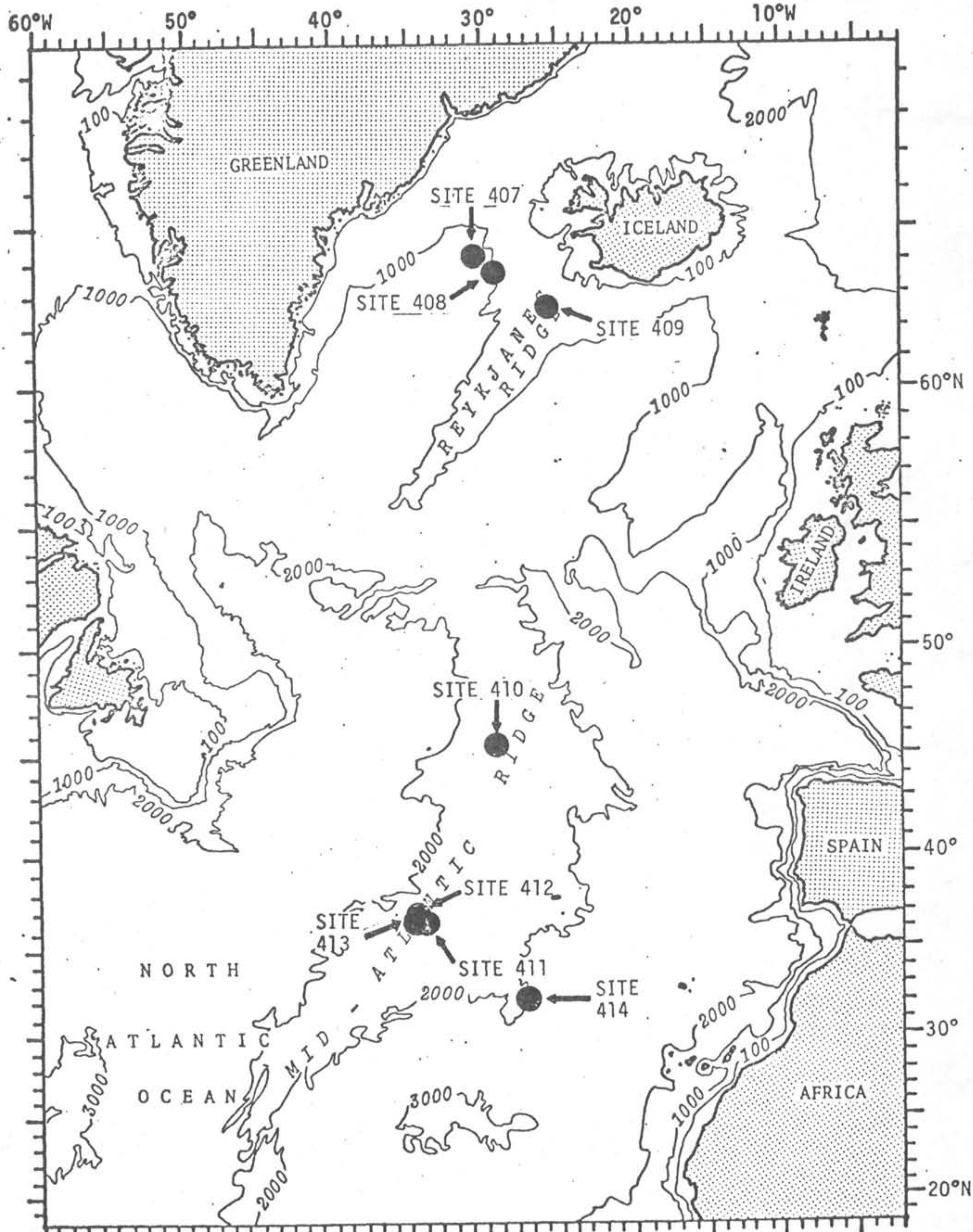
TOTAL TIME DISTRIBUTION



DAYS:	ON-SITE	22.75	=	42.6%
	IN PORT	6.92	=	12.9%
	CRUISING	23.8	=	44.5%

ON-SITE TIME BREAKDOWN





LEG 49 ...
PROPOSED SITES

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 49

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	Remarks
407	ORE	16.0	340	90.4	Satisfactory
408	ORE	13.5	359	50.6	Satisfactory
409	ORE	16.0	341	40.8	Satisfactory
410	ORE	16.0	350	87.3	Satisfactory
410A	ORE	16.0	350	35.2	
	Total On Beacon At 410 & 410A			122.5	
411	ORE	13.5	227	55.0	Satisfactory
411A	ORE	13.5	227	13.3	
	Total On Beacon At 411 & 411A			68.3	
412	ORE	13.5	357	36.7	Satisfactory
412A	ORE	13.5	357	58.0	
	Total On Beacon At 412 & 412A			94.7	
413	ORE	16.0	343	33.2	Satisfactory
413A	ORE	16.0	343	29.8	
	Total On Beacon At 413 & 413A			63.0	
414	ORE	13.5	329	16.8	

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 49

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
407	63° 56.30'N	30° 34.61'W	2492.5	47	45	96.0	458.5	183.81	40.0	0	458.5	19.3	87.5	90.4
408	63° 22.63'N	28° 54.71'W	1634.0	38	38	100.0	361.0	219.55	61.0	0	361.0	34.9	48.1	50.6
409	62° 36.96'N	25° 57.14'W	842.0	32	32	100.0	295.5	88.43	30.0	23.5	319.0	24.4	38.2	40.8
410	45° 30.51'N	29° 28.56'W	2984.0	41	40	98.0	387.5	232.15	60.0	0	387.5	26.8	86.0	87.3
410A	45° 30.51'N	29° 28.56'W	2987.0	6	6	100.0	57.0	26.91	47.0	325.0	382.0	63.0	33.0	35.2
411	36° 45.97'N	33° 23.30'W	1950.0	5	5	100.0	45.5	4.0	9.0	74.0	119.5	19.9	47.5	55.0
411A	36° 45.97'N	33° 23.30'W	1985.0	3	3	100.0	27.5	14.65	53.0	9.5	37.0	52.9	9.3	13.3
412	36° 33.74'N	33° 09.96'W	2624.0	15	14	93.0	133.5	85.89	64.0	38.0	171.5	40.8	33.7	35.5
412A	36° 33.74'N	33° 09.96'W	2624.0	15	14	93.0	138.0	23.07	17.0	156.0	294.0	18.8	54.0	58.0
413	36° 32.39'N	33° 10.69'W	2608.0	5	5	100.0	39.5	2.97	8.0	110.0	149.5	37.4	31.7	33.2
413A	36° 31.39'N	33° 10.69'W	2608.0	0	0	- - -	0	- - -	- -	0	- - -	- -	4.2	29.8
414	32° 03.00'N	27° 30.10'W	1548.0	0	0	- - -	0	- - -	- -	0	- - -	- -	10.4	16.8
				207	202	97.58	1943.5	881.43	45.35	736.0	2679.5			

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 49

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
407	Smith	10"	F94CK	321BV	458.5	0	458.5	23.8	T1,B8,0-7/8	Two cones loose - two cones locked
408	Smith	10"	F94CK	302BV	361.0	0	361.0	10.3	T1,B1,I	Aborted coring/illness.
409	Smith	10"	F94CK	301BV	295.5	23.5	319.0	13.1	T1,B1,I	Aborted coring/death
410	Smith	10"	F94CK	303BV	387.5	0	387.5	14.4	T1,B1,I	Terminated by stuck inner core barrel
410A	Smith	10"	F94CK	303BV(RR)	57.0	325.0	382.0	20.5	T1,B1,I	Terminated by stuck pipe
411	Smith	10"	F94CK	358BV	45.5	74.0	119.5	6.0		Terminated by sticking conditions.
411A	Smith	10"	F94CK	358BV (RR)	27.5	9.5	37.0	0.7	T1,B1,0-3/8	Terminated by scientists
412	Smith	10"	F44C	765BS	133.5	38.0	171.5	4.2		Bit failed/lost drilling cones
412A	Smith	10"	F94CK	353BV	138.0	156.0	294.0	15.6		Lost all cones
413	Smith	10"	F94CK	360BV	39.5	110.0	149.5	4.0	T1,B1,I	Terminated by weather
413A	Smith	10"	F94CK	355BV	0	0	0	0	New	Terminated by weather
414	Smith	10"	F94CK	355BV	0	0	0	0	New	Terminated by weather.

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 49

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
7/13/76										19.7			19.7	Moored Aberdeen
7/14/76										24.0			24.0	
7/15/76										24.0			24.0	
7/16/76										24.0			24.0	
7/17/76										24.0			24.0	
7/18/76										5.9		4.2	10.1	Lost Time Seaman Ill
TOTAL										121.6		4.2	125.8	TOTAL
7/18/76		13.9											13.9	
7/19/76		24.0											24.0	
7/20/76		24.0											24.0	
7/21/76		24.0											24.0	
7/22/76		24.0											24.0	
7/23/76		10.3											10.3	
TOTAL		120.2											120.2	TOTAL
7/23/76	407		10.0		2.0			1.7					13.7	
7/24/76					22.0				1.0			1.0	24.0	Heat Flow
7/25/76					22.0							2.0	24.0	Heat Flow
7/26/76			1.5		21.5							1.0	24.0	Deviation Survey Plug Hole W/Mud
7/27/76			3.5									1.2	4.7	Post Site Survey
TOTAL	407		15.0		67.5			1.7	1.0			5.2	90.4	TOTAL

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 49

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
7/27/76		19.3											19.3	Reykjavik GMI Personnel
7/28/76		18.2								5.8			24.0	
7/29/76		20.2											20.2	
TOTAL		57.7								5.8			63.5	TOTAL
7/29/76	408		3.0					.8					3.8	
7/30/76			2.3		18.5				2.2			1.0	24.0	Heat Flow
7/31/76			3.7		17.8							1.3	22.8	Heat Flow .8 Plug W/Mud .5
TOTAL	408		9.0		36.3			.8	2.2			2.3	50.6	TOTAL
7/31/76		1.2											1.2	Reykjavik GMI Personnel
8/01/76		23.3								.7			24.0	"
8/02/76		14.9											14.9	"
TOTAL		39.4								.7			40.1	
8/02/76	409		3.5	.8	3.2			1.1				.5	9.1	Computer Break-down Positioning
8/03/76					24.0								24.0	
8/04/76			2.7		2.0							3.0	7.7	Plugged Bit 2 Casualty 1
TOTAL	409		6.2	.8	29.2			1.1				3.5	40.8	TOTAL
8/04/76		15.7								.6			16.3	Reykjavik Death
8/05/76										24.0			24.0	
8/06/76		10.6								13.4			24.0	Underway Site 410
8/07/76		24.0											24.0	

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 49

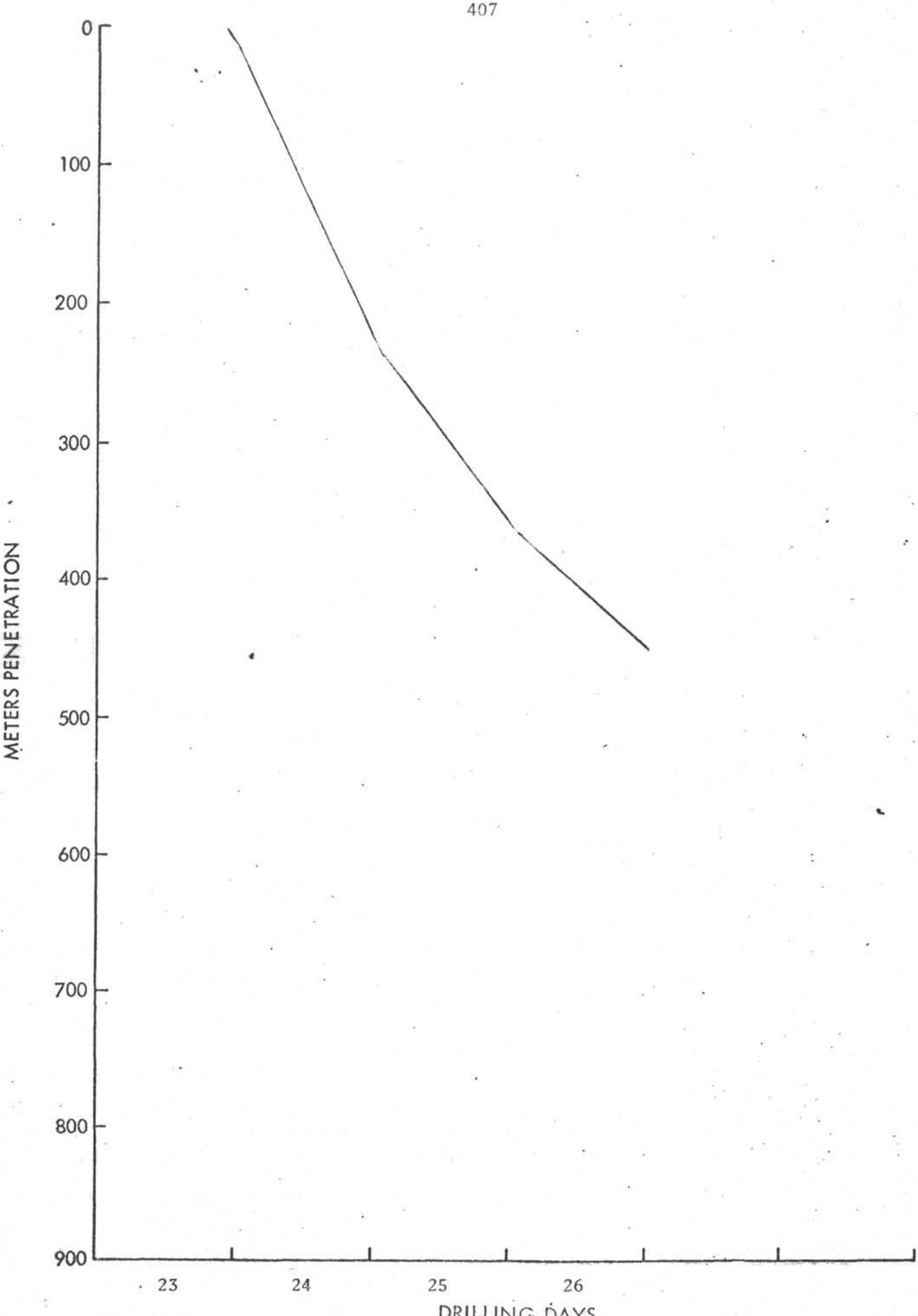
Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
8/08/76		24.0											24.0	
8/09/76		24.0											24.0	
8/10/76		25.0											25.0	Retard Clocks One Hour
8/11/76		24.0											24.0	
8/12/76		24.0											24.0	
8/13/76		17.7											17.7	
TOTAL		189.0											227.0	
8/13/76	410		5.0					1.3					6.3	
8/14/76			2.0		18.0						4.0	4.0	24.0	Pore Wtr Samp 2 Heat Flow 2
8/15/76					19.5							4.5	24.0	Heat Flow 2 Pore Wtr Samp 2½
8/18/76					17.5							6.5	24.0	Heat Flow 1 Stuck C.B. 3½
														Pick Up H.C. 2
8/17/76			7.7									1.3	9.0	Stuck Core Bbl
TOTAL	410		14.7		55.0			1.3				16.3	87.3	TOTAL
8/17/76	410A		7.0	4.0	1.0				3.0				15.0	
8/18/76			6.0		9.5	2.5						2.2	20.2	Post Site Survey
TOTAL	410A		13.0	4.0	10.5	2.5			3.0			2.2	35.2	TOTAL
8/18/76		3.8											3.8	
8/19/76		24.0											24.0	
8/20/76		24.0											24.0	

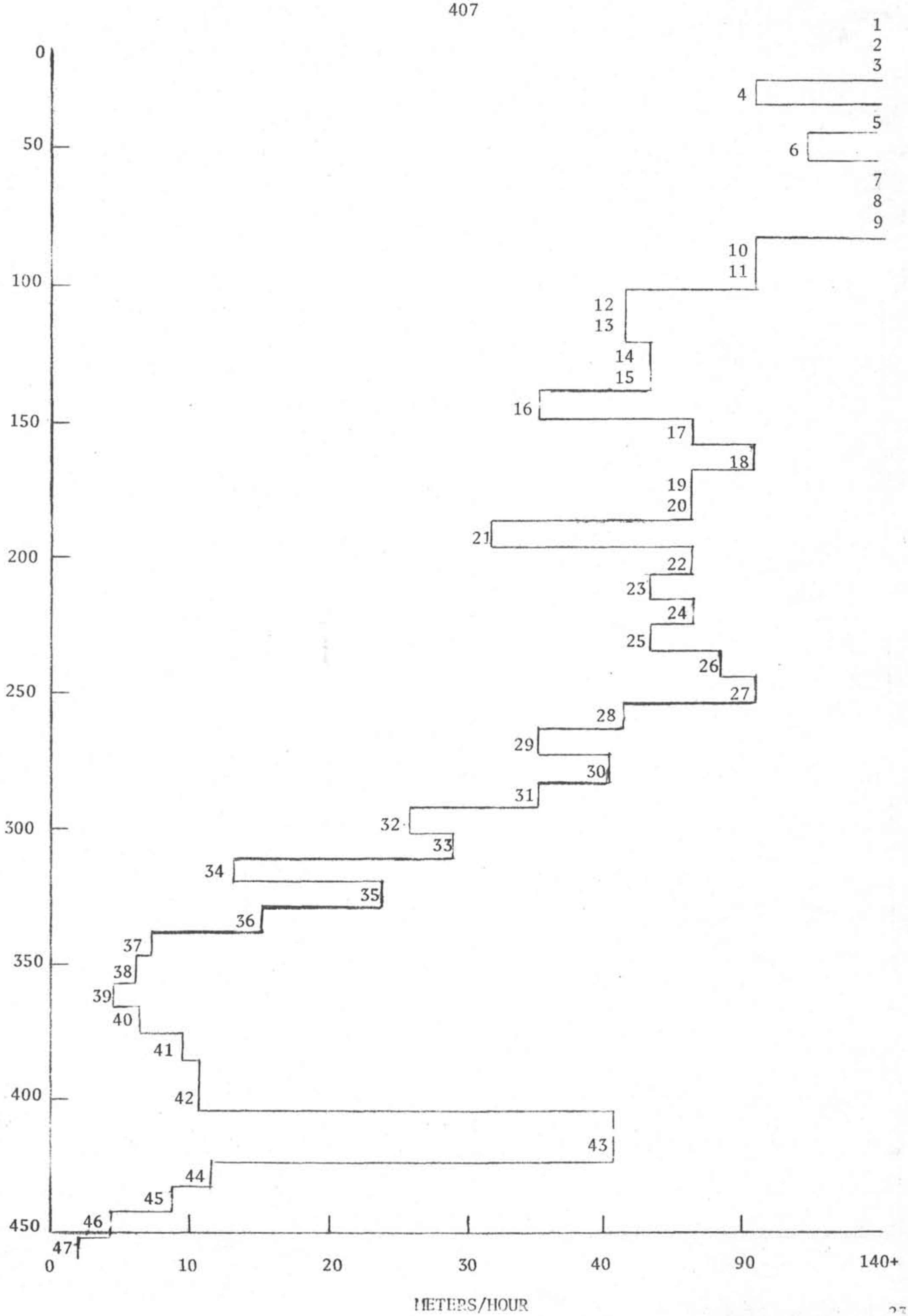
DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 49

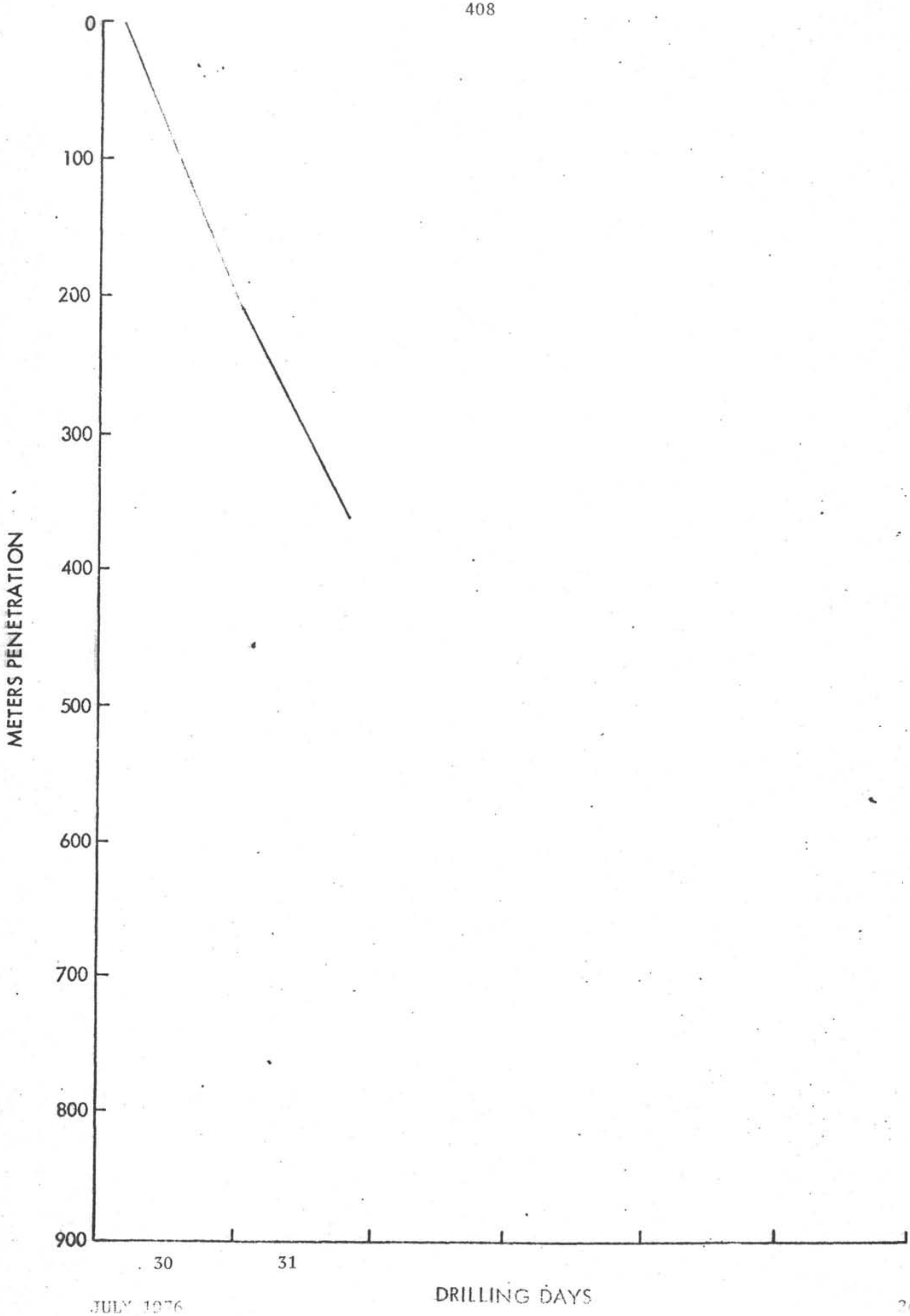
Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
8/21/76		6.0											6.0	
TOTAL		57.8											57.8	
8/21/76	411		6.0					7.5				4.5	18.0	Probing For Sufficient
														Sediment To Core
8/22/76				.7	2.0							21.3	24.0	"
8/23/76			1.0		9.5	2.5							13.0	
TOTAL	411		7.0	.7	11.5	2.5		7.5				25.8	55.0	TOTAL
8/23/76	411A		5.8	.2	3.3			1.5				.2	11.0	Post Site Survey
8/24/76												2.3	2.3	"
TOTAL	411A		5.8	.2	3.3			1.5				2.5	13.3	TOTAL
8/24/76		1.2											1.2	
8/24/76	412		6.1	1.0	7.3			1.8	4.3				20.5	
8/25/76			5.0		10.0								15.0	
TOTAL	412		11.1	1.0	17.3			1.8	4.3				35.5	
8/25/76	412A		6.0	2.0	1.0								9.0	
8/26/76					21.0	3.0							24.0	
8/27/76			5.0		11.5				3.5			4.0	24.0	Deviation 1 Magnaflux 3
8/28/76												1.0	1.0	Post Site Survey
TOTAL	412A		11.0	2.0	33.5	3.0			3.5			5.0	58.0	TOTAL
8/28/76		.3											.3	

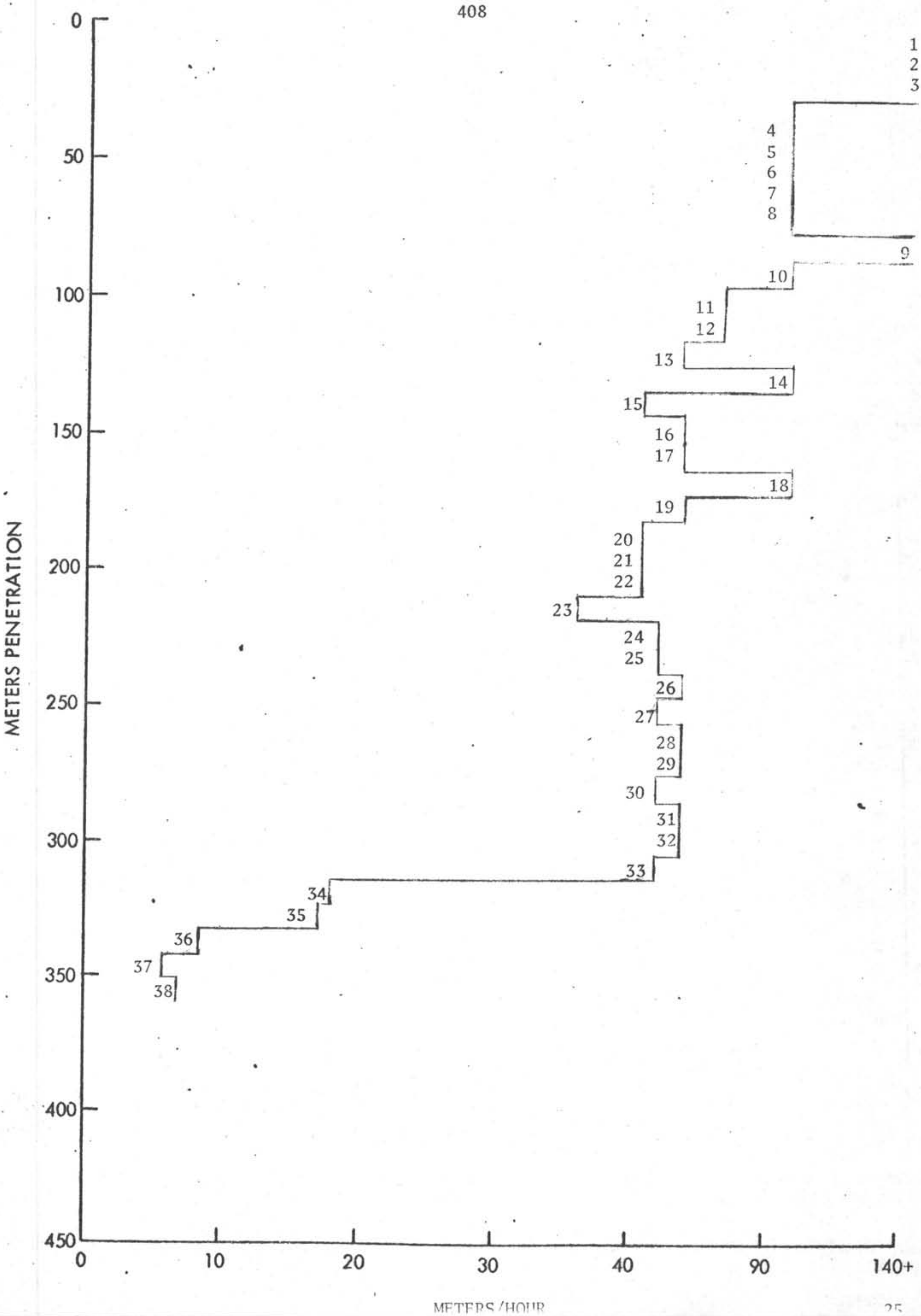
DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 49

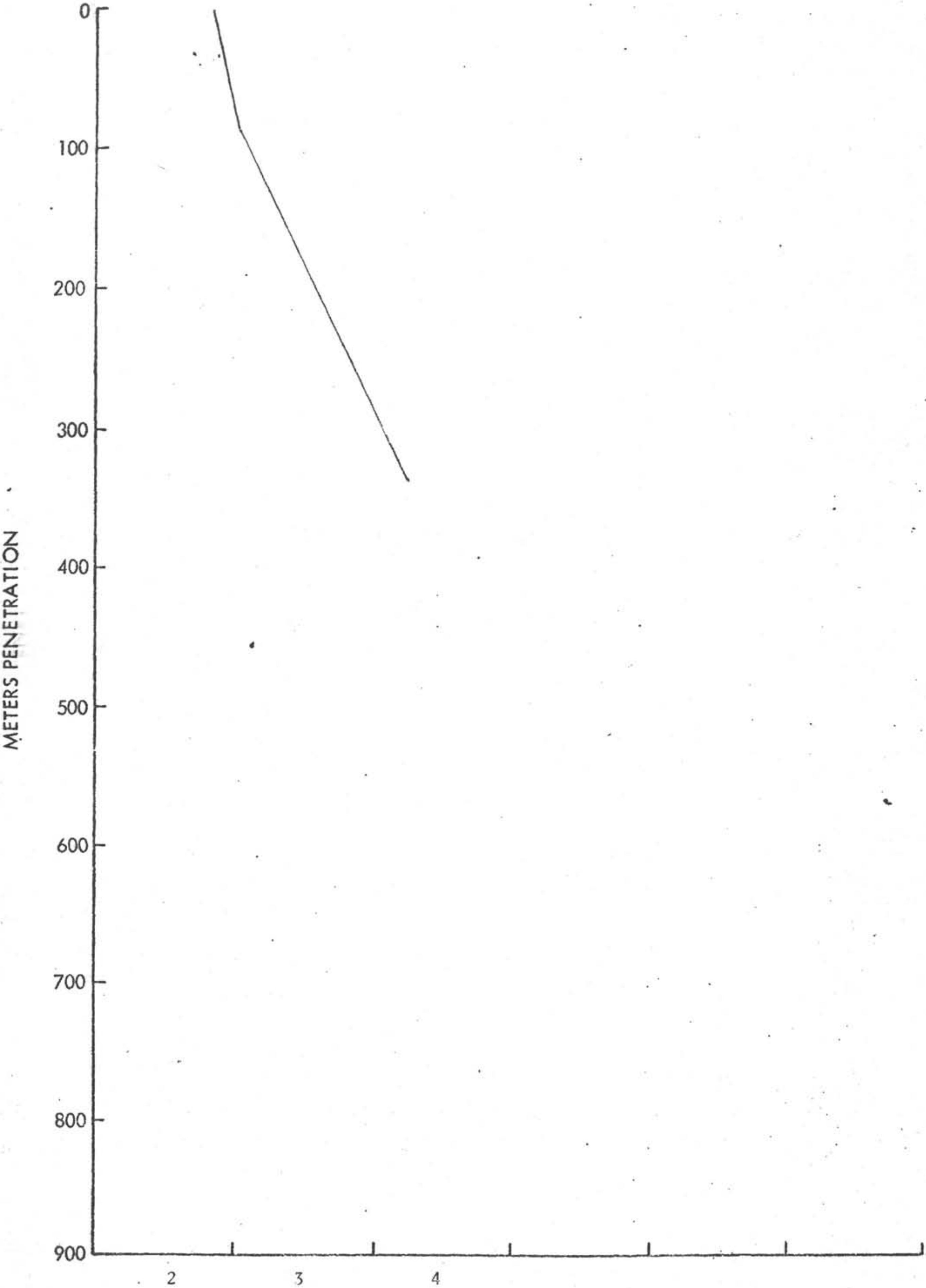
Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
8/23/76	413		10.0	2.5	4.5			2.7	3.0				22.7	
8/29/76			6.5		4.0								10.5	
TOTAL	413		16.5	2.5	8.5			2.7	3.0				33.2	TOTAL
8/29/76		1.4											1.4	
8/29/76	413A						10.8	1.3					12.1	
8/30/76			4.2				5.0		7.0			1.5	17.7	Post Site Survey
TOTAL	413A		4.2				15.8	1.3	7.0			1.5	29.8	TOTAL
8/30/76		6.3											6.3	
8/31/76		24.0											24.0	
9/01/76		13.4											13.4	
TOTAL		43.7											43.7	TOTAL
9/01/76	414		7.0					3.6					10.6	
9/02/76			3.4									2.8	6.2	Post Site Survey
TOTAL	414		10.4					3.6				2.8	16.8	TOTAL
9/02/76		17.8											17.8	
9/03/76		24.0											24.0	
9/04/76		18.6											18.6	End Leg 49
TOTAL		60.4											60.4	Funchal, Madeira
														Islands Portugal


METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
23
24
25
26
DRILLING DAYS


0
50
100
150
200
250
300
350
400
450
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
0
10
20
30
40
90
140+
METERS/HOUR

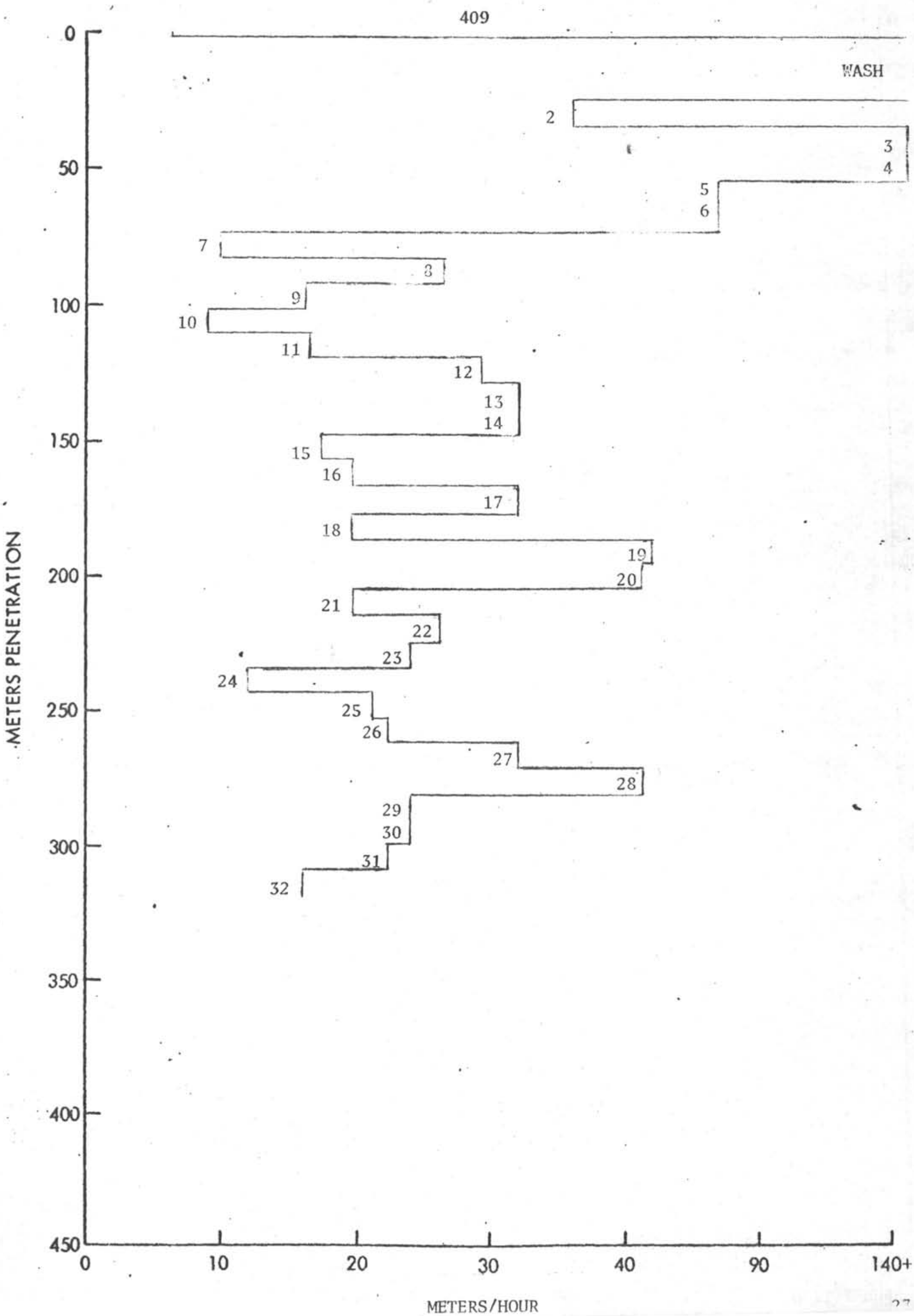

METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
30
31
DRILLING DAYS


METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
METERS/HOUR

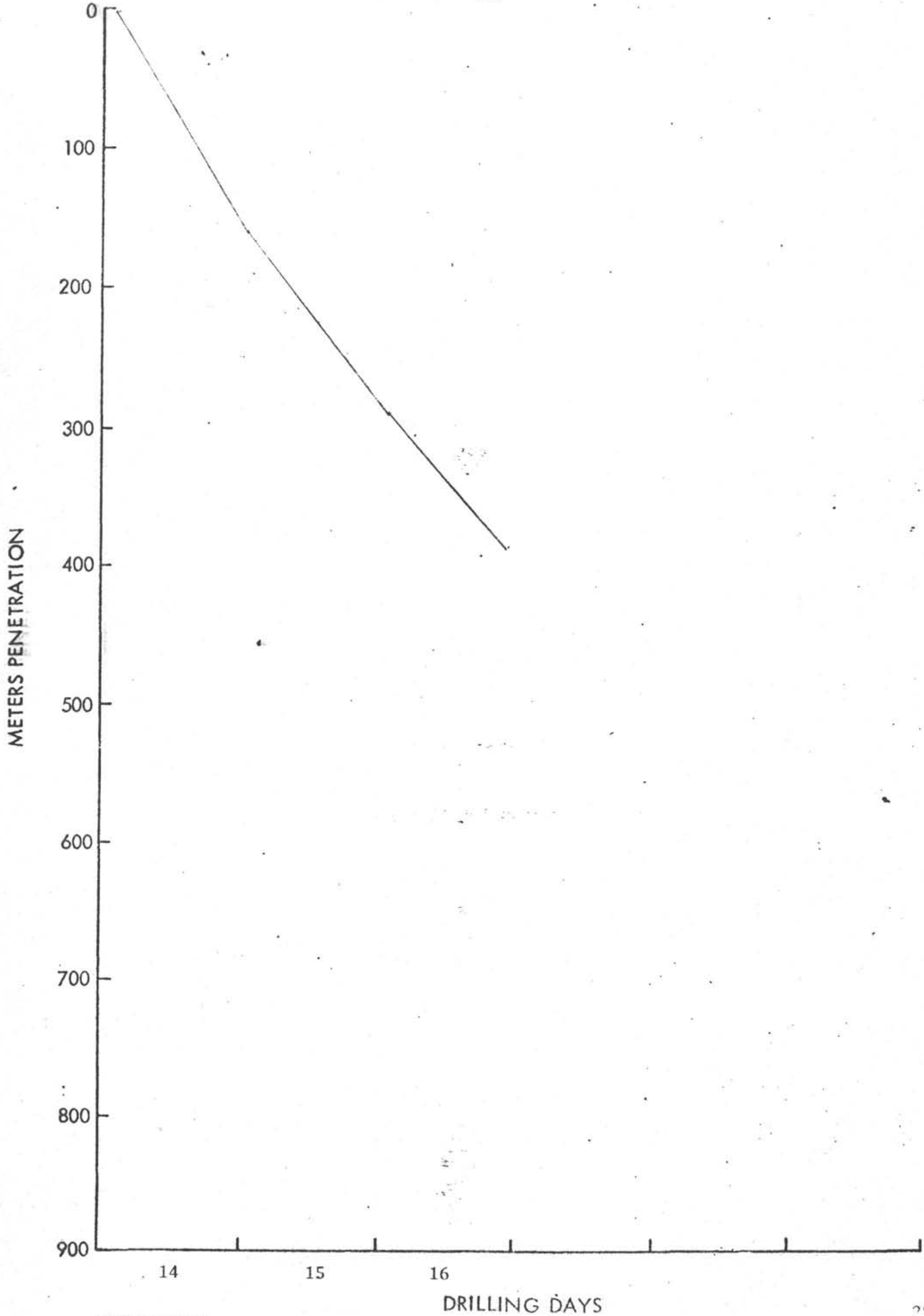


0
100
200
300
400
500
600
700
800
900
METERS PENETRATION
2
3
4
DRILLING DAYS

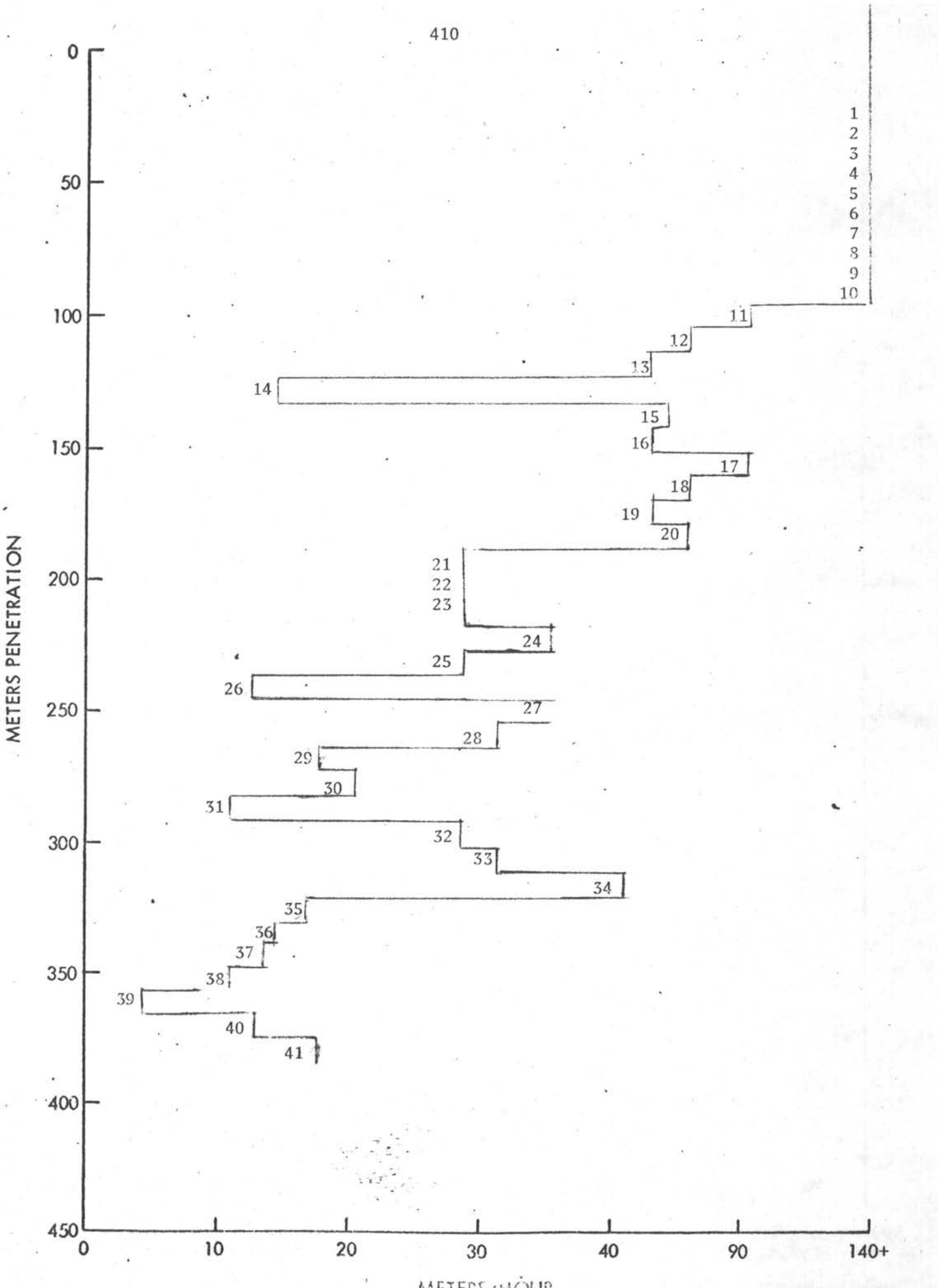
AUGUST 1976


409
WASH
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
0
10
20
30
40
90
140+
METERS/HOUR

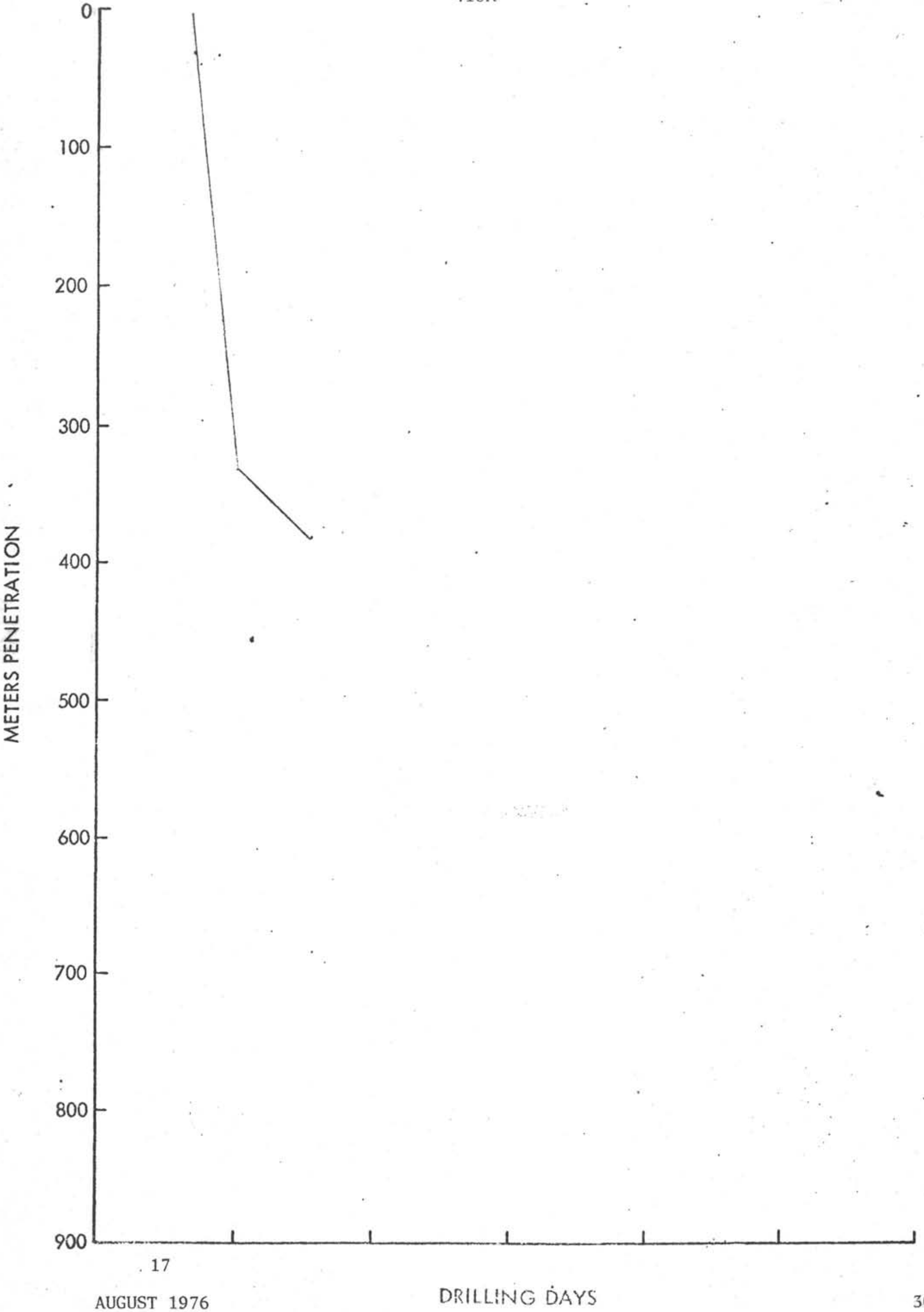
410

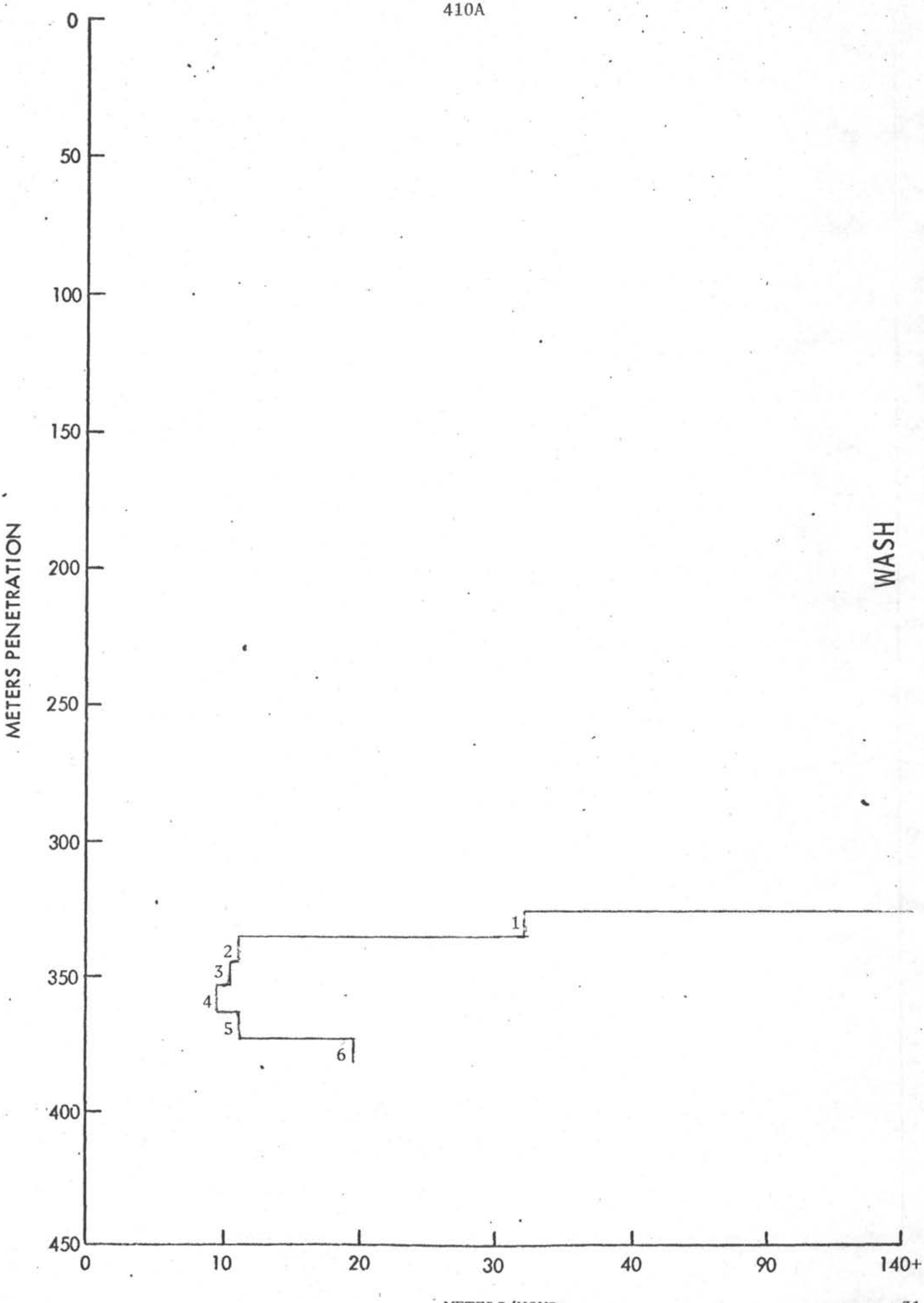


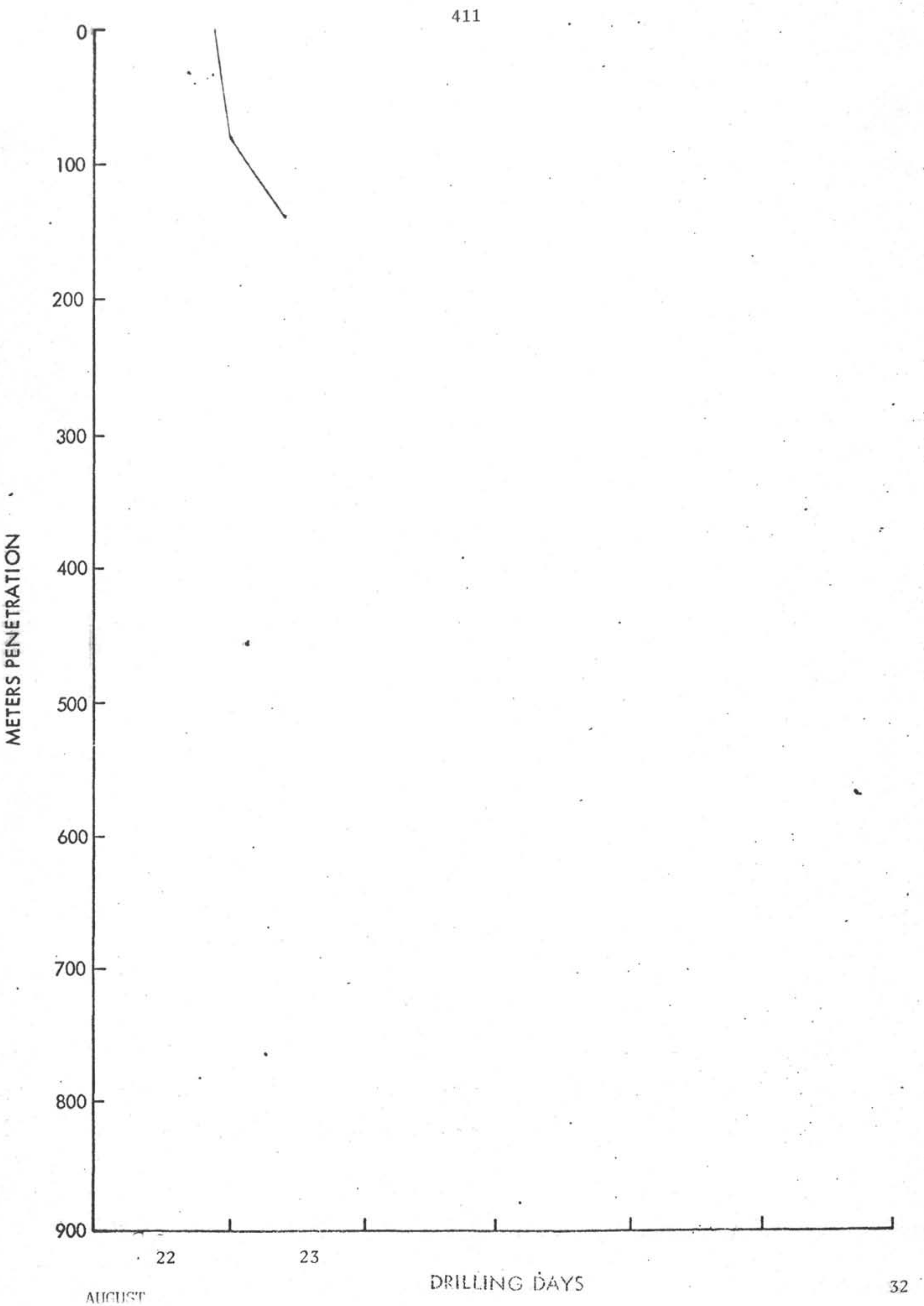
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
14
15
16
DRILLING DAYS

