XI. ROCK CORE SAMPLING FROM THE BANKS NORTH OF HACHIJO ISLAND USING THE SUBMERGED ROCK DRILL "MD500H"

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INTRODUCTION

The submerged rock drill "MD500H" (Plate XI-1) was designed by the Metal Mining Agency and the Geological Survey of Japan, and was constructed by Koken Boring Machine Co., Ltd. in 1978. Previously the G.S.J. had made a smaller rock drill "MD300PT" (KINOSHITA *et al.*, 1977) and used the machine for efficient rock sampling of the sea bed. However, the use of the machine had been limited to water depths of 300 m and the penetration of the drill was one meter at the maximum. In order to take rock cores from solid rock underlying superficial sediments of several meters in greater depths of water, the larger machine—MD500H was newly constructed and applied to rock sampling at 10 sites for the geological investigation of the continental shelf and slope around Oki Island in the Japan Sea during cruise GH78-3 (INOUE, *et al.*, 1978). The machine successfully took rock cores at 6 sites; the maximum length of core obtained was 2.9 m and the maxi-

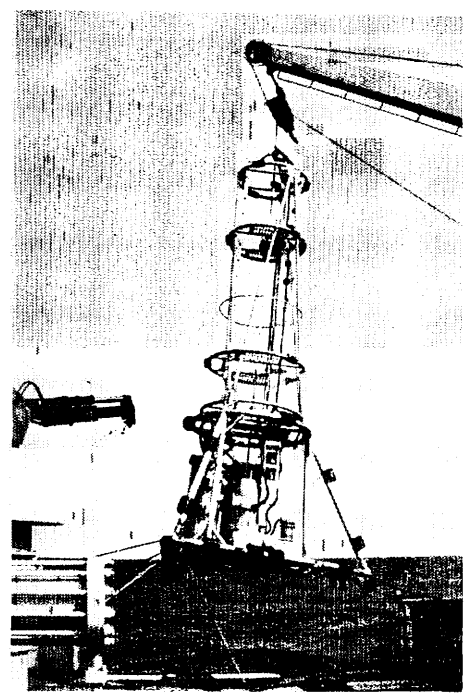

Plate XI-1 The MD500H machine lowered from the Hakureimaru.

mum depth of water operated in was 490 m.

The machine was also used by the National Railway Construction Corporation for a geological survey of the sea bottom in Tsugaru Strait. Rock sampling work with the machine was carried out at 50 sites, and rock cores were recovered from the sea bed at 40 sites.

In 1979, the G.S.J. used the machine at four sites on the banks north of Hachijo Island during cruise GH79-4. The banks are of volcanic origin, and one of them is thought to be a submarine caldera. Three rock cores were obtained at depths of 131–249 m.

This report is concerned with the features and specifications of this rock drill and the results of the undersea drilling operations.

FEATURES OF MD500H (Fig. XI-1)

The features of the MD500H are as follows.

1) It enables sampling of solid rock beneath superficial sediments of several meters in thickness, at depths down to the upper part of the continental slope.
2) It has a simple mechanism and is reliable.
3) It can be lowered and raised quickly and easily.
4) Its position and drilling conditions on the sea bottom are monitored by