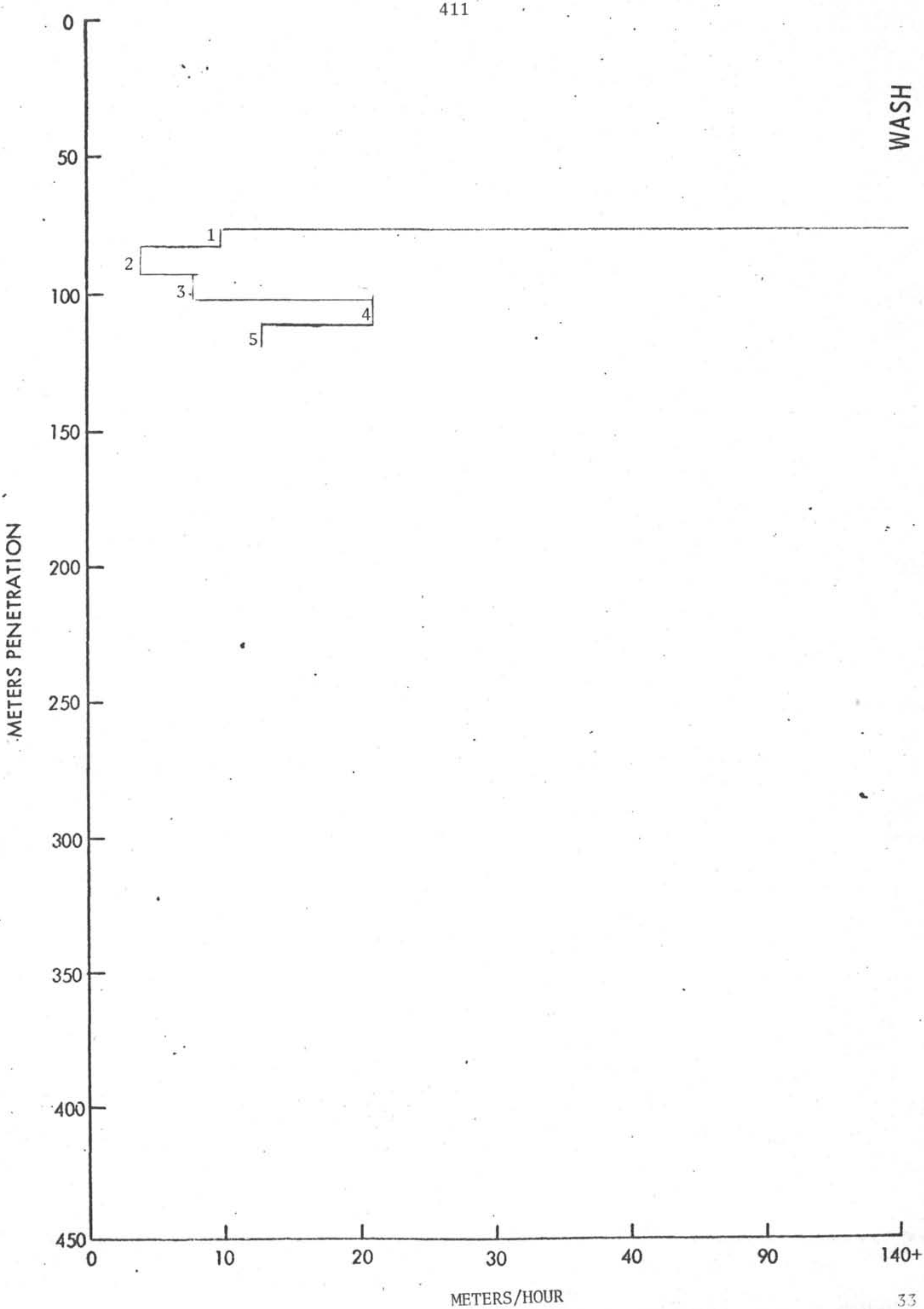

METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
METERS/HOUR
0
10
20
30
40
90
140+
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41

410A

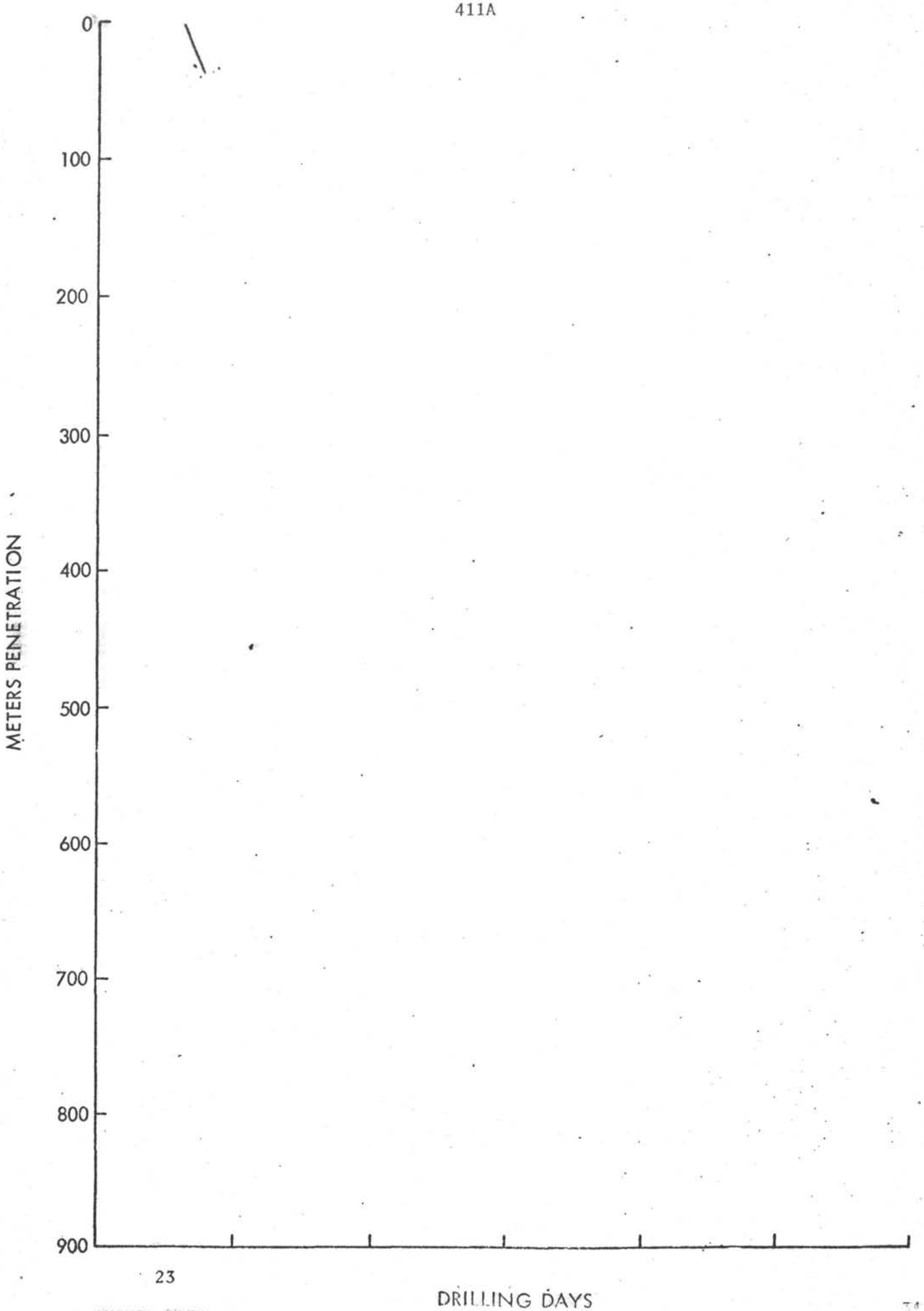

0
100
200
300
400
500
600
700
800
900
METERS PENETRATION
17
AUGUST 1976
DRILLING DAYS
30

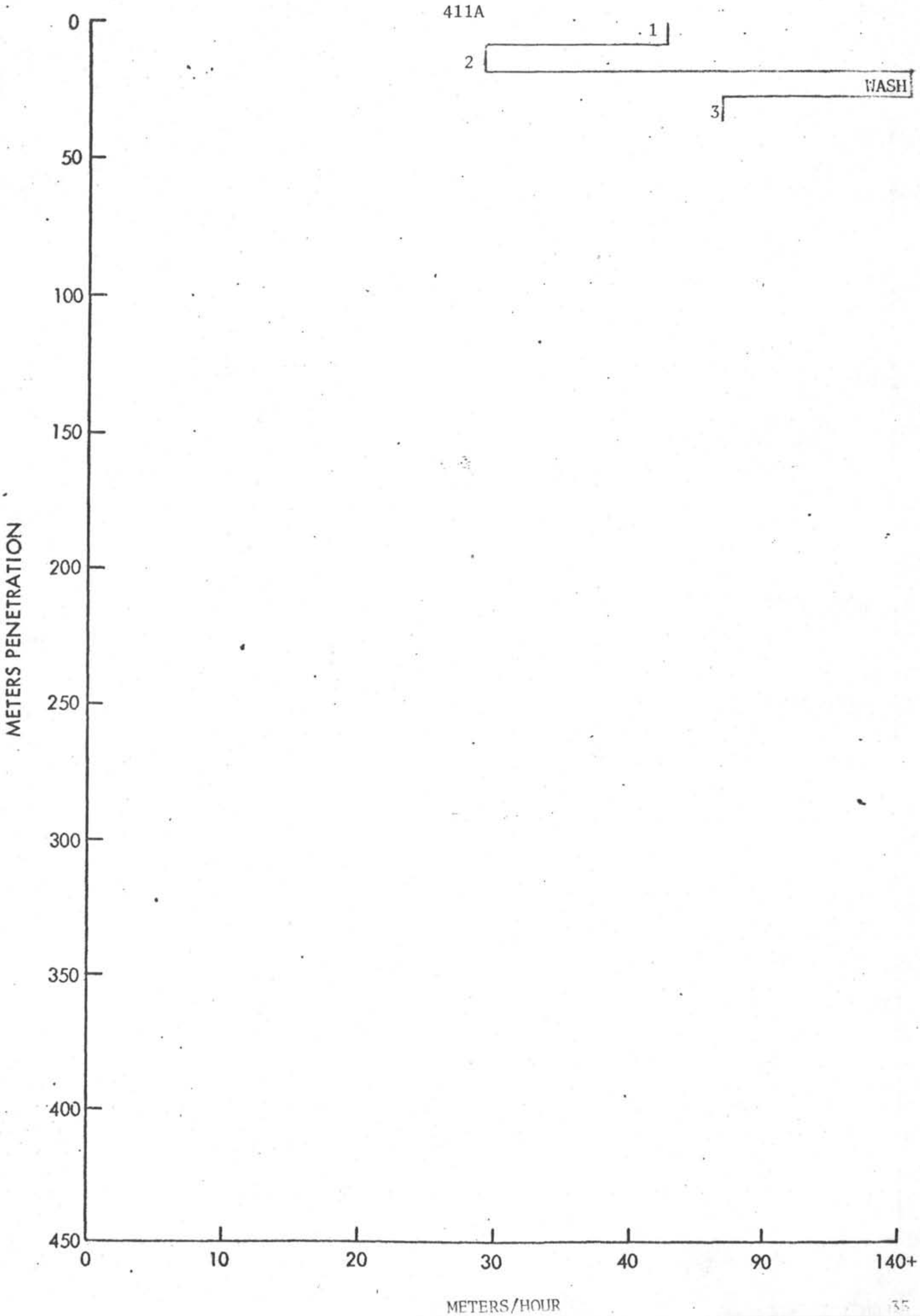

METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
WASH
1
2
3
4
5
6
0
10
20
30
40
90
140+
METERS/HOUR


411
METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
22
23
DRILLING DAYS
32
AUGUST

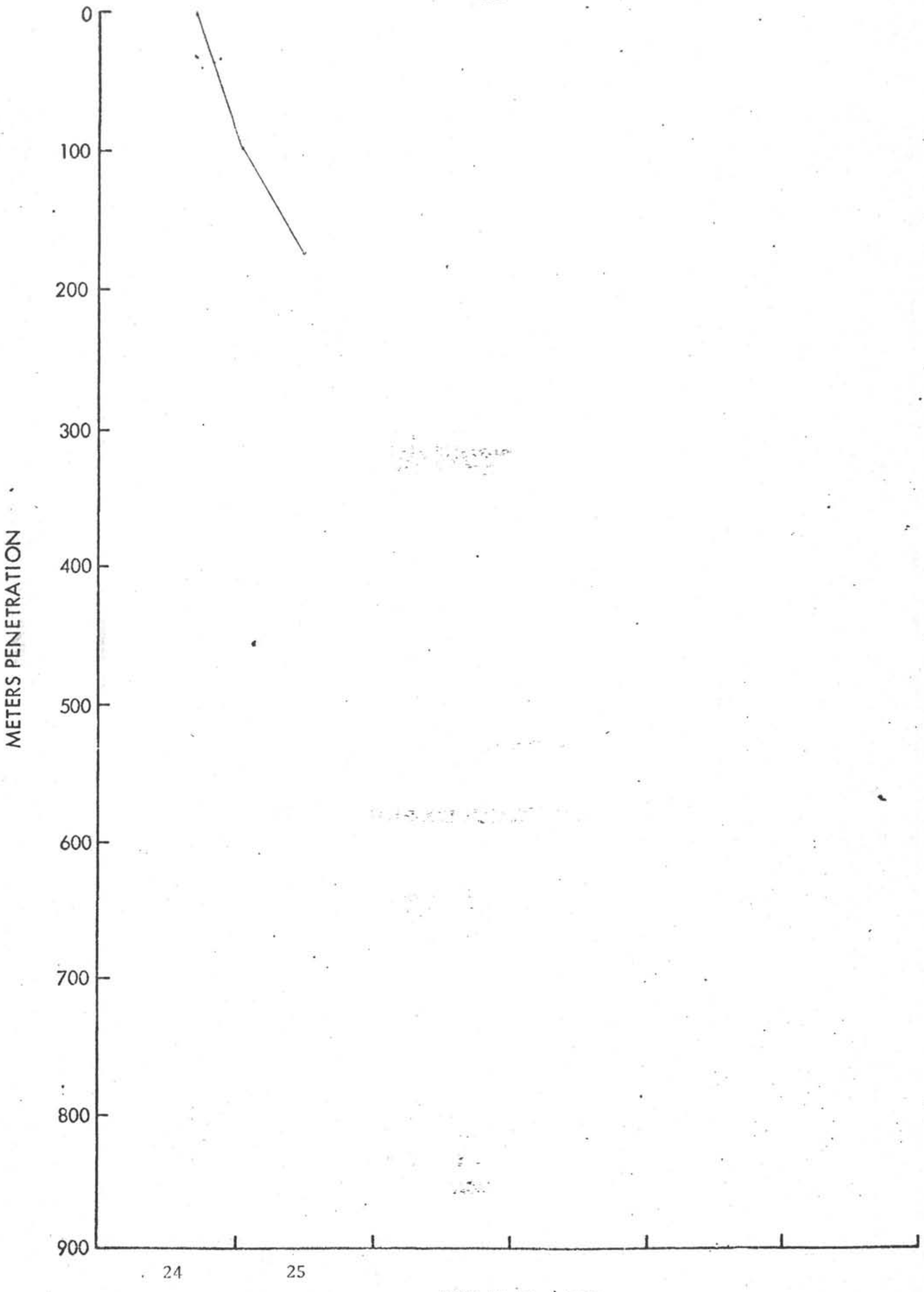

WASH
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
1
2
3
4
5
0
10
20
30
40
90
140+
METERS/HOUR

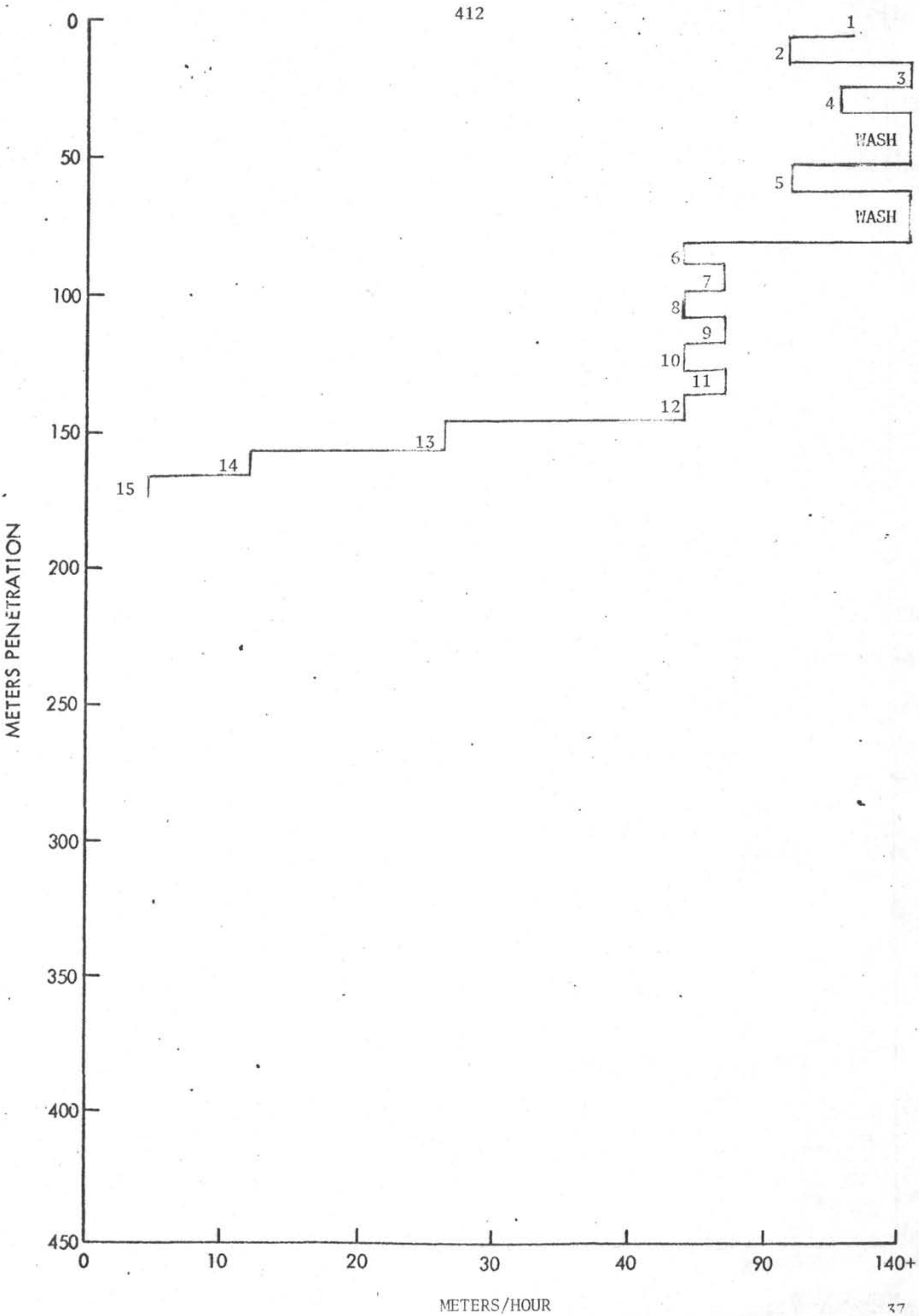
411A

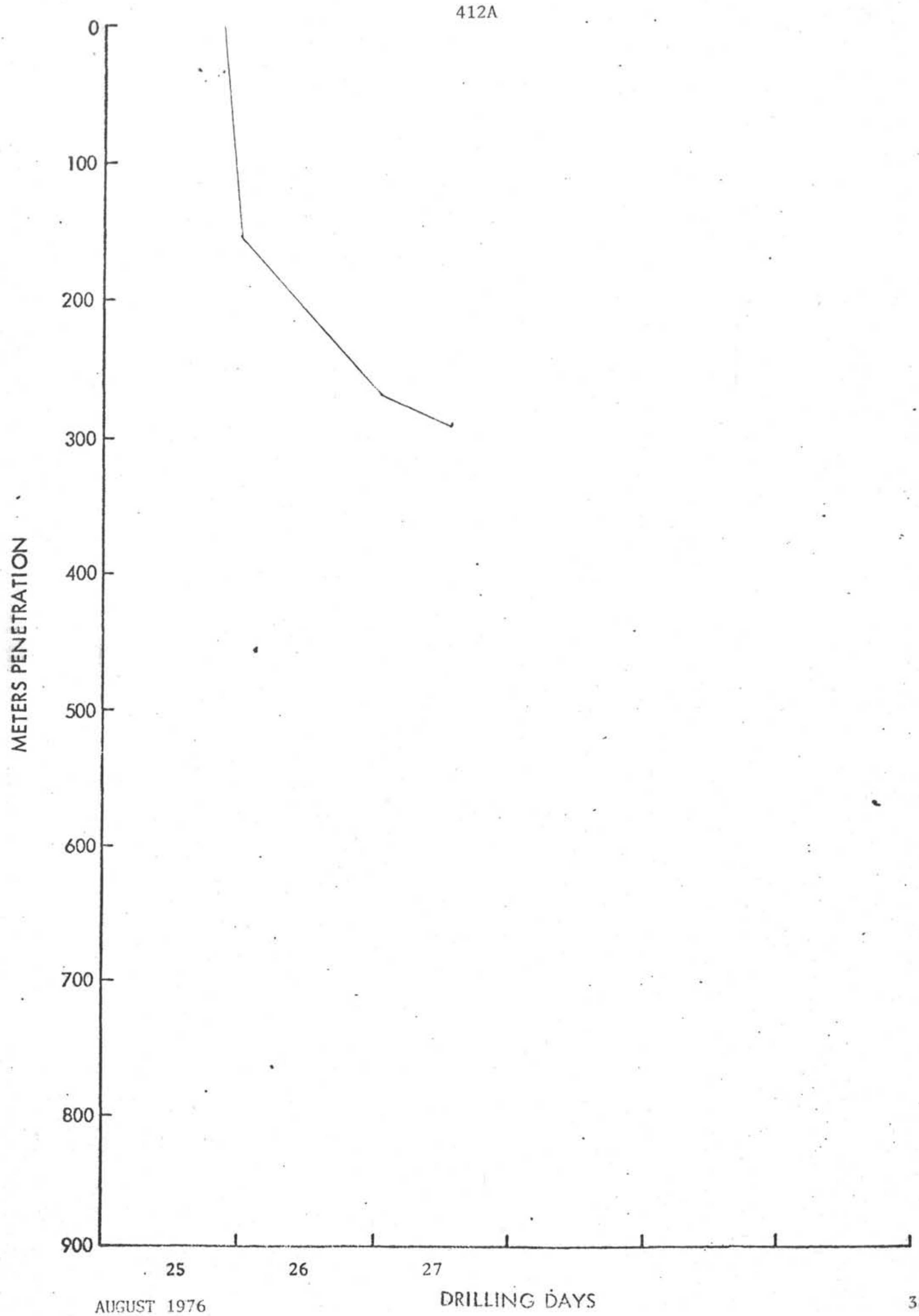

METERS PENETRATION
0
100
200
300
400
500
600
700
800
900
23
DRILLING DAYS

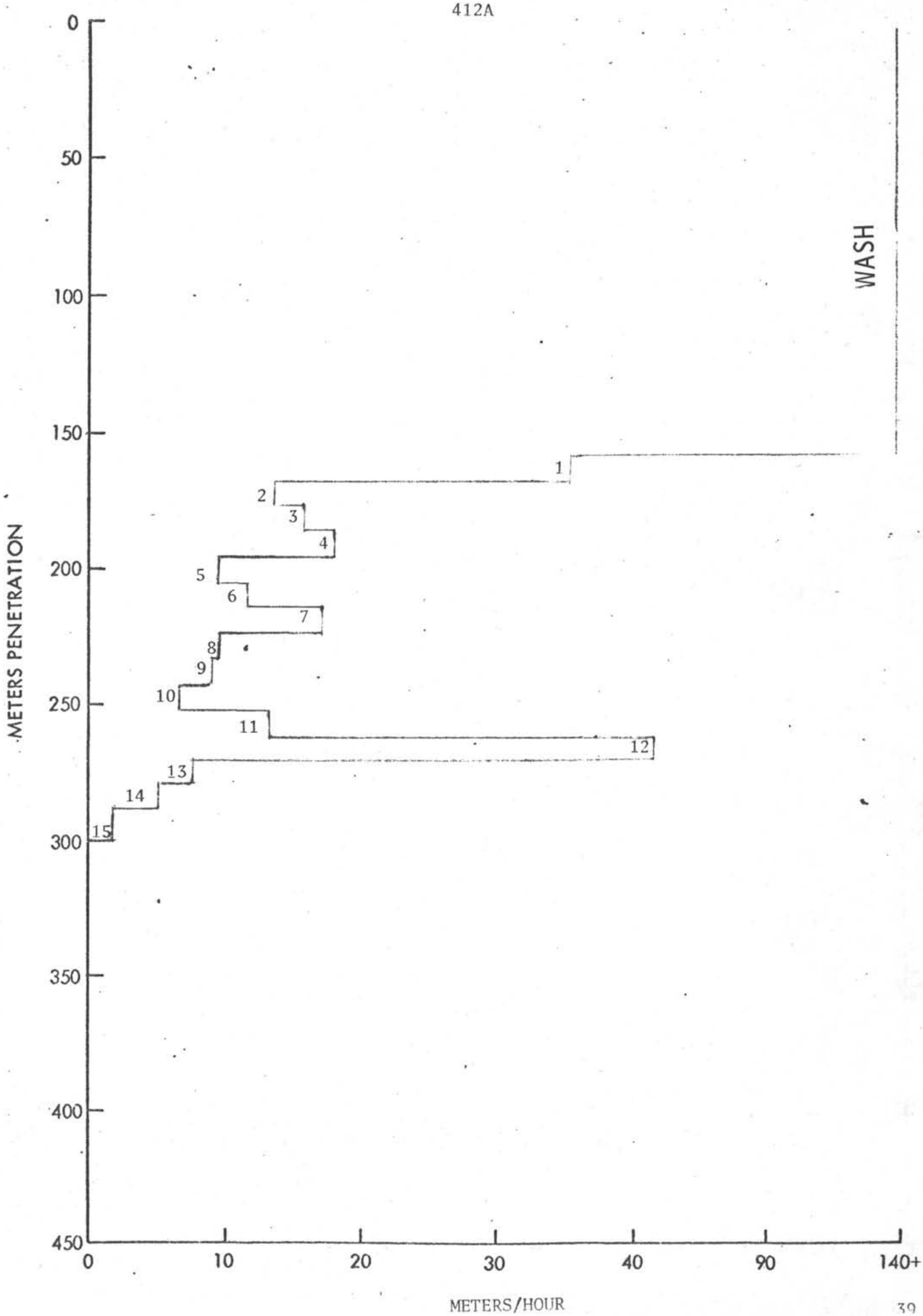


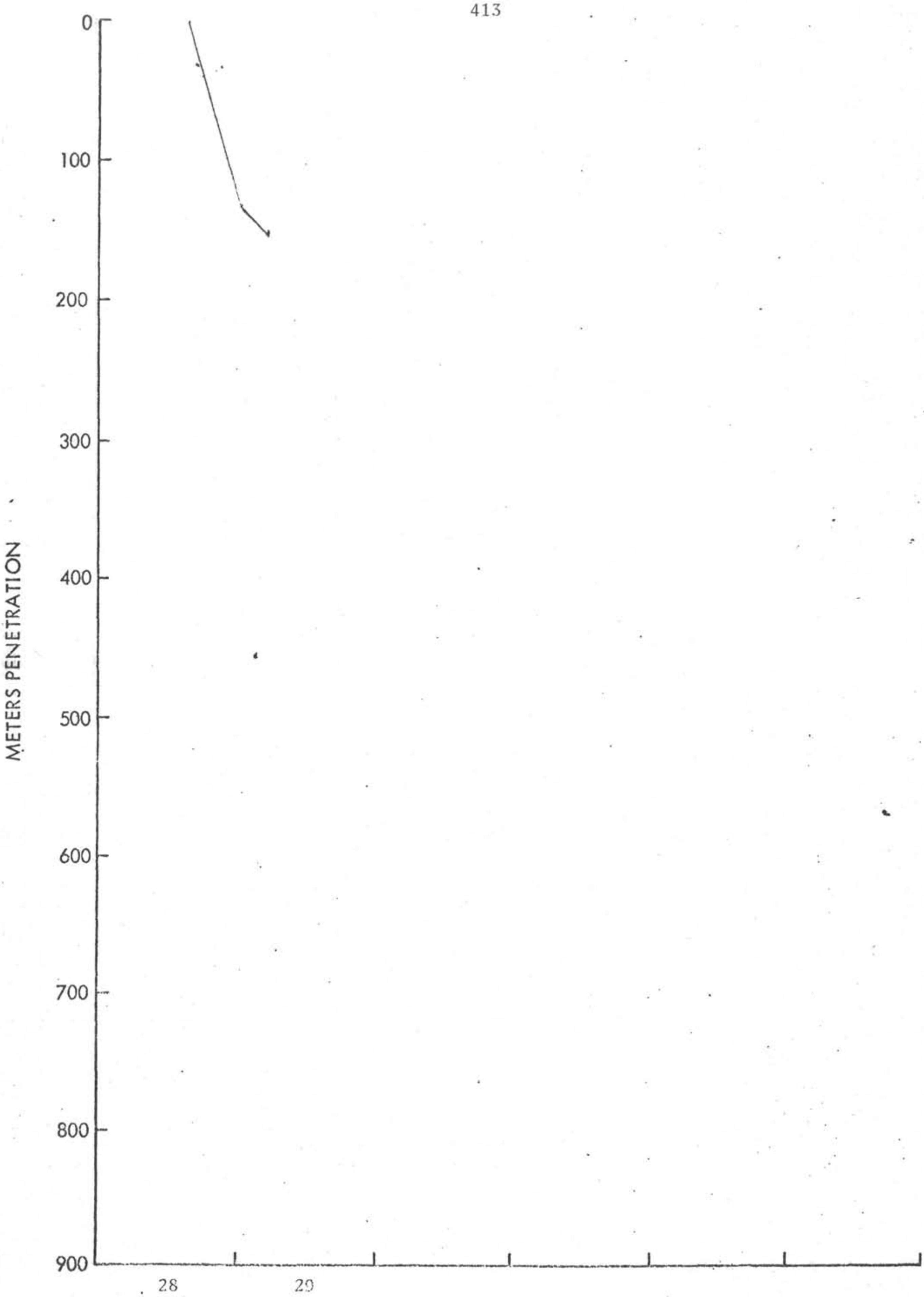
411A
1
2
WASH
3
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
METERS/HOUR

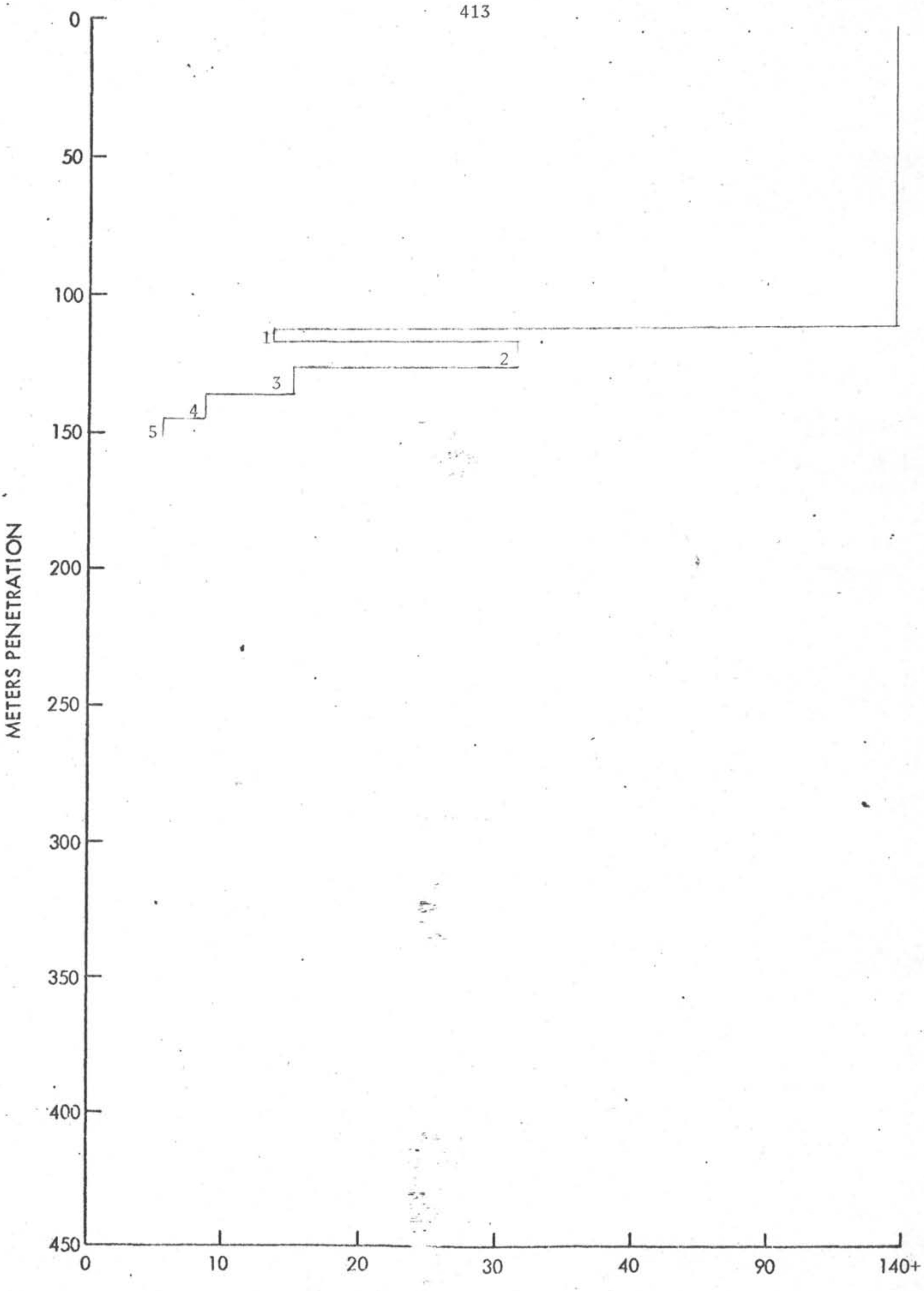

0
100
200
300
400
500
600
700
800
900
METERS PENETRATION
24
25
DRILLING DAYS


412
1
2
3
4
WASH
5
WASH
6
7
8
9
10
11
12
13
14
15
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
METERS/HOUR


412A
0
100
200
300
400
500
600
700
800
900
METERS PENETRATION
25
26
27
DRILLING DAYS


METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
WASH
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
10
20
30
40
90
140+
METERS/HOUR


413
0
100
200
300
400
500
600
700
800
900
METERS PENETRATION
28
29
DRILLING DAYS


METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
1
2
3
4
5
0
10
20
30
40
90
140+
METERS/HOUR

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 50

Leg 50 of the Deep Sea Drilling Project represented an attempt to study the earliest history of the Atlantic Ocean through the sampling of Pre-Oxfordian sediments of the North African continental margin. Full attainment of the scientific goals was predicated upon drilling through a sediment section of a thickness exceeding any previous penetration of the Project. Two deep penetration tries involving multiple re-entry operations were made, but in both cases adverse hole conditions proved insurmountable and the depth of penetration hoped for was not achieved.

The voyage commenced on September 4, 1976 at Funchal, Madeira Island, Portugal and ended at the same port on November 10, 1976. A brief port call was also made at Funchal on October 28 for a Global Marine crew change.

The leg established DSDP records for the most time on-site (51.6 days) and the most successful re-entries (12). Nine re-entries on Hole 416A equaled the previous record.

Total length of the voyage was 66.5 days, of which 51.6 days were spent on-site, 7.4 days underway and 7.5 days in port. 1.6 days of operating time were lost due to mechanical difficulties.

FUNCHAL PORT CALL

The port call at Madeira was routine and was concerned mostly with crew change, resupply and machinery maintenance. Previously unscheduled repairs were necessitated by a ruptured ballast tank bulkhead in the moon pool area. The damage was attributed to overpressuring of the tank while preparing for a mid-term inspection.

The loading of supplies and some of the maintenance was delayed because of the necessity to transship oncoming surface freight from Las Palmas. The freight did not arrive in Funchal until the fourth day after the arrival of the CHALLENGER.

The repair and subsequent testing and inspection of the tanks consumed more time than originally estimated. This delayed the operations of replenishing fuel and water. After tank repairs were completed, 202,000 gallons of marine gas/oil were taken on.

Early on September 10, the ship was required to vacate her pierside berth to make room for another vessel. A short move was made to anchorage outside the harbor breakwater and the ship remained at anchor until departure from port. Topping off of fresh water continued until a few hours before departure.

A rotary helper became ill on September 9 and a replacement was secured from the U. S. Departure of the vessel was delayed approximately ten hours after necessary repairs and resupply had been completed pending the arrival of the new man.

On September 11, after seven days and four hours in port, the CHALLENGER weighed anchor and departed for Site 415.

SITE 415

The prime drilling site of Leg 50 was located about 95 miles off Cap Tafelney, Morocco and about 270 miles from Madeira. After the transit to the immediate area and a brief seismic profile survey, the positioning beacon was dropped at DSDP Site 415. Less than 40 hours had elapsed since departure from port.

An initial hole was drilled to confirm the feasibility of re-entry operations at the location to determine the optimum length of conductor casing required and to conduct downhole tests not considered advisable in the re-entry hole. The projected total depth of the hole was to be about 500 m with openhole well logs to be run before abandonment. This exploratory hole also provided a good opportunity for the precise determination of water depth. The initial water depth for Site 415 as determined by the Precision Depth Recorder was 2803 m. The drill pipe was measured as it was run to the sea floor. The drill pipe pinger, attached to an inner core barrel, was carried down in position at the bit and was monitored constantly with the Precision Depth Recorder. A depth of 2817 m was determined by this method. Offsets of 200 feet west and 100 feet north were introduced into the dynamic positioning system so that bottom sediment disturbance resulting from the exploratory drilling would not adversely affect the re-entry cone setting later. After the pinger had been retrieved, a standard inner barrel was pumped down and a punch core taken to 2824.5 m total depth. (This established the official spud time of the site at 0824, September 14). Although the sea floor was not "felt" by the weight indicator, a nine-meter sediment core was recovered. The condition of the core indicated that the heave of the vessel could have caused some additional soft sediment to be "pumped" into the core barrel and the pinger depth was accepted as official.

To determine the optimum point for setting conductor casing, the drill bit was jetted in to a depth of 2891 m without rotation. The calcareous ooze encountered was unexpectedly firm, apparently as a result of the erosion of uncompacted sediment by bottom currents. When 21 minutes were required to jet the final 9.5 m, it was felt that the sediments were sufficiently consolidated to support the weight of the re-entry cone and both conductor and surface casing strings. It was also felt that difficulties could be encountered in attempting to jet the 16" conductor casing into the sediment beyond this depth. (Although a 14-7/8" bit was to be run with the casing string, a 10" bit was used on the exploratory hole to provide a suitable hole diameter for logging). At this point, 74 m below sea floor (BSF), pump pressure was cut and rotation of the pipe was employed to cut a core.

Drilling and coring continued to a total depth of 3100 m BSF. At this point the rate of penetration had slowed to about 13 m/hr and it was felt that drilling to the initial goal of 500 m would consume an inordinate amount of time that could be used in pursuit of the deep drilling objectives.

After a wireline run to release the bit assembly, the hole was filled with bentonite gel mud for logging. Borehole compensated sonic, dual induction-laterolog, and combination formation density-compensated neutron logs were run. All three logs included a natural gamma ray log for correlation purposes. After logging was completed, the hole was filled with weighted gel mud and abandoned.

Five cores were recovered from Hole 415. Two wireline runs each were made for in-situ pore water samples and for temperature probe measurements.

HOLE 415A

After operations were completed at Hole 415, the positioning offsets were removed and the vessel was returned to the position of the beacon. As the drill pipe pinger had been in place a few meters off bottom at the time of offsetting, the water depth could be monitored fairly accurately while the ship was moved. The northwesterly direction of the offset had been chosen to minimize any depth difference resulting from regional slope and depth readings at the two locations agreed within one or two meters.

The pinger had been damaged upon retrieval from the previous run and was out of commission for the duration of the voyage. The precision depth recorder was used, however, to follow the distinct reflection of the re-entry cone as it was lowered toward the sea floor. When the bit was at a depth of 2797 m and the top of the cone was at 2727 m, the PDR showed a distance of 75 m from the top of the cone to the sea floor which indicated a water depth of 2802 m. This was believed to be a false indication and after the bit had been lowered to 2807 m and the drill string raised one joint, the inner core barrel was retrieved. The barrel contained only water and the PDR indication was proven invalid. The option of pulling "water cores" until sediment was recovered in the core barrel was rejected as too time consuming in light of the information gained on the exploratory hole. The string was lowered and the weight indicator registered bottom at about 2817 m. Circulation was broken and the jetting operation began. It was calculated from the length of the casing string that the mud skirt of the cone should reach the sea floor or 2817 m when the bit had been washed to 2885 m. When the bit reached 2880 m (mud skirt 2812 m) the rate of penetration had dropped sharply. Less than one meter had been made in about 1-1/2 hours jetting with full pump pressure. This is the same effect experienced when a cone reaches the mudline. At the time, it appeared that the water depth could have been as much as five meters shallower than the drill pipe measurement if the interface sediments were too soft to "take weight". In any case, it was reasoned that, if the cone were released a little above the sea floor, it would settle into position when the 14-7/8" bit drilled out from beneath the 16" shoe. Continuing to jet and possibly forcing the cone into the sediment was considered a greater risk. The shifting tool was run on the sandline and the casing/cone assembly was released with the mud skirt at a depth of 2812 m.

After the release had been verified by weight indication and by free rotation, a 14-7/8" hole was drilled to a total depth of 3161.5 m. At this depth the penetration rate had decreased to less than 10 m/hr and geological information indicated no merit in a longer surface casing string. This interval was drilled with a center bit and no cores were taken. A wiper trip was made with the bit pulled above the casing shoe and run back to total depth. The hole was then flushed and filled with mud and the drill string was retrieved.

As soon as the bit was on deck, preparations were made for running the 11-3/4" surface casing string. At this point a three-hour delay in operations was experienced when the propeller of No. 1 bow thruster apparently became fouled. When this problem had been resolved, 331 m of surface casing was made up, attached to the drill string, and lowered to within a few meters of the sea floor.

The first re-entry attempt was fairly routine. After the logging sheaves had been rigged and the equipment assembled, the sonar tool was lowered into place at the casing shoe. One hour and 55 minutes were required to acquire the target, maneuver the ship into position with offsets to the positioning system, and to allow the drill string to swing over the cone. (The target image on the sonar screen was normal in all respects). After the casing had been stabbed into the cone and the sonar tool retrieved, the casing was lowered into place.

The casing hanger was "felt" to latch into the cone when the casing shoe was at 3151 m. (This would have located the mud skirt at 2816.5 m or 3.5 meters above the top of the 11-3/4" casing) Latching was verified by picking up on the drill string and noting a weight increase. This indicated that the re-entry cone had settled 4.5 m. It is necessary to transfer the weight of the surface casing string to the conductor casing/cone assembly to allow the releasing mechanism to function. The drill string was lowered carefully to put the running tool "in neutral", but each time this apparently had been accomplished, the weight indication returned. When the weight had stabilized enough to permit rotation of the drill pipe and disengagement of the surface casing, the casing shoe had been lowered an additional four meters to a depth of 3155 m. This placed the mud skirt at 2820.5 m and the top of the cone at about 2818 m.

After the casing had been released, the cementing equipment was rigged up. 515 sacks of neat cement were mixed and displaced into the annulus around the casing. No significant problems were experienced in the cementing operation except that the plug apparently did not clear the drill pipe and latch into the casing shoe until 1000 psi pump pressure had been maintained for several seconds.

The drill pipe was then pulled clear of the mudline where it was flushed of any remaining cement. After tripping the pipe, a standard bottomhole assembly and 10" bit were made up and the string run back for the second re-entry attempt.

As the positioning offsets from the first re-entry remained in effect, little change was necessary and a stab was made after 44 minutes of scanning. The target image was distinct and normal in appearance except that one of the reflectors appeared to be partially obscured. The weight indicator registered contact with the cone as the stab was made. All factors indicated a successful re-entry and the sonar tool was pulled. The standard practice of running two or three stands of drill pipe to verify re-entry was followed on this occasion and no weight drop was seen on the indicator until a slight "dragging" tendency was noted on the second verification stand. The first notable resistance was felt when the bit reached 2853 m. At this point the pipe was rotated and appeared to be free. An attempt to take a core from the interval 2853-2864 m was then made. Recovery was limited to a trace of material resembling a mixture of drilling mud and ooze. Another joint of drill pipe was added to the drill string (to 2873.5) and still the weight indication was inconclusive. A second core was attempted to 2881 m. This time sediment was recovered and a miss was confirmed. Since samples were collected, the cores were designated as taken from the aforementioned depths at Hole 415B.

The drill string was pulled back to re-entry position and the sonar tool run back to the bit. After one hour and 20 minutes scanning, another re-entry stab was made. Again, the driller reported "hitting" the cone. The sonar tool was lowered to the bit and indication of transducer rotation was lost indicating that the tool was in sediment. The drill string was immediately pulled clear and scanning recommenced. The third stab was successful.

After running the bit to the cement top, 23 m of firm cement were drilled before drilling out the casing shoe and latch-down plug. The hole was cleaned to total depth and five meters of new hole were drilled before the center bit was retrieved.

A core barrel was pumped down and the first core of the hole was cut. When the overshot was nearly to bottom on the retrieval run, the sandline was found to have jumped the crown sheave. Efforts to put the line back onto the sheave resulted in kinking and serious damage to the line. Despite the damage, the core was retrieved safely, but it was necessary to shift the retrieval tools to the draw-works sandline.

Recovery in the first core was limited to a few inches of cuttings and to pebbles of chert and other hard material. Nothing of full core diameter was present. Following Core No. 1, 57 m were drilled before pump pressure was reduced and Core No. 2 attempted. Nothing was recovered in this core barrel. As a core suitable for hydrocarbon monitoring was required before drilling ahead, the subsequent joint was also a coring attempt. Again, there was no recovery. The driller's pump pressure gauge indicated that the barrels were seating properly upon landing at the bit and it was reasoned that the core guide of the bit itself was plugged or damaged and was preventing any material from entering the inner barrel. An inner barrel with a small diameter extender was pumped down in an attempt to "punch" any obstruction from the bit. This barrel also appeared to seat normally and the extender was recovered clean and unmarked. A fourth attempt to recover a core was made and was to be the final attempt before a round trip to resolve the problem. This time the core catcher held a biscuit-shaped chunk of heavy metal about 2-1/2 inches in diameter and 1-1/2 inches thick. Examination revealed it to be the remains of the latch-down cementing plug which had been drilled with the casing shoe. On the fifth attempt, a sediment core was recovered.

A temperature probe measurement was made following Core No. 5. Due to the degree of induration of the sediments and to risk of damaging the sandline, this was the final temperature measurement attempted.

Drilling and spot coring proceeded virtually without incident to a depth of 1079 m BSF. The presence of cuttings accumulation in the hole was expressed as an increase in pump pressure and torque when drilling was resumed after pulling an inner barrel at 1041 meters BSF. The standard action of pumping a slug of bentonite mud to clear the annulus was taken. High torque and pump pressure were experienced after making a connection at 1079 m BSF. While attempting to "work" the pipe free, it became vertically and rotationally stuck. Because of high annular back pressure, it was necessary to equalize the hydrostatic heads with weighted mud before breaking the drill pipe connection. After working and pulling one or two joints, rotation was regained but sticking tendencies persisted until fifteen singles had been laid down. As the bit was near the end of its rotating life, the power sub/swivel and heave compensator assemblies were set back and a trip for a new bit was made before attempting to clean the hole to total depth.

While the drill string was on deck, line was spooled off the primary sandline reel through the moon pool until the damaged section was exposed. The line was then clamped off, the damaged section removed, and a long splice installed. The core retrieval tools were shifted back from the drawworks sandline for future coring operations.

The stabilizers and the diverter packoff assembly were deleted from the bottomhole assembly as they were considered possible contributors to the downhole problems.

On the next re-entry, the sonar presentation indicated that the primary sonar reflectors, mounted on the lip of the cone, were at least partially obscured by cuttings or had been pulled down to the mudline. It was difficult to distinguish the reflector images from that of the bottom. ("Bottom returns" can normally be minimized by reducing the gain settings of the sonar). Despite this complication, re-entry was accomplished after only 45 minutes scanning time by referencing on the three glass ball "auxiliary targets" floating on tethers above the cone.

On the trip into the hole, the drill string first began to "take weight" at about 540 m BSF. Torquing began at about 880 m and progress came to a virtual halt at about 1010 m. After working pipe, rotating and making a little progress at a particularly "hard" spot for about an hour, the abnormal torquing ceased and the weight on the bit began to decrease slowly and evenly with rotation. These normal drilling parameters indicated that the hole had probably been side tracked about 65 to 70 meters short of total depth. At this point, it was considered prudent to make a short trip to determine hole conditions at and above this trouble spot before proceeding. Ten doubles were pulled with no resistance, but problems returned almost immediately on attempting to run back toward bottom. Even more difficulty was encountered in getting down on this attempt. At one point the pipe was again stuck for several minutes. After struggling approximately seven hours without reaching the original sidetrack point, attempts at further drilling progress were abandoned.

A core taken from near the top of the "problem interval" was comprised of badly fractured claystone. It was apparent that the material was fractured <u>in-situ</u> as some of the fractures exhibited calcite healing.

The bit was pulled clear of the lowermost sticking conditions and a through-pipe gamma ray log was run.

The hole was abandoned by placing a plug of 200 barrels of barite mud.

SITE 416

After failing at Site 415 to penetrate the thick sediment section overlying the strata of primary scientific interest, the vessel moved to a location where the sediments were thinner and seismic records indicated the possible absence of the fractured shale interval encountered at Site 415. Water depth was considerably greater at the new location, however, and the scientific potential was not as great. Site 416 was situated about 80 miles west of the Moroccan coast, 120 miles northeast of Site 415 and two miles west of DSDP Site 370.

Transit time between the sites was about 15 hours. The initial penetration was again an exploratory hole to determine water depth and the conductor casing point. Geological records from Hole 370 and the fact that hole problems were not encountered at that site, indicated that little advantage would be gained by setting an 11-3/4" surface casing string.

The precision depth recorder reading was 4201 meters after stationing had been established over the beacon. The drill string was lowered and a punch core was taken to a depth of 4205 meters before the bit was pulled clear of the mudline. Spud time was established as 0017, September 30. The weight indicator registered bottom at 4204 meters. 1.3 meters of core was recovered, consisting of very soft. brownish ooze overlying firm, greenish clay. An official water depth of 4203 m was recorded.

Pump circulation was started and the 14-7/8" bit was jetted ahead to establish the firmness of the sediment. After the first double stand, weight began to fall off slowly and pump strokes were increased from 20 to 50 and then to 65 as the next double was pumped down. On the next stand, two pumps at 40 spm were utilized. Jetting continued in this manner to 4309.5 m. The Martin-Decker weight indicators behaved in a manner indicating that normal penetration was being made. At this point, the feasibility of setting up to 100 meters of 16" casing was considered established. Pump circulation was reduced and a core was attempted at 4309.5-4319 meters. The fact that rotation was not required to penetrate this interval was initially considered to be an indication that the bit had "broken through" the clay and entered an interval of softer ooze.

To save the time of a wireline trip, the core barrel was retrieved with the drill string.

The string was never rotated until the power sub had been set back and the trip out began. On attempting to use the rotary table to back off the tool joints, resistance to rotation was noted. As this suggested a bent bottomhole assembly, the pneumatic pipe spinner was used for the remainder of the trip and the pipe was not rotated.

On retrieval of the bottomhole assembly, the 5-1/2 inch drill pipe joint, located above the drill collar, was found to be severely bent. The threads in the box connection of the top drill collar were damaged and the mandrels of both bumper subs were bent to the extent that it was necessary to torch cut the mandrels to remove the subs from the string.

As the drill string had not been rotated during its retrieval, the BHA was retrieved with sediment still adhering to it. The sediment was found to be caked along one side of the drill collars only. Virtually the entire assembly had collected the soft brownish ooze while green clay was found only on the outer core barrel. The inner barrel was empty except for a trace of greenish clay similar in age and composition to that at the bottom of the first core.

This evidence implies that the bit failed to respud after the punch core had been retrieved. For some reason, possibly a plugged jet in the core bit or horizontal drill string motion, the drill string apparently "kicked off" vertical and slid along the sea floor instead of penetrating the ooze/clay interface.

HOLE 416A

The geology of the mudline punch core and of the shallow sediment cores from Site 370 was carefully reviewed. This information, together with considerations of the overall objectives and time available, prompted a decision to set the re-entry cone and conductor casing without a second attempt at an exploratory penetration.

Due to the unusual stresses that the bottomhole assembly had probably been subjected to on the exploratory attempt, the assembly was given a precautionary magnaflux inspection before further operations were undertaken.

The final re-entry cone remaining on board had been assembled during the transit from Site 415 and was keelhauled into place below the moon pool without delay. As no surface casing was to be set, 40 meters of conductor casing was judged to be adequate to support its own weight and that of the re-entry cone in the clay and/or ooze sediments present. The casing, cone and bottomhole assembly were made up, connected and run to the sea floor without incident.

The clay proved to be stiffer than anticipated and over 20 hours were required to jet the casing in. After a successful wireline trip to release the casing/cone assembly, a round trip was made to replace the 14-7/8" core bit with a new 10" bit.

The first re-entry operation progressed smoothly and a successful stab was made after 33 minutes of scanning time.

Drilling and spot coring proceeded with only minor difficulties to a depth of 764 m below sea floor. There pump pressure, while core barrel No. 6 was being pumped down, indicated the throat of the core bit to be plugged. The inner barrel was retrieved and an inner barrel with an extended shoe was pumped down to clear the bit. Conditions were back to normal after the retrieval of this barrel. A total of 3-1/2 hours were expended.

Early on October 6, after a depth of 920 m had been reached, it was necessary to discontinue rotating drilling operations due to excessive vessel motion. Wind and current conditions had combined in a direction about 80° divergent from that of a strong swell. The ship was unable to develop enough side thrust to maintain a heading that would keep the swell induced roll within the seven degree safe operating limit. To avoid lost operating time while awaiting the moderation of forces, a trip for bit change was begun. About three fourths of the core bit's life expectance had been consumed.

Weather conditions abated and vessel motion was within safe operating criteria before the bit had been pulled clear of the mudline. Therefore the bit was run back to total depth and drilling operations were resumed. Although no hole problems had been encountered in drilling to this point, some drag was experienced in pulling the drill string and the time consumed by the "wiper trip" was considered well spent from the standpoint of hole conditioning. Some resistance was encountered at one or two points while returning to total depth.

At a depth of 1093 m BSF, signs of possible bit failure were noted. As logging was scheduled for the first bit change, a second wiper trip was made to ensure the best possible hole conditions for the logging operations. No resistance was encountered in pulling the bit to the casing shoe. On the trip back to bottom, however, a solid bridge was hit at 684 m BSF. Attempts to clear the partially plugged bit and to wash through the obstruction with the circulating head were successful and resulted in a ruptured circulating hose. Further attempts after replacing the hose also failed and it was necessary to pick up the power sub for the remainder of the trip to total depth. Only minor obstructions were encountered after the aforementioned bridge had been cleared. After total depth had been regained, the hole was flushed and filled with drilling mud and the drill string retrieved. The string "pulled tight" as the bit passed 684 meters but did not become stuck.

A special logging adapter and short bottomhole assembly were installed and the drill string was run in to just above the sea floor in preparation for re-entry.

On commencement of sonar scanning, the image appeared to be that of bottom at very close range. The range indicated that the transducer was very near the level of the top of the cone and that it would be necessary to raise the end of the pipe to acquire the target at any distance greater than a few tens of feet from the drill string. It was inferred that the drill string measurement was somehow erroneous and that it would probably be necessary to retrieve the sonar tool and set back one joint of drill pipe. In order to save this operating time, raising the drill pipe a few feet was considered. If the target were at short range raising the pipe a few feet might have provided target acquisition and enough clearance to make the re-entry. In an effort to raise the triple stand in the derrick three to four feet, the vertical clearance was misjudged and the travelling block came into contact with the upper logging sheave. The sheave was tipped enough to allow the logging cable to jump off the sheave. This damaged the cable and electrical continuity was lost.

It was not considered feasible to splice the logging cable aboard the CHALLENGER. This cable was damaged near its midpoint and either end would have been too short for future operations at this site. It was therefore necessary to replace the entire winch drum and logging cable with a spare unit (a ten to twelve hour job) before any further re-entry or logging operations could be conducted.

Due to time constraints, it was decided to postpone logging plans until the next bit change. The winch drum interchange operation was conducted concurrently with a round trip for a core bit and drilling bottomhole assembly. The drum was a major operation and was accomplished through extraordinary effort on the part of a few individuals, as the drilling crew was not available to assist.

The anomalous sonar presentation remained unexplained as the drill pipe tally and bottomhole assembly measurements had been carefully scrutinized with no errors found. Downhole and surface electronics had been rechecked with no fault found. As a precaution, the subsequent re-entry attempt was made with a different downhole tool. This re-entry was routine and was accomplished after 55 minutes scanning time. The sonar range to bottom agreed with drill string measurements.

On attempting to run to bottom, a bridge was encountered at 465 m BSF that required the rigging of the power sub to wash through. Several more obstructions were encountered and rotation of the bit was required to reach total depth. Twelve hours were required for this portion of the trip.

Continuous coring commenced at 1177 meters, the approximate depth reached by Hole 370. Drilling problems began at 1214 meters. The pipe became vertically and rotationally stuck while core barrel No. 13 was being pumped down. The pipe worked free about the time the barrel landed and a mud slug appeared to clear the hole. From this point on a persistent tendency for "fill" to accumulate during wireline trips was noted. The lithology being penetrated was shaly and highly fissile. Cores had a deeply eroded "corrugated" appearance and considerable flaky spalled-off material was present in the liners.

While core barrel No. 15 was being pulled, the pipe again became stuck. Circulation was maintained but high back pressure indicated a large amount of material in suspension in the annulus. After equalizing hydrostatic pressure with weighted mud, the pipe could be worked vertically. Six joints were pulled before rotation was regained.

During the nearly seven hours required to free the drill pipe, power to the bow thrusters was lost twice resulting in excursions of approximately 300 and 425 feet.

Due to the development of hole problems, the heave compensator was set back before operations resumed. This was necessary due to the severely restricted vertical clearance in the derrick when the heave compensator and power sub/swivel assemblies are both in use. A double stand could again be "worked" without breaking a connection.

The following day, bow thruster problems were again experienced and an excursion to about 500 feet was taken. Drilling operations were halted for about 1-1/4 hours.

Coring operations continued through the life of this bit to 1404 meters BSF without further sticking problems, although three to four meters fill between cores was common.

Due to the previous hole problems, it was considered quite possible that total depth would not be regained after changing bits. A through-pipe gamma ray/compensated neutron log was considered advisable for purposes of correlation and of seismic reflector identification. The hole was slugged with mud to flush cuttings from the annulus. Two singles were set back, the power sub was rigged down and preparations for logging were made.

While the first logging sonde was being lowered through the drill pipe, wind and current conditions reached the point where thrusters were forced to run at maximum rpm and three propulsion engines were required for stationkeeping. Under these marginal conditions, it was not considered advisable to continue the logging operation. The sonde was retrieved, the sheaves rigged down and the drill string was pulled without further delay.

The stabilizers were removed from the bottomhole assembly in an effort to alleviate the sticking tendencies. As a trend toward a harder lithology had been noted in the cores, a type F94CK bit was run.

As the core bit neared re-entry position a few meters off the sea floor, positioning system problems developed. Weather conditions remained marginal and frequent temporary loss of acoustics was being experienced due to wave action and thruster wash around the positioning hydrophones.

The DPS computer would "trip out" following loss of acoustics and, on each occasion, several minutes of manual mode positioning would be required before normal positioning could be resumed. Despite efforts to correct the malfunction, nine hours and moderating weather were required before the system remained in the automatic mode continuously for one hour and it was deemed safe to proceed with re-entry operations.

On commencement of sonar scanning, an apparent bottom image at "too close" range was again observed. This time a check was made by raising the sonar tool in the pipe. The range to "bottom" increased when the tool was raised and continued to do so as the tool was pulled up inside the drill pipe. It was also noted that the range decreased after the cable tension indicator registered seating of the tool and slacking off of the cable. The image resembled bottom return even to the elliptical trace normally associated with the heave of the vessel. No re-entry target was acquired.

There was no reason to doubt the drill pipe measurement in this instance and the sonar tool was pulled for a replacement. The backup tool functioned normally and the target was detected at a distance of over 300 feet. Due to the distance, plotting and maneuvering were required and two hours and twenty minutes scanning time elapsed.

The re-entry was verified and the logging sheaves rigged down. The bottomhole assembly had barely been run through the cone when the positioning computer again went off the line. An excursion of approximately 2000 feet and a delay of one hour occurred before stationing was regained. This generated considerable concern for the drill string. However, no weight was lost and cautious engagement of the power sub resulted in no abnormal torque.

At 380 meters BSF, a bridge was struck that could not be washed out with the auxiliary circulating head. The power sub was rigged and the bridge was quickly cleared. Due to the inherently slower operation with the power sub in the string, the trip to total depth required twelve hours even though no more significant obstructions were encountered.

After three meters of new hole had been made, the inner barrel was retrieved. The core liner was found to be nearly filled with cuttings, including a considerable amount of coarse, angular gravel composed mainly of chert and porcellanite. The liner was jammed with large chert pebbles.

Shortly after coring recommenced, it became evident that the switch to the F94CK bit with its shorter inserts had been a move in the wrong direction. The lithology began a trend back to softer, more waxy claystone and one full core cut at only about 1.3 meters per hour. The bit was pulled after cutting 47 meters in 27 rotating hours - about half the rate of the previous F93CK bit.

Hole conditions, however, had shown a marked improvement and after the third full core it was considered safe to rig the heave compensator. The compensator was in the string for two cores before the trip was made. During this interval, comparison tests were made between active and passive modes of operation.

After replacing the bit with a new F93CK, the trip to sea floor and re-entry proceeded smoothly with only 31 minutes scanning time required. This time the pipe was run to about 1655 meters BSF before the power sub was required. Consequently, it required only about six hours to run from the re-entry cone to three stands off total depth. The back pressure resulting from suspended material in the annulus caused the bit to become plugged while the connection was being made. Circulation was regained after working the pipe for several minutes. A "pill" of weighted mud was started down the pipe to counteract the back pressure. The bit and the mud reached the bottom of the hole at about the same time. Immediately thereafter, the pipe torqued and became rotationally stuck for about 20 minutes and increased pump pressure indicated annular plugging tendencies.

After the mud had been pumped around, coring recommenced but the penetration rate remained rather slow. Sporadic torquing persisted and almost always occurred following a connection or the arrival of a mud slug at the bit.

On October 23, it became evident that two core bits would be required to continue coring until the scheduled time of departure for crew change. The bit in use was pulled somewhat early in an effort to divide the rotating time more equally between the bits and to reduce the risk of running a bit to destruction.

After over three hours were required to replace a burst hydraulic hose leading to the power sub, an uneventful trip for a bit change was made.

As re-entry preparations were being made, rain squalls with wind gusts to 36 mph promised to make precise positioning difficult. Initial detection of the re-entry cone at a range of 350 feet, however, postponed the requirement for precise positioning. Plotting and maneuvering procedures were initiated and the range was closed to about 60 feet after two changes of the positioning offsets. Subsequent movements of the ship proved ineffective in reducing the distance to the target below about 40 feet. The target appeared to be "moving" in a southeasterly direction. The core bit was successfully stabbed nearly seven hours after scanning began. The final offsets indicated the ship to be over 200 feet from the point of the original 60 foot range reading. A 20 minute interruption of the scanning occurred when power to the sonar tool was lost. Troubleshooting revealed that the shooting safety switch in the logging cab had been opened inadvertently. A delay of about the same duration occurred when a faulty relay in the positioning system caused the vessel to take a 400 foot excursion away from the target.

The pipe was run to a depth of 1170 meters BSF before an obstruction was encountered that required the employment of the power sub. Below that point serious problems with bit plugging and rotational sticking were encountered. The final 170 meters were particularly difficult as the bit took weight and rotation was required to work past apparent "ledges" in the hole. About 13 hours were required to run from 1170 meters to total depth at 1586 meters BSF.

During this time, a 40 minute delay was experienced when the positioning computer again tripped off following a loss of acoustics.

Two cores were cut with scattered incidences of torquing and annular plugging as on the previous bit. The second core cut very slowly and required over seven hours cutting time.

When the inner core barrel (No. 55) was retrieved, it was discovered that the landing sub had backed off from the core barrel. The landing sub, inner barrel sub, core catcher assembly, core liner and an unknown quantity of core therefore remained somewhere inside the drill string.

Fishing and retrieving the entire assemblage was the only hope of avoiding a round trip of the drill pipe. A wireline spear constructed for retrieving plastic liners was run into the pipe on the sandline. The sandline weight indicator registered contact with something about 1800 meters below the ship. The line was retrieved but nothing was recovered. On the second attempt, some weight was taken momentarily at about 5000 meters but the spear was lowered until the weight indicator and the flag on the sandline indicated that it stopped very close to the bit. The fishing tool was retrieved with the entire plastic liner firmly impaled, but without core or subs. One desperation attempt was made to fish the subs with a special tubing spear. This could only be successful if core recovery had been extremely low as the presence of core above the subs would prevent engagement of the spear. When the first attempt was unsuccessful, it was conceded that further efforts would be a waste of time and that a pipe trip was the only recourse.

As only about one day remained before the deadline for departure for Madeira, there was no time to run back to bottom with the bit. The only possible productive use of the days operating time on site appeared to be a through-pipe gamma ray/compensated neutron log. In view of hole conditions, however, the merits of such a log did not appear to outweigh the risk of sticking the drill string and thereby losing the hole. After a phone patch to GMI San Diego produced assurances that the crew change could be made one day early, the final decision was made to depart for port as soon as the drill string was pulled.

Due to the length of the expected absence from the site, the hole was filled with bentonite gel mud. A second sonar beacon (of alternate frequency) was launched before the mudline was cleared and was observed until the vessel departed the site.

The transit to Funchal was uneventful except that unexpectedly strong headwinds were encountered the second day. They reduced the ship's speed to an average of 7.8 knots and delayed arrival by eight to ten hours.

A new drilling line was installed while the vessel was underway. As this would have been required before the next round trip, several hours of operating time were saved by scheduling circumstances.

SECOND FUNCHAL PORT CALL

The CHALLENGER arrived at Funchal, Madeira at 1555, October 28, 1976. Principal activities included full GMI and partial SIO crew changes, onloading of 62,000 gallons of marine gas/oil and 121,000 gallons of fresh water and onloading of fresh vegetables and vital spares. Two members of the scientific party departed the ship. An observer representing the National Science Foundation and a GMI auditor jointed the ship. The vessel was underway on her return to Site 416 after only 8-1/2 hours in port.

Inclement weather continued through the first day of the return transit. The quartering seas increased the speed of advance somewhat, but caused the vessel to roll as much as 20 degrees. These conditions provided an opportunity for an engineering evaluation of the Muirhead-Brown roll stabilization system.

HOLE 416A CONTINUATION

On approaching the site, the original 16 kHz beacon was detected at a distance of about one half mile. After the ship had passed over the beacon, geophysical gear was retrieved and the ship positioned over the beacon without difficulty (the original beacon was utilized because it was believed to be closer to the cone than the subsequently dropped 13.5 kHz beacon). Rig operations recommenced at 1637, October 30, after an absence from the site of less than 91 hours.

During the trip to the sea floor, the bow thruster problem reappeared but full capabilities were regained after about 15 minutes.

The initial sonar range to the re-entry cone target was 380 feet. A successful stab was made after one hour and forty one minutes of plotting and maneuvering.

The first substantial bridge was encountered at about 860 meters BSF. Attempts to wash through with the auxiliary circulating head were unsuccessful and the power sub was rigged. After washing ahead to about 1490 meters BSF, "tight" hole conditons were encountered and seven additional hours were required to work pipe to total depth. High torque was nearly continuous and repeated vertical sticking occurred, but annular plugging tendencies were not significant.

After the previous total depth was reached, two cores were cut without problems other than torquing tendencies. A marked increase in rate of penetration over that of previous cores was noted, but recovery was quite low.

During the retrieval of Core No. 57, the already high torque began to increase. While the next inner barrel was being pumped down, the pipe began to stick rotationally. The pipe was worked free after one and one half hours, but the bit had become plugged in the process. The inner core barrel was retrieved. Torque dropped off considerably in this interval but the pipe again became stuck vertically. Rotation was finally regained after working the pipe for three hours and pulling 10 very tight joints of pipe. At this point, a center bit was pumped down and retrieved in an unsuccessful effort to clear the throat of the bit and regain circulation. A "wiper run" was completed and the bit pulled into the conductor casing. After further efforts to regain circulation failed, the drill string was pulled. The outer core barrel was recovered nearly full of cuttings.

The core barrel was cleared and a bit release assembly installed. The ninth re-entry was the fastest of the site, primarily because the cone was initially acquired by the sonar at a range of less than 50 feet. The drill string swung over the cone and the stab was made after 18 minutes scanning.

Pipe was run to about 810 meters BSF before the power sub was required. The hole appeared to be "tight" as weight was taken and torquing was experienced. After washing down three stands, however, conditions appeared back to normal and the power sub was set back. Resistance was again encountered at 1230 meters and the power sub was rigged again.

Three and one half hours were required to work and ream pipe to a depth of 1555 meters BSF where progress came to a virtual halt. Three hundred barrels of gel mud were pumped around in an effort to flush the hole. Serious torquing and sticking tendencies persisted after the mud had cleared the sea floor and no progress was being made toward reaching total depth. It became evident that further drilling efforts would be futile and the decision was made to log and abandon the hole.

The hole was filled with gel mud and the wireline shifting tool was run to release the core bit and lower bit sub assembly. The pipe was pulled to 4300 meters for the open hole logging attempt. The drill string pulled tight nearly continuously through the bottom 500 meters of the hole.

The sheaves were rigged and the gamma ray/sonic/caliper log sonde was run down the drill pipe. The tool came to a stop at the approximate location of the bit sub. The sonde was found to be stuck but was pulled free after working 20 minutes. The caliper arms of the logging tool with an outside diameter of nearly four inches were thought to be the source of the problem. The tool was retrieved, the caliper was removed and the tool was again lowered only to stop at the same point. It was then inferred that the bit assembly had failed to release. When the sonde could not be persuaded to go beyond the end of the pipe, it became necessary to make a round trip to "open up" the drill pipe.

After the logging equipment was rigged down and the pipe pulled, it was discovered that the bit assembly had been released. The end of the pipe (bit release sub top connector) had become jammed with shale cuttings and rock fragments. Circulation had been maintained through the openings in the side of the connector.

The top connector was removed and the special logging adapter was installed. The initial pipe trip and re-entry preparations were routine. The sonar system appeared to be functioning normally on commencement of scanning, but the re-entry cone target could not be detected within the 500 foot range capability of the system. After one hour a move of about 300 feet to the northwest was made but the target failed to appear. The vessel was returned to the offsets of the previous re-entry. It did not seem reasonable that the cone would be so far from the drill string and a malfunction of the downhole tool was therefore suspected. After 108 minutes scanning time, the tool was retrieved and replaced by a backup tool.

During the scanning interval, bow thruster power was lost on two occasions but was quickly regained.

The second tool also failed to acquire the target on initial scanning and it became apparent that the target was not within the detection range of the sonar. A check of recent satellite navigation printouts indicated the ship to be located several hundred feet north of the calculated mean position based on earlier readings.

The positioning offsets were changed from 300 N 120 E to 50 N 130W and the target was finally acquired at a range of over 400 feet. Standard plotting and maneuvering procedures were initiated and the range was gradually reduced. A successful stab was made with offsets of 50 N 300 E after four hours and fourteen minutes of scanning.

After the sonar tool had been retrieved, three stands of pipe were run to put the end of the pipe at the desired logging depth of 4300 m (97 m BSF).

The gamma ray/sonic/caliper tool was again made up and run down the pipe. Once more the sonde failed to pass beyond the end of the pipe. Attempts to retrieve the tool found it to be firmly wedged at or near the end of the pipe. After the cable had been worked one hour without freeing the tool, greater pull was exerted and the cable suddenly came free. Electrical continuity to the tool was lost and it was felt that the tool had been pulled off at the cable head weak point. It was noted, however, that there was no apparent loss of weight. The logging cable was retrieved and the tool was found to be attached and intact. Inspection revealed that the weak point had begun to yield when the tool pulled free and that conductors had parted in the cable head assembly.

The cable head was repaired and the caliper arms were again removed. On the next attempt the tool passed unimpeded into open hole. Bridging was encountered at about 690 meters BSF. At one point the tool appeared to work its way to about 847 m, but after attempts to raise the tool and "spud" for more depth, 685 m became the total penetration for the first log run. The subsequent gamma ray/compensated neutron/formation density and gamma ray/dual induction logs reached the same depth. The small, lightweight high resolution thermometer was run last and only reached a total depth of 4790 meters (587 m BSF).

The logging apparatus was rigged down and an attempt was made to wash the open ended drill pipe to total depth. It was hoped that, after cleaning the hole to total depth, the pipe could be raised above the bottom of the first logged interval and the remainder of the hole could be logged.

The power sub was picked up at 635 m BSF and the string was washed down easily to about 5000 meters (800 m BSF). No indication of any obstruction was noted as the pipe passed the point where the logging tools had been stopped. Torquing began at about 5000 meters and strong backflow was noted on the next connection. At 5040 meters, rotational sticking began and it became evident that open ended pipe would not reach total depth.

A pipe trip was made and a bit release assembly and used bit were installed. During the trip, the original 16 kHz beacon had begun to lose signal strength and positioning was switched over to the "fresher" 13.5 kHz beacon. It was therefore anticipated that some repositioning of the ship would be required before re-entry could be made. New offsets of 470 S 140 W had been introduced to put the ship at the approximate location of the 13.5 kHz beacon. The target was acquired shortly after the scan commenced and the ship was maneuvered to the final stabbing offsets of 50 S 30 W. The twelfth and final re-entry was made after one hour and forty nine minutes of scanning.

The first bridge was struck by the bit at about 760 m BSF and the power sub was rigged. Only widely scattered tight spots and bridges were encountered as the string was washed in to a depth of 1433 m BSF (the approximate top of the worst hole conditions).

After the hole was filled with mud, the inner barrel was retrieved and the shifting tool was run to release the bit. The string was then raised in the hole to put the end of the pipe at about 410 meters BSF for the second log run.

The gamma ray/sonic tool was again the first to be run. The tool was stopped by a bridge at 700 meters and could only be worked down to 723 meters.

The logging sonde was pulled and yet another attempt was made to clean the hole. The now open ended drill string was carefully lowered in an attempt to wash through the bridging interval. Progress came to a halt at about 830 meters. It was decided that conditions did not warrant further logging efforts and that the site should be abandoned.

The hole was again filled with mud and the drill string retrieved. The vessel was secured for sea and was underway at 1500 hours on November 8.

The return transit to Funchal was uneventful and Leg 50 came to its official conclusion at 0616 on November 10 as the first mooring line was put over.

DRILLING AND CORING EQUIPMENT

The standard DSDP bottomhole assembly was utilized for all routine drilling and coring operations. This consisted of a core bit, bit sub (with flapper valve and inner core barrel support bearing), outer core barrel assembly, three 8-1/4" drill collars, one 5' stroke Baash-Ross bumper sub, three 8-1/4" drill collars, one or two 5' stroke bumper subs, two 8-1/4" drill collars, one 7-1/4" drill collar and one joint 5-1/2" range three drill pipe. The assembly was modified to space out for running casing strings of varying length. Where bit release capabilities were desired, the bit sub was replaced by the special bit release sub. Only one upper bumper sub was employed when continuous use of the heave compensator was anticipated.

Stabilizers were run in the lower stand of drill collars at approximately 20 and 30 meters above the bit on both deep penetration attempts. In both cases they were removed as a precaution on the first bit change after hole problems were encountered. No significant deviations or rates of deviation from vertical were noted, either before or after the stabilizers were removed from the string. At Hole 416A, serious hole problems and sharply lower core recovery were noted in the hole section just below the point where the stabilizers had been removed. This may have been a coincidence or may have resulted from the unstabilized bit "walking" in the hole.

The outer core barrel (8-1/4" x 4-1/8" range two drill collar) was found to have a three to four inch bend upon retrieval after the 14-7/8" hole for surface casing had been drilled. Two bumper subs and a joint of 5-1/2" drill pipe were severely bent on the aborted exploratory Hole 416. At the same time the threads were damaged in the rotary connection box of the 7-1/4" drill collar. One joint of 5" drill pipe was bent when a stand of pipe was picked up from the automatic pipe racker and was accidentally caught under the jaws of the pipe stabber. The 5" joint immediately above the bottomhole assembly was found to be bent on the first pipe trip following the 2000 foot positioning excursion on Hole 416A. On the final trip out of the hole before departing the site, the fourth joint above the bottom-hole assembly was found to be bent (apparently during the final attempt to wash down for logging). Another joint of drill pipe had been removed from service at Hole 415 after the caliper logging tool had failed to pass below 165 m in the drill string. The inside diameter of the pipe was found to be at or below the minimum drift of four inches.

Coring equipment difficulties were minimal except for the instance in which a landing sub backed off the inner barrel. As this occurred while the barrel was being retrieved, the core was left in the pipe which precluded retrieval of the subs by fishing. Steps to prevent recurrence of this problem are being investigated.

SANDLINES

The core retrieval sandline was damaged on two occasions. On the very first core barrel retrieval, the warning flag was missed and the retrieval assembly was jammed into the ball valve at the top of the swivel. The impact parted the sandline at the winch and jarred the inner barrel loose from the overshot. (The inner barrel then fell back to the bit and the drill pipe pinger was destroyed). Only about 200 feet of line was lost and a new socket was poured. The second incident occurred as the wireline trip was being made to recover the first core from Hole 415A. An anomalous weight indication led to the discovery that the line had jumped the upper sheave. The line was damaged in an attempt to resheave it. As the damage was about 10,000 feet from the end of the line, it was necessary to change over to the draw-works sandline until a long splice could be made on the next bit trip.

Both of the installed sandlines were new at the beginning of the leg and were coated with a sticky black asphaltic substance. This material was exuded from the lines in considerable quantity during the first half of the leg and became ubiquitous about the ship. Accumulations inside the drill pipe resulted in an unacceptably high degree of core contamination and seriously degraded the quality of organic geochemistry sampled. It was necessary to remove quarts of the material from the overshot assembly after each wireline trip. The line tar buildup is believed to have been responsible for one extra wireline trip by preventing the overshot from engaging the core barrel pulling neck.

BITS

No operational problems were encountered with the tungsten carbide insert roller cone core bits. Bearing wear continued to be the failure mode and cutting structures were virtually unscathed. With one exception, the ten inch bits were all of the long insert Type 93. One Type 94, with intermediate length inserts, was run in Hole 416A.

The rate of penetration at Hole 415A was better than expected and at Hole 416A the rate was nearly twice that achieved over the same interval at nearby Hole 370. The difference is believed attributable to the improved drilling hydraulics gained by used two mud pumps in the drilled interval and to the greater effectiveness of the F93CK core bit. Hole 370 was alternately drilled and cored using one mud pump and a F94CK core bit. The last 250 meters of Hole 416A, however, drilled somewhat slower than had been anticipated. The lithology was well-indurated claystone with thin strata of limestone and hard fine sandstone. A Type F94CK bit was run at about 1400 meters BSF in an attempt to increase the rate of penetration in apparently "harder" and more calcareous sediments. The drilling rate dropped to about half that achieved by the preceding F93CK and the bit was pulled early in favor of another 93. Of the five F93CK bits run and recovered, the only cutting structure damage noted was one insert broken off on each of two bits. A proportionately small but significant amount of intercalated chert, hard limestone and hard sandstone was drilled. This would indicate that a bit with slightly longer chisels might be employed successfully to increase penetration rates in continental margin drilling where thick sections of fine clastics are anticipated.

SPECIAL TOOLS

Special downhole tools suffered considerable misfortune on Leg 50. The use of tools run in on the wireline and/or extending through the bit is confined as much as possible to exploratory and single bit holes due to the operational risks involved.

The downhole temperature probe instrumentation performed well and two out of three attempts provided good results. The backup instrumentation (paper tape punch, magnetic tape recorder, etc.) consumed an inordinate amount of time for trouble-shooting and repair. They appear to require upgrading or replacement. The unsuccessful attempt occurred at Hole 415 when a minor bridge or cuttings fill prevented setting the bit on bottom before time ran out on the recording tape.

The in-situ formation fluid sampler was run twice in Hole 415 but no usable samples were obtained. On the first run, the sampling valve was found open and investigation revealed that the battery had apparently run down before the valve operating cycle had been completed. On retrieval of the tool after the second attempt, a sample of the proper volume had been obtained, but the entire filter screen assembly and attached flow line had been pulled off the tool and lost. A chemical check of the sample indicated that it was sea water.

The drill pipe pinger was employed on the first pipe trip to the sea floor and made a valuable contribution in determining water depth. When the core barrel with pinger was retrieved after it had been dropped through the drill pipe, the electronics package and transducer were found to have been damaged by the impact. Because of this and other design problems, the retrievable pinger will be temporarily taken out of service and expendable pingers will be utilized on a trial basis.

HEAVE COMPENSATOR

The heave compensator was used for all drilling and coring operations until hole and weather conditions dictated its removal from the string. The compensator was quite effective in minimizing hookload fluctuations. Topside components were remarkably free of former mechanical maintenance problems and accounted for only about two hours breakdown time. One of the high pressure air compressors was out of service for the entire leg for lack of parts. The other compressor required a great deal of maintenance due to carbonization of the lubricating oil in use but caused no lost operating time.

A representative of Brown Bros. was sent to the ship in mid-leg to evaluate the operational effectiveness of the active mode of the compensator. Tests were conducted in both modes while drilling. Active operation was found to reduce hydraulic pressure fluctuations in the system, but no change in hook load variation was noted. A quicker stroking response of the compensator cylinder was observed. The active system was found to be highly susceptible to radio transmission and other outside interference. Erratic behavior of the compensator resulted from this interference. and certain design changes appear to be required if the system is to be operated in this mode.

BEACONS

Only three sonar beacons were launched in the course of the leg. The beacon utilized for the entire occupancy of Site 415 was a prototype Benthos double life unit featuring a pressure case housed in a single glass ball flotation. The compactness and lightweight of the unit are desirable features and the signal characteristics were entirely acceptable. The strength of the signal received at the hydrophones, however, was only about half that produced by ORE beacons in similar water depths. The bail arrangements for lifting the beacon and for suspending the weight were judged to be underdesigned for their functions. An alternative stronger bridle arrangement was rigged aboard the ship. It is not presently known if the transmitted signal was weak or if the attitude of the beacon on bottom was a few degrees off vertical as a result of the bridle arrangement.

The ORE 16 kHz double life (14-day rated) beacon initially dropped at Site 416 was still pinging when the ship departed the site 41 days later. It had been used for positioning until three days earlier when noticeable signal degradation began.

An ORE 13.5 kHz double life dropped prior to departure for the crew change port call remained strong until final site departure 12 days later.

RE-ENTRY HARDWARE

No defects or design problems of consequence were encountered in the assembly or deployment of the re-entry cones, casing, etc. The diverter packoff assembly was run initially on both sites but was removed from the drill string after hole problems began. It was considered a possible hindrance to cuttings removal in the event the diverter lines had become blocked. The concavity in the top of the packoff assembly was found to be packed full of cuttings when it was retrieved at Hole 416A. This was considered an indication that the diverter system was not functioning as designed.

RE-ENTRY ELECTRONICS

The entire sonar system functioned nearly flawlessly for the 15 re-entry attempts. On one or two occasions, problems suspected to originate within the system were traced to external causes (open switch, pipe dope, ship off station, etc.). Late in the leg an inaccuracy in the target range in the CRT display was noted. This was quickly determined to be the result of pulse time delay caused by the greater length of the replacement logging cable. The error was removed by a simple adjustment.

The two "anomalous bottom image" malfunctions were reviewed and it was found that the only elements of the re-entry system common to both instances were the bridge console and the cable head. Both had been checked out and no fault was found. The one other circumstance noted in both occurrences was a liberal coating of pipe thread compound on the transducer when it was recovered. The pipe "dope" was found to contain over 60% powered lead. In the opinion of the sonar system manufacturer, even a thin film of this material could seriously impair the functioning of the transducer. A change in the drilling crew's technique of applying pipe dope has apparently eliminated the problem.

With multiple re-entry and logging attempts, the Mohole logging unit received probably the heaviest usage of its career. The unit performed reliably and well. The only serious casualty was the damaged logging cable with the attendant major replacement project. On initial checkout and the first re-entry run, the depthometer drive unit was "stiff" and threatened to seize up as in the past. With the exercise of subsequent runs, however, the drive freed up completely. Late in the leg, the Spicer-Thompson retarder was noted to be running hot while in use in running the tool down the drill pipe. This is currently being investigated. Although nothing is considered wrong mechanically, prolonged periods of running under little or no load result in considerable "blow-by" of lube oil through the diesel exhaust. A trap and drain have been installed in the exhaust header in an attempt to minimize oil spatter in the area of the unit.

LOGGING

A Schlumberger well logging engineer and two sets of instrumentation were carried on board for the duration of the cruise to provide a varied suite of geophysical logs for the section penetrated. The principal equipment problem encountered was with the caliper arm assembly for the borehole compensated sonic log sonde. The caliper was modified to reduce the diameter sufficiently for passage through drill pipe of four inch inside diameter after the initial problem on Hole 415. Any further reduction in the calipers diameter would have required a more complicated modification. The modification was sufficient for the open ended pipe operation planned, but proved inadequate to clear the 3-15/16" latch sleeve when the outer core barrel was left in the bottomhole assembly as is necessary when using the bit disconnect.

Gamma ray-sonic, gamma ray-formation density-neutron and gamma ray-dual induction laterolog (DIL) surveys were run on exploratory Hole 415. The quality of the logs was less than optimum due to the nature of the poorly indurated sediment penetrated. In addition, the sonic log quality was degraded by the lack of centralization normally provided by the caliper. The hole diameter curve, valuable for both log interpretation and casing point determination, was also sacrificed.

It is significant that, even though the Hole 415 logs were considered to be of poor quality by the logging engineer, the scientific staff found that a considerable amount of useful and valuable data could be obtained from the logs.

Due to hole conditions, time considerations and non-attainment of drilling objectives, an open hole logging program was not attempted at Hole 415A. Before the drill string was pulled, however, a through-pipe gamma ray log was run for purposes of lithologic unit correlation. Good results were obtained and again a surprising amount of scientific information was gleaned from less than an optimum log.

At the conclusion of operations at Hole 416A, the same suite of open hole logs was run with the addition of a high resolution thermometer. The results were disappointing in that hole conditions only permitted the shallower sediments to be logged. The gamma ray sonic log again lacked the centralization of the caliper, but a usable log was obtained. An electric (DIL) log of good quality was run, but a broken bow spring rendered the neutron-density log nearby useless. A backup tool was on hand and it was decided to attempt to run this log on a longer interval after cleaning the hole to bottom. (Hole cleaning attempts failed, however, and the rerun was not made).

The HRT temperature log was also run but the tool could only be lowered to about 585 meters BSF. The log provided a geothermal gradient determination and proved the viability of the tool, however.

DYNAMIC POSITIONING

Two rather serious malfunctions of the dynamic position system, both intermittent, plagued the operation during the latter half of the leg. An apparently heat-related problem in the relays of the bow thruster control circuitry in the engine room resulted in the loss of power to the bow thrusters on several occasions varying in duration from one minute to over an hour. Power to the thrusters would be lost and regained again before the malfunctioning component could be identified.

The problem with the computer going off line following loss of acoustics is believed to have been resolved by replacing two circuit cards during the transit to Funchal for crew change. Troubleshooting of this problem involved artifically inducing computer failure and thereby risking a positioning excursion. The problem was therefore not resolved while the drill string was in the hole.

The reason for the changes of several hundred feet in the ship's position between re-entries with no change in offset settings is not completely understood. External forces, such as the effect of subsurface currents, have been suggested. It was observed on review, however, that the major shifts at Site 416 accompanied changes in the ship's heading and/or the hydrophone array in use.

HYDROCARBONS

The risk of encountering hydrocarbon accumulations is considered greater in deep continental margin penetrations than in other deep sea drilling. For this reason a particularly stringent program of hydrocarbon monitoring was instituted for Leg 50 in accordance with recommendations of the JOIDES Panel on Pollution Prevention and Safety.

Gas samples were collected from the liners of all cores recovered and all cores were checked for fluorescence or oil staining. The gas samples were analyzed for relative concentrations of hydrocarbon gases by the ship's gas chromatographs. In addition, a prototype unit was provided by the French to analyze sediment samples. This unit provided data on the amount and type of organic compounds present. From this information, the degree of maturation of hydrocarbon compounds present and the potential for hydrocarbon generation could be assessed. In addition, a shale density plot was maintained to spot any sign of undercompaction indicative of abnormal geopressure.

Scientific personnel directly involved in the hydrocarbon monitoring program included a petroleum geologist, an organic geochemist and a specially trained technician who operated and compiled data from the pyroanalyzer.

No hydrocarbons were detected in the shallow exploratory Holes 415 and 416. Minor amounts of gas were encountered in Hole 415A below about 300 meters BSF but analysis data provided no indication of the proximity of a significant hydrocarbon accumulation. In Hole 416A, the first gas was sampled from about 450 meters BSF. The three samples collected above the continuous coring point (about 1180 m BSF) were typical of the apparently biogenic gas sampled in Hole 370. Upon commencement of continuous coring, a sharp rise in the proportion of ethane and heavier gases indicated a greater degree of maturation. The gas quantity, however, was miniscule and within the range of the very limited generation potential indicated for the sediments by the pyroanalyzer. The analyses were watched closely as operations progressed and the ratio of methane to ethane through pentane fell to consistently around 100. The gas quantity, however, continued to decrease until it was necessary to allow the cores to sit in rack for two hours before an adequate sample could be obtained.

No sign of interstitial liquid hydrocarbons was observed at any time during the leg.

ENGINEERING

In general, the ship's propulsion, generating and auxiliary machinery performed exceptionally well for the duration of the leg and little adverse effect on operations resulted.

On September 18, the propeller of bow thruster No. 1 apparently became fouled and began to overload its engine-generator. The thruster was deassigned for trouble-shooting. No bearing problems were indicated, but the propeller could be turned only with difficulty. After repeatedly "working" the thruster in both directions, the propeller began to free up gradually. Full operational capabilities were regained after a three hour interruption and no further problems were encountered with the thruster.

During routine generator cleaning and maintenance on October 24, the resistance to ground on the field winding of DC generator 9B was found to be far below the "danger level". Considerable efforts made to correct the situation by cleaning and drying were unsuccessful. The field insulation had apparently broken down and the generator was secured for the duration of the cruise. The unit was kept on standby in case of emergency. Its loss had no direct effect on operations but some flexibility in power assignment was lost. If three propulsion generators had been required for positioning, only one generator would have been available for the drawworks. It was also necessary to complete the leg with two engines assigned to AC generators instead of three.

In addition to his normal duties, the ship's electrician spent a great deal of time in conducting a survey of the vessel's AC load distribution. "E-call" phone stations were installed by the electrician on the cementing unit and on the fantail. These installations will contribute to increased operating efficiency and personnel safety.

DECK AND UNDERWAY

In addition to their indispensible functions of maintenance and upkeep of the ship's topside areas, deck personnel aided the operational effort on several occasions. Their proficiency in long splicing the sandline resulted in saving the line at minimal cost in operating time. In addition to splicing wireline and handling slings, they were available to pour wire rope sockets on several occasions. Seamen were of valuable assistance in moving and interchanging the logging cable assemblies.

Alert and timely action by the ship's officers prevented major positioning excursions on several occasions when the positioning system failed.

Cruising time was limited to only a little over seven days. It was fairly uneventful with the exception of a period of rough weather when the ship's heading resulted in rolls to 20 degrees. Head winds, sea conditions and marine growth on the hull combine to produce a below normal average speed of advance of 8.1 knots.

WEATHER AND CURRENTS

Weather conditions for the first half of the leg were generally excellent and of little or no operational significance. During the latter month, however, the onset of autumn weather patterns resulted in the passage of numerous trailing fronts related to North Atlantic weather systems. These conditions provided a pattern of fairly heavy northwesterly swells and unsettled local weather.

On October 6, a strong northwesterly swell combined with moderate northeasterly wind and current to produce vessel motion in excess of operating limitations. On October 15 and 16, wind and current combined to tax propulsion and thruster power to the limit while thruster wash and wave action resulted in frequent loss of acoustics. Temporary marginal conditions existed on several other occasions.

The currents at both sites appeared to be a combination of open ocean, longshore and tidal elements. Definite patterns of diurnal direction changes were noted. Changes in strength were also suspected, but the CHALLENGER has no effective means of measuring current velocity. The velocity of the currents did not appear to exceed about two knots at any time. Current was not a significant individual force but changes of direction into or out of alignment with the wind would tend to tip the balance in times of marginal wind/swell conditions.

COMMUNICATIONS

A reliable radio link with Scripps Station WWD was not established on Leg 50 and only a few messages were exchanged by this means.

Virtually all the message traffic was handled through the U.S. Navy's secondary circuit. Messages to the CHALLENGER were copies from the Mercast System and outgoing traffic was handled by the Naval Communications Station in Greece, although a few messages went through the stations at Guam and Northwest Cape, Australia.

Communications with Europe were satisfactory with several personal commercial phone calls made and messages sent.

Three commercial phone calls were made to DSDP at La Jolla via Portishead Radio in England with variable degrees of success. Numerous personal phone calls were made via amateur radio operators for the benefit of shipboard personnel.

PERSONNEL

With the exception of a seizure suffered by a rotary helper prior to the ship's initial departure from port, no serious diseases or injuries occurred. A few rather severe cases of cold and influenza-like symptoms occurred early in the cruise.

In general, shipboard morale remained high throughout the cruise. The variety and pace of operations and the numerous problems encountered provided challenges for virtually everone and there was little time for boredom or introspection.

The Global Marine crew once again exhibited great enthusiasm, resourcefulness and cooperation in making complex drilling and re-entry systems work and in overcoming repeated operational problems.

Glen N. Foss

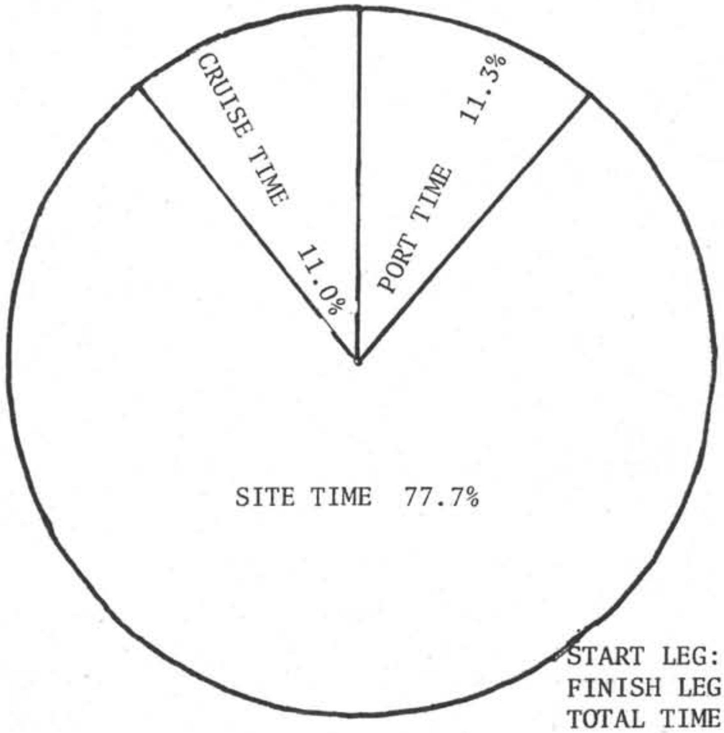
Glen N. Foss
Cruise Operations Manager
Deep Sea Drilling Project

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 50

Total Days (September 4, 1976 - November 10, 1976)		66.49
Total Days In Port		7.53
Total Days Cruising		7.28
Total Days On Site		51.68
Trip Time	15.6	
Drilling Time	6.2	
Coring Time	11.3	
Stuck Drill Pipe	1.9	
Position Ship	0.2	
Mechanical Downtime	2.6	
Re-entry and Related	6.8	
Logging	2.9	
Other	4.2	

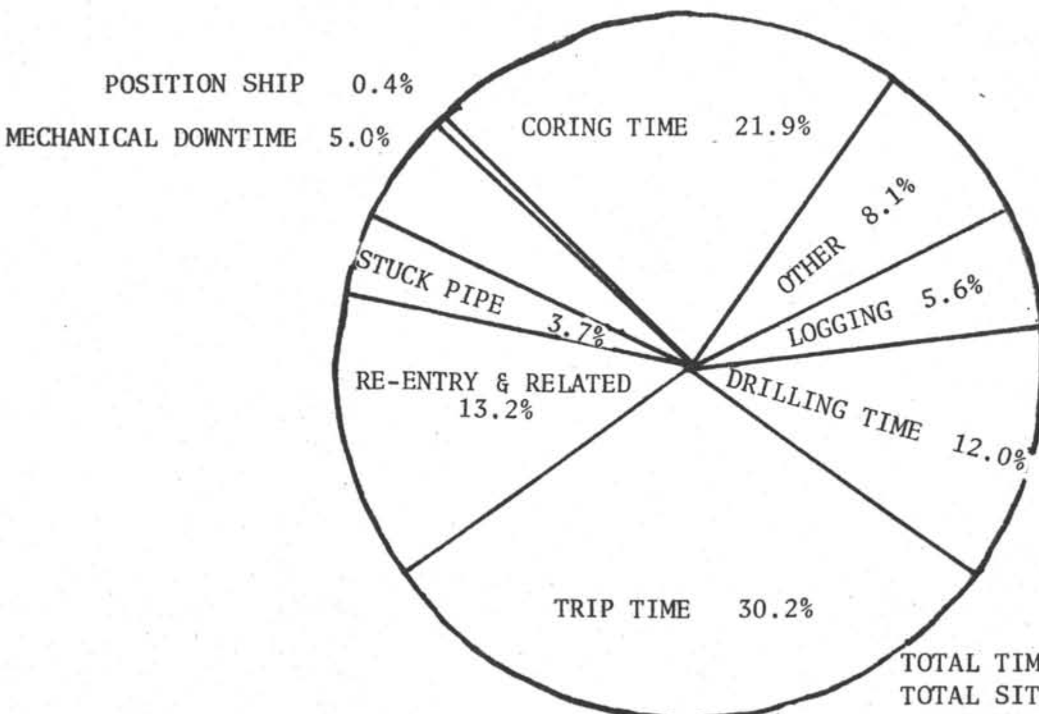
Total Distance Traveled (nautical miles)	1334
Average Speed (knots)	8.1
Sites Investigated	2
Holes Drilled	5
Number of Cores Attempted	80
Number of Cores With Recovery	78
Percent of Cores With Recovery	97.5
Total Meters Cored	707.3
Total Meters Recovered	357.6
Percent Recovery	50.6
Total Meters Drilled	2354.7
Total Meters Penetration	3062.0
Percent Penetration Cored	23.1
Maximum Penetration (meters)	1624.0
Minimum Penetration (meters)	64.0
Maximum Water Depth (meters)	4203.0
Minimum Water Depth (meters)	2817.0

TOTAL TIME DISTRIBUTION
LEG 50



START LEG: September 4, 1976
FINISH LEG: November 10, 1976
TOTAL TIME: 66.49 Days

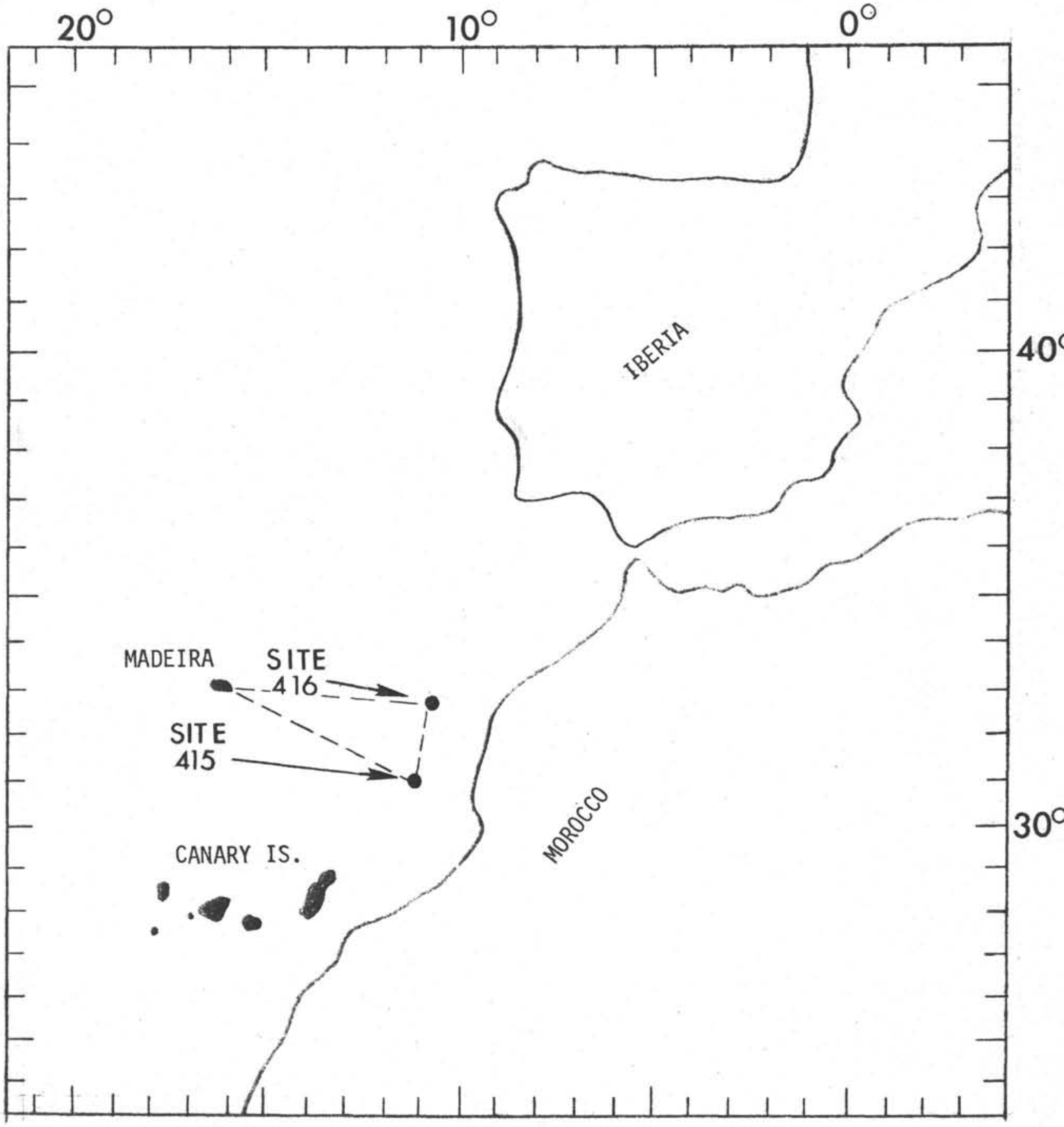
...ME DISTRIBUTION
LEG 50



TOTAL TIME ON SITE: 51.68 Days
TOTAL SITES: 2
TOTAL HOLES: 5

LEG 50 DRILL SITES

MADEIRA — MADEIRA



INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 50

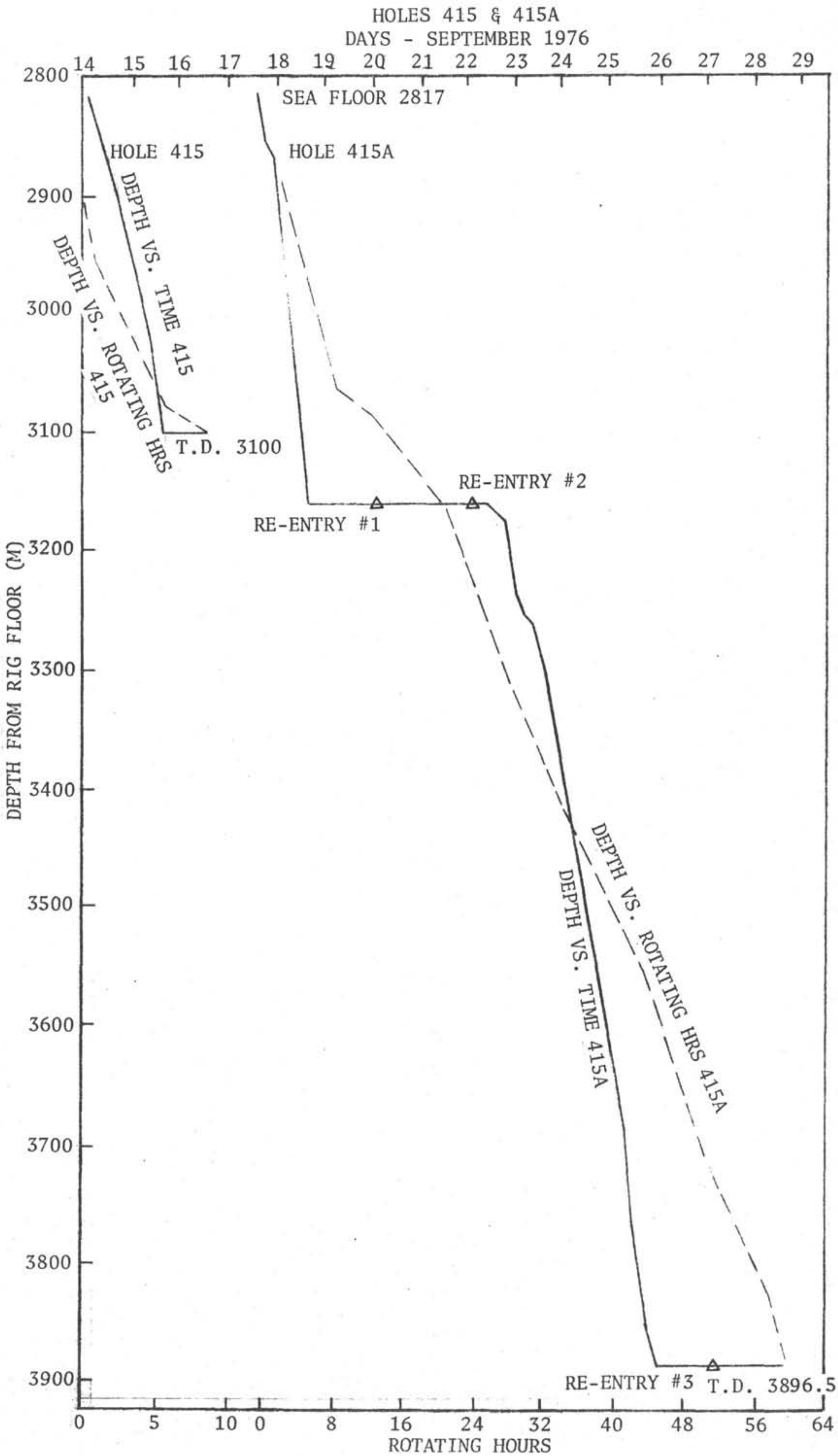
Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
415	Smith	10"	93CJS	HM618	45.5	237.5	283.0	8.1		Released on bottom.
415A	Smith	14-7/8"	F94C	697AN	- -	281.5	281.5	18.0	TO-B2-SQ-I	Rerun. Total hrs approx. 48. Approx half jetting time.
415A	Smith	10"	F93CK	958EL	122.5	612.5	735.0	47.1	TO-B1-SE-I	3 hrs drilling cement shoe. 8 hrs w/junk from plug in hole.
415A	Smith	10"	F93CK	960EL	- -	- -	- -	1.5*	TO-BO-SE-I	*Sidetracked hole. Approx 17.5 hrs cleaning hole.
416	Smith	14-7/8"	F94C	697AN	2.0	10.0	12.0	0.2	TO-B2-SQ-I	Apparently deflected & slipped on bottom. Bent BHA.
416A	Smith	14-7/8"	F94C	697AN	- -	42.0	42.0	67.0*	TO-B2-SQ-I	*Total jetting time. Wash in casing.
416A	Smith	10"	F93CK	964EL	53.0	998.0	1051.0	59.2	T1-B7-0-1/8	Some chert.
416A	Smith	10"	F93CK	965EL	230.1	86.0	316.1	57.0	T1-B7-I	Claystone/shale with some hard sandstone.
416A	Smith	10"	F94CK	355BV	47.0	- -	47.0	27.0	TO-B1-I	Couldn't make it-drill waxy claystone.
416A	Smith	10"	F93CK	966EL	134.6	1.0	135.6	51.5	TO-B1-SE-I	Claystone with limestone stringers.
416A	Smith	10"	F93CK	960EL	18.8	- - -	18.8	12.5	TO-BI-SE-I	Total bottom hrs about 14. Rerun after Hole 415A.
416A	Smith	10"	F93CK	962EL	19.0	- - -	19.0	2.3	- - - - -	Washed in-released on bottom.
416A	Smith	10"	F93CK	966EL	- - -	- - -	- - -	- - -	- - - - -	Rerun-washed in-released in hole.

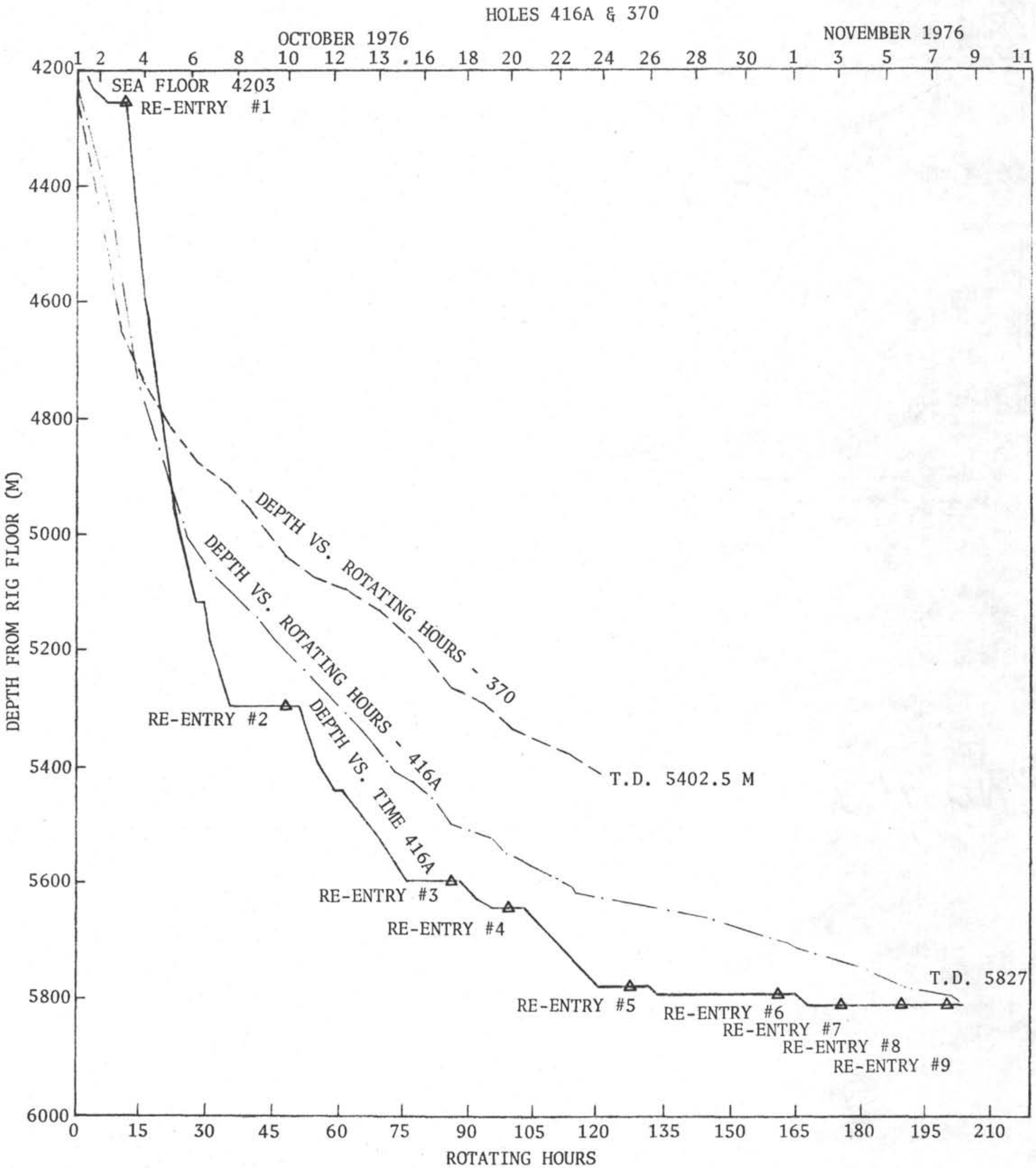
INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 50

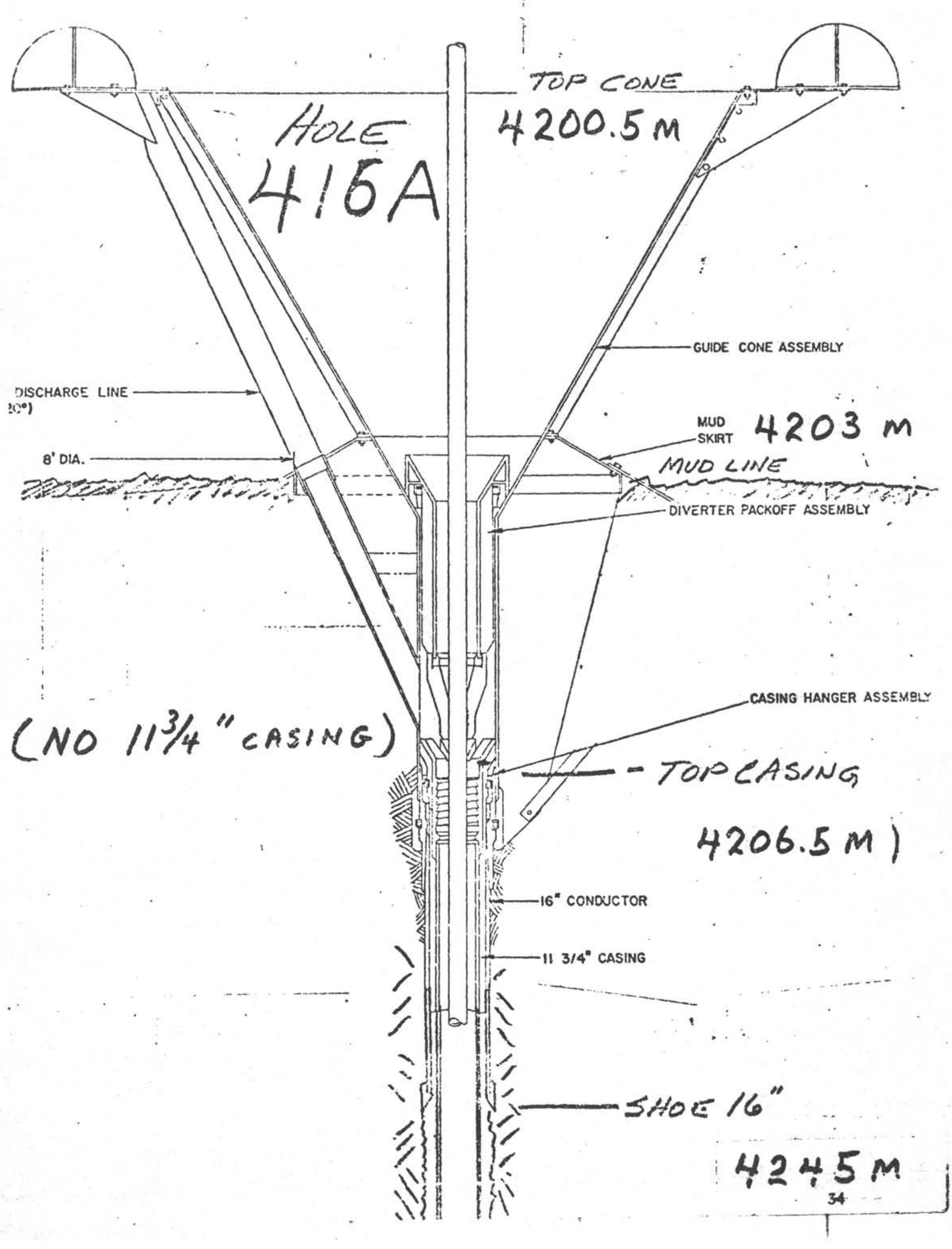
Site	Make	Freq. kHz	Serial Number	Site Time Hours	Remarks
415A	Benthos Double Life	13.5	002	369.3	Signal about 1/2 as strong as ORE. Otherwise satisfactory.
416A	ORE Double Life	16.0	373	912	Began to fade after 38 days.
416A	ORE Double Life	13.5	367	289.9	Dropped prior to departure for crew change. Strong at final departure.

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 50

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
9-4-76 9-13-76		39.2								172.0			211.2	1st line Funchal to arrival 415
9-13-76 9-16-76	415		15.8	11.7	8.1			1.5	10.7		0.8	26.1	74.7	Wkr. valve logging
9-16-76 9-28-76	415A		66.5	60.8	25.8	25.5			15.1		67.2	29.4	290.3	Sand line logging [illegible]
9-21-76	415B			0.4	3.9								4.3	Missed re-entry
9-28-76 9-29-76		15.5											15.5	Site 415 to site 416
9-29-76 9-30-76	416		16.0		2.6			1.5				3.3	23.4	Bent BHA
9-30-76 10-26-76	416A		157.9	77.1	222.4	12.6	2.8		34.8		[illegible]	[illegible]	[illegible]	[illegible] line positioning [illegible] hose hole trouble
10-26-76 10-30-76		80.4								8.6			89.0	To port, crew change & return
10-30-76 11-8-76	416A		117.0		8.0	8.5		1.6	2.0		[illegible]	51.2	216.1	Continuation hole trouble logging
11-8-76 11-10-76		39.4											39.4	Departure 416 to arrival Funchal
TOTALS		174.5	373.2	150.0	270.8	46.6	2.8	4.6	62.6	180.6	164.2	165.1	1595.8	


HOLES 415 & 415A
DAYS - SEPTEMBER 1976
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
SEA FLOOR 2817
HOLE 415
HOLE 415A
DEPTH VS. TIME 415
DEPTH VS. ROTATING HRS 415
T.D. 3100
RE-ENTRY #1
RE-ENTRY #2
DEPTH VS. ROTATING HRS 415A
DEPTH VS. TIME 415A
RE-ENTRY #3
T.D. 3896.5
DEPTH FROM RIG FLOOR (M)
2800
2900
3000
3100
3200
3300
3400
3500
3600
3700
3800
3900
0 5 10 0 8 16 24 32 40 48 56 64
ROTATING HOURS


HOLES 416A & 370
OCTOBER 1976
NOVEMBER 1976
1 2 4 6 8 10 12 13 .16 18 20 22 24 26 28 30 1 3 5 7 9 11
SEA FLOOR 4203
RE-ENTRY #1
DEPTH VS. ROTATING HOURS - 370
DEPTH VS. ROTATING HOURS - 416A
DEPTH VS. TIME 416A
RE-ENTRY #2
T.D. 5402.5 M
RE-ENTRY #3
RE-ENTRY #4
T.D. 5827
RE-ENTRY #5
RE-ENTRY #6
RE-ENTRY #7
RE-ENTRY #8
RE-ENTRY #9
DEPTH FROM RIG FLOOR (M)
4200 4400 4600 4800 5000 5200 5400 5600 5800 6000
0 15 30 45 60 75 90 105 120 135 150 165 180 195 210
ROTATING HOURS


TOP CONE
4200.5 M
HOLE
416A
GUIDE CONE ASSEMBLY
DISCHARGE LINE
MUD SKIRT
4203 M
8' DIA.
MUD LINE
DIVERTER PACKOFF ASSEMBLY
CASING HANGER ASSEMBLY
(NO 11 3/4" CASING)
TOP CASING
4206.5 M)
16" CONDUCTOR
11 3/4" CASING
SHOE 16"
4245 M

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
SITE SUMMARY

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
415	31° 01.72'N	11° 39.11'W	2817	5	5	100.0	45.5	31.3	68.8	237.5	283.0	34.5	74.7	
415A	31° 01.65'N	11° 39.97'W	2817	14	12	85.7	122.5	24.7	20.2	957.0	1079.5	17.4	290.3	
415B	31° 01.65'N	11° 39.97'W	2817	2	2	100.0	17.0	3.1	18.2	47.0	64.0	85.0	4.3	
														369.3
416	32° 50.17'N	10° 48.06'W	4203	2	2	100.0	11.5	1.3	11.3	- - -	11.5	- - -	23.4	
416A	32° 50.18'N	10° 48.06'W	4203	55	55	100.0	491.8	295.3	60.0	1113.2	1605.0	7.1	631.9	
416A	Continuation		4203	2	2	100.0	19.0	1.9	10.0	- - -	19.0	8.3	216.1	
														871.4
			TOTALS	80	78	97.5	707.3	357.6	50.6	2354.7	3062.0	11.1		1240.7

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONAL RESUME
LEG 51

SUMMARY

Legs 51 and 52 of the IPOD Program were designed to drill a deep multiple re-entry hole to study the older western Atlantic crust. Operationally, Leg 51 was manned by two different crews and their work is described separately herein. The first part, Leg 51A, consisted of the transit from Funchal and the drilling of the exploratory holes at general Site 417 at the Bermuda Rise. The second part, Leg 51B, includes the setting of the re-entry cone and multiple bit runs.

SUMMARY OF LEG 51A

After a transit of the Atlantic Ocean from Funchal Harbor, Madeira Island to San Juan, Puerto Rico, the first part of Leg 51 began on November 23, 1976 and ended on December 13, 1976, again, in San Juan. During this part of Leg 51, the CHALLENGER traveled 868 nautical miles and drilled two holes at one site. The water depth at this site was 5478 meters. The two holes were 113 meters and 421 meters deep, respectively. A total of 429.5 meters of cores were recovered, a recovery percentage of 58.7%.

Time distribution for Leg 51A was 5.77 days in port with an additional 1.64 days of equipment breakdown. 4.9 days were used in cruising plus 0.4 days of associated equipment breakdown and 8.03 days on-site. The on-site time consisted of 1.14 days tripping, 0.02 days drilling, 5.7 days coring, 0.28 days positioning the ship, 0.49 days of mechanical downtime and 0.4 days in miscellaneous activities. No time was lost due to unfavorable weather conditions.

TRANSIT FROM FUNCHAL, MADEIRA TO SAN JUAN, PUERTO RICO

Leg 50 was completed on November 10, 1976 at 0626 hours when the GLOMAR CHALLENGER arrived in Funchal, Madeira. Some provisions, fuel and water were taken aboard, as well as loading 40 joints of 11-3/4" R-3 casing before the ship departed for San Juan at 0234 hours on November 11, 1976.

During the transit, many things were accomplished. A representative from the Magnaflux Corporation was on board. Such things as the bottomhole assembly, nine sets of 250-ton and two sets of 350-ton elevators, the Bowen swivel, torque arms for the Bowen unit and heave compensator, bails, pup joints, latch subs were inspected using the "magnaflux" magnetic particles systems. In addition, the welds on the pedal stools, the mouse and rat holes, and the welding associated with the moon pool were inspected.

While this was being accomplished, a set of windshield wipers were installed on the Schlumberger unit and the operation of its electric motor was checked. A new sprocket assembly was installed on the pipe stabber.

All the pieces of equipment inspected were primed and painted after inspection. In addition, new handles were put on break out tongs and new clamps were installed on the tires of the heave compensator hoses.

Also, while underway, measurements were made to check out the ship's stabilizer system. In addition, about nine hours were spent making dynamic positioning tests, but a computer problem went unsolved; to be worked on in San Juan.

The transit ended with the first line on the dock at 1936 hours on November 23, 1976. Time underway was 12-1/2 days.

SAN JUAN PORT CALL

The port call in San Juan, prior to departing for Site 417, was involved with the usual loading of supplies such as groceries, acetylene, oxygen, mud and barite. In addition, the drill pipe was given a "Sonoscope" inspection. The electric motor for the No. 2 mud pump was used to replace a drawworks motor which was removed for repairs. The drawworks electric brake was inspected. Some of the 250-ton elevators and the special "duomatic" elevator bushing were cracked and repaired in San Juan. Some 250-ton and all 350-ton elevators were cracked and sent to Houston for repairs. Three re-entry cones were loaded on board with one assembled in anticipation of placing it in position during Leg 51. While supplies were being loaded and repairs being made, the positioning system was also worked on in hopes of correcting problems that had developed on Leg 50. On November 28, after all the supplies, new equipment and repaired equipment had been placed on board, the ship left the dock at 1750 hours to travel to an area outside the harbor where the positioning system could be checked and adjusted.

The ship traveled approximately five miles into about 2,000 feet of water and a 16 kHz beacon was hung over the side to check the equipment. However, a shackle pin broke and the beacon dropped to the bottom. The testing continued for about 3-1/2 hours at which time it was determined that the equipment was unsatisfactory and it would be necessary to return to port to efficiently effect necessary repairs. The ship was alongside the dock at 0552 on November 29th.

While the positioning equipment was being repaired, the sandline was unspooled and respooled. During the respooling, a kink developed and it was necessary to make a long splice before the balance of the line could be respooled.

At 0707 on November 30, the ship again left the dock to travel to the spot where the beacon had previously been dropped to troubleshoot the positioning system. After about 12 hours of maneuvering, the equipment appeared to be operating satisfactorily and the technicians were transferred to a tug and at 1736 the ship departed for Site 417.

SITE 417

The site chosen for Leg 51 was located near 25°N and 68°W at the southern end of the Bermuda Rise to evaluate the older western Atlantic Ocean crust. This multiple re-entry site had been shifted about five degrees south from its original location to take advantage of the better winter weather conditions. After approximately 48 hours of travel and profiling, the beacon (13.5 kHz D.L.) was dropped at 1810 on December 2, 1976. At 2225, the ship was positioning in an automatic mode and makeup of the drill string was begun.

There was a difference of opinion on how to read the PDR as to what the water depth was at the chosen location. This difference varied from 5471 meters to 5478 meters. Two water cores were taken before the correct water depth of 5478 was verified with a core. The hole was then washed without rotation to 5591.0 meters which established the amount of 16" casing as 113 meters that could be washed in with the re-entry cone.

SITE 417A

After completing Hole 417, the drill pipe was pulled above the mudline and the ship was offset 650 feet to the southwest at the request of the Co-Chief Scientists. This hole was spudded at 2015 hours on December 3. The hole was continuously cored from the mudline; heat flow measurements were taken following Cores No. 6, 9, 12, 15, and 19. The heat flow measurements were discontinued after Core No. 19 because basaltic material was recovered in Core No. 22 and therefore the material was considered too hard.

While cutting Core No. 47 (5895.2 - 5899.2 m), it became necessary to discontinue coring and pull pipe to clear the mudline because both bow thrusters failed. The pipe was pulled with no apparent damage to the drill string. However, when all of the pipe had been recovered, it was found that the bit release had been activated prematurely dropping the bit and bit release sub. The bit release sub had been included in the bottomhole assembly so the hole could be logged with downhole logging equipment after the bit had been drilled to destruction. After the drill string was recovered, the ship departed this site to return to port to make the necessary repairs to the bow thrusters.

DRILLING AND CORING ASSEMBLY

The bottomhole assembly used on this part of Leg 51 was the standard DSDP assembly with the exception that the bit disconnect assembly was included because it was planned to log the hole with downhole logging equipment after the bit was worn out.

The bottomhole assembly consisted of a bit, bit disconnect sub (with float valve), top connector core barrel, three 8-1/4" drill collars, one 5-foot stroke bumper sub, three 8-1/4" drill collars, two 5-foot stroke bumper subs, two 8-1/4" drill collars, one 7-1/4" drill collar, one heavy wall 5-1/2" drill pipe. Core recovery was quite good averaging 60% and this was the same for the 200 meters of claystone as well as the 221 meters of crustal material.

The only equipment that was lost on this leg was the bit disconnect sub, bit, and inner core barrel. When it was necessary to terminate drilling due to the bow thrusters failure and weather, it was decided not to attempt to retrieve the inner barrel before laying down the drill string. When the outer barrel reached the derrick floor, it was discovered that the bit disconnect sub had released prematurely and had allowed the inner barrel to drop to the bottom. The reason for this unexpected release has not yet been determined.

BITS

Only one F-93CK bit was used on this leg for a total penetration of 584 meters. Based on the interpretation of the geophysical records, it was anticipated that there would be a sedimentary section of about 400 meters which resulted in the F-93CK being selected. However, when it developed that there was only 200 meters of relatively soft claystones, there was some concern that the bit would fail before a significant amount of basalt could be penetrated. However, it was a pleasant surprise that the bit had over 52 hours of rotating time and the core diameter was still better than 5.1 cm when the thrusters failed. Unfortunately the bit was lost when the bit disconnect sub was released. It would have been helpful for future drilling to see what had happened to this longer toothed bit while drilling in crustal material.

BEACONS

Three ORE beacons were used during this leg and all performed well. One beacon was inadvertently dropped when the shackle pin broke at the positioning test site. The second was used for positioning while on Site 417 and 417A. The third beacon was dropped at Site 417 prior to departure for San Juan crew change and bow thruster repair. This last beacon could be used to locate this area in the event that the site is selected for the setting of a re-entry cone.

POSITIONING

Positioning was generally good on this leg, however, there were some sags of 100' $\pm$ in the "Y" occasionally in light winds. This seems to be an intermittant hardware problem and is being investigated. Winds of 40 mph were experienced near the end of the leg; the ship help generally within 60 feet except for gusts across the bow and the "Y" would sag 100 to 200 feet. The system recovered normally after these gusts. The site was abandoned when an overspeed occurred on the bow thrusters causing one trunk shaft to bend and pull out of the coupling box and the other trunk shaft to bend and shear off at the top coupling box. When these failures occurred, the ship was placed in manual while the drill string was recovered.

HEAVE COMPENSATOR

The heave compensator was not used on this leg because first, the sediments were soft and it was planned to put the heave compensator in the string when they became firmer. Next, at 100 ± meters, the cores changed to crustal material abruptly. After four cores had been cut in this material, plans for connecting the heave compensator were initiated. However, the hole showed a tendency to fill with rubble; therefore, it wae necessary for the safety of the drill string not to connect the heave compensator. This proved to be fortunate because when the thrusters failed, it allowed pulling doubles instead of singles to clear the mudline.

HEAT FLOW

Five heat flow measurements were taken at Hole 417A. Four of these were successful. The one that failed apparently did not start when activated with the magnet. The measurements were discontinued when hard crustal material was encountered. A total of about ten hours were required to make these measurements, or about two hours per run. This was good considering a water depth of approximately 18,000 feet.

LOGGING

Downhole logging had been planned for the pilot hole, however, this was not accomplished due to the bow thruster failure. The Schlumberger engineer had modified the caliper arm to pass through the latch assembly. This problem, which appeared on Leg 50, then required the removal of the caliper assembly before the tool could be run into the open hole. The tool, however, could not be centralized and the data recorded was not as reliable as desired.

COMMUNICATIONS

As in the past, when the CHALLENGER has been working in this general area, daily communications of 17 mHz with Radio WWD were maintained with little or no interference. Usually communication was best between 1600 and 2000. Likewise, voice communications via radio with the marine operator in Miami was good and easily established at almost any time. In addition, personal telephone calls were made each Sunday for the convenience of everyone on board.

Both radars operated satisfactorily after considerable repair work was done on one of them by our radio operator. The total volume of traffic was normal for the average leg and was handled with no problems.

ACKNOWLEDGEMENTS

Although this part of Leg 51 was short as compared to normal legs, the Global Marine personnel and Scripps technicians were extremely helpful. They performed efficiently and contributed greatly to the scientific accomplishments of the leg.

The scientific party was dedicated in achieving what scientific objectives could be accomplished during the abbreviated drilling period. A great deal of pleasure was derived from their dedication and enthusiasm.

Robert R. Knapp
Cruise Operations Manager
Deep Sea Drilling Project
Leg 51A

INTERNATIONAL PHASE OF OCEAN DRILLING

DEEP SEA DRILLING PROJECT

OPERATIONS RESUME

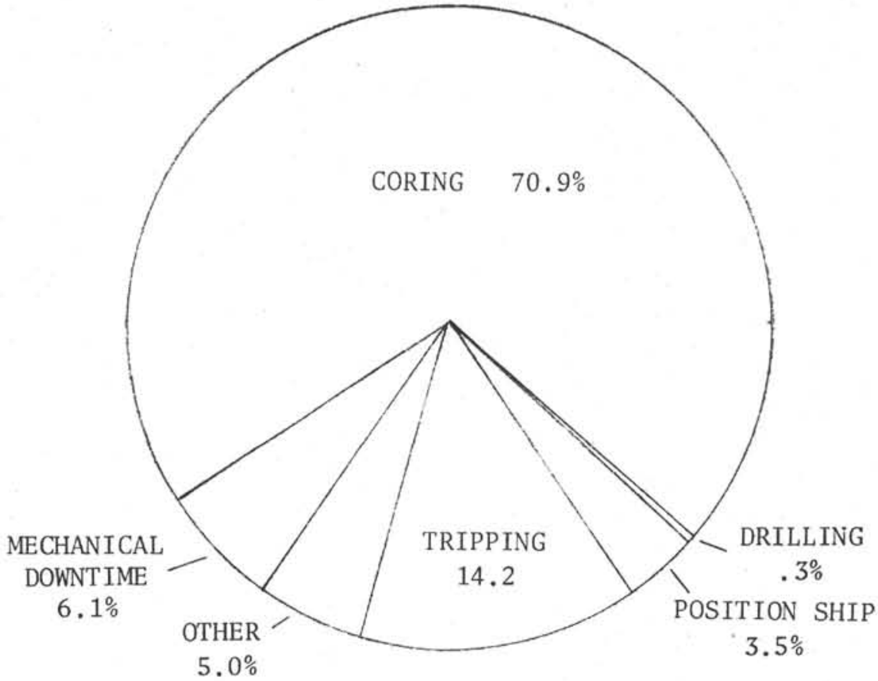
LEG 51A

Total Days (November 10, 1976 - December 13, 1976)	33.2
Total Days In Port	5.77
In Port Downtime	1.64
Total Days Cruising Including Site Survey	17.37
In Transit Downtime	.41
Total Days On Site	8.03

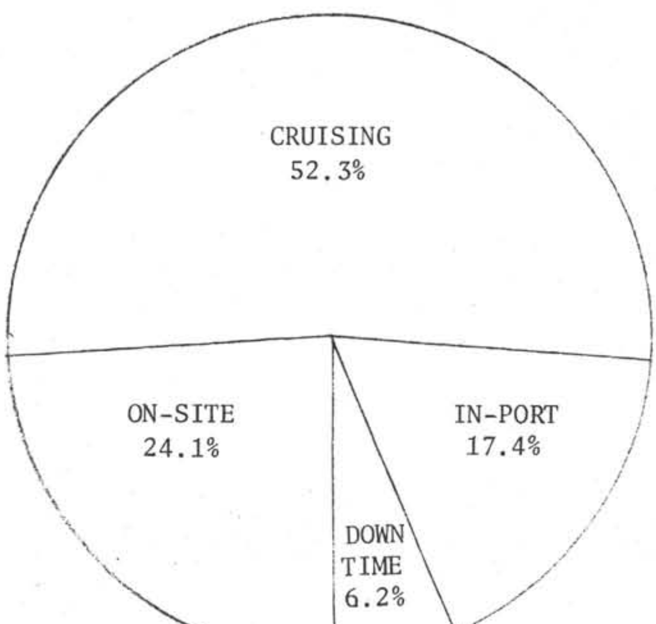
Trip Time	1.14
Drilling Time	0.02
Coring Time	5.7
Position Ship	0.28
Mechanical Downtime	0.49
Waiting On Weather	0.0
Other	0.4

Total Distance Traveled (Nautical Miles) Including Transit & Survey	3702
Average Speed	9.14
Number of Sites	1
Number of Holes Drilled	2
Number of Cores Attempted	48
Number of Cores With Recovery	44
Percentage of Cores With Recovery	91.6%
Total Meters Cored	429.5
Total Meters Recovered	252.21
Percent Recovery	58.72%
Total Meters Drilled	113.0
Total Meters of Penetration	534.0
Percent of Penetration Cored	80.4%
Maximum Penetration (meters)	421.0
Minimum Penetration (meters)	113.0
Maximum Water Depth (meters)	5478.2
Minimum Water Depth (meters)	5478.2

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
LEG 51A
ON-SITE TIME DISTRIBUTION



TOTAL TIME DISTRIBUTION
LEG 51A



INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 51A

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
417	Smith	10"	F93CK	959EL	8.5	- -	8.5	.4		
417A	Smith	10"	F93CK	959EL	421.0	- -	421.0	52.6		Dropped when bit sub released.

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 51A

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	
Test Site	ORE	16.0 S.L.	351	45+	Dropped while working on positioning problems just outside of San Juan Harbor.
417 & A	ORE	13.5 D.L.	396	181+	Dropped 1810 December 1, 1976.
417A	ORE	16.0 D.L.	375		Dropped for return to site December 10, 1976 2347 hours.

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 51A

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 M/Hr.	Time On Hole Hr.	Time On Site
417	25° 06.71'N	68° 02.57'W	5478.2	1	1	100.0	8.5	3.6	42.4	113.0	113.0	225.0	22.6	
417A	25° 06.63'N	68° 02.48'W	5478.2	47	43	91.5	421.0	248.61	59.0	- - -	421.0	8.06	170.2	192.8
			Total	48	44	91.6	429.5	252.21	58.72	113.0	534.0	8.06	192.8	192.8

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 51A

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
11-10-76 11-11-76										20.2			20.2	IN PORT FUNCHAL
11-11-76 11-23-76		299.0							10.0*				309.0	U/W TO SAN JUAN *POSITIONING SYSTEM
11-23-76 11-28-76										118.2			118.2	IN PORT SAN JUAN
11-28-76 12-2-76		56.1							39.3*				95.4	SAN JUAN TO SITE 417 * POS. SYSTEM
12-2-76 12-3-76	417		14.7	0.4	3.9			3.6					22.6	
12-3-76 [illegible]	417A		12.2		135.6			3.0	11.0*			5.4**	170.2	* SAND LINE ** HEAT FLOW
12-10-76 12-13-76		61.0							0.2				61.2	SITE 417 TO SAN JUAN
TOTALS		416.1	26.9	0.4	139.5			6.6	60.5	138.4		5.4	796.8	

SUMMARY OF LEG 51B

Leg 51B of the International Phase of Ocean Drilling was a continuation of deep crustal investigation at Site 417 on the southern Bermuda Rise. Exploratory drilling had been done on Leg 51A to the extent allowed by a single bit. The GLOMAR CHALLENGER returned to the site on Leg 51B to set a re-entry cone and to proceed with a deep multiple-bit penetration.

The total depth of penetration achieved on Leg 51B fell short of expectations due to a series of operational setbacks. Site operations were terminated two days early by a combination of a premature pipe trip and an unfortunate spate of injuries involving the rig crew. Despite these limitations, the re-entry cone was emplaced, three successful re-entries were made, downhole logs were run and a significant amount of both sediment and basalt coring was done. A hole reaching about 240 meters into basement and in excellent condition was left for further drilling on Leg 52.

The leg commenced on December 13, 1976 at San Juan, Puerto Rico and terminated at the same port on January 17, 1977. Total length of the cruise was 35 days of which 20.9 days were spent on site, 5.0 days under way and 9.1 days in port. 1.8 days of operating time were lost due to mechanical difficulties and one day of delay due to weather was experienced.

PORT CALL - SAN JUAN, PUERTO RICO

Leg 51B began at 0810, December 13, 1976 when the CHALLENGER berthed at Isla Grande, San Juan, Puerto Rico. The arrival was two days ahead of schedule due to a major mechanical failure of both bow thrusters.

A one day port call had been planned for Global Marine and technical crew changes and for minimal resupply. Procurement of parts and repair of the thrusters, however, delayed the vessel's departure for an additional eight days.

As the result of a failure in the electrical feedback system controlling bow thruster RPM, both thruster motors had run at speeds far in excess of the system's design. Both 12-foot intermediate drive shafts were severely twisted. In addition, there was damage to the shaft couplings, the lower stub shafts and the thruster right angle gear boxes. After the 750-horsepower vertical-shaft drive motors had been removed, it was found that the lower bearings and the shafts of both motors had also sustained damage.

Replacements for the intermediate shafts had to be fabricated in Holland while the motors were shipped by truck to a heavy machine shop in Ponce, Puerto Rico for machining.

A thorough investigation of the cause of the overspeed failure was made. A faulty exciter feedback relay was found to be the origin of the problem. Other deteriorated exciter components were found and replaced. A temporary overspeed alarm system was installed to aid bridge personnel in avoiding a runaway in the future.

Other significant maintenance items included the replacement of a main seawater circulating pump housing, inspection and rewelding of sandline sheaves, repair of an engine room ventilation supply fan and ABS inspections.

In addition to normal resupply, 1500 sacks of bentonite, 500 sacks cement and 11 drill collars were onloaded.

SAN JUAN TO SITE 417

The vessel departed her berth at 1050 hours, December 22 and proceeded to the vicinity of an acoustic beacon that had been dropped for positioning system tests at the beginning of Leg 51A. At this location, about five miles outside San Juan Harbor, about 15-1/2 hours were spent to assure proper functioning of the positioning system. The bow thrusters were run at progressively higher speeds to check for proper alignment and bearing installation. Response to the control system was tested and exciters, feedback circuits and tachometers were recalibrated. As a final integrated test the vessel held station on the beacon in the automatic mode for over an hour with no irregularities noted.

A harbor tug was dispatched to the CHALLENGER to remove the six personnel representing GMI, General Electric and Schottel, who had remained aboard for the "sea trials".

At 0350 on December 23, the vessel set course for the Bermuda Rise operating area. Good weather and a following current prevailed and an unusually rapid, average speed of 9.8 knots was realized. With the aid of satellite navigation, the signal of the beacon dropped at the end of Leg 51A drilling was acquired without a search pattern. The beacon was passed close aboard and a pre-site survey was initiated. The survey was complete and the vessel was positioning in the automatic mode at 0630 on Christmas day.

HOLE 417B

Site 417 is located on the Bermuda Rise near its southern terminus. The site is located about 400 miles north of Puerto Rico and 700 miles east of the tip of the Florida Peninsula. Two exploratory holes, 417 and 417A, had been drilled on Leg 51A to verify the geological and technical suitability of a multiple re-entry deep penetration at the site.

Hole 417B was an intermediate step to determine the proper length of 16-inch conductor casing to set with the cone. On the basis of wash-in tests with only a drill bit on Hole 417, a 84.5 meter string of casing was made up and attached to the drill string without a re-entry cone.

The water depth at Holes 417 and 417A had been determined to be 5478 meters. The new precision depth recorder reading was 5483 meters. As 417B was to be located with reference to a different beacon from that used for the first two holes, it was considered to be several hundred feet distant. It was therefore important to redetermine the water depth before setting the re-entry cone.

A positioning offset of 100 feet west was introduced prior to spudding the hole. The pipe was lowered to a depth of 5485 meters, then raised one joint while the inner core barrel was retrieved. No sediment was recovered and the procedure was repeated with the addition of one joint of drill pipe to a depth of 5494.5 m. On the basis of 5.2 meters of soft sediment core recovered and of weight indicator readings, a water depth of 5489 meters was established.

The casing was then washed into the sea floor with an initial pumping rate of about 175 gallons per minute. This was increased as the clay sediment became stiffer with depth to 400 gallons per minute. Washing progressed easily to a depth of 5513 meters where penetration slowed abruptly. An additional 43 minutes of pumping advanced the pipe only about three meters. The bumper subs above the casing running tool were put in neutral and the weight of casing and bottomhole assembly rested at bottom. After 15 minutes an overpull of about 25,000 pounds was required to move the casing. The procedure was repeated for a period of 45 minutes with the same results.

The test was considered complete with a total (but unexpectedly short) penetration of 27 meters and the drill string with casing was retrieved.

As the casing string was being recovered, a weather front passed through with squalls and wind gusts to 50 miles per hour. At one point the ship was blown an estimated 5,000 feet off station. Wind strength gradually declined to a light breeze during the ensuing day, but the ground swell had steadily increased to 10 to 12 feet during the same period. The next step, the keelhauling of the cone, required relatively good weather and a weather delay of 25 hours was endured while the swell slowly decreased.

HOLE 417C

Operations recommenced at 1000 on December 28. The re-entry cone, with an expendable bottomfinder pinger attached to the mud skirt, was keelhauled into place beneath the moon pool without incident. A 23 meter string of 16-inch casing was made up and hung off in the moon pool. (The casing and lower cone together would space the casing shoe 25-1/2 meters below the mud skirt). The bottomhole assembly was then made up. The short casing string allowed only two drill collars below the running tool. After latching the casing to the bottomhole assembly and the resulting assembly into the re-entry cone, the cone's support slings were cut free and the trip to the sea floor began.

When about two thirds of the pipe had been run, the derrickman was seriously injured in a rig accident. The extent of the injuries were not known and it was evident that he needed medical attention ashore as soon as possible.

The ship could not depart the site for port, however, until the cone/casing assembly had been washed in and released and the drill pipe pulled. It was felt that our position was outside helicopter range of land. The U. S. Coast Guard was contacted by radio, however, and a helicopter was dispatched from Puerto Rico. Even though a fueling stop was made at Turk Island, the pilot was too low on fuel to hover long enough after the basket litter was aboard to load the injured man's suitcase.

The 100 foot offset was removed and bottom was again "felt" by the weight indicator at 5489 meters and washing commenced immediately. Progress came to a virtual halt after 16 meters penetration. The pinger showed several meters to the sea floor, agreeing closely with drill pipe measurements. Pumping continued at 400 gallons per minute for about four hours with slow progress being made. Although the pinger had not yet been silenced by contact with bottom sediment, its PDR traces indicated no more than one meter to the mudline when decreases in both pump pressure and weight were noted. Cautious application of torque did not produce free rotation but it was attained after two joints of pipe were pulled. Also, the lack of change in the pinger trace told that the cone/casing assembly was no longer attached to the drill string.

The drill string was pulled and all hands waited to see if the casing running tool had released by itself or if the drill string itself had parted. On retrieval of the bottomhole assembly, it was found that the pin of the rotary connection of the lowermost bumper sub had failed and disengaged from the index sub. The bumper sub was also bent. This left the running tool still latched into the throat of the cone with only the box of the index sub "looking up" and no reasonable means of re-entry or fishing.

The bottomhole assembly was magnafluxed on retrieval as is standard practice after it has been subjected to severe stress.

HOLE 417D

A second re-entry cone was assembled and keelhauled as before a 26 meter casing string was made up. A bottomhole assembly with more bumper subs and modified weight distribution was assembled and once again the assemblage was connected.

A one thousand foot west offset was programmed to separate the two cones and to reduce chances of a re-entry attempt on the wrong cone.

After running the string to just off the sea floor, the power sub was picked up and a mudline punch core was taken. This was considered necessary due to the 1000 foot move and a PDR reading of 5492 meters. The string was lowered to put the shoe at 5496.5 m before it was pulled back. A 5.5 meter core was retrieved, indicating a depth of 5491 meters. The weight indicator "felt" bottom about two meters deeper.

The pump was started and the casing was spudded. This time washing-in proceeded at a reasonable pace until the casing shoe reached a depth of 5514 meters. At this point progress came to an abrupt halt, strongly indicating that the mud skirt had reached the sea floor. (The only operational pinger on board had been expended on the first cone. Its indication would have been welcome at this point). It did not seem unreasonable that the earlier depth measurements could be off by one or two meters and the water depth was again established at 5489 m. The "rotary" shifting tool was run on the wireline to release the assembly. The procedure went smoothly and the cone/casing assembly was "planted" at 2050 hours on New Years Eve.

As the sediment section had been continuously cored at Hole 417A, only spot coring was done to a depth of 144.5 meters BSF. Continuous coring began at this point and continued to total depth. Possibly due to the sticky nature of the clay, core recovery was not good in the sediment section which was, surprisingly, 135 meters thicker than at Hole 417A.

Basalt was finally encountered in the bottom of Core No. 21. Core No. 22 gave good recovery of basalt core but Core No. 23 came up empty. Two short cores were attempted that recovered only pebbles. A center bit was pumped down in an attempt to clear the apparent obstruction. Upon its retrieval, another short core was attempted, again without success. Scarring of the center bit and core catcher subs indicated a hard (probably metal) obstruction. It was therefore necessary to make a round trip to clear the obstruction and to change bits. The core bit had 25-1/4 rotating hours. When the bit was retrieved, the flapper of the float valve was found to be broken off and lying across the bit seal plate in the box of the bit. Both ears of the flapper were broken off and were recovered. The pin and spring were missing.

RE-ENTRY NO. ONE

When the bit had been changed and the casing running tool removed from the bottomhole assembly, the drill string was run to within four to five meters of the depth of the top of the re-entry cone. The logging sheaves were rigged and the sonar tool was lowered to the bit.

Near perfect weather and excellent range resolution by the sonar combined to produce a "textbook" re-entry. The cone target was initially acquired at a range of 70 feet. Plotting of the initial range and two subsequent moves of the ship gave three range circles that intersected nearly at a common point. The ship was offset to locate it over the common intersection of the circles and the drill bit moved directly over the cone. A successful stab was made after 36 minutes of scanning time.

After retrieving the sonar tool, running a stand of drill pipe to verify re-entry and rigging down the sheaves, the bit was run to bottom and coring recommenced. No significant bottom fill was noted by the driller, but solid basalt was encountered 10.1 meters shallower than the previously measured total depth. This was attributed to previously noted discrepancies in the ship's stationkeeping amounting to up to several hundred feet.

Fourteen basalt cores were cut with the second bit. Recovery was excellent and long, smooth core sections were recovered. The rock was quite fractured but the fractures were "healed" with calcite and alteration products. Weather was excellent for most of the period and the heave compensator was used on eight cores. It was out of the string with mechanical problems for the remainder of the time.

Although no signs of failure were noted, the bit was pulled after more than 40 hours. This was a truly exceptional bit life for basalt drilling and the decision to retire the bit was based on a desire to avert catastrophic bearing failure or loss of gauge.

When the bit had been retrieved, the special open-ended logging bottomhole assembly was made up. To provide for logging all the way up to the casing shoe, this consisted only of one drill collar with sonar landing sub, a bumper sub, and a crossover sub below seven joints of 5-1/2 inch drill pipe.

RE-ENTRY NO. TWO

The second re-entry attempt began with an experiment intended to determine conclusively that the ship's heading had a major impact on the vessel's position. On the first re-entry, the heading had been only five degrees off the cone setting heading and the cone was found to be only 70 feet away when scanning commenced. As weather conditions permitted it, scanning for the second re-entry began with the offsets used for the first re-entry but on a reciprocal heading. No target was acquired within the 500 foot range of the sonar. The ship's heading was then reversed and, after a few minutes required for the positioning system to "settle down", the cone target appeared near the edge of the screen. The target was closed to less than one hundred feet before additional maneuvering was done.

Considerable difficulty was experienced in positioning the ship for the stab attempt. After plotting and maneuvering the end of the pipe to within 35 feet of the cone on the second move, numerous ensuing moves failed to swing the pipe directly over the cone. The light bottomhole assembly is believed to have affected the drill string's behavior. Instead of displaying excessive motion as had been feared, however, it appeared to "deaden" the action of the string. Movement of the end of the string did not appear to follow the ship's motion when small offset increments were introduced. Also, the slow "pendulum" effect which generally causes the pipe to swing over the cone was greatly reduced.

A stab at a "nearly perfect" target pattern was made after two hours and 36 minutes. The pipe had apparently swung clear of the cone, however, and the string "took weight". Also, the hydrophone at the sonar tool was too quiet.

The drill string was raised to its former position and the scanning recommenced. The target remained close, but repeated minor offset changes failed to put the string in the right position. A somewhat larger stepout was attempted and the pipe swung over the target three hours and 21 minutes after the first stab. On this stab, the weight indicator showed that the pipe struck the rim of the cone and fell off to the side, taking weight from the sediment.

The pipe was again pulled back. After 20 additional minutes on the same offsets, a successful stab was made. Total time from beginning the search was six hours 28 minutes.

After the sonar tool had been retrieved and the re-entry verified, logging operations commenced. These operations are discussed in some detail later in this report. They required about 54-1/2 hours, including a short trip to clean the hole.

RE-ENTRY NO. THREE

On this occasion, weather conditions dictated that the ship's heading be maintained at 010°, 150° from the previous stab-in headings. Scanning commenced on the previous offsets and again, the cone target was out of sonar range. This time the ship was maneuvered by offsetting on the basis of satellite navigation fixes. Again, the cone target soon came into range.

The bit was again readily brought to within 40 to 45 feet of the cone but the drill string refused to swing over the cone. Weather conditions caused positioning to be somewhat unstable and the oscilloscope dot would remain only within a 60 to 80 foot radius much of the time. Several points with ranges of 35 feet were plotted and the ship was eventually moved to the center of this pattern for a bullseye and stab after three hours and four minutes of scanning. The new offsets differed from those of the previous stab by a linear distance of 740 feet.

About 45 meters of soft clay fill was encountered following the logging. Drilling was resumed with caution due to a thin steel standoff spring that had broken off a logging tool and remained in the hole. Although irregular torque was observed during the first meter or two of coring, no metal fragments were found in the core barrel.

The basalt bottom of the hole was tagged five meters high. This was again attributed to the fact that the ship was more directly above the hole than it had been before drilling stopped prior to the trip.

Five more cores were retrieved with excellent recovery. The core catcher was jammed on the sixth and only 2-1/2 meters were recovered. The next core barrel was retrieved empty after having been firmly stuck at the bit. The bottom of the core catcher was badly bent and dented. At this point another flapper valve failure was surmised as the symptoms appeared identical. One more core barrel was pumped down and a short core was attempted. This barrel did not stick but was retrieved empty. Marks on the core catcher sub indicated that it had not seated completely.

Chances of rectifying the situation without a round trip were considered slim. It was estimated that it would be possible to recover three or four additional cores before terminating operations to return to port if the round trip were started immediately. The drilling joints and power sub were set back and the trip began.

On the previous day, two members of the rig crew had been injured seriously enough to prevent them from working. With the crew now three men short, the Captain and Drilling Superintendent decided that two round trips in such a short time would be too hazardous for men working 18-hour days. A ship to shore phone call to San Diego was made to notify GMI and DSDP management of the situation and to finalize plans for arrival in port two days early.

The core bit was recovered with the flapper valve intact and with no obstruction. Minor damage to the flapper and to the bit seal plate confirmed that an obstruction had been present, however.

As the bottomhole assembly was being recovered, a fresh double-life acoustic beacon was launched. After the beacon had reached the sea floor and the signal quality had been verified, the positioning system was put into the semi-automatic mode and the new beacon frequency was selected. Readouts of the system indicated that the new beacon had drifted to a point 1320 feet west and 580 feet north of the re-entry cone during its descent. (The ship's heading and offsets were unchanged since the last re-entry

SITE 417 TO SAN JUAN

The difference in basement topography between Holes 417A and 417D presented a need for additional seismic profiling across the operating area. A post site survey was conducted for about four hours before the ship departed the site on an east-southeasterly transect of the Bermuda Rise. About 13 hours later, course was set due south for San Juan.

Good weather with light head winds was encountered and an average speed of advance of 9.1 knots was made good.

A stop of less than one hour was made on January 16 to calibrate the main shaft tachometers against computer output voltages.

At 0903, January 17, the first line was put over in San Juan and Leg 51B came to its official end.

DRILLING AND CORING EQUIPMENT

Various configurations of the standard DSDP bottomhole assembly were used depending on casing running tool, weight and heave compensator requirements. This consisted of nine 8-1/4" drill collars (including the outer core barrel), one 7-1/4" drill collar, two or three five-foot stroke bumper subs and crossover and core barrel subs. Seven joints of 5-1/2" drill pipe were run above the drill collars. Three 9-7/8" stabilizers were employed in the lower portion of the assembly. They were apparently effective as hole deviation was held to less than one degree off vertical.

The most serious drilling equipment failure was that experienced on December 29 when the pin of the rotary connection of the lowermost bumper sub failed and pulled out of the box of the index sub. Both the upper and mandrel sections of the bumper sub itself were bent and the connection apparently had buckled in compression without lateral support. The pin had collapsed slightly, allowing the threads to disengage. The pounding action of the heavy drilling assembly located above the single bumper sub during the long washing-in operation is blamed for the failure. No particular weakness in the construction of the connection is indicated.

The flapper valve failure that halted coring operations on January 3 was initially believed to be the result of simple impact of the landing core barrel. Further review of this failure and of the "obstruction" that precipitated the termination of operations on January 14 suggests that both were the result of basalt core fragments in the bit. Only two core catcher malfunctions occurred on the leg and they occurred on the two cores immediately preceding the two obstructions.

On Core No. 22, all the dogs had been stripped from the conventional core catcher by the entry of the core. The core was retained only because one of the dogs was jammed between core and liner about a foot above the catcher. No core occupied the catcher itself. Although 6.6 meters were recovered, subsequent recovery rates indicate that as much as two meters easily could have been lost. It is believed that a piece of basalt could have acted as a fulcrum under the flapper and caused the ears or the pin to snap upon the impact of the core barrel.

After about 2-1/2 meters had been cored on Core No. 45, a short segment of core had jammed in the lower portion of the slip type catcher. About 6-1/2 meters of core had evidently been ground up between that point and the cones of the bit. A piece of basalt perched on the bit seal plate beneath the flapper could have prevented its full opening and thus caused the failure of the inner barrel to seat fully.

The equipment failure with the gravest potential consequences occurred on January 7 when a crack opened in the wall of the 20-foot drilling pup joint with the full drill string suspended. The approximately two cm horizontal crack was located about 1.2 meters above the pin shoulder of the joint. Under tension the crack opened wide enough to spray considerable water, but it virtually disappeared when the drill string weight was removed. The failed joint will be sent to a laboratory for study.

After the conventional core catcher failure on Core No. 22, slip-type hard formation catchers were used on an alternate basis. Eleven cores were recovered with these catchers and no problems were encountered prior to the jam on Core No. 45. Ironically, the use of conventional catchers had just been discontinued after most of the dogs had been destroyed on Cores No. 42 and 44. The sudden upsurge in catcher problems was attributed to the more broken nature of the basalt being cored in a fault zone.

HEAVE COMPENSATOR

The heave compensator was left out of the string until the second bit run at Hole 417D. The inclusion of three bumper subs in the bottomhole assembly to facilitate setting the re-entry cone defeated much of the compensator's purpose as a great deal of time must then be spent drilling off the subs with the compensator closed and reduced weight on the bit.

As the compensator was being moved into position to be picked up following the first re-entry, the ram of the hydraulic rack operating cylinder snapped. The lower end of the racker arm came into contact almost immediately with a structural brace of the moon pool complex. Only this prevented the heavy compensator cylinder from falling across the rig floor and quite possible snapping the suspended drill pipe. The failure occurred at the very end of the ram where it is connected to a yoke. A pivot pin connects the yoke to the racker arm. It is believed that the pin was frozen in place and that the ram was subjected to a bending moment as the racker arm traveled through its arc.

The compensator cylinder was picked up without further incident. After four cores had been cut, the pilot valve began leaking and the system would not hold hydraulic pressure. Repairs to the rack operating cylinder had not been completed, but placid weather conditions prompted the decision to set the compensator back for repairs with the aid of the 50-ton crane and air tuggers.

The following day the racker arm had been repaired. The pilot valve assembly had been replaced with a rebuilt unit and the system had been tested. After the compensator had been picked up and stroked out, the pilot valve again failed to hold pressure. The compensator was locked but left in the string while troubleshooting progressed. The problem was eventually traced to a burned-out solenoid. The solenoid was replaced with a spare, but shortly after operations recommenced, the replacement solenoid burned out.

Troubleshooting continued with scant time available during logging operations. The electrician eventually isolated the problem to a voltage induced into the solenoid coil by nearby power cables which had been installed as part of an indicator light circuit. The final bit had already been run (with three bumper subs) when it was determined that the compensator could be operated satisfactorily with the already inoperative indicator circuits deenergized. Therefore, the compensator was not employed on the third bit run.

Although over 10-hours of mechanical downtime were attributed to the heave compensator, it is felt that its employment contributed to the long life of the second drill bit. (Eight of the 14 cores were cut with a heave compensated drill string).

CORE BITS

All bits used were 10-inch model F94CK Smith tungsten carbide insert roller cone bits. The first bit was used only for washing in casing on Holes 417B and 417C. It was lost when the bottomhole assembly parted on 417C.

Only one core bit was given a "full" run on this leg. The second bit on Hole 417D was pulled after 40.5 hours and was found to be in excellent condition, though very slightly under gauge. The life of this bit was about twice the historical average of similar bits used in basalt drilling the Project, even though many were run to destruction. In this case the decision to replace the bit was based on concern that rapid bearing failure could occur that would leave a bit cone in the hole and that the hard, abrasive basalt could significantly reduce bit gauge.

The other two bits run at Hole 417D were pulled early as a result of the previously mentioned obstructions which prevented the recovery of core.

ACOUSTIC BEACONS

The ORE double-life beacons employed were satisfactory in all respects. All Leg 51B on-site operations were conducted while referencing on the 16-kHz beacon dropped on December 8. The 13.5 kHz beacon launched on December 2 was monitored occasionally and though too weak for positioning, was still operating on the vessel's departure.

The longevity of these beacons supports earlier observations that a double life beacon has a "working life" of up to 40 days, even in relatively deep water.

The launching of a fresh 13.5 kHz beacon was delayed until just prior to vacating Hole 427. After it reached the sea floor, the positioning system was put into the semi-automatic mode and referencing was switched from 16 kHz to 13.5 kHz. The induced "excursion" indicated that the beacon had drifted approximately 1500 feet to the west-northwest before coming to rest. This procedure was repeated after repositioning.

The persistence of signals from both Leg 51A beacons reinforces the need for a remotely actuated means of silencing beacons that are no longer producing usable signals. Pulses of intermittent strength or unacceptable character could "confuse" the positioning system when a new beacon of that frequency must be utilized. The Project is currently developing a system to solve this problem.

SPECIAL TOOLS

Due to continuing design problems with the drill pipe bottom finder pinger, two expendable pingers manufactured by ORE were procured for trial use on Leg 51B. One of the two units was found to be defective upon its delivery to the ship. It is being repaired under warranty. The second unit was attached to the mud skirt extension of the first re-entry cone and was activated just before the cone was keelhauled. As the cone approached the sea floor, the delay between initial and reflected pulses could be read with a resolution of about two meters. Unfortunately, the cone was prematurely detached before the pinger came into contact with the sea floor and the expected abrupt cessation of signal was not observed. A gradually diminishing signal was observed through periodic monitoring for four to five days.

Earlier attempts at temperature probe measurements at Site 417 had been unsuccessful. Conventional temperature probe measurements are considered unduly hazardous to high investment re-entry holes, but geothermal gradient data was deemed highly desirable at this site.

One of the existing temperature tools was modified to incorporate a short, strong probe that extended only as far as the bit cones, a strengthened electronics support structure and an eight-hour recording period. The inner core barrel with temperature tool was pumped to the bit at a very low circulation rate following the third re-entry. The tool remained in place as the bit was lowered nearly to the total depth of the hole. It was then retrieved and a standard inner core barrel was dropped.

Upon opening the tool, it was found that no data had been recorded subsequent to impact. Inspection of the hardware revealed that the electronics and tape recorder were undamaged, but a wire had been jarred loose where it was soldered into the battery pack.

The battery pack has been modified and cushioned and it is anticipated that this mode of operation will be successful in the future on re-entry holes.

RE-ENTRY EQUIPMENT

With the exception of problems attendant to the difficulty of washing 16-inch casing into the stiff abyssal clay, little trouble was encountered with re-entry hardware.

Because of the very short casing string, it was necessary to pass seven 8-1/4" drill collars through the latch sleeve of the lowering tool after releasing the casing/cone assembly. Due to very limited clearance, cuttings were restricted from passing between the latch sleeve and the collars and considerable torquing was experienced during this phase of drilling. Modifications to the latch sleeve to relieve this problem are under development.

Glass balls floating six feet above the re-entry cone were again installed as auxiliary sonar reflectors. They were visible on the sonar display but it was fortunately not necessary to use them as all primary reflectors were clearly discernable on all re-entries.

Both downhole and bridge electronics performed without fault on all re-entries. The recent addition of an oscilloscope at the bridge console has been valuable in that ranges can be read more accurately than on the EDO PPI display.

LOGGING UNIT

With three re-entries and several logging runs, the Mohole logging winch received a great deal of use. The winch unit proved dependable and no serious mechanical problems arose.

Bearing seals in the drive train fluid retarder failed and began leaking after the first few runs. Although it was necessary to add oil to the retarder frequently, no loss of operating efficiency occurred.

On two occasions, short delays were caused by minor mechanical failures in the depthometer drive mechanism.

The logging cable generated considerable concern on one of the logging runs when a strand of outer armor began to unlay and became fouled at the line wiper. After about 60 meters of wire had been untangled and removed, it was found that the cable had been spliced and that the loose strand had pulled out where the free end had been brazed into place. The new free end was silver brazed by the ship's welder and was holding well at the end of the cruise after three additional runs.

After the second re-entry, it was necessary to cut off about three meters of cable due to fairly severe kinking. The open ended logging bottomhole assembly was in use at this time and the sonar landing assembly was employed. It is felt that contact of the drag blocks of the landing sub with the inside of the drill pipe prevented the sonar tool from spinning and relieving torsional stress.

The cable was cut and reheaded on two other occasions. Kinking occurred when it was dropped to the rig floor during the process of rigging sheaves and when excess slack accumulated due to the failure of the temperature logging tool to pass a bridge.

At no time were electrical problems experienced with either the cable or cable heads.

LOGGING

Logging operations were moderately successful despite several operational problems that resulted in the nonattainment of two types of logs and greater time consumption than had been anticipated.

The first log attempted following re-entry was the high resolution thermometer (HRT). Planned logging strategy was altered in this respect because it was felt that better temperature data could be recorded if the hole fluid were not disturbed by prior logging.

As soon as the sheaves were rigged, the cable tension indicator began to malfunction and was replaced.

The HRT tool was then lowered through the drill pipe, logging downward. The end of the drill string was above the casing shoe so that open hole began at 5514 meters. An initial temperature increase was noted on the recorder camera as the tool passed the sea floor, but a constant reading with depth was noted shortly thereafter. It became apparent that the tool was malfunctioning or had stopped. The very light weight of the tool with respect to that of the line and the effect of the ship's heave made it virtually impossible to discern from the tension device whether the tool had come to rest on a bridge.

The tool was pulled and the log film was developed concurrently. The developed film and knots in the logging line confirmed that the tool had stopped after logging less than 100 meters. In addition, the thermistor "cage" at the bottom of the tool was noted to be packed full of clay. This explained the very sluggish temperature reaction noted as the tool was being retrieved.

The HRT was set aside as it was felt that a heavier logging tool would break through the shallow clay bridges. After cutting off about 180 meters of cable, cable heads were changed and the borehole compensated sonic/gamma ray/caliper tool was rigged.

Upon checkout after assembly of the tool, the caliper was found to be inoperative. An hour of troubleshooting determined that the problem was electrical and could not be solved without complete disassembly of the tool and additional hours of delay. It was decided to run the log without benefit of the caliper curve.

The logging tool (with caliper attached for centralization) was run into the hole and would descend no further than two or three meters below the casing.

After retrieving the tool a "short trip" was made with drill pipe to open the hole. Nothing was "felt" until the open ended pipe reached 5937 meters, where a solid obstruction was met (total depth was 5965 meters). The circulating head was rigged, but pumping failed to reopen any additional hole. The drill pipe was pulled back inside the casing shoe and the hole was not refilled with drilling mud.

The caliper had been repaired during the trip and the BHC/GR/CAL tool was again rigged up. This time the tool was worked to 5565 meters after originally stopping at 5525 meters. When further progress was stymied, the tool was again retrieved.

Four stands of drill pipe were added to the string and circulated down. This was calculated to put the end of the pipe below the unconsolidated clay zone and located it at 5630 meters.

On the subsequent attempt, the logging sonde reached a depth of 5925 meters and a log was run from that depth into pipe. The film was developed immediately and it was discovered that one of the films had jammed in the can and the log had not been recorded. Also, the caliper had redeveloped its electrical problem on the way into the hole. The tool was run back to total depth and the interval was re-logged. This time good BHC and gamma ray curves were obtained, but the caliper curve was intermittent and virtually unusable. A gamma ray log was run through pipe to the sea floor with increased sensitivity settings to provide correlation information.

After pulling one stand of pipe to 5602 meters, the compensated neutron/compensated formation density/gamma ray tool was rigged up. Due to the delays to this point, it was necessary to recalibrate the radioactive detectors to the sources. On final checkout, the gamma ray detector was found to be malfunctioning. It was therefore necessary to replace the entire CNT module with the spare unit (which had to be calibrated).

The trip into the hole with this sonde was delayed about an hour by the loose cable armor stand mentioned earlier. It was necessary to work the sonde past two or three tight spots to reach the previous logging total depth.

A repeat section is routinely run with each log to check the reliability of data. In this case the curves did not repeat. This appeared to be the result of the detectors failing to maintain contact with the wall of the borehole. After another log run and failure to repeat, the sonde was retrieved. The excentralizer belly spring at the lower end of the sonde was found to have broken in two places. The middle portion, about 40 cm of spring steel strap, remained in the hole. The formation density log obtained was of qualitative value only and of little use for detailed study. No further attempts to run this log were made as no spare spring were aboard.

The final log run was the dual induction-laterolog/gamma ray. After a minor electrical problem in the surface electronics has been traced and rectified, a routine log was run with good results. Total depth reached for the final log was 5915 meters.

DYNAMIC POSITIONING

Following the initial test and calibration exercise shortly after departing San Juan, the system's performance was excellent.

The only exception occurred on January 1, when the stern thrusters began over-speeding intermittently. This caused a great deal of concern that another serious failure was imminent. Troubleshooting by the electrician, however, localized the problem at a faulty relay in the stern thruster feedback circuit. The relay was replaced before it failed completely and no further difficulties were experienced.

The "Y axis sag" noted on Leg 51A did not recur on Leg 51B. For the past two legs a discrepancy of several hundred feet in the ship's apparent position with respect to the re-entry cone had been noted on subsequent re-entries with identical positioning offsets. This appeared to be supported by satellite navigation, but little data was available to indicate the source of the inaccuracy as the positioning system, the satellite navigation, the hydrophone array in use or elsewhere. Considerable attention was given to this problem by SIO and GMI personnel during Leg 51B site occupancy. After much data collection and plotting and observations on two re-entries, the position discrepancy was confirmed to be heading related and to be reflected accurately by the satellite navigation system. As a large number of SAT NAV fixes were plotted on various headings, they described a circle about 865 feet in diameter. A 300 foot diameter circle could be ascribed to a known and predictable error caused by the 150 foot distance from the SAT NAV antenna to the moon pool. An additional 283 feet in radius remained to be explained. System checks by GMI technicians led to the discovery that the positioning system's vertical reference gyro was mounted with its axis not exactly perpendicular to the plane of the reference hydrophones. It was tilted slightly less than one degree forward from the normal position. It was calculated that this would produce approximately the 283 foot positioning error noted. This, of course, would be doubled as the ship reversed its heading. The gyro was realigned in port following the cruise and Leg 52 data are expected to reflect a return to normal positioning.

ENGINEERING

Following the major bow thruster repair in port, no lost time or operational problems were experienced as a result of the ship's propulsion or power generating machinery.

Good weather and numerous pipe trips provided adequate opportunity to take engines and generators off-line for maintenance. A top overhaul of one diesel had been scheduled for the Leg 51A/52 port call, but had been nearly completed by the ship's engineering personnel prior to arrival in port.

DECK AND UNDER WAY

A total of only 4.3 days was spent cruising to and from San Juan. Good weather prevailed during these periods and an average speed of advance of 8.94 knots was achieved. Pre-site and post site surveys and a detour transect of the Bermuda Rise consumed an estimated eight hours of under way time.

Relatively good weather on-site provided the deck department with adequate conditions and time to perform topside preservation and maintenance work.

COMMUNICATIONS

All routine communications were handled through Scripps Station WWD without significant transmission problems or delays. The U. S. Coast Guard was in direct communication with the ship regarding evacuation of the injured man. Many personal phone calls to the United States were handled through amateur radio operators. Several phone calls to Europe were handled for scientific personnel via commercial radio when communications windows allowed.

WEATHER AND CURRENTS

In general, the on-site weather conditions for the duration of site occupancy were somewhat better than the norm for the season and geographical area. This was particularly true of the latter half of the period.

A frontal squall struck the vessel with little warning on December 27 as 16-inch casing was being recovered. Wind gusts in excess of 50 miles per hour were experienced and the ship was blown about 5,000 feet off station. Fortunately the drill string was on board at the time. The casing joint being handled at the time swung out of control and was damaged, but crew injuries were averted.

Wind and wind waves delayed the resumption of operations for several hours. As the wind was diminshing a northerly swell was building. The swell increased to 10 to 12 feet before gradually falling off and excessive vessel motion resulted. A total of 25 hours elapsed before operations could be resumed. The lost time would normally have been a few hours less, but the next scheduled operation was that of keelhauling the re-entry cone. This evolution requires considerably better weather than can be tolerated in other operational modes.

On two or three other occasions, moderate to heavy swells from a direction divergent from that of wind and/or current produced difficult positioning situations and threatened to disrupt operations. It was considered necessary to move the ship's head into the wind to relieve the load on the thrusters. This placed the vessel somewhat "in the trough" and resulted in rolls that briefly reached the operating limitations for a rotating drill string.

Current was again a significant factor only when its force was aligned with that of the wind in the situations described above. Current velocity was estimated at two knots or less at all times.

The decision of the Planning Committee to move the drill site about 300 miles south in view of seasonal weather considerations proved to be a wise one. Weather maps monitored on the ship (and northerly swells experienced) indicated that a great deal of inclement weather occurred in the Bermuda area. It is certain that more operating time would have been lost at the more northerly site.

PERSONNEL

No serious illness occurred in the course of the voyage but three work related accidents involving rig floor personnel resulted in serious injury. The shortage of operating personnel prompted a supervisory decision that further rig operations would be hazardous and was a major factor in the ship's departure for port two days ahead of schedule.

On December 28 a derrickman was attempting to realign a stand of drill pipe in the automatic racker skate. He lost his footing and fell to the main deck. The full extent of his injuries could not be determined with shipboard facilities, but the ship's surgeon judged them sufficiently serious to warrant his removal to a hospital ashore. After the man had been evacuated to Miami by Coast Guard helicopter, he was found to have three cracked vertebrae.

To compensate for the resulting crew deficiency, a schedule was set up for alternating men from the off tour to "double over" and work 18-hour shifts instead of the usual 12.

On January 13, the other derrickman seriously injured a finger when it was caught under the core barrel release plate. He was unable to continue his duties. A few hours later a rotary helper's foot was broken when a 175-pound crossover sub was dropped on it.

It should be noted that each of these men was injured while working hours beyond his 12-hour tour.

The extraordinarily long port call took its toll in shipboard morale, but spirits rose after the ship was under way. The cruise was relatively short and busy and morale remained high for the duration.

The GMI crew performed in a manner consistent with their traditional high standards of professionalism and attention to detail. The scientific staff showed great patience in the face of operational delays. They were able to work harmoniously under a "feast or famine" workload as an effective multinational team.

Glen N. Foss
Cruise Operations Manager
Deep Sea Drilling Project
Leg 51B

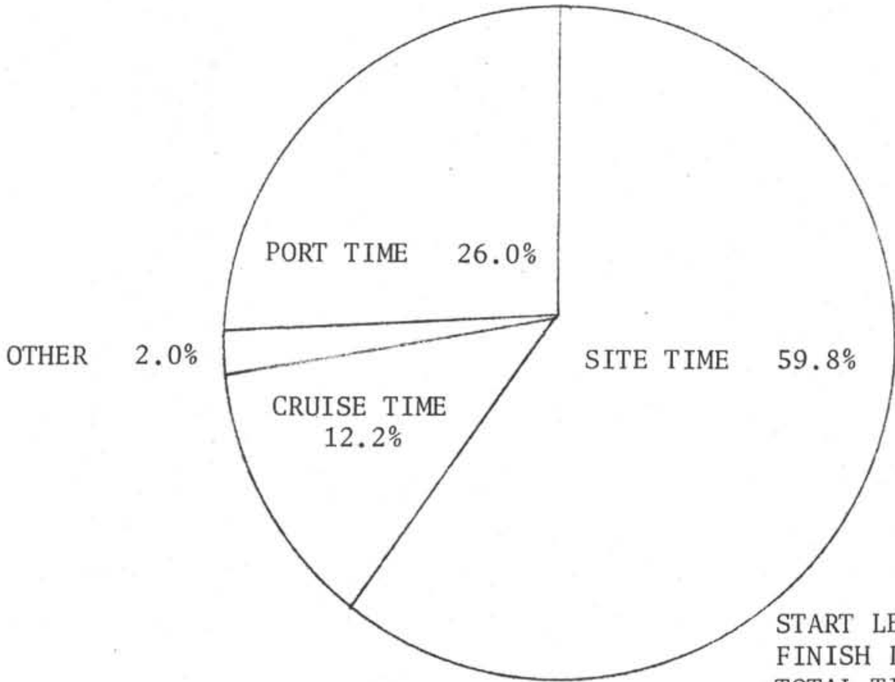
INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 51B

Total Days (December 13, 1976 - January 17, 1977)		35.04
Total Days In Port		9.11
Total Days Under Way		4.99
Cruising Time	4.3	
Mechanical Downtime	0.7	
Total Days On-Site		20.94
Trip Time	6.0	
Drilling Time	0.3	
Coring Time	6.7	
Mechanical Downtime	1.1	
Position Ship	0.1	
Re-entry & Related Operations	3.6	
Logging	1.4	
Wait On Weather	1.0	
Other	0.8	
Total Distance Traveled (Nautical Miles)		922.2
Average Speed (Knots)		9.4
Sites Investigated		1
Holes Drilled		3
Number of Cores Attempted		48
Number of Cores With Recovery		44
Percent of Core With Recovery		91.7
Total Meters Cored		371.6
Total Meters Recovered		208.7
Percent of Recovery		56.2
Total Meters Drilled		210.9
Total Meters Penetration		582.5
Percent of Penetration Cored		63.8
Maximum Penetration (Meters)		532.5
Minimum Penetration (Meters)		24.0
Maximum Water Depth (Meters)		5489.0
Minimum Water Depth (Meters)		5489.0

DEEP SEA DRILLING PROJECT

TOTAL TIME DISTRIBUTION

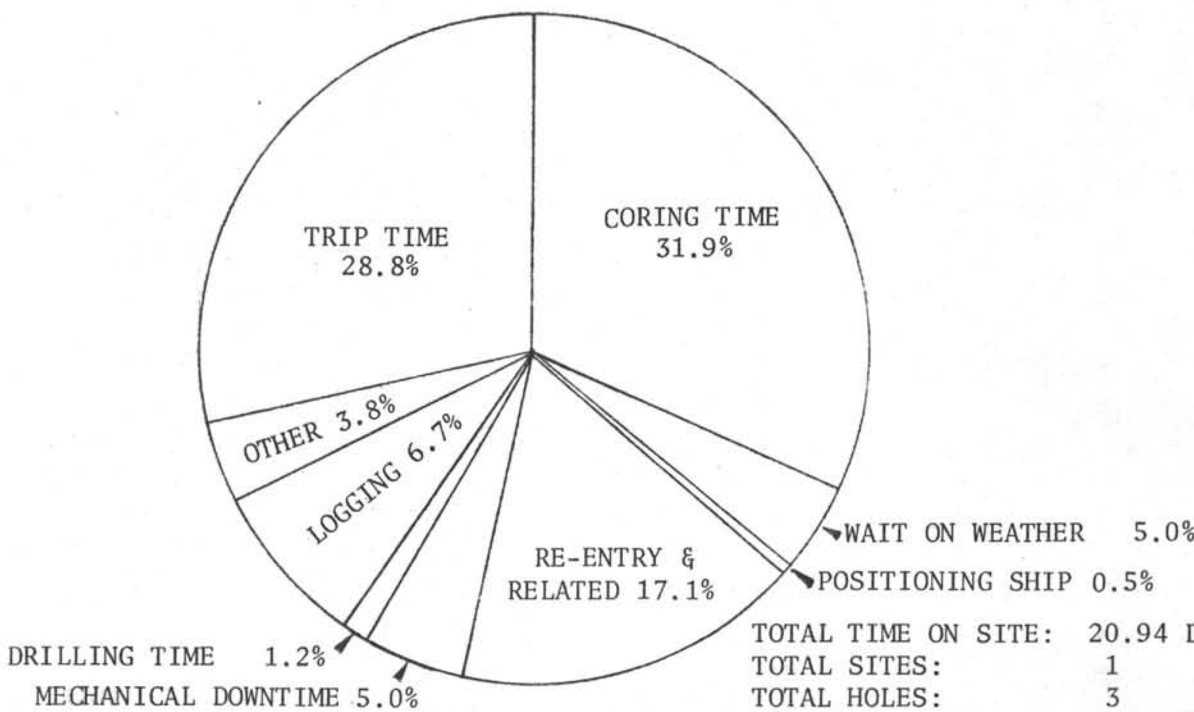
LEG 51B



START LEG: December 13, 1976
FINISH LEG: January 17, 1977
TOTAL TIME: 35.04 Days

ON-SITE TIME DISTRIBUTION

LEG 51B



TOTAL TIME ON SITE: 20.94 Days
TOTAL SITES: 1
TOTAL HOLES: 3

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 51B

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
12-13-76 12-22-76										218.6			218.6	IN PORT SAN JUAN
12-22-76 12-25-76		50.5							15.7				66.2	U/W TO SITE 417
12-25-76 12-27-76	417B		30.3		1.7			1.5	0.3		11.2		45.0	CASING WASH-IN TEST
12-27-76 12-29-76	417C		23.0				25.0		1.0		21.0		70.0	BHA PARTED LOST R/E CONE
12-29-76 1-15-77	417D		91.2	6.7	158.6			0.6	23.9		53.6	53.0	387.6	3 RE ENTRIES LOGGING
1-15-77 1-17-77		52.6										0.9	53.5	U/W TO SAN JUAN
TOTALS		103.1	144.5	6.7	160.3		25.0	2.1	40.9	218.6	85.8	53.9	840.9	

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 51B

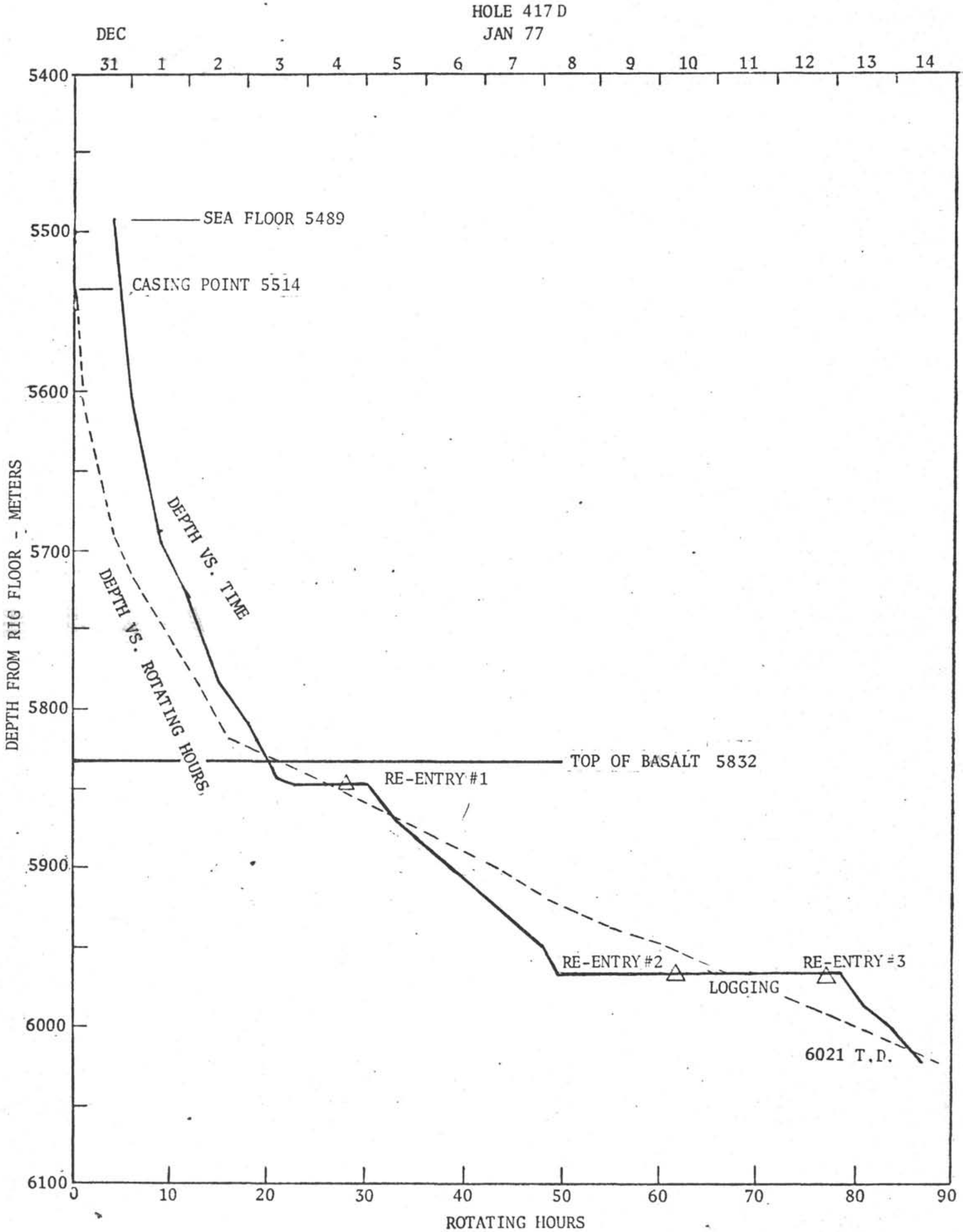
Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
417B	Smith	10"	F94CK	361BV	5.5	18.5	24.0	- -	TO-BO-I	Wash in only.
417C	Smith	10"	F94CK	361BV	- -	26.0	26.0	- -	- - - -	Wash in only. Lost when BHA parted.
417D	Smith	10"	F94CK	304BV	188.9	168.6	357.5	25.2	TO-B2SE-I	Pulled early. Broken Flapper - 8 hours basalt.
417D	Smith	10"	F94CK	322BV	113.5	- - -	113.5	40.5	T1-B2SE-0 1/16	Basalt
417D	Smith	10"	F94CK	925BV	61.5	- - -	61.5	22.3	TO-B1SE	Pulled early - Obstruction - Cored only basalt. May have drilled on junk.

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 51B

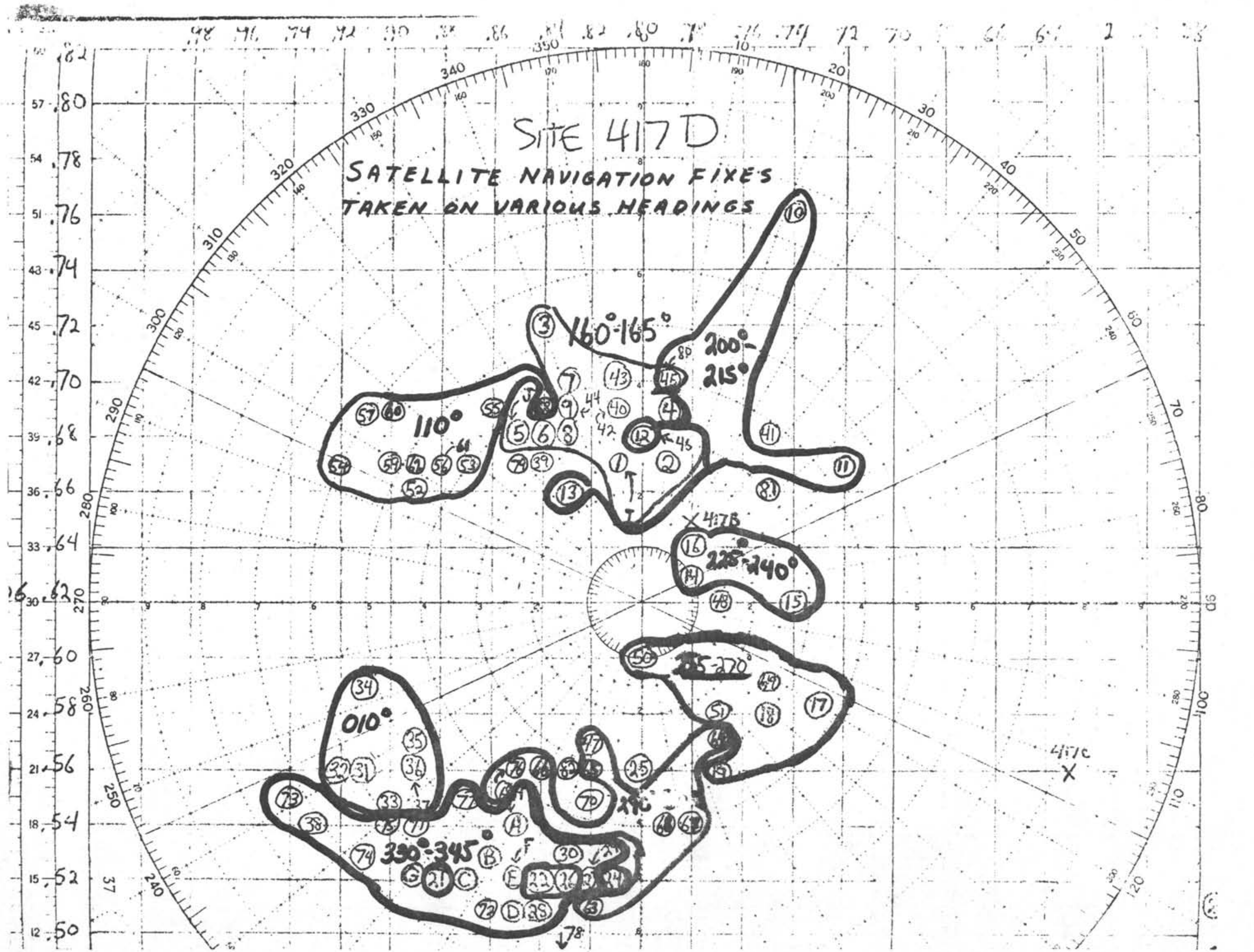
Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	
417	ORE Double Life	16 kHz	S/N 375	843.6	Dropped at end of Leg 51A operations. 2347 hrs, 10 December. In use but weakening end 51B operations.
417D	ORE Double Life	13.5 kHz	S/N 394	1.2	Dropped at end of Leg 51B operations, Hole 417D.

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 51B

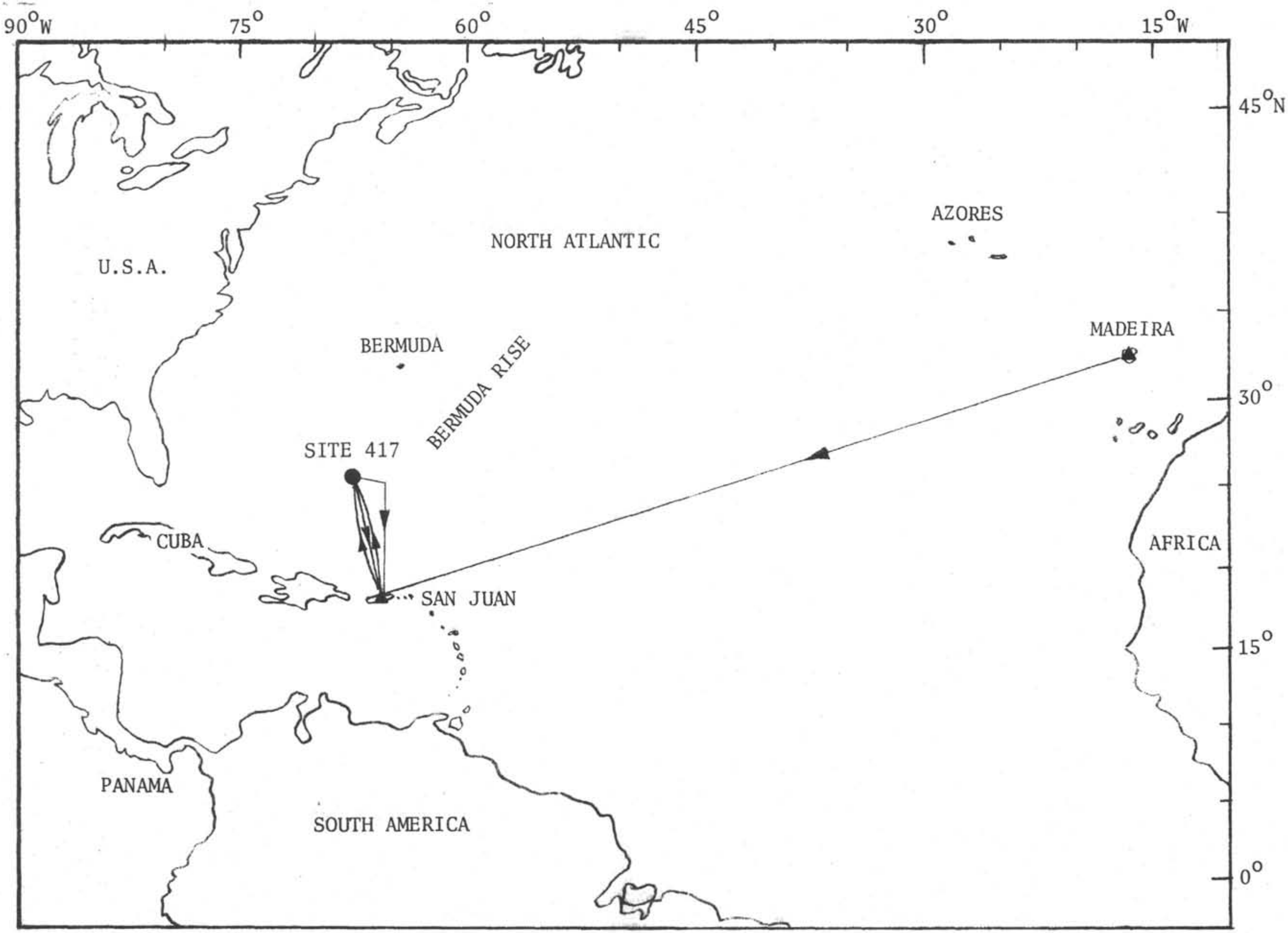
Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent of Cores With Recovery	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet Meters	Avg Rate Penet	Time On Hole	Time On Site
417B	25° 06.65'N	68° 02.78'W	5489	1	1	100.00	5.5	5.3	96.4	18.5	24.0	- -	45.0	- -
417C	25° 06.56'N	68° 02.63'W	5489	-	-	- - -	- -	- -	- -	26.0	26.0	- -	70.0	
417D	25° 06.69'N	68° 02.82'W	5489	47	43	91.5	366.1	203.4	55.6	166.4	532.5	6.1	387.6	
			Total	48	44	91.7	371.6	208.7	56.2	210.9	582.5			502.6



HOLE 417 D
DEC
JAN 77
31 1 2 3 4 5 6 7 8 9 10 11 12 13 14
5400
5500
5600
5700
5800
5900
6000
6100
DEPTH FROM RIG FLOOR - METERS
SEA FLOOR 5489
CASING POINT 5514
DEPTH VS. TIME
DEPTH VS. ROTATING HOURS
TOP OF BASALT 5832
RE-ENTRY #1
RE-ENTRY #2
RE-ENTRY #3
LOGGING
6021 T.D.
0 10 20 30 40 50 60 70 80 90
ROTATING HOURS


SITE 417D
SATELLITE NAVIGATION FIXES
TAKEN ON VARIOUS HEADINGS
160°-165°
200°-
215°
110°
225°-240°
255-270°
010°
330°-345°
X 417B
417C
X

DSDP LEG 51


90°W
75°
60°
45°
30°
15°W
45°N
30°
15°
0°
U.S.A.
NORTH ATLANTIC
AZORES
BERMUDA
BERMUDA RISE
MADEIRA
SITE 417
CUBA
SAN JUAN
AFRICA
PANAMA
SOUTH AMERICA

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONAL RESUME
LEG 52

SUMMARY

Leg 52 was designed for the final drilling of a site selected and begun on Leg 51. It was to be the deep penetration of the older western Atlantic crust.

The ship returned to Site 417D, which was started on Leg 51B, on January 24, 1977. The hole was re-entered and drilling continued until February 4, 1977 when drilling was terminated due to the loss of the bottomhole assembly of the drill string. Efforts were made to "fish" this assembly out of the hole but all efforts failed. Another deep penetration hole nearby was then begun which would hopefully be finished on Leg 53.

Site 418A was started on February 13, 1977 and was drilled to sub-bottom depth of 570.5 meters before the Glomar Challenger left to return to Site 417D to conduct some geophysical experiments. At Site 418A, 386.5 meters were cored and 217.74 meters were recovered for a recovery percentage of 56.3%.

Time distribution for the leg was 3.6 days in port with an additional 1.3 days of downtime. The total time spent cruising was 5.0 days and 41.3 days were spent on site. The on site time consisted of 16.8 days tripping, 11.5 days coring, .2 days drilling, .4 days positioning, 6.1 days re-entering, .9 days of mechanical downtime and 5.4 days in miscellaneous activities with the total time for the leg being 51.01 days. No time was lost due to unfavorable weather conditions.

SAN JUAN PORT CALL

Before the ship returned to Site 417D, a port call in San Juan involved the usual loading of supplies such as groceries, spare parts, acetylene and oxygen. In addition, 202,022 gallons of marine gas-oil was taken. While the supplies were being loaded, the positioning system was being worked on as a result of problems on the previous leg. The main area of interest was safety tripouts for thrusters and their rotational speeds as related to positioning. After work had been done in port the ship left for a test area just outside the harbor and sea trials and additional work was done with the thruster exciters and cut off alarm system. The ship then had to return to port for additional work and once again back to sea before the system was considered satisfactory for normal operation. The technicians were transferred to a tug and at 0815 on January 22, 1977, the ship departed for Site 417D.

HOLE 417D

The Challenger departed San Juan for Leg 52 on January 22, 1977 to continue drilling the deep crustal hole, 417D. On January 24, 1977 the 13.5 kHz beacon, which had been dropped on the 15th of January, was detected and the ship started homing in on it. At 1400 hours, the ship was in automatic mode over the cone and makeup of the drill string was started. The drill string was run in to 5474 meters which placed it, according to Leg 51B data, 16 meters above the top of the cone. The re-entry sheaves and tool were made up and run in the hole to attempt the first re-entry for Leg 52. When the tool started operating, the target was observed at a range of 500 feet. After scanning and maneuvering for 1 hour 34 minutes, the tool was directly over the cone on a 50 foot range scale and 45° scanning angle.

At this time the ship was turned 180° to check on the positioning problem which had been detected on Leg 51B. After the ship was turned, the target was detected after 28 minutes using the 8° scanning angle at a distance of 500 feet.

The problem appears to be related to the reference gyro which had a 2° inclination from the vertical which could account for this dramatic change in distance from the target.

The ship was then returned to the original heading and after 1 hour 8 minutes, the cone was stabbed and verified as re-entry No. 1. The drill string was washed in to the old total depth of 6021 meters. Two cores were cut and recovered when positioning problems developed. They were serious enough that it was necessary to stop drilling and pull the drill string. Approximately 16 hours were then required to analyze the problem and make the necessary corrections.

Again, the re-entry equipment was rigged after the drill string had been run into 5474 meters. However, after scanning for 26 minutes of re-entry attempt No. 2, the tool was pulled when it was discovered that only enough pipe was hanging in the derrick to allow but 4 meters to be in the cone after the stab.

The drill string was run back after a single had been added and the last half of re-entry No. 2 required 1 hour 30 minutes.

The drill string was lowered and Cores 50 to 60 were cut and recovered before a decrease in core diameter indicated that a bit change should be made before the bit failed and possibly leave a cone in the hole. When the drill string was recovered, a two hour check of the thruster operation was made and at the same time the pup joint and saver sub were magnafluxed. The pup joint was found to be usable, however, the saver sub was determined to have a crack and was replaced.

Following the thruster testing, the drill string was made up and re-entry No. 3 was completed in 19 minutes. The drill string was washed to 6128 and Cores 62 to 67 were cut and recovered. After cutting Core 68, it could not be recovered immediately because the coring reel hydraulic pump shaft froze and it was necessary to rig and recover the core using the drawworks sandline. After the core was recovered, it was necessary to pull the string because the core diameter had decreased to 5.3 cm. When the drill string had been run in for re-entry attempt No. 4, the original heading of 340° was used until the cone was in a position to be stabbed. The heading was then changed 180° to 160° to establish offsets, in case due to weather or sea conditions, this heading would be required. The total time required to make the original positioning for stabbing, the course change and establishment of new offsets, and then return to original heading and stab for re-entry attempt No. 4, required 6 hours 24 minutes. After the drill string was run in and Core 69 was being cut, the drill string weight decreased about 40,000 pounds which indicated that, apparently, the bottomhole assembly had been lost. When the drill string was recovered, it was observed that the 5-1/2" heavy wall drill pipe had broken 12.18 inches above the top of the connection with the 7-1/4" drill collar.

A fishing tool setup was assembled with a 7-1/4" grapple so spaced that it would engage the fish below the 5-1/2" drill pipe. This was necessary because there was no fishing equipment for 5-1/2" equipment. Re-entry attempt No. 5 required 5 hours 44 minutes before it succeeded in entering the cone. After the top of fish was located, 40 minutes were spent trying to engage it. However, when efforts appeared to be unsuccessful, the drill string was pulled to see if the fishing tools were still intact. When they were retrieved everything was in order and the bottom of the tool indicated that it had been in contact with the fish so it was decided to try again. Re-entry attempt No. 6 required only 37 minutes of maneuvering to re-entry, however, while pulling the re-entry tool, the Schlumberger cable broke at about 4402 meters and dropped the tool and cable back to the bottom of the drill pipe. Two stands of drill pipe were added to ensure that re-entry was deep enough to allow fishing for the cable. A fishing spear was run in on the sandline, however, when starting out with the spear, it pulled to 14,000 lbs. The shear pins in the Otis overshot were sheared and the sandline recovered. The spear remained in the hole. It was then decided to pull out of the hole to the top of the cable and retrieve it. After pulling 46 stands, the cable was located and attached to the Schlumberger cable reel and recovered along with the spear which was entangled in the cable about three feet above the EDO tool. It was then necessary to change out the cable reel before any additional fishing attempts could be made.

After the cable and reel were replaced, re-entry No. 7 was attempted. The tool was lowered but after scanning for 20 minutes, the tool did not appear to be operating properly and was pulled. Re-entry No. 8 required 2 hours 26 minutes but when pipe was added to verify the stab, the drill string began decreasing in weight which indicated that the cone had been missed. The sonar tools were rigged again and run in for attempt No. 9. However, after 48 minutes of scanning, the tool appeared damaged and was pulled. When recovered, it was found to have lost three extenders, one drive shaft and the transducer. While the new tool was being checked out a center bit was dropped to clear any possible tool debris that might have wedged in the drill string. After replacing the tool, it was run back in the pipe for re-entry attempt No. 10. However, after scanning for 40 minutes, this tool also would not operate satisfactorily so it was pulled and found to also have lost three extenders, the drive shaft and the transducer. The loss of this equipment was due in part to the original design of the tool which did not anticipate the use of three extenders, the excessive motion of the ship and consequently the pounding of the tool on its seat in the top of the fishing tool. Following the loss of the last tool, the drill string was pulled.

A modification was then made in the fishing tool to allow the EDO equipment to be seated lower and therefore, not require the use of extenders. After these modifications were completed, the drill string was again run into re-entry depth and the tool was lowered for re-entry attempt No. 11. The tool was seated and after attempting to scan for 72 minutes with very little success, the tool was pulled. When recovered nothing appeared to be wrong but the tool was changed. Re-entry attempt No. 12 lasted 73 minutes and was also unsuccessful. It appeared that the tool did not seat properly and as a result, the display was very poor. The depth measurement on the Schlumberger cable indicated that the tool was deeper than its seat in the fishing tool which indicated that the seat had broken loose and, therefore, allowed the tool to rotate freely and without any orientation. This fact was substantiated when the drill string was recovered. Following the recovery of the re-entry tool, the drill pipe was pulled and the ship departed for Site 418.

SITE 417D (CLAMPED GEOPHONE EXPERIMENT)

The ship returned to Site 417D at 1200 hours on March 2, 1977. The drill string was rigged for re-entry using the modified bit assembly for landing the EDO tool and was run in to 5478 meters by 2200 hours. The EDO tool was rigged and run in. After ten minutes it appeared that the tool was not seating properly in that there was a loss in pump pressure. Also, the tool appeared to be only four meters from bottom and it should have been eleven. It was felt that the tool was not latching and was, therefore, pulled. When recovered all things seemed correct but the latch assembly was changed with stronger springs behind the latch keys. The tool was back on bottom at 0602 hours and scanning for the cone began. After five changes in offsets, the cone was as close as 44 feet. However, this was the closest the cone was approached until the tool was pulled at 1003 hours. Seven more changes in offsets had been made and three heading changes but the string was no closer to the cone. During these maneuvers, the tool again seemed not to be seating properly. Because of this the tool was pulled again. When returned to the derrick floor and the tool was checked, it was found that the voltage could not be regulated so the tool was changed. The latch springs were changed and the tool was run again. The tool was down at 1648 hours and scanning/locating the target at 200 feet. After seven offset changes the cone was no nearer than 150 feet. In addition, the tool did not seem to be operating properly so at 2043 hours it was pulled. After working on the tool for about an hour, it was agreed to pull the drill string and put a bit release setup onto the drill string. This would make a more stable seat for the EDO tool and possibly improve the re-entry capabilities.

The drill pipe was pulled and the bit release installed and then run back to 5480.5 meters at 1730 on March 4, 1977. The tool was down and scanning at 2136 hours. At 3302 hours, the cone was 40 feet away but it was not until 0457 hours on the 5th of March that a stab was made. During this time eleven offsets had been made and the cone remained relatively close. But due to the erratic nature of the pipe motion and the ship's motion, it was extremely difficult and frustrating to get close enough to try and stab the cone. After this first stab it was felt that the cone had been missed so it was pulled and scanning began again. Another stab was made at 0545 hours and it was felt that it too had missed. The third stab was made at 0724 hours and re-entry was verified at 0840 hours.

Drill pipe was then run to 5587 meters where a bridge was encountered. The Bowen sub was hooked up and the drill string was washed in to 6079.0 meters. The inner barrel was retrieved and the hole filled with 200 barrels of 8.8 ppg 155 second viscosity mud. After the hole was filled, the Rotary shifting tool was run in and the bit released. Following this the Bowen sub was set back and pipe was pulled to 5825 meters.

At 2025 hours started running in the hole with the geophysical tool. At 2335 it had been run to 606 meters and testing began. Testing the equipment and clamping and unclamping the tool continued until 0715 hours of March 6, 1977. All shots that were fired in this experiment were 20 pounds and went off at a depth of 100 feet. The shooting program called for charges to be fired every three minutes while steaming toward and away from the Challenger over six mile courses. Also, every ten minutes while making a circular course to the new line. Shooting began at 0715 hours and ended at 1548 hours. The geophone was then unclamped and raised to 5840 meters. Shooting began again at 1639 hours and ended at 1851 hours while on a NNE course. There were a total of 165 shots fired during the experiment. The tool was recovered with no trouble and then the drill pipe was pulled with the ship underway for San Juan at 0848 hours on March 7, 1977.

Shooting required for the above tests were accomplished by the NOAA vessel "Virginia Key" which made rendezvous with the Glomar Challenger on March 2, 1977. Planning for the clamped geophone experiment had been handled by Cambridge University.

SITE 418

The ship was moved to drill Hole 418 after drilling was terminated at Hole 417D due to the loss of the bottomhole assembly. This hole is located about three miles south of Site 417 at coordinates, 25° 02.1'N and 68°03.5'W.

The ship arrived in the area selected and dropped a 16 kHz beacon at 0943 hours on February 10, 1977 and at 1120 hours the ship was positioning in automatic and make up of the drill string was begun. The PDR indicated a water depth of 5521 meters, so a core was attempted from 5115.52 to 5525.02 and recovered six meters of soft sediments. A second core attempt of the interval 5506.02-5515.52 recovered only water and a water depth of 5519 meters was established. The drill string was then washed to 5591.5 meters or a 72.5 meter penetration. This was used to determine the amount of 16" casing that would be used with the re-entry cone. The drill string was then pulled and 71.16 meters of 16" casing was made up and hung on the drill string. This string of casing was then run to bottom and washed in to verify that it would be a satisfactory length to be washed in with the re-entry cone. No problems were encountered in washing in and then recovering the casing. After the casing was latched to the cone and drill string and at 1350 hours on February 13, 1977, the assembly was started for bottom. At 0215 hours on the 14th of February the string was at 5494 meters and preparations were made to wash in when bottom was contacted. A pinger had been attached to the mud skirt to assist in determining when bottom was reached. However, the presentation on the PDR gave no hint as to when the bottom would be reached, so drill pipe measurements were used to determine when the casing should reach bottom and when it should be washed in far enough to release the cone. At 0600 hours February 14, 1977, the cone and casing were released and Hole 418A was spudded. The 16 kHz beacon began losing transmitting strength so a 13.5 kHz beacon was dropped at 0502 hours on February 14, 1977 as a back up in case the 16 kHz beacon stopped transmitting. This proved to be a wise decision because at 1900 hours on February 14, 1977, it was necessary to change over to the 13.5 kHz beacon as the 16 kHz unit was failing.

Because of the other holes in the area that had cored the sedimentary section completely, this hole was not continuously cored until reaching a penetration depth of 282 meters. The top of the basalt was encountered in Core 15 at a penetrated depth of 324 meters. Following Core 20 it was decided to pull the bit because of increased torqueing while cutting the first meter of Core 21 and a decrease in core diameter in the lower part of Core 20.

After making a round trip to replace the bit, the first re-entry at this site was attempted. The first stab was made after 2 hours 8 minutes, however, when a stand of pipe was added to verify, it showed a decreased in weight indicating that the cone had been missed. The second attempt was successful after scanning for 2 hours 21 minutes. One 8.5 meter core was cut and recovered 1.91 meters of basalt. Then the new core barrel did not seat so it was assumed that some of the core had fallen out and would not allow the core barrel to seat properly. However, when running in to retrieve this barrel, it was found to have stopped about 800 meters from the derrick floor. A center bit was dropped and when retrieved, the plug had only been lowered about 150 feet. The center bit was dropped again with full pump pressure. When the overshot was dropped to recover the center bit, the plug was found to have dropped to about 5,000 feet but the overshot returned with its pins sheared. It was then necessary to pull the pipe to retrieve the core barrel because, apparently, the lost core material was scattered through the pipe. After five stands had been pulled, the pump was hooked up and it appeared that the plug was moving. The center bit was recovered. The hole was pumped again and appeared to be open. However, when the center bit was dropped it stopped near 7,000 feet and when dropped again it stopped at the same place and could not be recovered. Pipe was pulled and when 85 stands had been laid down the plug and wedged core barrel were found.

In a final attempt to save trip time, the core barrel was dropped again but pump pressure indicated that the barrel had not seated. After a few more drops it was decided that the float valve and bit were plugged with rock fragments and, therefore, it was necessary to pull the balance of the pipe, Indeed, when the bit was on the derrick floor, it was found to be wedged with rock fragments. The bit was changed because one cone was partly broken and the bearings were loose. This could have happened when the first re-entry attempt missed.

A new bit was installed and the pipe run back to attempt re-entry No. 3. However, after 3 hours 7 minutes when the stab was made, it was felt that the cone had been missed. A successful re-entry was made on the next attempt after scanning and positioning for 2 hours 14 minutes. However, when the Schlumberger cable was recovered, it was discovered that the EDO tool had pulled loose at the rope socket. A fishing tool was made up and on the first try the tool was recovered but the transducer extender and stainless steel drive shaft had fallen out when the tool dropped to the bottom of the drill string. A center bit was dropped and the string was run in to 5872.5 where the center bit was pulled and a regular core barrel was dropped. The string was run to bottom and a one meter core was cut and recovered. It recovered .24 meters of basalt but nothing to indicate any junk in the hole. It is believed that the EDO tool parts had been pushed into the softer clay sediments above the basalt. More cores were cut and then it was decided to pull the bit. Core material was varying in diameter with many small pieces and the torque had increased. When the bit was recovered, it was not worn excessively or damaged, so it was decided that the section being cored was badly fractured and accounted for the bit action.

The bit was changed and the next re-entry was made after 2 hours 5 minutes of scanning. Three cores were cut and when the third core was retrieved, only the swivel and latch assemblies were recovered. The swivel assembly had apparently unscrewed because when the barrel had been spaced out the latch had been cut back two inches too much. This did not allow the barrel to latch and then the balance of the barrel unscrewed. The first attempt to fish the barrel out with a spear was unsuccessful but the next attempt using a modified core barrel wedged in the fish and both were recovered.

Coring continued until the bit had 29 hours of drilling time and the string was then pulled. The three bumper subs were changed because a pressure drop was noted on the TOTCO while using the same number of strokes and there was concern that a possible leak was occurring.

The last re-entry at this site was successful after scanning for 1 hour 21 minutes. The drill string was run in the hole and coring continued. After the fifth core was recovered the next barrel did not seat so it was pulled and a center bit dropped. The core barrel that had been dropped was dented on the bottom of the core catcher sub and looked like it could have possibly landed on the float valve. The center bit was pulled and the core barrel dropped again but, again, pressure build up was not sufficient. When recovered, it had two small dents in the core catcher sub. It was dropped again and plans were to cut a 2 to 3 meter core and see what the results would be. When the barrel landed and coring started the pressure returned to normal so a regular length core was cut with no trouble. The bit was pulled after 29 hours because of the time necessary to return to Site 417D and attempt the clamped geophone experiments. When the bottomhole assembly was recovered, it was magnafluxed before it was stood back. Also, a 16 kHz beacon was dropped for Leg 53 to return to and continue drilling.

DRILLING AND CORING ASSEMBLY

There were four bottomhole assemblies used on this leg. The first, which was used at Site 417D, consisted of a bit, bit sub (with float valve) core barrel, latch sub, top sub, three 8-1/4" drill collars, one 5-foot bumper sub, three 8-1/4" drill collars, two 5-foot bumper subs, two 8-1/4" drill collars, one 7-1/4" drill collar, seven joints of 5-1/2" heavy wall drill pipe. This bottomhole assembly was lost when the bottom joint of 5-1/2" heavy wall broke 12.18 inches above the connection with the 7-1/4" drill collar.

A bottomhole assembly used to attempt to fish the original bottomhole assembly, consisted of the fishing tool, three 8-1/4" drill collars, two 5-foot bumper subs, one set of jars, three 8-1/4" drill collars, a crossover sub and a joint of 5-1/2" heavy wall.

Fishing attempts were unsuccessful in recovering the bottomhole assembly at Hole 417D so the ship was moved to location 418. The bottomhole used at this site consisted of bit, bit sub (with float valve), core barrel, latch sub, top sub, three 8-1/4" drill collars, one 5-foot bumper sub, three 8-1/4" drill collars, two 5-foot bumper subs, five 8-1/4" drill collars, crossover sub, one joint 7-1/4" heavy wall, seven joints 5-1/2" heavy wall.

When drilling had been completed for this leg at Site 418A, the ship returned to Site 417D to re-enter and conduct some clamped geophone experiments. The bottomhole assembly used consisted of a modified bit (for re-entry purposes), bit sub, core barrel, three 8-1/4" drill collars, two 5-foot bumper subs, three 8-1/4" drill collars, crossover sub, seven joints 5-1/2" heavy wall. When re-entry could not be accomplished using this set up, the drill string was pulled and the modified re-entry bit was exchanged for a bit release sub and a top connector and re-entry was accomplished. This change in bottomhole assembly apparently gave more stability to the re-entry tool. This was necessary due to the wind and sea conditions which existed at the time.

CORING AND BITS - HOLE 417D

After returning to Site 417, Hole 417D, three F94CK bits were used before loss of the bottomhole assembly caused abandonment of the hole. The first bit was used for 41.3 hours and cored 107 meters before it was pulled. The drill rate was 2.59 meters per hour and there was a 56% recovery. When recovered, three cones showed moderate bearing wear but the bearings were gone from the fourth cone. The core diameter had decreased to about 5.5 cm.

The next bit was pulled after only 19.6 hours and having cut only 66 meters of core because the core diameter had decreased rapidly to 5.2-5.3 cm. However, when the bit was recovered, no bearing problems were observed and no good explanation could be offered for the decrease in core diameter. The drill rate for this bit was 3.3 meters per hour and a recovery percentage of 84%.

The third bit was lost with the bottomhole assembly after cutting only one 3.5 meter core.

CORING AND BITS - SITE 418

Hole 418 - The first bit used at Site 418 was a F94CK and was used to take the mudline core of 6 meters and then was used to determine the casing depth for the re-entry cone. This required approximately 30 minutes to wash 72.5 meters with no bit rotation.

Hole 418A - This same bit was used as the first bit for Hole 418A. It drilled and cored 367 meters at an average rate of penetration of 14.9 meters per hour with a 52.3% recovery. The next two bits used were F99CK or "button bits". The first bit cut only 8.5 meters before it was pulled when part of the core fell out of the inner barrel and wedged in the drill pipe. When the bit was recovered, the bearings in one cone were loose and two inserts and part of the cone were broken. Apparently, the bit had hit the cone when re-entering. This bit took 2.6 hours to cut 8.5 meters and recovered 1.91 meters of basalt. The next bit used was also a F99CK and cored 39 meters before it was pulled because of irregular core diameter and torquing while coring. Drill rate was 1.6 meters per hour with recovery of 54.5%.

The last two bits used were F94CK and they cored 156 meters at a drill rate of 2.65 meters per hour and a 60.4% recovery.

BEACONS

Three beacons were dropped at Site 417D and two were used successfully for positioning. The 13.5 kHz beacon, which had been dropped just before the ship departed on Leg 51B, was used until the ship departed for Site 418. The 16.0 kHz beacon.

which had been dropped as a back up, was never used. However, the 13.5 kHz, which had been dropped when leaving for Site 418, was used for positioning while the clamped geophone experiment was conducted on the ship's return to Site 417D.

A 15 kHz beacon was dropped when Site 418 was reached. However, a 13.5 kHz beacon was dropped when the 16 kHz began deteriorating over a 12-hour period beginning about the time the re-entry cone was washed in. This 13.5 kHz beacon proved satisfactory for the remaining 16 days on site. Before leaving a 16.0 kHz beacon was dropped to insure an adequate signal for returning to Leg 53.

POSITIONING

Positioning was generally good on this leg particularly after work had been done at sea in calibrating the thruster motors.

Drilling was terminated on January 25 when positioning could not be maintained due to the erratic operation of the thrusters. When checked, both the bow and stern thruster motor voltages indicated that they were running at 1160 rpm, or slow. However, a strob tachometer found them to be running at 1350 rpm or fast. Speeds were then set on all thruster motors using feed back rheostats and strobe light. After the adjustments, positioning was maintained with few problems for the balance of the leg.

LOGGING

Downhole logging had been planned for this leg at Site 417D, however, the loss of the bottomhole assembly cancelled any plans for logging at the site. No logging was to be done at Site 418A because maximum hole penetration was the prime objective. The Schlumberger engineer went ashore when a tug arrived with supplies and an engineer to assist with the downhole re-entry tools.

RE-ENTRY

RE-entry enjoyed varying degrees of success, failure, and frustration on this leg. The detailed description of each re-entry attempt for Site 417D and 418A are made in the beginning of this report and condensed in the charts following this section.

At Site 417D no real problem developed in re-entering until the bottomhole assembly had been lost. Then the problems began. The first re-entry attempt after the bottomhole assembly was lost (No. 5) required 5 hours 44 minutes. Most of the time could be attributed to many heading changes in manual mode because of the effects of wind and currents. The second attempt required only 37 minutes to re-entry but the Schlumberger line broke and the string had to be pulled. Six more attempts were made and all were either unsuccessful or equipment was lost. The fact that the fishing equipment was not properly constructed to handle the equipment was clearly demonstrated in the tool's rotation and bouncing. The latter condition was the main reason the drive shafts were lost, plus the fact that the EDO tool was not designed to support as many as three extenders. But the main concensus of opinion is that this fact plus the poor sea conditions made for the poor success in re-entering.

When the ship was moved six re-entries were attempted and four were successful with an average of a little over two hours for each attempt. This is about the average time established for re-entry since it was started. But again, the EDO tool was in the normal tool seating position in the drill string and the weather had improved.

When the ship returned to Site 417D for the geophysical experiment, re-entry again took unusually long. Again, the most apparent reason was that the re-entry tool was placed in a modified tool arrangement because it had to operate in a tool that would allow the geophysical tool to pass through after re-entry had been made.

Clearly some changes will have to be made either in the tool assembly or in the holder it will be placed in for re-entry under all conditions.

COMMUNICATIONS

Communications both radio telegraph and radio telephone were generally good during this leg with no excessive delays on any traffic. A considerable volume of radio telephone traffic was handled via Radio Miami (WOM) Nearly all radio telegraph traffic was via Radio WWD (Scripps). 17 MHZ was usable from about 1600Z through about 2300Z daily, but during the early part of this period interference from Radio Rome (IRM) was pronounced and during the latter, fading and static were usual. Optimum communication with Radio WWD was usually about 2100-2200A. 12 MHZ was also useful at times during the above period. Equipment performed well with no failures other than minor ones. The radar equipment (two Decca 914's) also performed well throughout the voyage with no breakdowns.

ACKNOWLEDGEMENTS

With all the problems that developed during this leg there was still a great deal of enthusiasm and dedication generated by all concerned. This includes the scientific staff, Scripps technicians and Global Marine personnel. All in all, it was a great pleasure to be working with so many enjoyable people.

Bob Knapp

R. R. Knapp
Cruise Operations Manager
Deep Sea Drilling Project

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 52

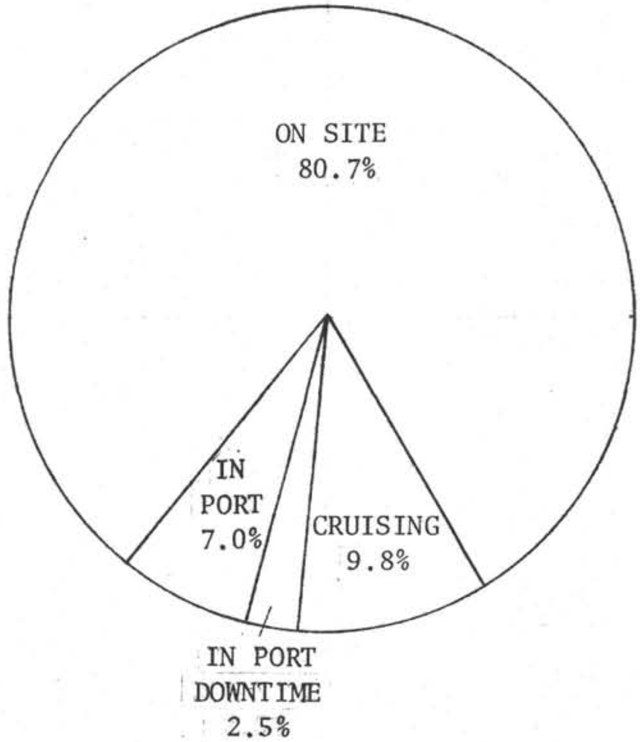
Total Days (January 17, 1977 - March 9, 1977)	51.01
Total Days In Port	3.82
In Port Downtime	1.3
Total Days Cruising (Including Site Survey)	4.5
Total Days On Site	41.3

Trip Time	16.8
Drilling Time	.2
Coring Time	11.5
Position Ship	.4
Mechanical Downtime	.9
Re-entry	6.1
Other	5.4

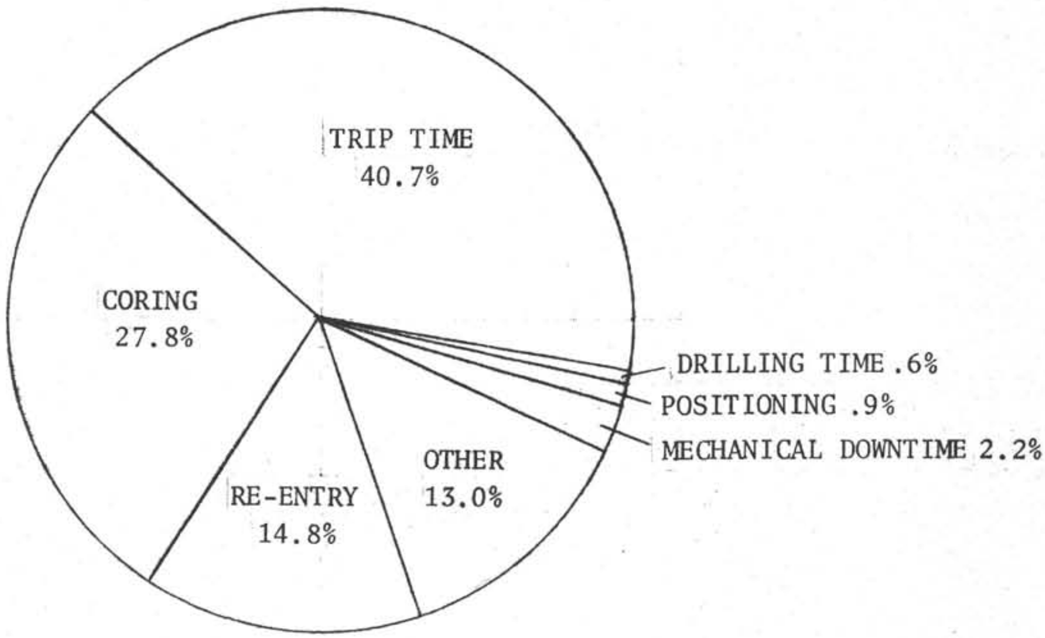
Total Distance Traveled (Nautical Miles) Including Survey	878.7
Average Speed	8.4
Number of Sites	2
Number of Holes Drilled	3
Number of Cores Attempted	71
Number of Cores With Recovery	71
Percentage of Cores With Recovery	100.0
Total Meters Cored	566.0
Total Meters Recovered	335.31
Percent Recovery	59.2
Total Meters Drilled	187.0
Total Meters of Penetration	819.5
Percent of Penetration Cored	69.0
Maximum Penetration (Meters)	570.5
Minimum Penetration (Meters)	72.5
Maximum Water Depth (Meters)	5519.0
Minimum Water Depth (Meters)	5519.0

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT

TOTAL TIME DISTRIBUTION
LEG 52



ON SITE TIME BREAKDOWN
LEG 52



INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 52

Site No.	Make	Freq. kHz	Serial Number	Hours	Remarks
417D	ORE	13.5	394	604.4	Dropped 0226 hrs 1/15/77.
417D	ORE	16.0	374	260.25	Dropped 1045 hrs 1/30/77.
417D	ORE	13.5	392	605.25	Dropped 2315 hrs 2/9/77.
418 & A	ORE	16.0	383	105.3	Dropped 0943 2/10/77.
418A	ORE	13.5	395	369.5	Dropped 0502 hrs 2/14/77. Started positioning on it 1900 hrs 2/14/77.
418A	ORE	16.0	386	131.7	Dropped 1648 3/1/77.

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 52

Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent Of Cores With	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet Drilled	Avg Rate Penet	Time On Hole	Time On Site
417D	25° 06.69'N	68° 02.82'W	5489	22	22	100.0	176.5	117.57	66.6	- - -	176.5	2.84	517.7	517.7
418	25° 02.08'N	68° 03.45'W	5519	1	1	100.0	6.0	6.0	100.0	- - -	72.5	96.0	68.3	- - -
418A	25° 02.08'N	68° 03.45'W	5519	48	48	100.0	383.5	211.74	55.2	187.0	570.5	5.3	494.9	563.2

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 52

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
417D	Smith	10"	F94CK	CA763	107.0	- - -	107.0	41.3	T2-B8-I	Three cones easy rotation. One cone bearing gone.
417D	Smith	10"	F94CK	357BV	66.0	- - -	66.0	19.6	T1-B3-I	Few teeth missing. Bearings hand rotatable.
417D	Smith	10"	F94CK	CA762	3.5	- - -	3.5	1.0	- - -	Bit left in hole with BHA.
418 & A	Smith	10"	F94CK	CA739	180.0	187.0	367.0	24.6	T6-B8-0	
418A	Smith	10"	F99CK	843BP	8.5	- - -	8.5	2.6	T1-B1-I	One cone broken on edge & bearings loose
418A	Smith	10"	F99CK	842BP	39.0	- - -	39.0	24.3	T2-B1-I	
418A	Smith	10"	F94CK	CC011	83.0	- - -	83.0	29.5	T1-B6-I	
418A	Smith	10"	F94CK	KK985	73.0	- - -	73.0	29.2	T2-B4-I	

RE-ENTRY MANEUVERING TIME
SITE 417D

(Time required once scanning sonar tool down until re-entry stab made. Includes successful and unsuccessful attempts)

RE-ENTRY NO.	TOOL DOWN	STABBED	ELAPSED TIME
1	0505 hrs. 1/25/77	0858 (successful)	3 hrs. 53 min.
2	1528 hrs. 1/27/77	0658 (successful)	1 hr. 30 min.
3	0756 hrs. 2/31/77	0815 (successful)	19 min.
4	0822 hrs. 2/03/77	0923 (successful)	1 hr. 01 min.
5 (w/fishing tool)	0106 hrs. 2/05/77	0650 (successful)	5 hrs. 44 min.
6 (w/fishing tool & line broke)	1316 hrs. 2/06/77	1353 (successful)	37 min.
7	0911 hrs. 2/06/77	pulled - tool not working right	20 min.
8	1512 hrs. 2/07/77	1738 (unsuccessful)	2 hrs. 26 min.
9	2254 hrs. 2/07/77	pulled-tool damaged	29 min.
10	0735 hrs. 2/08/77	pulled-tool damaged	40 min.
11	1404 hrs. 2/09/77	pulled tool not working	1 hr. 24 min.
12	2002 hrs. 2/09/77	pulled tool not rotating	1 hr. 13 min.
13A	0130 hrs. 3/03/77	pulled tool not seating right	10 min.
13B	0602 hrs. 3/03/77	pulled tool not seating right	4 hrs. 1 min.
13C	1646 hrs. 3/03/77	pulled to check operation	3 hrs. 57 min.
13D	2136 hrs. 3/04/77	0457 (unsuccessful)	5 hrs. 21 min.
	0500 hrs. 3/05/77	0545 (unsuccessful)	45 min.
	0555 hrs. 3/05/77	0724 (successful)	1 hr. 29 min.

No average calculated because of varying conditions.

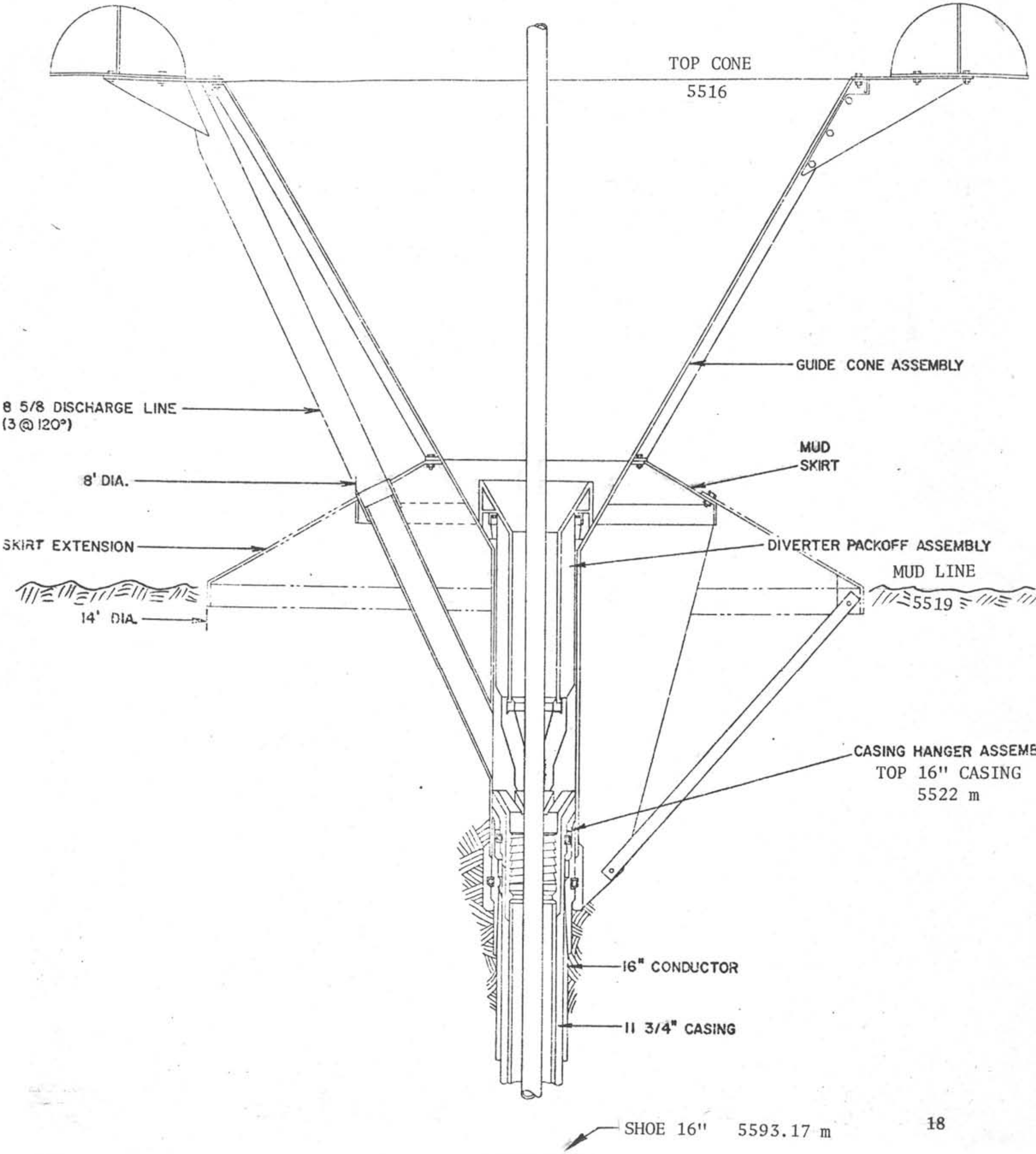
RE-ENTRY MANEUVERING TIME
SITE 418A

(Time required once scanning sonar tool down until re-entry stab made. Includes successful and unsuccessful attempts)

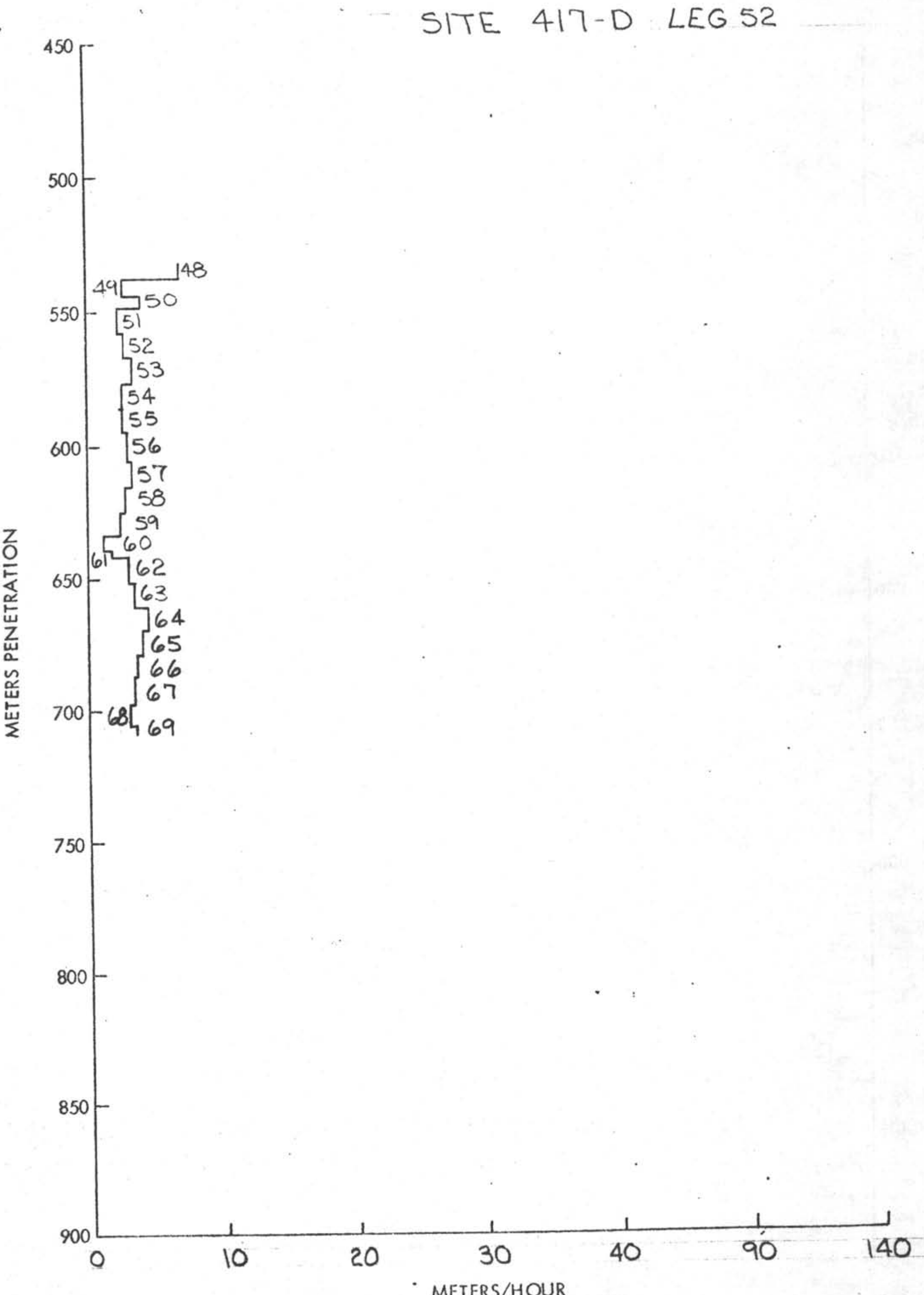
RE-ENTRY NO.	TOOL DOWN		STABBED	ELAPSED TIME
1	0256 hrs.	2/18/77	0504 (unsuccessful)	2 hrs. 8 min.
2	0955 hrs.	2/18/77	1216	2 hrs. 21 min.
3	0506 hrs.	2/20/77	0813 (unsuccessful)	3 hrs. 7 min.
4	0823 hrs.	2/20/77	1037	2 hrs. 14 min.
5	1249 hrs.	2/23/77	1454	2 hrs. 5 min.
6	0302 hrs.	2/27/77	0423	1 hr. 21 min.

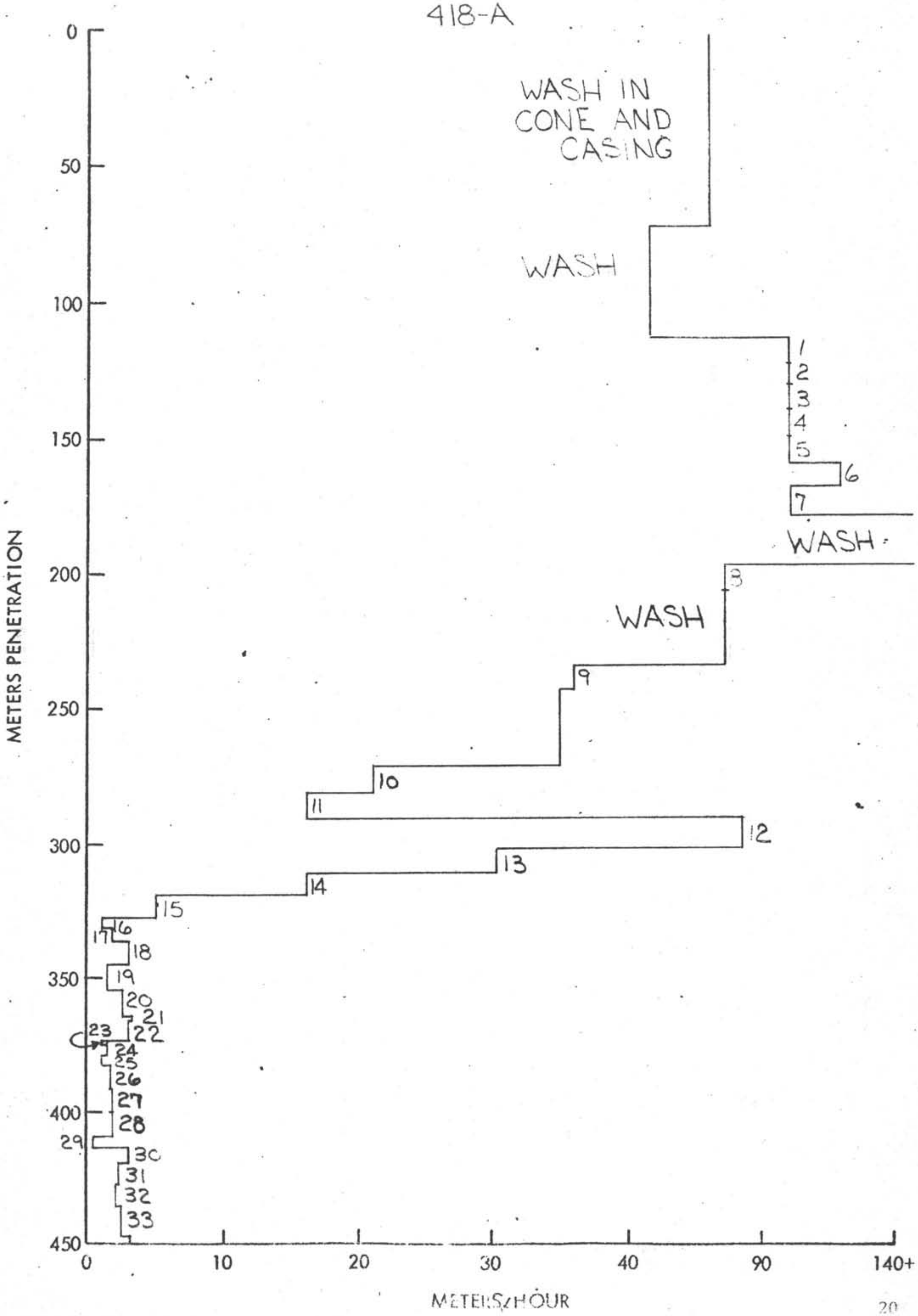
Average 2 hrs. 12 min.

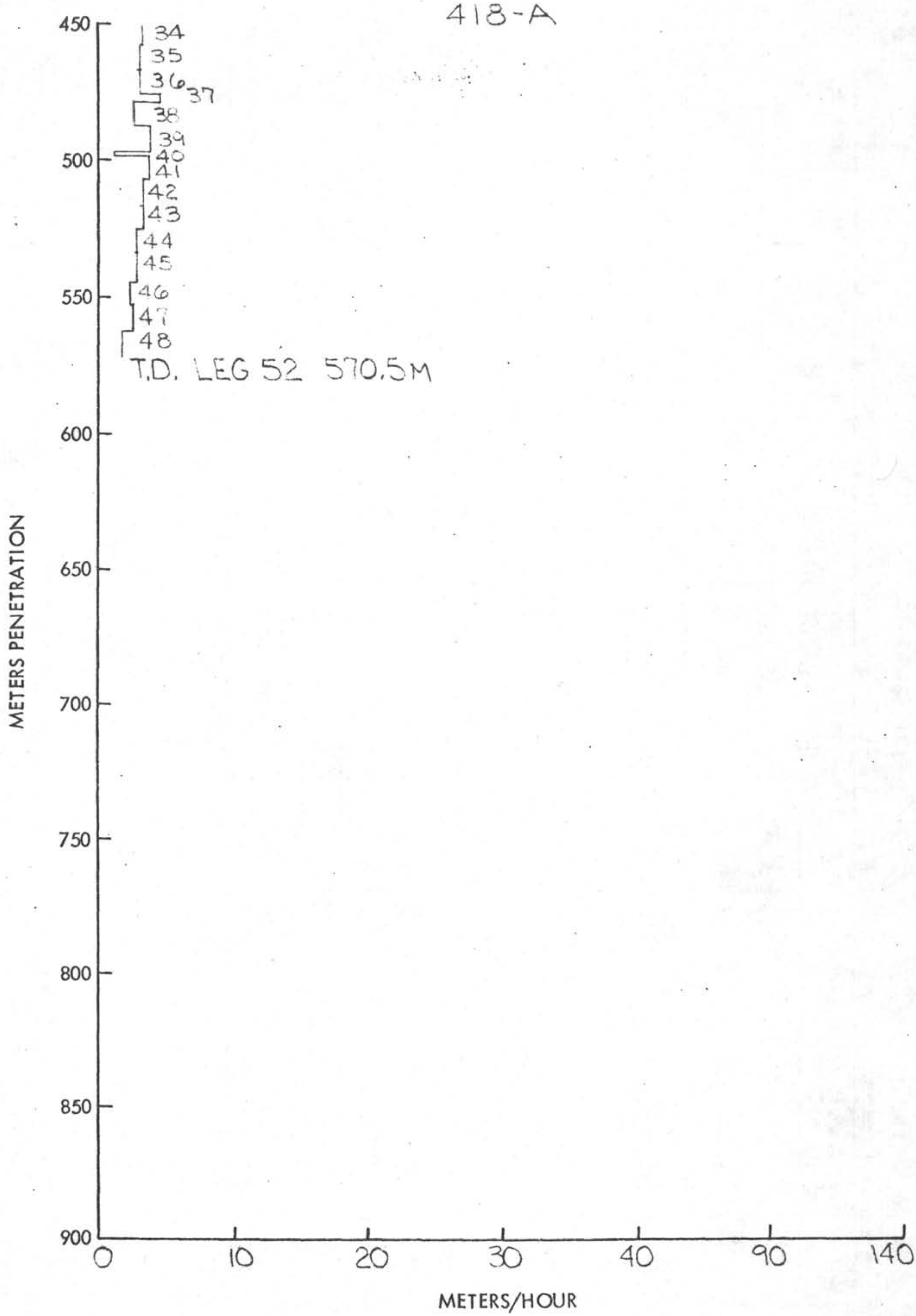
HOLE 418A



TOP CONE
5516
GUIDE CONE ASSEMBLY
8 5/8 DISCHARGE LINE
(3 @ 120°)
MUD
SKIRT
8' DIA.
SKIRT EXTENSION
DIVERTER PACKOFF ASSEMBLY
MUD LINE
5519
14' DIA.
CASING HANGER ASSEMB
TOP 16" CASING
5522 m
16" CONDUCTOR
11 3/4" CASING
SHOE 16" 5593.17 m


SITE 417-D LEG 52
METERS PENETRATION
METERS/HOUR
450
500
550
600
650
700
750
800
850
900
0
10
20
30
40
90
140
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69


418-A
WASH IN
CONE AND
CASING
WASH
WASH
WASH
METERS PENETRATION
0
50
100
150
200
250
300
350
400
450
0
10
20
30
40
90
140+
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
METERS/HOUR


418-A
450
500
550
600
650
700
750
800
850
900
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
T.D. LEG 52 570.5M
METERS PENETRATION
0
10
20
30
40
90
140
METERS/HOUR

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 52

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
1.17.77		.	.	.	.	.	.	.	.	14.9	.	.	14.9	
1.18.77		.	.	.	.	.	.	.	.	24.0	.	.	24.0	
1.19.77		.	.	.	.	.	.	.	.	24.0	.	.	24.0	
1.20.77		.	.	.	.	.	.	.	.	24.0	.	.	24.0	
1.21.77		.	.	.	.	.	.	.	.	24.0*	.	.	24.0	*INCLUDES TESTING OF
1.22.77		.	.	.	.	.	.	.	.	8.3*	.	.	8.3	*THRUSTER EQUIPMENT
TOTAL		.	.	.	.	.	.	.	.	119.2	.	.	119.2	
1.22.77		15.7	.		.	.	.	.	.	.	.	.	15.7	
1.23.77		24.0	.		.	.	.	.	.	.	.	.	24.0	
1.24.77		11.1	.		.	.	.	.	.	.	.	.	11.1	
TOTAL		50.8	.		.	.	.	.	.	.	.	.	50.8	
1.24.77	417-D	.	10.4	.	.	.	.	2.5	.		.	.	12.9	
1.25.77		.	7.8	.	7.0	.	.	.	.	.	9.2	.	24.0	
1.26.77		.	10.0	.	.	.	.	.	14.0	.	.	.	24.0	
1.27.77		.	10.5	.	2.0	.	.	.	.	.	10.5	1.0*	24.0	*RIG FOR RE-ENTRY
1.28.77		.	.	.	24.0	.	.	.	.	.	.	.	24.0	
1.29.77		.	.	.	24.0	.	.	.	.	.	.	.	24.0	
1.30.77		.	14.0	.	7.8	.	.	.	2.2	.	.	.	24.0	
1.31.77		.	7.7	.	11.0	.	.	.	.	.	5.3	.	24.0	
2.1.77		.	.	.	22.5	.	.	.	1.5	.	.	.	24.0	

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 52

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
2.2.77	417D	.	18.5	.	.	.	.	.	2.5	.	.	3.0	24.0	RETRIEVE CORE, DROP C.B. & SINGLE SHOT, RIG FOR REENTRY
2.3.77		.	9.0	.	4.5	.	.	5.6	.	.	4.5	.4	24.0	
2.4.77		.	11.8	.	.	.	.	.	.	.	1.5	10.4	24.0	MAKE UP FISH TOOL ETC.
2.5.77		.	15.4	.	.	.	.	.	.	.	7.9	.7	24.0	FISHING
2.6.77		.	9.2	.	.	.	.	.	.	.	4.0	10.8*	24.0	FISHING & REEL REPLACEMENT
2.7.77		.	1.5	.	.	.	.	.	.	.	17.7	4.8	24.0	REEL REPLACE
2.8.77		.	8.0	.	.	.	.	.	.	.	4.5	11.5	24.0	REPAIR & RIG REENTRY GEAR
2.9.77		.	10.0	.	.	.	.	.	.	.	12.0	2.0	24.0	
2.10.77		.	8.3	.	.	.	.	.	.	.	.	.	8.3	
TOTAL		.	152.1	.	102.8	.	.	8.1	20.2	.	77.1	44.9	405.2	
2.10.77		1.4	.	.	.	.	.	1.6	.	.	.	.	3.0	
TOTAL		1.4	.	.	.	.	.	1.6	.	.	.	.	3.0	
2.10.77	418	.	4.5	.	.	.	.	.	.	.	.	8.2	12.7	RIG CONE REPLACE BHA
2.11.77		.	17.0	.8	2.0	.	.	.	.	.	.	4.2	24.0	MAKE UP 16" CASING
2.12.77		.	24.0	.	.	.	.	.	.	.	.	.	24.0	
2.13.77		.	7.6	.	.	.	.	.	.	.	.	.	7.6	
TOTAL		.	53.1	.8	2.0	.	.	.	.	.	.	12.4	68.3	
2.13.77	418-A	.	16.1	.	.	.	.	.	.	.	.	.	16.4	
2.14.77		.	2.5	3.5	15.0	.	.	.	.	.	.	3.0	24.0	RUNNING SHIFTING TOOL
2.15.77		.	21.5	1.0	.	.	.	.	.	.	.	1.5	24.0	CONDITIONING HOLE

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 52

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
2.16.77	418A	.	2.5	.	20.0	.	.	.	1.0	.	.	.5	24.0	SPOT MUD PILL
2.17.77		.	20.0	.	.	.	.	.	.	.		4.0	24.0	ATTEMPTING TO UNPLUG PIPE
2.18.77		.	3.0	.	3.5	.	.	.	.	.	13.5	4.0	24.0	
2.19.77		.	24.0	.	.	.	.	.	.	.	.		24.0	
2.20.77		.	2.5	.	4.8	.	.	.	.	.	10.0	6.7	24.0	FISHING FOR EDO TOOL.
2.21.77		.	.	.	24.0	.	.	.	.	.	.	.	24.0	
2.22.77		.	11.2	.	7.3	.	.	.	.	.	.	5.5	24.0	TESTING CLAMPED GEOPHONE
2.23.77		.	12.7	.	4.0	.	.	.	.	.	.	7.3	24.0	
2.24.77		.	.	.	19.0	.	.	.	.	.	.	5.0	24.0	FISHING INNER CORE BARREL
2.25.77		.	.	.	24.0	.	.	.	.	.	.	.	24.0	
2.26.77		.	22.5	.	1.0	.	.	.	.	.	.	.5	24.0	RIG SHEAVES
2.27.77		.	.8	.	15.0	.	.	.	.	.	5.5	2.7	24.0	
2.28.77		.	.	.	19.0	.	.	.	.	.	.	5.0	24.0	TRYING TO UNSTICK FLOAT VALVE
3.1.77		.	8.0	.	13.3	.	.	.	.	.	.	2.7	24.0	FILL HOLE W/ MUD, SLIP DRILL LINE
3.2.77		.	4.5	.	.	.	.	.	.	.	.	.	4.5	
TOTAL		.	152.1	4.5	169.9	.	.	.	1.0	.	29.0	48.4	404.9	
3.2.77		.	.	.	.	.	.	.	.	.	.	7.5	7.5	SURVEY BETWEEN 418 & 417
3.2.77	417D	.	10.6	.	.	.	.	.	.	.	1.4	.	12.0	
3.3.77		.	.	.	.	.	.	.	.	.	23.5	.5	24.0	
3.4.77		.	17.5	.	.	.	.	.	.	.	5.2	1.3	24.0	RIG SHEAVES & CHECK FOR OPEN CIRCUIT

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 52

Date	Site No	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
3.5.77	417-D		9.2						2.5		8.7	3.6*	24.0	*GEOPHONE EXPERIMENT
3.6.77			3.5									20.5	24.0	"
3.7.77			4.5										4.5	
TOTAL			45.3						2.5		38.8	25.9	112.5	
3.7.77		15.2										4.3	19.5	TESTING THRUSTERS
3.8.77		24.0											24.0	
3.9.77		9.2											9.2	
TOTAL		48.4										4.3	52.7	
TOTAL		100.6	402.6	5.3	274.7			9.7	23.7	119.2	144.9	143.4	1224.2	

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONAL RESUME
LEG 53

SUMMARY

Leg 53 of the Deep Sea Drilling Project marked the close of a three year program of Atlantic Ocean drilling and the close of the first portion of IPOD. Objectives of the voyage included deepening Hole 418A at the southern extremity of the Bermuda Rise and sampling most of Layer 2 of the oceanic crust. The resulting penetration was expected to be the deepest ever achieved into the igneous rocks of the ocean.

The voyage commenced on March 13, 1977 at San Juan, Puerto Rico and terminated at Cristobal, Canal Zone on April 25, 1977. A brief port call was made at San Juan on April 21 to debark scientific personnel.

Hole 418A was situated in 5519 meters of water about 700 miles east of the tip of the Florida Peninsula. It had been drilled on Leg 52 to a depth of 570.5 meters below sea floor and 247.5 meters into basement. Leg 53 succeeded in deepening the hole an additional 287.3 meters. With good drilling conditions prevailing, progress survived two drill pipe failures only to be halted by a series of misfortunes involving the cable used to re-enter and log the hole. Hole 418A was successfully re-entered a total of 13 times on Legs 52 and 53 and was considered a scientific success.

Total length of the voyage was 47.3 days, of which 34.1 days were spent on-site, 8.9 days underway and 4.3 days in port. 3.3 days lost time was attributed to equipment failure (SIO AND GMI) and 0.9 day to weather delay.

PORT CALL - SAN JUAN, PUERTO RICO

The Leg 52/53 port call was relatively routine. Crew change, resupply and scheduled machinery maintenance were accomplished.

In addition to normal resupply, three re-entry cone assemblies and 150,000 gallons of fuel were onloaded. A replacement logging cable was received and installed and a damaged cable was sent to Houston for repair. A shipment of cores and miscellaneous surface freight were offloaded.

Representatives of AMF Tuboscope and National Supply were in attendance to inspect critical drill string components and the rig's drawworks, respectively.

SAN JUAN TO SITE 418

The last mooring line was off the dock at 1210 hours on March 13. After clearing San Juan Harbor, the CHALLENGER hove to for approximately 2-1/4 hours to test and calibrate thruster overspeed trips.

The remainder of the voyage to the operation area was uneventful and an average speed of 9.1 knots was made good. Accurate navigation took the ship directly to the immediate area of the positioning beacon dropped on Leg 52. The beacon's signal was acquired at a distance of two miles. Stationkeeping commenced after a short delay to lower the hydrophones to operating position.

SITE OPERATIONS - 418A

After running pipe to just off the sea floor, the re-entry sonar tool was lowered and scanning for the re-entry cone target began. No target was acquired. A check of satellite navigation showed the ship's position to be nearly a half mile from that of the cone as determined on Leg 52. The ship was slowly moved by offsets to the SAT NAV indicated location, but the cone was not detected. While scanning with the sonar, the ship was moved via a different route back to the predicted beacon offset position. An expanding square search pattern was then initiated. After several unsuccessful hours of search, the ship was returned to the area indicated by SAT NAV. This time the cone was detected as the position was approached. A successful re-entry stab was made at 1935 on March 16, 15 hours and 12 minutes after scanning began.

A considerable discrepancy between the positioning system's performance on Leg 52 and on Leg 53 was indicated but its nature was not understood. On the following day it was necessary to reverse the ship's heading due to weather conditions. The drill pipe immediately began to indicate that the ship was "off the hole" as it was pulled strongly against its restraining guide. Using the pipe as a guide. The positioning offsets were changed to minimize stress on the pipe. When the pipe again hung straight down, the offsets showed a move of nearly 4,000 feet.

Troubleshooting also showed the discrepancy to be related both to heading and to the hydrophone array in use. It was shortly discovered that a hydrophone tether had broken and allowed one hydrophone to drop two to three feet below the plane of the array.

After this was corrected, a relatively small heading-related error remained. This was neutralized after careful SAT NAV plotting revealed its pattern and subsequent re-entries became more straightforward.

Due to a broken bumper sub washpipe, the first bit was pulled after only three cores. An unscheduled pipe trip was made after the first core on the fourth bit due to a plugged bit. This proved to be a fortuitous setback as water was discovered spraying from a crack in the drill pipe high in the string. It is likely that the pipe would have parted before the next regular bit trip.

Operations continued relatively smoothly until April 4. While the sonar tool was being run down the pipe for a re-entry, the outer armor of the logging cable began to unravel as the cable left the winch drum. It was determined that an old splice was unraveling and about half the strands of the outer armor were involved. Though the tool was within about 60 meters of the bit, the cable was considered too badly weakened to run the splice over the sheaves and complete the re-entry. The tangled armor strands were cut away and the sonar tool was retrieved. It was then necessary to replace the winch drum and cable with a spare unit stored in the hold of the ship.

As the seven ton cable reel was being lifted out of the hold, a topping lift wire parted on the 50 ton crane. This allowed the crane boom to fall across the "core walk" area and the cable reel to fall two decks back into the hold. Fortunately, only minor injuries were sustained by one man and the cable was undamaged. Damage to the cable shipping cradle and to the core walk structure was fairly extensive and there was minor damage to the crane boom. After repairs to the crane, the new cable was installed and the re-entry was accomplished without incident.

Routine coring operations had proceeded for about one day when a sudden drop in pump pressure was noted by the driller. This was being investigated when the hook load weight indication abruptly decreased by about 60,000 pounds and the heave compensator stroked shut. There was no doubt that the drill string had twisted off.

When the drill string was recovered, it was found that the five inch pipe had parted about 210 meters above the bottomhole assembly. Due to the clean nature of the break and the excellent condition of the hole, chances of fishing the pipe and saving the hole seemed good.

An 8-7/8" circulating and releasing overshot carried on board was fitted with a five inch basket grapple assembly for the fishing attempt. Weather and sea conditions were good and the re-entry was accomplished without difficulty. The fishing drill string was run into the hole to just above the fish. The power sub was picked up and the fish was successfully engaged at the very first contact. Circulation through the fish could not be regained and it was necessary to pull it off bottom "dry". After pulling tight on the first two doubles, the fish came out of the hole freely. The lower stand of drill collars and the space between core barrels were found to be filled with cuttings. Nearly a full core had been cut at the time of the twist-off and the inner barrel was recovered with core intact.

This latest core contained rocks somewhat different from those of the overlying unit. They were also more highly fractured than most of those encountered higher in the hole. The decision was made to log the hole short of the anticipated total penetration while chances of success were good.

The special open ended logging bottomhole assembly was made up to the drill string and the pipe was run to re-entry scanning position. The sonar tool seated satisfactorily in the special landing adaptor and the re-entry cone was acquired at an initial range of 30 feet. Nearly two and one half hours were required, however, to coax the light bottomhole assembly to swing over the cone. (This lack of response to ship movement has been noted previously with light bottomhole assemblies).

A successful stab was finally made and verified and the logging sheaves were rigged down. A short trip to total depth was made to clean the hole. A sediment bridge about 40 meters below the casing shoe required washing through with the circulating head. This bridge was the only obstruction that had been encountered consistently on previous bit trips. Two other minor bridges were encountered in the sediment section but they "broke through" without circulation. Soft fill was encountered at 6323 m and the power sub was picked up to wash to the total depth of 6386.6 m. When total depth had been reached, the hole was flushed with 30 barrels of drilling mud followed with 20 barrels of special high viscosity guar gum gel.

The pipe was then pulled to put its end at 5664 m. This was a compromise depth intended to put the less stable upper sediment section of the hole behind pipe and yet allow logging of the better indurated deeper sediments and the sediment/basalt contact. The logging sheaves and drill pipe were rigged in the re-entry configuration with one stand of pipe up in the derrick "on the hook". This would permit lowering the pipe to clear any bridging formed by the motion of the pipe in the hole due to vessel heave.

The first logging tool, the sonic/caliper/gamma ray assembly, was run down the drill pipe to a depth just a few meters below the end of the drill pipe. At this point, the cable tension indicator registered a loss of weight as the tool stopped on an obstruction. The tool was pulled back inside the pipe, the mud pump was started and the pipe was lowered to 5692 meters.

The logging tool then cleared the pipe into the open hole. The weight indicator was monitored closely as the tool proceeded down the hole, but the heave of the ship caused continual apparent weight fluctuations approximately equal to the weight of the tool. As the length of cable paid out approached the depth of the hole, caliper and sonic log traces were noted to be behaving in a manner indicating no tool motion.

On reversing the winch, no "pickup" indication was noted on the tension device and the log traces were unchanged. After a considerable amount of cable had been retrieved, the tension device showed a sharp increase, indicating that the tool or the cable was stuck. After pulling to the maximum recommended tension and "working" the cable for a short time without results, the drill pipe was raised. This resulted in a decrease in cable tension. As the depthometer indicated the tool to be well below the end of the pipe, it was apparent that the line itself had become fouled inside the pipe.

Continued "working" of the cable resulted in upward movement of about 40 meters, but no additional cable could be recovered.

The cable was then clamped off and cut at the rig floor. The drill string was retrieved and the cable was cut as each stand was recovered. The lowermost stand of five inch pipe contained the expected interval of knotted and tangled cable.

The cable was hanging free inside the bottomhole assembly obviously without the weight of the logging tool. The remaining cable was pulled from the pipe to facilitate recovery of the bottomhole assembly.

The length of the free cable recovered was roughly equal to that of the pipe and the bitter end appeared to have been cut with a dull edge. Approximately 300 meters of cable was not recovered. It is speculated that the drill string swung away from the re-entry cone after clearing it, but while the tool and cable were still in the hole. The resulting horizontal force component could have caused the cable to be cut by the sonar landing shoe on the pipe or by an edge of the re-entry cone itself. If this were the case, the tool and cable remained in the hole.

It is considered possible, but less likely, that the cable parted by chafing at the end of the pipe during the pipe trip to the surface. The tool and cable would then have fallen to the seafloor.

Due to the likelihood of cable in the hole, it was considered imprudent to enter the hole with a bit or with open ended pipe to attempt to wash to bottom. The cable could have wrapped around the drill string and caused it to stick in the hole. It was therefore decided to re-enter the hole with open ended pipe and to cautiously fish for the logging line with a wireline cable spear that extended through the end of the pipe.

Before a re-entry could be made, however, it was necessary to replace the logging line on the winch. The only remaining cable on board was the one that had been removed earlier due to a bad splice. As the splice was closer to the drum end of the cable, about 2300 pounds less tension would be applied to the splice if the cable were spooled from the spare drum onto the winch drum and therefore reversed.

First, however, it was necessary to remove the approximately 1200 meters remaining on the winch drum and transfer it onto a wooden spool for storage. With this done, the full spare winch drum was lifted into place and secured for the transfer. After some difficulty in properly securing the drum (collector) end of the cable, respooling began. Nearly 5500 meters of cable had to be transferred before the splice was uncovered for inspection. It was determined that the outer armor damage was severe enough that the only feasible repair was the replacement of the outer armor for the entire interval of the splice.

While the cable transfer and splicing operations were in progress, weather conditions deteriorated considerably. The tedious splicing procedure was a concerted and coordinated effort involving the deck crew and the rig welder. It continued on the damaged core walk in weather too rough for pipe handling.

Upon completion of the splice repair, transfer of the cable continued. After about 1400 m additional cable had been spooled, a second defective splice was discovered. Inspection revealed this to be an old splice that had been repaired, but several outer armor strands were again broken.

Sufficient cable for re-entry was now on the winch and the decision was made to cut and rehead the cable at this point. The repair job required would have been at least as extensive as the earlier one and the cable (about 1950 m) on the "short" side of the splice appeared badly worn.

Although re-entry capability had been regained, a half day passed before weather conditions permitted the handling of drill collars. Ten additional hours of marginal vessel motion conditions were used in breaking down and stowing the bottomhole assembly used on the fishing job and in the magnaflux inspection of the drilling bottomhole assembly. The pipe trip to fish for the logging cable finally began three days after the pipe fish had been recovered.

The new fishing bottomhole assembly was also abbreviated, but was fitted with a standard outer core barrel assembly. The assembly terminated with a truncated and bored out bit body. A special fishing spear had been fabricated which would be attached to a standard retrievable inner core barrel and which would extend through the lower support bearing to engage the cable fish.

The split line wiper packoff element was not installed due to a previous experience with a cable splice stranding at the line wiper. This prevented the standard practice of "pumping down" the sonar tool to minimize its floating in the pipe.

The sonar tool was run down the pipe and landed in the normal manner. Tool operation had been checked each thousand meters down the pipe, but power regulation was lost immediately when the tool was energized upon landing. A quick check of surface circuits determined the problem to be downhole and the tool was retrieved. The pressure case was found to be flooded with sea water.

A backup re-entry tool was then run. The logging unit tension device indicated "set down" of the tool at the proper depth and the tool was energized. The sonar presentation, however, indicated that the transducer was still inside the pipe. The winchman was then requested to pick up the tool and make a second attempt at seating. The tool would not move up the pipe. It was inferred that the tool had "floated" enough on the down trip to form a knot or to loop around the cable head.

The cable was repeatedly pulled to the maximum recommended tension in an attempt to free the stuck tool. At one point this apparently succeeded in moving the tool about 20 meters up the pipe. During this interval, the sonar tool abruptly went dead. After about one hour of attempting to free it, the cable parted at the repaired splice.

The drill string was retrieved and the broken end of the cable was encountered 42 stands from the end of the pipe. Another attempt was made to pull the tool free at this point and save some of the cable, but it remained firmly stuck.

The re-entry tool was recovered from the outer core barrel. About 40 meters at the bottom of the cable was kinked and knotted, but much of this damage would have occurred when the cable broke.

The sonar tool was checked out and found to be undamaged. Free flooding spaces in the landing sub and cable head were found to be packed with rust flakes from the interior of the drill pipe. The role played by the rust formed during the three day operational hiatus is unknown. It is possible that an accumulation of it may have impeded the downward movement of the sonar tool and permitted excessive slack in the cable.

Operations at Hole 418A had come to an end as there was no logging cable remaining of sufficient length to make a re-entry. The CHALLENGER does not have the onboard capability to make a complete cable splice.

HOLE 418B OPERATIONS

Due to logistical and scheduling considerations, the best use of remaining Leg 53 time was judged to be an additional penetration of the sediment section at Site 418. Earlier coring had not produced a complete sediment record due to poor recovery and drilled intervals.

A sediment bit and bottomhole assembly were made up and the pipe was run to just off the sea floor. (A 400 foot north offset had been programmed to keep the drill pipe clear of the re-entry site).

The precision depth recorder reading indicated a few meters greater water depth than at Hole 418A. A mudline punch core was attempted by lowering the bit to 5529.8 m and then setting back a joint of pipe. The rig weight indicator registered bottom at about 5523 m. No core was recovered on the first attempt, but the liner was muddy at both ends. A second mudline core was attempted on the same interval and this time 50 cm of very soft clay was recovered. Water depth was officially established at 5523 m and spud time at 1315 hours, April 15.

Continuous coring continued smoothly and the sediment section was penetrated in 2-1/2 days and 34 cores. One basalt core was cut after basement was reached.

The final pipe trip was made in very good time and the ship was under way at 1620, April 18.

SITE 418 TO SAN JUAN

After spending about seven hours conducting a post site survey, the CHALLENGER departed for San Juan. Strong beam winds resulted in choppy seas and held the ship's average speed to 8.4 knots. Transit time was 2.0 days.

PORT CALL - SAN JUAN

The vessel anchored in San Juan Harbor at 0010 hours on April 21 for a brief stop to transfer personnel. Thirteen scientific and two GMI personnel debarked at this time. Boarding the ship at San Juan were three of the Leg 54 scientific staff, two GMI electrical specialists, two AMF Tuboscope personnel and a replacement for the injured cook.

A GMI engineer was also present to inspect the condition of the ship's drill pipe racker during the in-port period.

In addition to personnel transfer, the time was used to onload drill pipe inspection equipment, structural steel for core walk repairs and fresh vegetables.

The CHALLENGER was under way for Cristobal after just five hours in port.

SAN JUAN TO CRISTOBAL

Vigorous winds continued but the new course across the Caribbean put them nearly dead on the stern and an average of 9.2 knots was made good. Marine growth on the hull probably slowed the ship by at least 1/2 knot.

The ship was forced to proceed at about half speed for one hour while transiting the Mona Passage. A ground relay in number three propulsion motor had tripped and it was necessary to investigate the cause before reactivating the motor. Number four propulsion motor was secured for similar reasons a few miles short of Cristobal Harbor.

The 985 mile transit was completed in 4.5 days and the anchor was dropped at 1603 hours, April 25, 1977 ending Leg 53.

DRILLING AND CORING EQUIPMENT

The bottomhole assembly employed for basalt drilling at Hole 418A was somewhat longer and heavier than the previous standard assembly. This was intended to provide more drilling weight at the bit and to protect the bottom joints of drill pipe from vibrational and compressive loading. The assembly consisted of a bit, core barrel assembly, three 8-1/4" drill collars, one 5-foot stroke bumper sub, six 8-1/4" drill collars, two bumper subs, five 8-1/4" drill collars, one 7-1/4" drill collar and seven joints 5-1/2" drill pipe. The 5-1/2" drill pipe was rotated to put a different joint directly above the collars on each bit trip.

A more conventional assembly was utilized for sediment coring on Hole 418B. Three stands of drill collars, separated at the breaks by two bumper subs, were run above the core barrel assembly.

Assemblies used for fishing and logging consisted of two stands of collars separated by one bumper sub.

A bumper sub failure necessitated pulling the first bit early. The problem was first thought to be an obstruction at the bit as no pump pressure kick was observed to indicate seating of the inner barrel. After two attempts to clear the bit with a core breaker center bit, the inner core barrel became stuck and it was necessary to retrieve the drill string. On recovery of the lowermost bumper sub, it was found that the wash pipe had broken at the threads. This allowed the pipe to drop down inside the bumper sub body. The up-looking end of the pipe impeded the passage of core barrels and fluid was allowed to escape through the ports of the bumper sub.

Sandline problems were minimal. The line used was new and therefore coated with protective tar. Some inconvenience and lost time was anticipated as a result of tar accumulation and one extra wireline trip was required. In one case an inner core barrel was found to be stuck and not retrievable by sandline. Although attempts were made to shear the pin and release the overshot, the core barrel remained attached. After repeated slacking and pulling, the sandline failed about 150 meters from the sinker bars. Upon recovery of the drill string, the pin was found to have sheared, but the fragments failed to fall clear and jammed the release mechanism.

Basalt drilling has a history of being destructive to core catchers and catcher failures have been responsible for round trips due to dropped core becoming lodged in the drill pipe and/or bit. A special slip type catcher had been designed to supplant the conventional core catcher for hard rock drilling, but jams and low recovery on early runs had somewhat discouraged its use. Following core catcher failures earlier in the Bermuda Rise drilling, Leg 53 operations were begun with specially strengthened and hardened conventional catchers alternating with slip type catchers. After two cores with the conventional catcher assembly, it became evident that the dog hinge pins would continue to fail. The new hardened pins broke cleanly where the softer old style pins had bent and twisted. The slip type catcher was utilized for the remainder of the basalt drilling with excellent results. Overall recovery of basalt core was 77.8% vs 52.2% for sediments.

BITS

For basalt drilling, three each of F94CK and F99CK tungsten carbide insert core bits were used. Definite differences in the performance of the two models were observed, but insufficient data was collected for a conclusive indication of the superiority of either for the type of drilling. In general, the greater penetration rate of the F94CK was roughly offset by the longer life of the F99CK. Data are further degraded by the fact that two F99's and one F94 were pulled before definitive signs of failure were noted.

The heavier bottomhole assembly and the heave compensator permitted the application of 35,000 pounds bit weight (in the range recommended by bit manufacturers for hard rock drilling). Early experimentation indicated a greater rate of penetration at 60 rpm than at 40. Critical drill string rpm was in the 50-55 rpm range so this speed was not used.

The cutting structures of the F99's were virtually undamaged, but there were a considerable number of broken inserts in the drive rows of the F94's. The combination of weight and rpm was apparently a bit too much for the longer inserts.

The only hole trouble encountered was a single instance of sudden rotational and vertical sticking. This was thought to be the result of a chert or basalt fragment from uphole becoming wedged in the drill collar annulus. The rock apparently worked its way past the bit, as the problems abruptly ceased, only to reappear as torquing and apparent bit locking as the bit touched the bottom of the hole. Drilling parameters returned to normal after about an hour and the remainder of the core was cut. On retrieval of the core, its diameter was found to decrease suddently from about 6 cm to about 5.1 cm at a point corresponding to the depth at which the sticking and torquing occurred.

The bit (F94CK) was pulled at this point and the bearings were found to be in good condition with effective seals. The reduced core diameter was apparently the result of cutting structure damage only as 83 broken inserts were found. Bit life had been 9.7 rotating hours.

HEAVE COMPENSATOR

The heave compensator performed well for the duration of operations after an initial modification to the control system. An electrically operated solenoid controlling the bypass valve burned out on the very first attempt to stroke out the compensator cylinder. The compensator remained out of the string for the entire first bit run while repairs were effected. The rig mechanic and ship's electrician designed and built an alternate control system in which an air operated solenoid was substituted for the electrical one. This has proven to be an operationaloy satisfactory alternative.

Some problems were encountered with icing in the high pressure air drying system. In one instance this prevented recharging the air bank in time to employ the compensator on the first core after a bit trip.

Minor problems included malfunctioning stroke indicators, difficulty in operating the air bank charging selector valve and a leaky stand pipe valve (O-ring deteriorated by pydraul).

Motion compensation held drill string weight fluctuations generally within one percent of total string weight and is felt to have contributed to extended bit life in the basalt drilling. The compensator was employed on alternate cores through the soft upper sediment section at Hole 418B. Core recovery for 14 cores with the compensator was 66.3% while 51.3% was recovered of 14 cores cut with the compensator locked out. No discernable difference was noted in the degree of drilling disturbance.

BEACONS

Beacon performance presented no operational problems. The 16 kHz double life beacon dropped on March 1 on Leg 52 was acquired at a distance of two miles as the ship approached the site on March 13. It was used for positioning for 19 additional days. The 13.5 kHz double life dropped on February 14 had marginal strength at the beginning of Leg 53 operations and could have been used for stationkeeping for a short time if necessary.

A fresh 13.5 kHz double life was launched on April 2 as the 16 kHz began to weaken and was used for the duration of operations.

RE-ENTRY ELECTRONICS

The re-entry sonar system saw heavy utilization with 12 re-entry starts and 9 stabs into the cone. On only one occasion was operational time lost due to the failure of a re-entry tool. No significant problems were experienced with the electronic circuitry as such, but there were repeated failures in the mechanical and watertight integrity of pressure cases and motor housings. Four times tools were recovered with seawater inside the electronics housing. Only in the final instance did the electronics short out before a successful re-entry could be made.

In one case a successful stab was made after the transducer had apparently struck a floating target reflector and knocked out the 45° transducer crystal. The tool was recovered with the motor shaft completely broken off.

A great deal of effort on the part of the Scripps' Electronics Technicians and the ship's Oiler/Machinist was required between the frequent re-entries to keep an adequate amount of equipment operational.

For more detail on the technical and procedural aspects of the re-entry operations the reader is referred to the Re-entry Report, Leg 53 by R. M. Byrne.

DYNAMIC POSITIONING

On the initial pipe trip on arrival at the drill site, the positioning display gave false indications of stationing excursions up to 3,000 feet. These anomalies were noted to occur during periods of radio transmission. Investigation disclosed that a radio frequency ground had been disconnected. After this was corrected no further difficulty of this nature was experienced.

The gross heading related positioning error encountered during and after the first re-entry operation was rectified by replacing hydrophone cables and re-adjusting collar clamps.

A much smaller, but significant, heading related error remains in the system. Careful plotting of SAT NAV fixes on various headings during the first two bit runs revealed that, as the ship changes heading through 360°, she rotates about an imaginary point roughly 200 feet forward and 100 feet to starboard of the moon pool. This model was used by the Second Officer to compile a table of offsets required to station the vessel over the re-entry cone on any given heading. Use of the table consistently put the drill string within 50 feet of the cone. Three re-entries were made with no change in the offsets set in from the table on the most recent heading change.

No further difficulties were encountered with the dynamic positioning system and it performed dependably for the remainder of site occupancy.

ENGINEERING

The ship's propulsion, power generating and auxiliary machinery performed without adverse effect on operations for the entire on-site period. Slight delays occurred when the ground relay on Number Three propulsion motor tripped shortly after departing San Juan on April 21 and when Number Four propulsion motor tripped off the line on the approach to Cristobal.

WEATHER AND CURRENTS

Weather conditions during the first three weeks of site occupancy were almost unbelievably good. There were many days of flat calm seas and virtually no swell or current. On one occasion a brief period of 25 to 30 knot winds and eight foot swells resulted in marginal conditions of vessel motion. This prompted a decision to make a round trip that was already imminent due to rotating hours on the bit.

The weather deteriorated on April 10 and did not fully recover during the eight remaining days on site. A stationary trough to the south of the site produced wind, rain and clouds. Storms far to the north produced the swells. Stray currents of up to two knots could come from any direction. Fortunately the wind and swell were aligned in a northerly direction. Vessel motion and positioning power requirements ruled out suspended pipe operations for about 2-1/2 days until conditions gradually abated. The pipe was already on deck following the logging attempts when conditions worsened and surface work on the cable continued through much of the period.

Continuing strong winds were a factor in the CHALLENGER's progress on the voyage to Panama. Speed was retarded by beam winds on the run from Site 418 to San Juan, but this was more than offset by tail winds on the Caribbean crossing to Cristobal.

COMMUNICATIONS

Radio communications with DSDP and with GMI San Diego were handled on a daily basis through Scripps Radio Station WWD. Contact with WWD could not generally be established prior to noon, ship's time, and on two occasions messages of greater urgency were relayed through the U. S. Navy circuit via Station NGR in Greece.

Two direct phone calls were made from the ship to DSDP Management.

Daily weather observations were relayed to Washington, D.C. through the U. S. Coast Guard radio station in San Juan.

The Coast Guard station and the AMVER network were instrumental in arranging the transfer at sea of the injured crewman to the tanker TRANSEASTERN. Had the transfer been delayed even a few hours, it probably would have been prohibited by weather for the remainder of the leg.

Many personal phone calls to the U. S. were handled through amateur radio operators and calls to Europe were made through the commercial station at Portishead, England.

No significant communications equipment failures occurred.

PERSONNEL

No serious illness occurred during Leg 53, but the voyage was marred by a rash of minor injuries mostly to fingers and toes.

A finger injury resulted in the transfer of the Third Cook to a passing ship bound for the U. S. An attempt by the ship's surgeon to treat the finger and avoid partial amputation was unsuccessful. The finger was eventually amputated at the second joint.

Shipboard morale remained high during the first month. The subsequent operational reversals, coupled with the drastic weather change, seemed to have a depressing effect on nearly everyone.

The GMI crew turned in a superb effort. Several serious setbacks were overcome be their combined expertise and initiative. The scientific staff, again a multinational and multidisciplinary body, worked with admirable harmony. They were most patient and philosophical in the face of operational delays and problems. The SIO technical staff remained cooperative and cheerful despite a last minute switch from "hard rock" to "soft rock" procedures at an already hectic point in the cruise.

Glen N. Foss

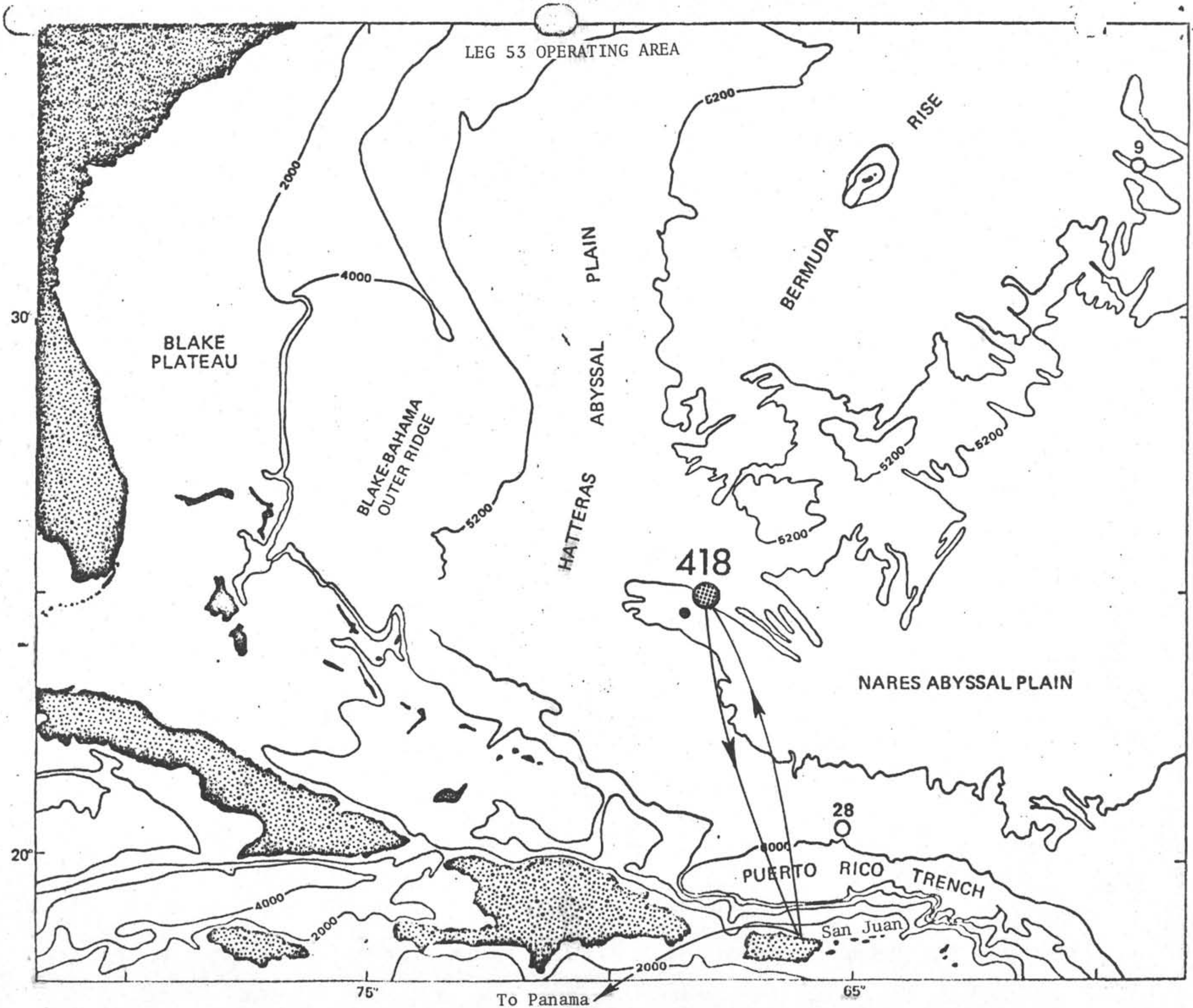
Glen N. Foss
Cruise Operations Manager
Deep Sea Drilling Project

DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 53

Total Days (March 9, 1977 - April 25, 1977)		47.33
Total Days in Port		4.34
Total Days Cruising		8.87
Total Days On Site		34.12
Trip Time	10.1	
Drilling Time	0.0	
Coring Time	11.4	
Mechanical Downtime	3.3	
Re-entry and Related	3.8	
Wait on Weather	0.9	
Other	4.7	

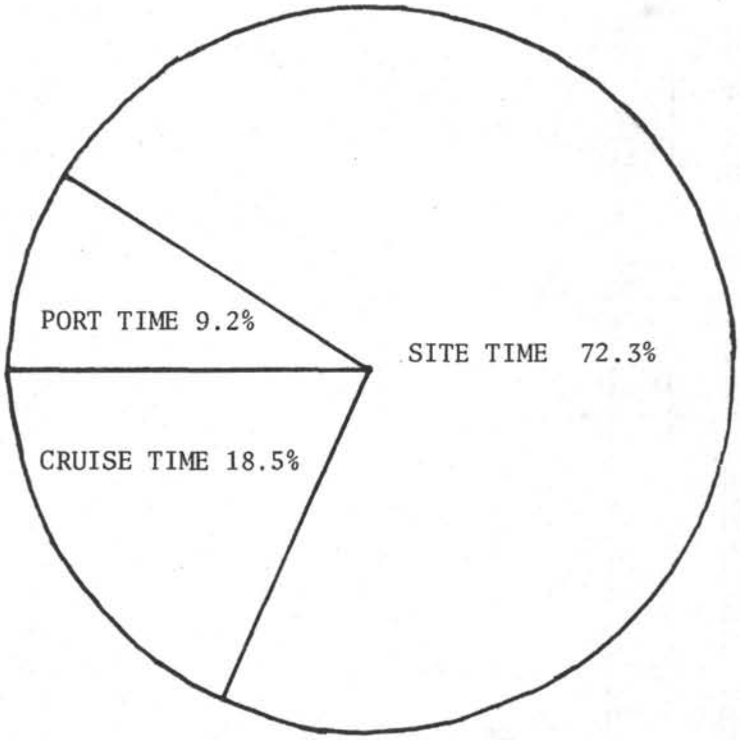
Total Distance Traveled (Nautical Miles)	1867
Average Speed (Knots)	8.95
Sites Investigated	1
Holes Drilled	2
Number of Cores Attempted	73
Number of Cores With Recovery	72
Percent of Cores With Recovery	98.6
Total Meters Cored	626.9
Total Meters Recovered	405.7
Percent Recovery	64.7
Total Meters Drilled	0
Total Meters Penetration	626.9
Percent Penetration Cored	100.0*
Maximum Penetration (Meters)	867.8
Minimum Penetration (Meters)	329.6
Maximum Water Depth (Meters)	5523.0
Minimum Water Depth (Meters)	5519.0

*Combined Leg 52 and 53 penetration



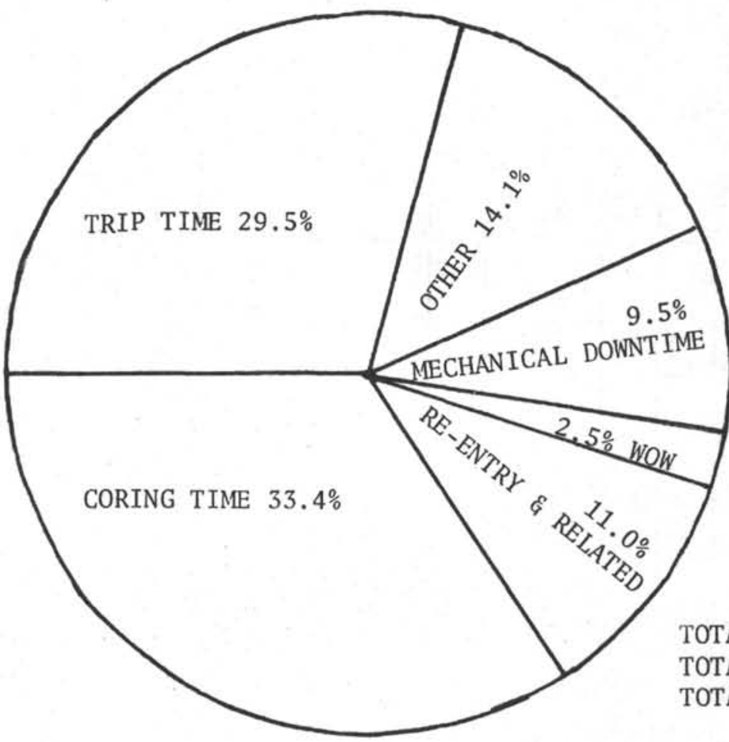
LEG 53 OPERATING AREA
BLAKE PLATEAU
BLAKE-BAHAMA OUTER RIDGE
HATTERAS ABYSSAL PLAIN
BERMUDA RISE
NARES ABYSSAL PLAIN
PUERTO RICO TRENCH
418
9
28
San Juan
To Panama
2000
4000
5200
6000
30°
20°
75°
65°

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
TOTAL TIME DISTRIBUTION
LEG 53



START LEG: March 13, 1977
FINISH LEG: April 25, 1977
TOTAL TIME: 47.33 Days

ON-SITE TIME DISTRIBUTION
LEG 53



TOTAL TIME ON SITE: 34.12 Days
TOTAL SITES: 1
TOTAL HOLES: 2

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 53

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
3/09/77 3/15/77		47.0								99.0		2.2	148.2	San Juan to Site 418
3/15/77 4/14/77	418A		221.2		208.3	1.0	20.4	0.9	77.3		90.7	110.3	730.1	
4/14/77 4/18/77	418B		21.3		65.2				1.0			1.3	88.8	
4/18/77 4/25/77		163.7								5.1				Site 418 to San Juan to Cristobal
TOTAL		210.7	242.5	0.0	273.5	1.0	20.4	0.9	78.3	104.1	90.7	113.8	1135.9	

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 53

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
418A	25° 02.19'N	68° 03.44'W	5519	38	38	100.0	297.3	233.1	78.4	- - -	297.3	2.1	780.1	
418B	25° 02.17'N	68° 03.45'W	5523	35	34	97.1	329.6	172.6	52.3	- - -	329.6	33.6	88.8	
				73	72	98.6	626.9	405.7	64.7	- - -	626.9	18.7		818.9

HOLE 418A - LEGS 52 & 53

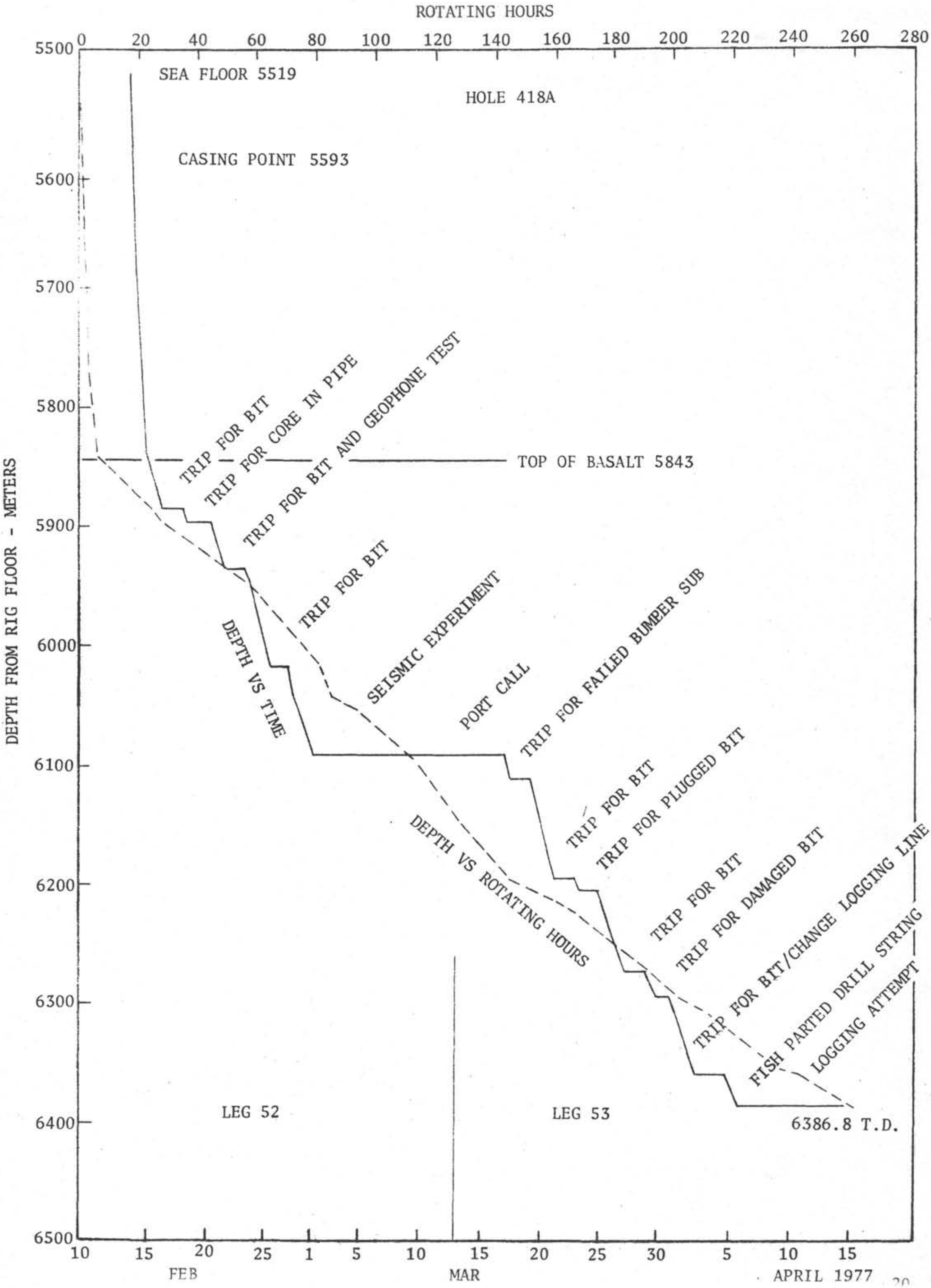
Hole	Latitude	Longitude	Water Depth Meters	Number Of Cores	Cores With Recovery	Percent Of Cores With Recovery	Meters Cored	Meters Recovered	Percent Recovered	Meters Drilled	Total Penet Meters	Avg. Rate Penet.	Time On Hole	Time On Site
418A	25° 01.10'N	68° 03.44'W	5519	86	86	100.0	680.8	444.8	65.3	187.0	867.8	4.2	1225.0	

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 53

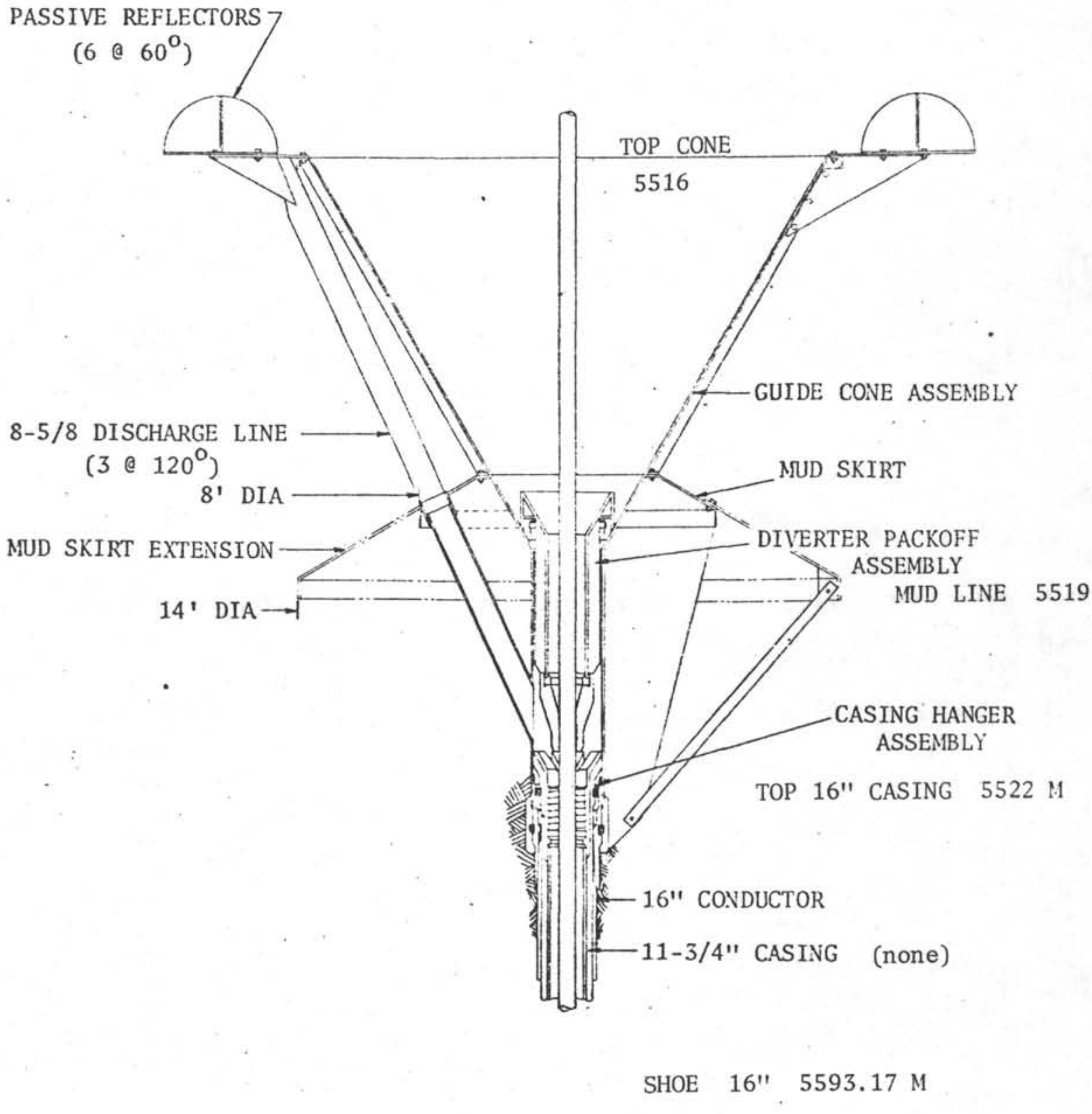
Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
418A	Smith	10"	F94CK	076CE	21.7	- - -	21.7	7.3	T1-B1SE-0 7/16	9-7/8 pads. Excessive cone face wear.
418A	Smith	10"	F94CK	CA747	84.3	- - -	84.3	26.6	T2 BT-B8L-0 1/8	All bearings gone. Two cones locked.
418A	Smith	10"	F99CK	852BP	76.2	- - -	76.2	41.5	T1-B1SE-I	Good shape.
418A	Smith	10"	F94CK	PC160	21.6	- - -	21.6	9.7	T3 BT-B2SE-I	83 BKN inserts after torquing and sticking on last core (core dia 5.1 cm)
418A	Smith	10"	F99CK	850BP	66.2	- - -	66.2	39.1	T3BT-B2SE-I	Pulled when R.O.P. dropped. Crack across top of cone leg.
418A	Smith	10"	F99CK	844BP	27.4	- - -	27.4	16.6	TO-B1SE-I	Fish out after twistoff.
418B	Smith	10 1/8"	F93C	KN262	329.6	- - -	329.6	9.8	T1-B1SE-0 1/16	3-cone - 10m basalt - 5 broken inserts

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 53

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours	Remarks
418A	ORE (d.1)	13.5	395	700 ±	Dropped 2/14/77 on Leg 52. Marginal strength. Not used on Leg 53.
418A	ORE (d.1)	16.0	386	770 ±	Dropped 3/1/77 on Leg 52. Fading 4/2/77.
418A	ORE (d.1)	13.5	405	379	Dropped 4/2/77, 2108. Strong for duration.
					All beacons double life.


ROTATING HOURS
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
5500
5600
5700
5800
5900
6000
6100
6200
6300
6400
6500
DEPTH FROM RIG FLOOR - METERS
SEA FLOOR 5519
HOLE 418A
CASING POINT 5593
TOP OF BASALT 5843
TRIP FOR BIT
TRIP FOR CORE IN PIPE
TRIP FOR BIT AND GEOPHONE TEST
TRIP FOR BIT
SEISMIC EXPERIMENT
PORT CALL
TRIP FOR FAILED BUMPER SUB
TRIP FOR BIT
TRIP FOR PLUGGED BIT
TRIP FOR BIT
TRIP FOR DAMAGED BIT
TRIP FOR BIT/CHANGE LOGGING LINE
FISH PARTED DRILL STRING
LOGGING ATTEMPT
DEPTH VS TIME
DEPTH VS ROTATING HOURS
LEG 52
LEG 53
6386.8 T.D.
10
15
20
25
1
5
10
15
20
25
30
5
10
15
FEB
MAR
APRIL 1977

HOLE 418A


PASSIVE REFLECTORS
(6 @ 60°)
TOP CONE
5516
GUIDE CONE ASSEMBLY
8-5/8 DISCHARGE LINE
(3 @ 120°)
8' DIA
MUD SKIRT
MUD SKIRT EXTENSION
DIVERTER PACKOFF
ASSEMBLY
MUD LINE 5519
14' DIA
CASING HANGER
ASSEMBLY
TOP 16" CASING 5522 M
16" CONDUCTOR
11-3/4" CASING (none)
SHOE 16" 5593.17 M

LEG 53 REENTRY REPORT

by

Robert M. Byrne

The following is a list of attempts made this Leg at Site 418A:

Attempt	Tool	Scan Time	Comments
1.	#101	15 hr. 12 min.	Hydrophone malfunction placed us 2300 ft. from cone. Long search necessary. CONFIRMED
2.	#104	6 hr. 43 min.	Hydrophone malfunction repaired. Necessary to reestablish cone position. CONFIRMED
3.	#104	1 hr. 35 min.	CONFIRMED
4.	#101	3 hr. 17 min.	CONFIRMED
5.	#105	2 hr. 55 min.	CONFIRMED
6.	#102	12 min.	CONFIRMED
7.	#104	--------------	Logging cable began to unravel during tool's descent. Tool pulled to replace cable. NO SHOT
8.	#104	28 min.	CONFIRMED
9.	#104	8 min.	CONFIRMED
10.	#104	2 hr. 26 min.	CONFIRMED
11.	#102	--------------	Tool failed due to pressure case flooding before reaching bottom. NO SHOT
12.	#103	--------------	Tool floated, cable knotted up. Tool became stuck before exiting pipe. During attempt to free tool cable parted. Tool pulled up with pipe. NO SHOT

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONAL RESUME
LEG 54

Leg 54 marked the return of the GLOMAR CHALLENGER to the Pacific Ocean for the first time since Leg 35. While the primary area to be investigated was the East Pacific Rise, the ship also visited the Galapagos area to evaluate this area for future drilling possibilities. This additional investigation of the Galapagos necessitated an extension of six days to the total planned time of Leg 54. Some of the scientific objectives were achieved; and some were not. Foremost was the inability to find a site suitable for placing a re-entry cone and drilling deep into the young crustal material near the ridge crest.

The leg started on April 25, 1977 in Colon, Panama and ended 53.7 days later, June 18, 1977 in Los Angeles, California. The CHALLENGER traveled 6567.5 nautical miles and attempted to drill 18 holes at 12 sites. Water depths varied from 2617 meters to a maximum of 3848 meters. The hole depths ranged from the shallowest of 31.0 meters to the deepest of 174.5 meters. The average depth was only 80.1 meters. This relatively shallow penetration was due mainly to the thin sediment covering and the destructive nature of the crustal material beneath the sediments on the bits. A total of 847.0 meters of coring was attempted with 461.37 meters recovered for a recovery percentage of 54.5%.

Time distribution for the leg was 4.6 days in port (includes 0.7 days of downtime) 31.3 days cruising and 17.8 days on-site. The on-site time breakdown consisted of 6.1 days tripping, 0.2 days drilling, 8.6 days coring, 1.5 days positioning the ship, 0.4 days of mechanical downtime, 0.1 days with stuck pipe and 0.9 days for miscellaneous items.

SITE 419 (HOLES 419 & 419A)

The primary scientific objective of this leg was to determine the crustal composition of oceanic crust associated with a fast spreading center and Site 419 was the first of these sites. It was located approximately 1600 miles west of Panama.

After arriving at the proposed location, a 16.0 kHz Benthos beacon was dropped. However, after about 30 minutes, the pulse rate doubled and it appeared to be losing strength so a 13.5 kHz beacon was rigged and dropped. The drill string was then made up and a mudline core was taken at 3294 meters. The hole was continuously cored to 35 meters where crustal material was encountered, which could not be penetrated due to insufficient soft sediment support for the bottomhole assembly. The sediment thickness, which had been calculated to be 80 ± meters from the geophysical data available, came as a surprise.

The drill string was then pulled to 91 meters above the mudline and the ship was slowly moved 3,000 feet southwest of the original location. Another mudline core was taken at 3277 meters and then the pipe was washed in to 46 meters where crustal material was again encountered. Again, due to this lack of sediment support for the bottomhole assembly, the site was abandoned.

While drilling Hole 419, the pore water sampler was run successfully at a bottom depth penetration of 29 meters.

SITE 420 (HOLES 420 & 420A)

After abandoning Site 419, the ship moved 26 miles westerly to Site 420. While the ship moved to this location, bottom profiling indicated a sediment thickness that could support the bottomhole assembly.

When the ship was on location, the drill string was made up and a mudline core taken at 3404 meters; the hole was then continuously cored to a subbottom depth of 147 meters. Crustal material was encountered at 115 meters. The 32 meters of basalt penetrated required more than eight hours to core. The main difficulty was in the apparent badly fractured nature of the rock as evidenced by the poor recovery (1.22 meters). While this section was being cored, almost continuous torquing and sticking was experienced with pulls as much as 400,000 lbs. required to move the pipe. In addition, more than 200 barrels of mud were spotted in an attempt to assist the coring. However, poor drilling conditions persisted and it was finally decided to abandon this hole. While coring the sediments, three successful pore water samples were obtained at subbottom depths of 23.5, 71.0 and 99.5 meters.

The drill string was pulled 195 meters above the mudline and the ship was moved 3,400 feet on a course of 045^{o}. Hole 420A was spudded with a mudline core at 3412 meters. The drill string was then washed down to the top of the basalt which was encountered at 63 meters subbottom. Again, because there was insufficient support for the bottomhole assembly, the drill string was pulled to move to a new location.

When the drill bit was pulled, it was worn out after 9.87 rotating hours. When recovered, the bit was found to have no cones or core guides and the stabilizer pads had been worn off. This was further evidence of the poor drilling possibilities in the fractured crustal basalt.

SITE 421

This site was located only about three miles east of Site 420 and appeared to have about 100 meters of sediment cover based on the profile geophysics.

Before the drill string could be run, about five hours were spent changing out the diaphragm and clutch lining in the make up drum of the drawworks. After this, the drill string was made up and a mudline core was cut at 3342 meters. The hole was then washed 85.5 meters to where the basalt was again encountered. Three 9.5 meter cores were cut in the basalt with a total recovery of 1.74 meters.

Torquing began almost as soon as the basalt was topped and continued during the time the three cores were being cut. Also, during this coring, 300 barrels of mud were spotted with very little increase in coring efficiency. After cutting the third core, two hours and 45 minutes were spent trying to get back to bottom. However, the drill bit could get only to within nine meters of the total depth of the preceding core. With occasional pulls on the drill string up to 425,000 lbs., it was decided that this site should be abandoned. When the bit was recovered, it was about 1/8" out of gauge and all of the stabilizer pads had been destroyed due to the abrasive nature of the basalt.

SITE 422

This site was located about 48 miles east of Site 421 and was located to try to encounter a more drillable section. After coring 46 meters of sediments, a sill or flow of basaltic material was cored. Below this another four meters of sediments were cored, followed by about 9.5 meters of massive basaltic material. However, directly below this rock fractured basaltic material was again encountered as in the previous sites. Again, torquing and sticking developed and resulted in slow penetration rates. After cutting Core No. 10, the pump pressure indicated that the bit was plugged so a center bit was dropped. When it was recovered there were four evenly spaced grooves on it and it was felt that the bearings had failed and that the core guides were being pushed in and not allowing a full gauge core to be cut. Core No. 10 had only 0.17 meters recovery for 9.5 meters cored. Because of this evidence, it was decided to abandon the site.

However, when the bit was recovered, the bearings were intact as well as the core guides. When the center bit was inserted into the bit again, it was observed that the gauge cutting inserts did touch the center bit as though the cones had been squeezed toward the center of the bit. The stabilizer pads also were about half worn away from the abrasive action of the fractured basalt.

SITE 423

This site was located about ten miles east of Site 422 and was considered to be the prime location for a location for a re-entry site in the original prospectus. However, the thin sediment cover encountered in the beginning of the leg made this site less attractive. In order to attempt drilling this site, the bottomhole assembly was modified so there would be less chance for it to be broken off. The total length was reduced from 120+ meters to 83+ meters.

A mudline core was taken at 3177.5 meters and the hole was then continuously cored. Basalt was topped in Core No. 5 at 38 meters and when the core barrel was recovered, a piece of basalt was jammed in the catcher. After coring about ten minutes on Core No. 6, the pipe torqued up and stopped rotating. The pipe was picked up and it required one hour to get back to the same depth. The pipe continued to torque so 50 barrels of mud were spotted and the pipe worked until 4.5 meters had been cored and the core barrel was recovered. Core recovery for this core was 22 cm.

Core No. 7 required 128 minutes to core five meters and recovered 38 cm. After cutting Core No. 7, about eight meters of fill were encountered when the pipe was run back to bottom. While attempting to work back to bottom, the pipe would torque up and stop requiring 75,000-100,000 lbs of overpull to release it. After about two hours and two meters of penetration, it was decided to abandon the hole because of the risk to the drill string.

SITE 424

This site is located about 1,250 miles east-southeast from Site 423. This change in the area of investigation was due to a Project decision to include drilling trials along the Galapagos spreading center. The basic reason for this change was to determine the drillability of the mounds and ridges believed to be associated with geothermal activity. Two geothermal legs in this area are planned in the future.

After arriving in the area to be tested, about five hours of profiling was done before a beacon was dropped at 1438 on May 22, 1977. The PDR indicated a water depth of 2701 meters and 2691 meters of drill string were made up and run. The Schlumberger sheaves were made up and the re-entry tool was run as would be done for a cone re-entry. However, this time the tool would be used in an attempt to locate the drill string directly over a geothermal mound. The basic idea for locating and drilling a mound was to position the ship, as close as possible, to directly over the mound, pull the EDO tool, drop an inner core barrel and then with sufficient pipe above the derrick floor, take a punch core deep enough so the drill string would remain in the bottom while the core barrel was being retrieved.

After about three and one half hours of positioning, it was felt that the ship was over a mound and the EDO tool was pulled and a core barrel dropped. The core recovered 6.5 meters of black manganiferous material and it was felt we were on at least a flank of the mound, if not on top. The hole was then continuously cored and penetrated about 31 meters of sediment before encountering crustal material. A successful pore water sample was obtained approximately two meters above the sediment-crustal contact.

Drilling continued into the basalt for 45 meters before the bit wore out and the drill string was pulled.

The normal bottomhole assembly had been changed because of the information indicating a relatively thin sediment thickness in this area. It consisted of the bit, bit sub, core barrel, top sub, head sub, three 8-1/4" drill collars, one 5' bumper sub, two 8-1/4" drill collars, crossover sub, one 7-1/4" drill collar, one 5-1/2" heavy wall with an overall length of 83.5 meters and it appeared to make the coring operation effective.

HOLE 424A

The second hole to be drilled in this area was located about 2,000 feet southerly from Hole 424, hopefully in another mound chain or ridge. The move south was made by offsetting from the beacon and using the PDR to note changes in bottom depth.

After one hour of positioning the ship, a satisfactory location was reached and the drill string was run in to 2692 meters. During the positioning, the changes in water depth were quite subtle and therefore, final location would be made from the bottom configuration as seen with the re-entry tool.

The EDO tool was lowered and the search for the mound was begun at 1429 hours. Two hours and 26 minutes later a mound was believed to be located and the tool was pulled. When the search began the bottom was located at 2716 meters and when the tool was pulled bottom was calculated to be 2708 meters or above a mound about eight meters high.

The inner barrel was dropped and when the positioning dot was centered in the bridge console again, the pipe was lowered and a core was taken. Again, the penetration was deep enough that the pipe would remain in the bottom while the core was recovered. The cored material was again black manganiferous material as at Hole 424 and was conceded to be from a mound. Two sediment cores were recovered and the third core encountered resistance after 29 meters of penetration. However, after recovery of Core No. 3, it was not possible to run the bit back to total depth. One hour was spent trying to accomplish this, but torquing and sticking was so bad that rotation was lost and pulls up to 350,000 lbs were necessary to free the drill string. Apparently the basalt was badly fractured and could not be penetrated safetly. Therefore, the hole was abandoned and the ship would be moved a short distance and another attempt would be made.

HOLE 424B

After completing the drilling of the two mound locations, the ship was moved about 3,200 feet north of 424A and about 1200 feet north of 424 with the drill pipe pulled to 2511 meters. This site was located between mound areas and therefore did not require the use of the EDO tool to locate the drill site.

A mudline core was taken and established bottom at 2710 meters. The hole was continuously cored and encountered basalt in Core No. 5 at a penetrated depth of about 38 meters. No more than five meters could be cored in Core No. 6 after two hours of difficult rotating time. During this time 50 barrels of mud were spotted but failed to improve drilling conditions. Therefore, because of the torquing, sticking, and lack of ability to core the apparently fractured material, the hole was abandoned.

HOLE 424C

After completing Hole 424B, the drill string was pulled to 54 meters above bottom and the ship was moved 650 feet north of the abandoned hole.

A mudline core was taken and as in Hole 424B, there was no manganese type material recovered which apparently verified the fact that these sites were not located on mounds. Two joints were washed and the second core encountered crustal material at about 31 meters. While cutting the last part of Core No. 2, the drill string began torquing and sticking, requiring pulls of over 300,000 lbs to free it. Core recovery from this 9.5 meter core was only 35 cm. While Core No. 3 was being cut only three meters were penetrated in 112 minutes and the same torquing and sticking was experienced. Because of this, the hole was abandoned after a total penetration of 34.5 meters.

SITE 425

This site was located about 50 miles north of Site 424 and was the last site to be drilled in the evaluation of the Galapagos area.

After a seven hour trip, the 16 kHz beacon was dropped 0308 hours on May 26, 1977. After positioning of the ship was completed, pipe was run to 2836.5 meters. A mudline core was taken establishing bottom at 2872 meters. The hole was then alternately cored and washed to a subbottom penetration of 62.5 meters, then the hole was continuously cored to total depth. Core No. 6 encountered basalt at about 80 meters and Core No. 7 was cut with little difficulty. However, Core No. 8 had trouble getting back to bottom and began torquing, so 25 barrels of mud were spotted before retrieving the core. Core No. 9 also encountered the same trouble getting back to bottom and it required 212 minutes to cut this core. Again, mud was spotted before retrieving the core. The beginning of Core No. 10 was the same as the two preceding cores; however, the bit plugged and the drill became stuck after working back to bottom. It required about one hour to work the pipe free with pulls up to 425,000 pounds. During this time the bit remained plugged and due to this difficulty in getting back to bottom, it was decided that the site be abandoned. When the bit was recovered, all the jets were plugged with basalt cuttings.

SITE 426

This site was located 1,362 miles west-northwest of Site 425. It was the first site visited after leaving the Galapagos area and returning to the PAC-4 area and was made possible with a seven day extension for Leg 54. This first site was to be located on the East Pacific Rise axial crest in an attempt to recover some of the youngest rock in this area.

After doing some preliminary profiling to determine the amount of sediment cover, a 13.5 kHz beacon was dropped at 1954 hours on June 2. Positioning was begun but, before the ship was placed in the automatic mode, it was determined that the beacon was not operating properly and a 16.0 kHz beacon was dropped for final positioning.

The drill string was made up with the short bottomhole assembly that had been used in this area before when thin sediment cover was anticipated. Due to the fact that the profiles showed only a questionable 10 meter sediment thickness, it was decided to take a number of "mudline" cores to assist in the coring program.

The first location selected had a PDR reading of 2617 meters. The drill pipe was lowered and encountered very hard resistance at 2624 meters (no pump or rotation) and when the inner barrel was recovered, there was no evidence of sediments even though a plastic sock was used with soft formation catchers. The ship was then moved 700 feet west and with a PDR depth reading of 2621 the experiment was tried again. The pipe stopped at 2628 meters and again no sediments were obtained. The ship was then moved an additional 2,290 feet west and a third try was made. The PDR read 2632 but water cores and no resistance were observed at depths of 2637.5, 2647.0 and 2656.5 meters. Finally, hard resistance was reached at 2666 meters but no sediments were recovered. Based on these six attempts, it was decided that this area had no sediment cover and could not be cored safely. The site was then abandoned.

SITE 427

This site was located about 80 miles southwest of Site 426 in the Siqueiros transform fault area. The ship departed Site 426 at 1130 hours on June 3 and it was not until 2200 hours that a possible area with enough sediment cover was located.

A beacon was dropped and when the ship was positioning properly in automatic, running in with the drill was begun. Because of the uncertainty of the amount of sediment to be encountered (estimates ranged from 54 to 185 meters), a modified bottomhole assembly (83.66 meters) was used. This assembly was first used at Site 423 and after that whenever less than 100 meters of sediments were anticipated.

The PDR failed as the final approach to the site was being made so the ship's fathometer was used and proved to be quite accurate in determining the water depth. It showed a water depth of 3750 meters and a Matthew's Table correction factor plus distance to the derrick floor brought the value to 3850. After the drill string was run a bottom depth of 3848 meters was established with a mudline core.

The hole was then alternately cored and washed, feeling for crustal material until this was encountered after 146 meters of sediments. Two 9.5 meter basalt cores were cut with 12.06 meters recovered or about a 63% recovery factor. However, while cutting the third core, the pipe became stuck for about an hour before the balance of the core could be cut. When the inner barrel was recovered it was empty. It required almost three hours to work the bit back to bottom and then the rate of penetration was so poor it was decided to abandon the site with the assumption that the bit was worn after 12 hours of rotating time. When recovered, this assumption proved to be correct. The bit was practically destroyed with all three cones missing and only the worn core guides remaining.

SITE 428

This site was located about 75 miles west-northwest of Site 427 on the south side of the OCP Ridge. While enroute to this site an alternate was investigated with the profiling equipment but little or no sediment cover could be detected and the ship continued on to the original destination.

After 13 hours of travel, the beacon was dropped at 0518 hours on the 6th of June. The drill string was made up again using the modified bottomhole assembly of 83.66 meters because less than 100 meters of sediments were anticipated. The PDR had been repaired and indicated a bottom depth of 3299 meters and the mudline core established the depth of 3301 meters.

Following the mudline core, two singles were washed in and then the hole was continuously cored to total depth. Basalt was topped at 61 meters in Core No. 5 and required 96 minutes to core six meters of this material. Core No. 6 required only 44 minutes to core 9.5 meters and there was some concern that the ship had moved off position. The maximum movement of the ship had been 80 feet but the ship was again placed directly over the hole and the same cored interval was done again and required only 10 minutes to accomplish. After the core barrel was dropped to cut Core No. 7, about six meters of fill was encountered and while trying to get back to bottom the pipe became stuck. Apparently the material that had drilled so quickly in Core No. 6 was badly fractured and had fallen in the hole. After approximately five hours of working the pipe it was pulled loose. During this time 75 barrels of mud and also 20 barrels of Halliburton "Guar Gum" were spotted in an attempt to help release the drill string. Due to these bad hole conditions, it was decided to pull above the mudline and move a short distance and spud an "A" hole. The bit had been rotating only 2.6 hours at this time so the move was considered a satisfactory maneuver.

HOLE 428A

The ship was moved 500 feet north and the hole was spudded in 3296 meters of water at 0330 on June 7th.

The string was washed to 62.5 meters where the crustal material was encountered. The hole was then continuously cored to a depth of 115 meters subbottom before the bit wore out.

The first two cores cut at a rate of about 3.5-4 meters/hour, however, after cutting about five meters of Core No. 3 the bit stopped cutting and it was feared that the bit was worn out or damaged due to the mistreatment while trying to unstick the pipe at Site 428. However, when the core was retrieved, the core catcher had badly jammed so it was decided to try to core deeper. While running back to bottom some fill was encountered and torquing developed, but by working the pipe properly the bit reached bottom again and coring continued. After each core the problem of reaching bottom decreased until there was no problem before cutting Cores No. 6 and No. 7. The core diameter was slowly decreasing indicating that the bearings were going and eventually in Core No. 7, after five meters had been cored, the bit gave out. The last core recovered 2.74 meters of rock for five meters cored with a diameter of 4.0-4.1 cm. When the bit was recovered, one cone was missing and the bearings were gone in the remaining three. However, it had performed well for 20.1 rotating hours and the longest bit life for the leg. This longer bit life could be attributed to the apparently less fractured nature of the rock below the top 10-15 meters. With the amount of sediment and the nature of the rocks, this area could be considered a good candidate for a re-entry site on the Ease Pacific Rise.

SITE 429

This site was located due west of Site 428, a distance of 79.2 miles. It was located on the west flank of the East Pacific Rise and was to sample the oldest rocks (4.3 ± million years) encountered in this area of investigation.

The ship arrived in the area about midnight on June 8 and a 13.5 kHz beacon was dropped at 0034 hours, June 9. The PDR indicated a water depth of 3422 meters and the profiling equipment indicated about 40 meters of sediments. The shortened bottomhole assembly was again used because of this thin sedimentary cover.

The drill string was made up and run in and took a mudline core 3426.0-3431.0 meters. Plans were to then wash to approximately 35 meters subbottom and take a core which would span the sediment-crustal material contact. However, while washing in contact with the basalt was made after only 31 meters of sediments. This amount of sediment was considered insufficient to support the drill string safely so it was decided to abandon this location and attempt to find one with more sediments.

HOLE 429A

After the drill string had been pulled 100± meters above the mudline at Hole 429, the ship was moved 2,990 feet east to the new location.

The PDR indicated a water depth of 3426 meters. The pipe was then run in and washed to 3457 meters or 31 meters subbottom where crustal resistance was encountered. It therefore appeared as though there was no appreciable increase in sediments in this area and because time was running out before the ship had to depart for Los Angeles, it was decided to carefully try to core the basalt with this thin sediment cover.

Three cores were attempted with a penetration of 21.5 meters into the basalt before the core catcher plugged on Core No. 3 and the time had come for the ship to depart. During this short coring period, 2.95 meters were recovered and proved to be scientifically rewarding.

DRILLING AND CORING ASSEMBLIES

Three different bottomhole assemblies were used on this leg. At Sites 419, 419A, 420, 420A and 421 the bottomhole assembly consisted of a bit, bit sub (with float valve) core barrel, top sub, latch sub, three 8-1/4" drill collars, one 5-foot Baash-Ross bumper sub, three 8-1/4" drill collars two 5-foot bumper subs, two 8-1/4" drill collars, one 7-1/4" drill collar and one joint of heavy wall drill pipe. This assembly was modified at Site 422 and decreased the number of bumper subs to a total of two. From Site 423 through 429 the bottomhole assembly was shortened appreciably due to the thin sediment cover being encountered. The bottomhole assembly consisted of bit, bit sub, core barrel, three 8-1/4" drill collars, one 5-foot bumper sub, two 8-1/4" drill collars, one 7-1/4" drill collar and one 5-1/2" heavy wall. This assembly was 83.66 meters in length and made possible attempts to core crustal material with as little as 29 meters of sediment cover. This shallow sediment was cored with at least one basalt core recovered on all these last sites except at Site 426. At this site six attempts were made to recover mudline or sediment cores and recovered nothing. This site was located on the Pacific Rise axial crest and apparently no sediment cover exists. At least, of a consistancy that can be recovered with our coring equipment. Because of the lack of sediments no drilling into the crust was attempted.

BITS

Ten bits were used during this leg to drill the 18 holes that were attempted.

These included one 10-1/8" F93CM, one 10" RBF94CK and seven 9-7/8" F94CK. These bits enjoyed a total rotating time of 192.77 hours or about 19 hours per bit. The rocks that were cored were about the most abrasive yet encountered during the CHALLENGER drilling program. The first bit run, RBF94CK, after 9.87 rotating hours, returned to the derrick floor with all of the cone's core guides and stabilizer pads worn off as well as the body of the bit being badly worn. The two F93 fared little better with the first recovered with most of the inserts broken or missing, the bearings gone and 5/8" out of gauge and the stabilizer pads gone after 10.8 hours. The second was in worse condition with all cones gone, worn core guides and no stabilizer pads after 12 hours rotating.

The 9-7/8" F94CK bits seemed to bear the abrasive nature of the rocks somewhat better and only one returned missing a cone, but this was after 17.5 hours of rotating time.

One of the most significant things was the loss of the stabilizer pads on almost all the bits. This same abrasive effect of the rocks was seen in wear on the bit sub and drill collars.

A re-entry program should be studied carefully as related to bit life and the number of trips that would be necessary to achieve a particularly deep penetration of this very abrasive rock.

Overall core recovery on this leg amounted to 54.5% with about 22% in the crustal material.

BEACONS AND POSITIONING

Thirteen beacons were used on this leg, twelve ORE and one Benthos. All of the ORE beacons were single life except one double life 16.0 kHz. They all performed satisfactorily except one 13.5 that began to weaken soon after it had been dropped, so a 16.0 kHz was dropped and used for positioning. The Benthos beacon also had to be replaced because it too began to lose strength after an hour and 16 minutes. It also began pulsing every second.

Positioning on this leg was excellent with no problems. This could probably be attributed to the performance of the beacons and the excellent weather conditions which were enjoyed throughout the leg.

RE-ENTRY EQUIPMENT

Re-entry equipment was used at two locations on this leg but not for re-entry. It was used to try to locate mounds or ridges created by geothermal activity in the Galapagos area.

The first time it was attempted was at Site 424. After the tool had been lowered to the bottom of the drill pipe, it required about three hours to locate the potential target. The mound was cored with a mudline core and recovered manganese crustal material which is supposed to characterize a mound or ridge.

The second attempt was made at Hole 424A after the ship had been moved 1,750 feet south where another ridge was supposed to be located. This time it took about two hours to locate the ridge and again was verified with a mudline core which recovered the same manganese crustal material.

In both cases the EDO equipment was also used to determine not only the visual contact with the ridge but also the height that the mound was above the surrounding sea floor. It proved to be more accurate than the PDR which was affected by the pulses emitted by the EDO tool.

Two additional holes were drilled in the same general area but did not use the re-entry tool and the mudline cores did not contain the manganese material, more or less verifying the fact that the hole was not located on a ridge.

DRILLING EQUIPMENT

Following completion of drilling (Leg 53) operations on the Bermuda Rise, the horizontal drill pipe racker was found to be in a deteriorated condition. Interference between moving parts was a problem. Proper repair was judged to be a major undertaking and for Leg 54 approximately one half of the active drill string was removed from the racker. This action proved sufficient to allow proper working of the racker and was feasible due to the relatively shallow water depths of Leg 54. Proper repairs are planned during the drydock period scheduled following the voyage. It was necessary to off load some of the used drill pipe to provide the necessary room for planned re-entry operations.

At the last site two malfunctions were reported in the operation of the drawworks auxillary brake. The brake is operated by the application of electric current. The probable cause appears attributable to associated control equipment.

The heave compensator was not used during the leg because of two basic reasons. First, the weather and sea conditions were excellent and vessel motion was minimal. Second, the very fractured nature of the basaltic material required a great deal of flexibility in drilling techniques and this is not possible with the heave compensator in the drill string.

COMMUNICATIONS

Radio telegraph communication via radio WWD (Scripps) was easy on this leg as the vessel was in direct communication on 1710 kHz throughout the entire working day for WWD. The volume of traffic, so transmitted, was as usual high both outgoing and incoming. Radio telephone calls were made directly to WWD on several occasions with very satisfactory results. The volume of personal radio telephone calls was low but consistent. Due to extreme crowding of the amateur bands no traffic for individuals was handled via the once familiar "phone patch". All equipment worked well, the only difficulty being with the auto alarm which was repaired. One distress call, not in the vessel's area, was received via auto alarm.

PERSONNEL

Although this leg enjoyed only about 18 days on site and the balance of the time cruising, the scientific party appeared to enjoy some of their scientific objectives and attempted to retain their enthusiasm.

Both Global Marine and SIO personnel people teamed together to make the leg as successful as possible. The drilling department should be especially commended in obtaining crustal material under very difficult drilling conditions.

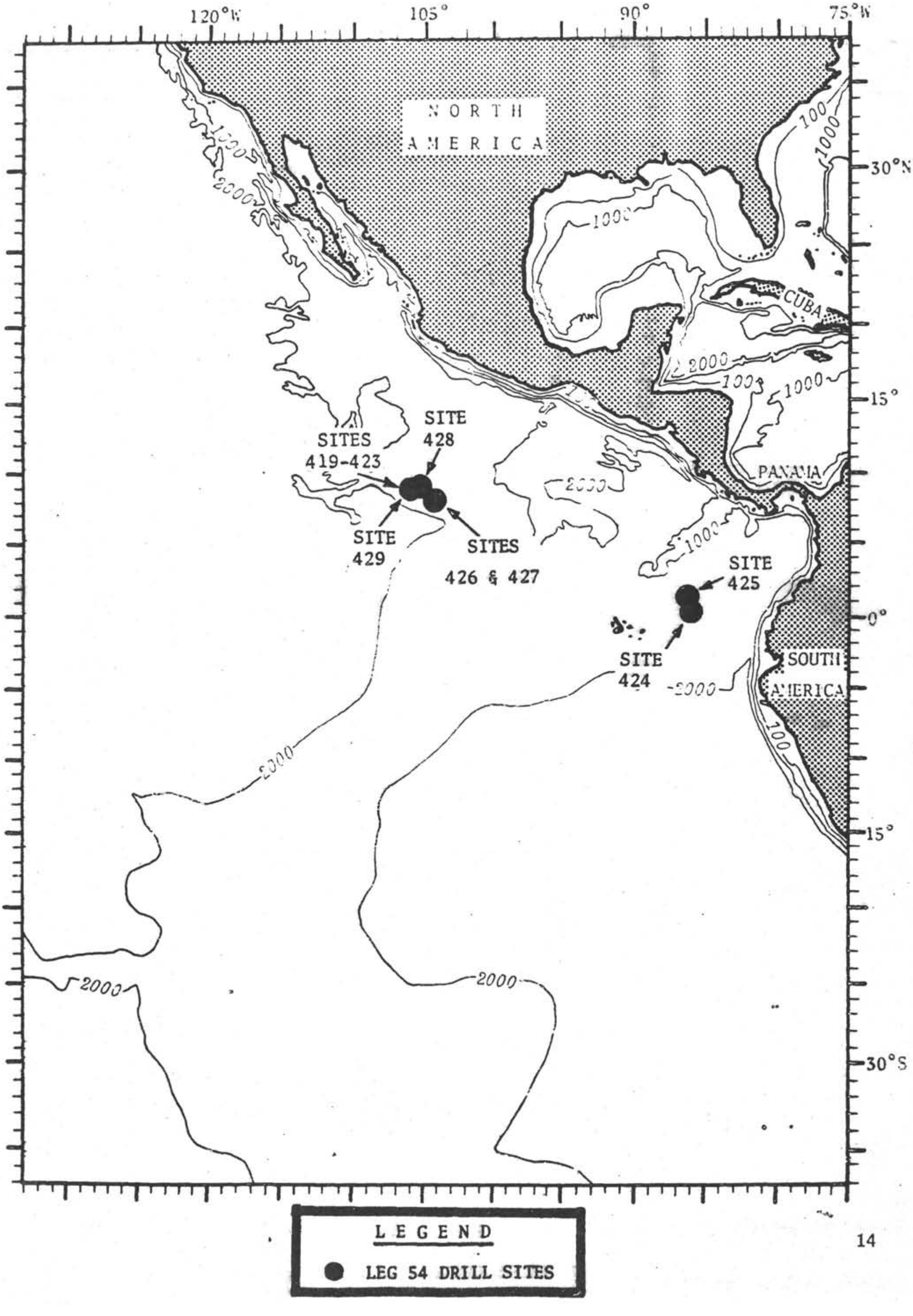
R. R. Knapp
Cruise Operations Manager
Deep Sea Drilling Project

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
OPERATIONS RESUME
LEG 54

Total Days (April 25, 1977 - June 18, 1977)	53.7
Total Days In Port	3.9
In Port Downtime	.7
Total Days Cruising Including Site Survey	31.3
Total Days On Site	17.8

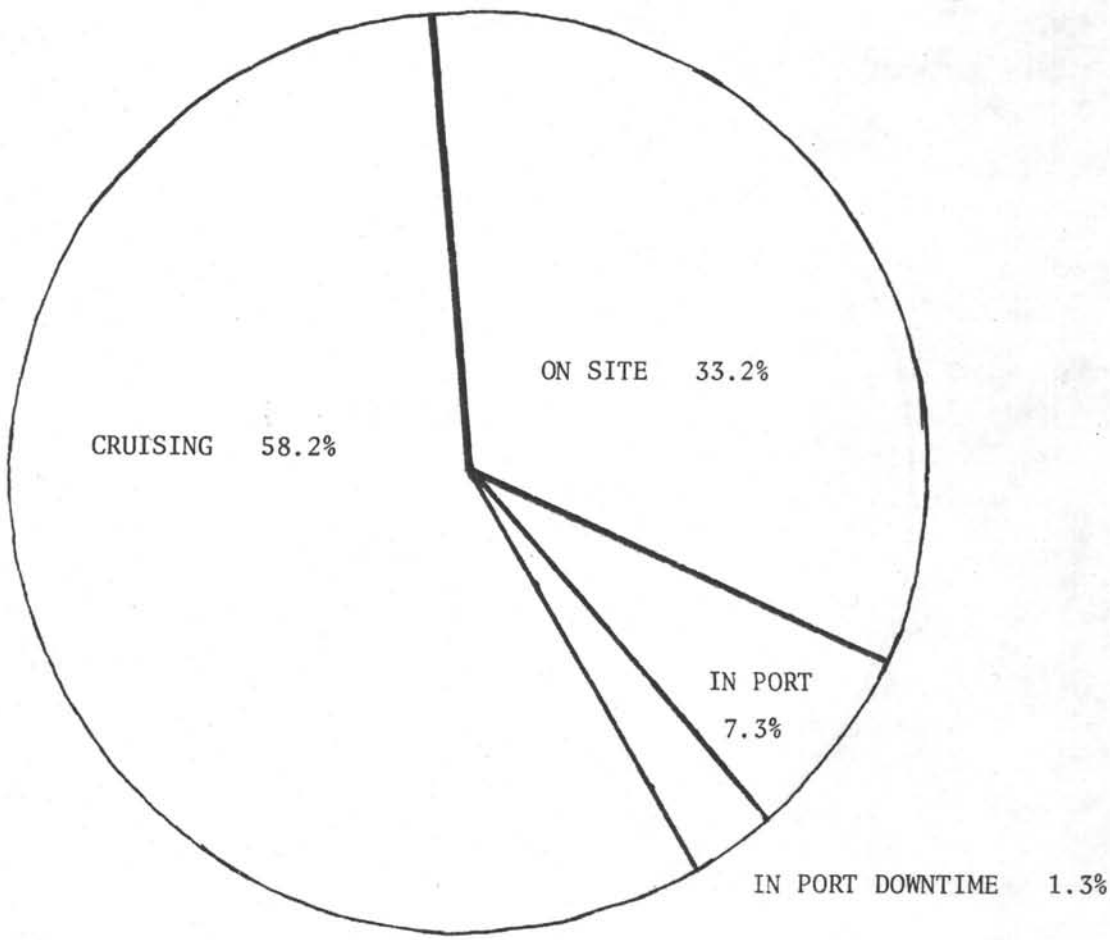
Trip Time	6.1
Drilling Time	.2
Coring Time	8.6
Position Ship	1.5
Mechanical Downtime	.4
Stuck Pipe	.1
Other	.9

Total Distance Traveled (Nautical Miles) Including Survey	6567.5
Average Speed	9.05
Number of Sites	11
Number of Holes Drilled (Attempted)	18
Number of Cores Attempted	102
Number of Cores With Recovery	101
Percentage of Cores With Recovery	99.0
Total Meters Cored	847.0
Total Meters Recovered	461.37
Percent Recovery	54.5
Total Meters Drilled	435.0
Total Meters of Penetration	1282.0
Percent of Penetration Cored	66.0
Maximum Penetration (Meters)	174.5
Minimum Penetration (Meters)	26.0
Maximum Water Depth (Meters)	3848.0
Minimum Water Depth (Meters)	2617.0



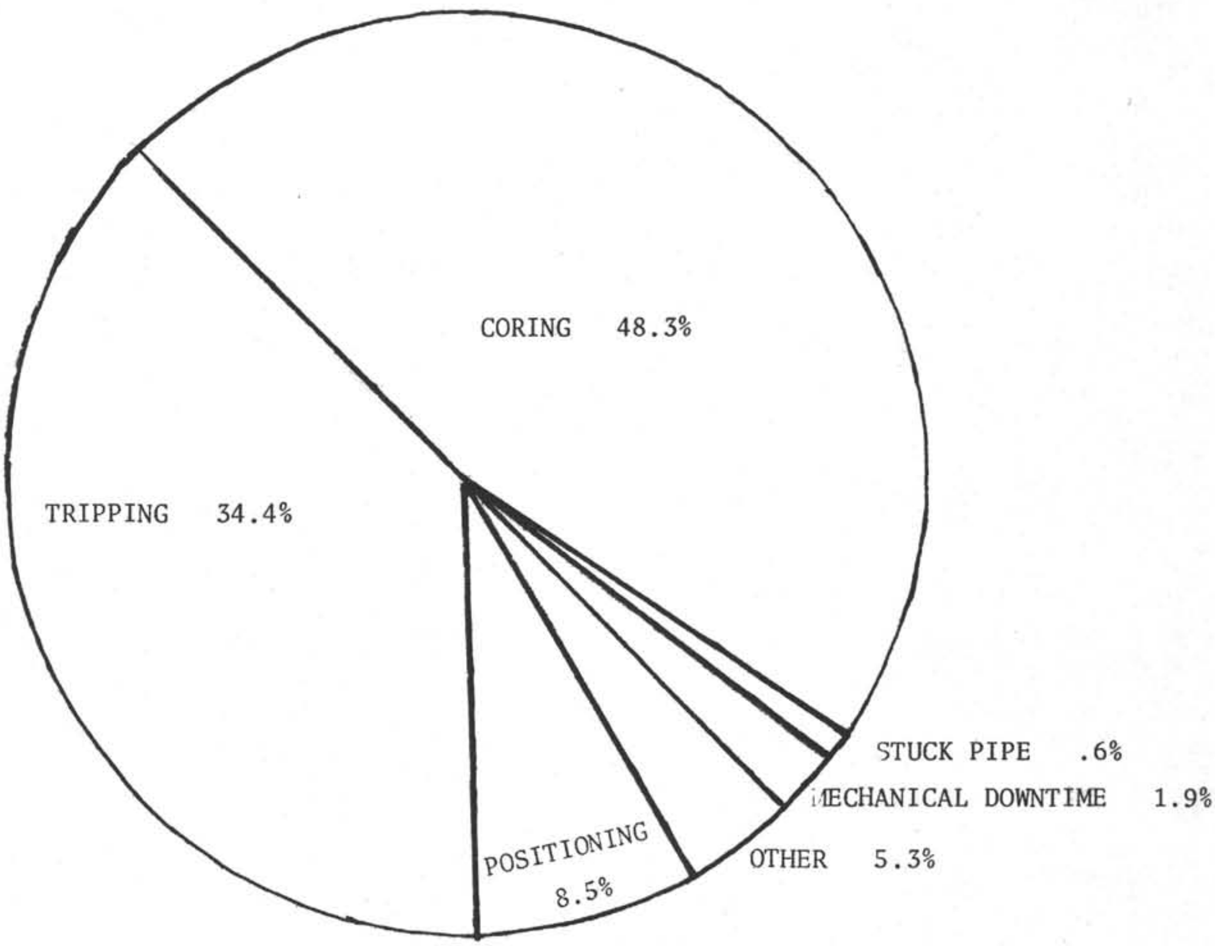
120°W
105°
90°
75°W
30°N
15°
0°
15°
30°S
NORTH AMERICA
CUBA
PANAMA
SOUTH AMERICA
SITES 419-423
SITE 428
SITE 429
SITES 426 & 427
SITE 425
SITE 424
100
1000
2000
LEGEND
LEG 54 DRILL SITES

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
TOTAL TIME DISTRIBUTION
LEG 54



START LEG: April 25, 1977
FINISH LEG: June 18, 1977
TOTAL TIME: 53.7 Days

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
ON SITE TIME BREAKDOWN
LEG 54



TOTAL TIME ON SITE: 17.8 Days
TOTAL SITES: 11
TOTAL HOLES: 18

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BEACON SUMMARY
LEG 54

Site No.	Make	Freq. kHz	Serial Number	Site Time Hours		Remarks
419	Benthos	16.0	003*	1.3		*Electronics #9307 - Transducer #374 - Beacon lost strength after 1 hr 16 min. Pulsed every second.
419A	ORE	13.5 SL	360	33.4		
420/420A	ORE	16.0 DL	385	55.2		
421	ORE	13.5 SL	409	32.1		
422	ORE	16.0	388	29.6		
423	ORE	13.5 SL	411	26.9		
424	ORE	16.0 SL	391	40.4		
424A	ORE	16.0 SL	391	17.5		
424B	ORE	16.0 SL	391	10.8		
424C	ORE	16.0 SL	391	9.5		
425	ORE	16.0 SL	390	27.9		
426	ORE	13.5 SL	408	Died		
426	ORE	16.0 SL	389	15.6		
427	ORE	13.5 SL	398	41.8		
428	ORE	16.0 SL	379	21.1	57.6	
428A	ORE	16.0 SL	379	36.4		
429	ORE	13.5 SL	397	8.8	24.9	
429A	ORE	13.5 SL	397	16.1		

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
BIT SUMMARY
LEG 54

Hole	Mfg.	Size	Type	Serial Number	Meters Cored	Meters Drilled	Meters Total Penet.	Hours On Bit	Condition	Remarks
419-419A	Smith	10"	RBF94CK	RC902	43.0	38.0	81.0	1.01		Will rerun on Site 420.
420-420A	Smith	10"	RB94CK	RC902	153.0	57.0	210.0	8.86	Destroyed	Cones, core guides, stabilizer pads gone.
421	Smith	9-7/8"	F94CK	104FJ	38.0	76.0	114.0	4.2	T1-B1-0 1/8"	Stabilizer pads worn off.
422	Smith	9-7/8	F94CK	160FF	73.0	- -	73.0	8.2	T1-B1-0 1/16"	Stabilizer pads starting to go.
423	Smith	9-7/8"	F94CK	085FF	53.5	- -	53.5	7.06	T1-B4-SQ-0 1/16+	Stabilizer pads gone. Body badly worn.
424	Smith	10-1/8"	F93C	KN306	76.0	- -	76.0	10.8	T7-B8-0 5/8"	Stabilizer pads gone.
424A	Smith	9-7/8"	F94CK	157FF	34.0	- -	34.0	2.35		
424B	Smith	9-7/8"	F94CK	157FF	46.5	- -	46.5	3.7	T1-B4-SQ-0 1/8	Stabilizer pads gone. Diameter at shank down
424C	Smith	9-7/8"	F94CK	157FF	16.5	18.0	34.5	2.6		from 9-1/4" - 8-1/2".
425	Smith	9-7/8"	F94CK	161FF	81.5	28.5	110.0	6.7	T1-B1-I	Pads starting to wear.
426	Smith	10-1/8"	F93CM	KN263	- -	- -	- -	- -	T1-B1-I	Not rotated. Water cores.
427	Smith	10-1/8"	F93CM	KN263	98.5	76.0	174.5	12.0	Destroyed	All cones gone. Worn core guides remaining.
428	Smith	9-7/8"	F94CK	192FF	54.5	22.0	76.5	2.6	20.1 hrs total	One cone gone. Seals gone. Stabilizer pads
428A	Smith	9-7/8"	F94CK	192FF	52.5	62.5	115.0	17.5	T7-B8-0	gone. Body of bit worn to internal threads.
429	Smith	9-7/8"	F94CK	917FE	5.0	26.0	31.0	.1		Rerun on 428A.
429A	Smith	9-7/8"	F94CK	917FE	21.5	31.0	52.5	5.1	T1-B1-SE-I	
					847.0	435.0	1282.0	192.77		

INTERNATIONAL PHASE OF OCEAN DRILLING
DEEP SEA DRILLING PROJECT
SITE SUMMARY
LEG 54

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. M/HR	Time On Hole Hrs.	Time On Site
419	08° 55.96'N	105° 41.17'W	3294	5	5	100.0	35.0	21.64	61.8	- -	35.0	46.6	24.0	
419A	08° 55.47'N	105° 41.22'W	3277	1	1	100.0	8.0	4.74	59.3	38.0	46.0	65.7	8.9	32.9
420	09° 00.10'N	106° 06.77'W	3404	17	17	100.0	147.0	95.07	64.7	- -	147.0	16.8	42.5	
420A	09° 00.50'N	106° 06.36'W	3412	1	1	100.0	6.0	6.05	100.8	57.0	63.0	4.8	12.7	55.2
421	09° 01.41'N	106° 03.68'W	3342	4	4	100.0	38.0	11.22	29.5	76.0	114.0	27.1	32.1	32.1
422	09° 10.59'N	105° 16.27'W	3254.5	10	10	100.0	73.0	46.97	64.3	- -	73.0	8.9	35.6	35.6
423	09° 08.81'N	105° 06.57'W	3177.5	8	8	100.0	53.5	27.98	52.3	- -	53.5	7.6	26.9	26.9
424	00° 35.63'N	86° 07.82'W	2703.5	8	7	87.5	76.0	36.45	47.9	- -	76.0	7.0	40.4	
424A	00° 35.33'N	86° 07.81'W	2708.0	3	3	100.0	34.0	13.13	38.6	- -	34.0	15.3	17.5	
424B	00° 35.82'N	86° 07.82'W	2710.0	6	6	100.0	46.5	29.3	63.0	- -	46.5	12.5	10.3	
424C	00° 35.93'N	86° 07.82'W	2710.5	3	3	100.0	16.5	7.81	47.3	18.0	34.5	13.2	10.0	78.2
425	01° 23.68'N	86° 04.20'W	2872.0	9	9	100.0	81.5	43.42	53.2	28.5	110.0	3.9	26.9	26.9
426	08° 47.28'N	104° 15.27'W	2617-2632	-	-	- - -	- - -	- - -	- - -	- - -	- - -	- - -	15.6	15.6
427	08° 06.79'N	104° 36.35'W	3848.0	11	11	100.0	98.5	57.26	58.1	76.0	174.5	14.5	41.8	41.8
428	09° 02.77'N	105° 26.14'W	3301.0	6	6	100.0	54.5	36.34	66.7	22.0	76.5	29.4	21.2	
428A	09° 02.77'N	105° 26.14'W	3296.0	7	7	100.0	52.5	16.37	31.2	62.5	115.0	6.6	36.9	58.1
429	09° 02.01'N	106° 46.35'W	3426.0	1	1	100.0	5.0	4.67	93.4	26.0	31.0	260.0	8.8	
429A	09° 02.01'N	106° 45.87'W	3426.0	3	3	100.0	21.5	2.95	13.7	31.0	52.5	10.3	16.1	24.9
		Totals		103	102	99.0	847.0	461.37	54.5	435.0	1282.0	6.6	428.2	428.2

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 54

Date 1977	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
4/25-29										87.4				
4/29		9.6												
4/29-30									16.3	8.2				
4/30-5/8/		182.0											182.0	Cristobal to Site 419
5/8-9	419		14.0		5.8			2.2				2.0	24.0	Pore Water Sampler
5/9	419A		5.9	.9	.6			1.5					8.9	
5/9		9.4											9.4	
5/9-11	420		7.8		26.0			1.2	2.0			5.5	42.5	Pore Water
5/11-12	420A		9.8	.8	.8			1.3					12.7	
5/12		1.4											1.4	
5/12-13	421		12.7	.5	11.8			.9	5.0			1.2	32.1	
5/13-14		9.3											9.3	
5/14-15	422		11.7		20.8			3.1					35.6	Attempt Clear Bit
5/15		4.1											4.1	
5/15-16	423		10.0		14.0			2.0				.9	26.9	
5/16-22		138.2											138.2	
5/22-24	424		9.3		21.0			6.6				3.5	40.4	
5/24-25	424A		4.8		5.2			7.5					17.5	
5/25	424B		1.2		8.2			.9					10.3	
5/25	424C		4.3	.3	4.9			.2				.3	10.0	Secure for Move

DEEP SEA DRILLING PROJECT
TIME DISTRIBUTION
LEG - 54

Date	Site No.	Cruise	Trips	Drill	Core	Stuck Pipe	W.O.W.	Position Ship	Mech. Repair	Port Time	Re-Entry	Other	Total Time	Remarks
5/25-26		6.3											6.3	
5/26-27	425		9.6	.1	14.6			1.1				1.5	26.9	Stuck Pipe Set Back Sub
5/27-6/2		157.9											157.9	
6/2-3	426		7.2		5.6			2.3				.5	15.6	Water Cores Only
6/3		10.3											10.3	
6/3-5	427		11.1	.5	25.8			.9	1.5			2.0	41.8	Stuck Pipe
6/5-6		13.7											13.7	
6/6-7	428		5.4	.2	6.7	3.5		1.9				3.5	21.2	Stuck Pipe
6/7-8	428A		8.9	.5	26.5			.5				.5	36.9	Magnaflux BHA
6/8-9		9.2											9.2	
6/9	429		6.2	.2	1.4			1.0					8.8	
6/9-10	429A		6.6	.5	7.7			1.3					16.1	
6/10-18		197.6											197.6	
TOTALS		749.0	146.5	4.5	207.4	3.5		36.4	24.8	95.6		21.4	1289.1	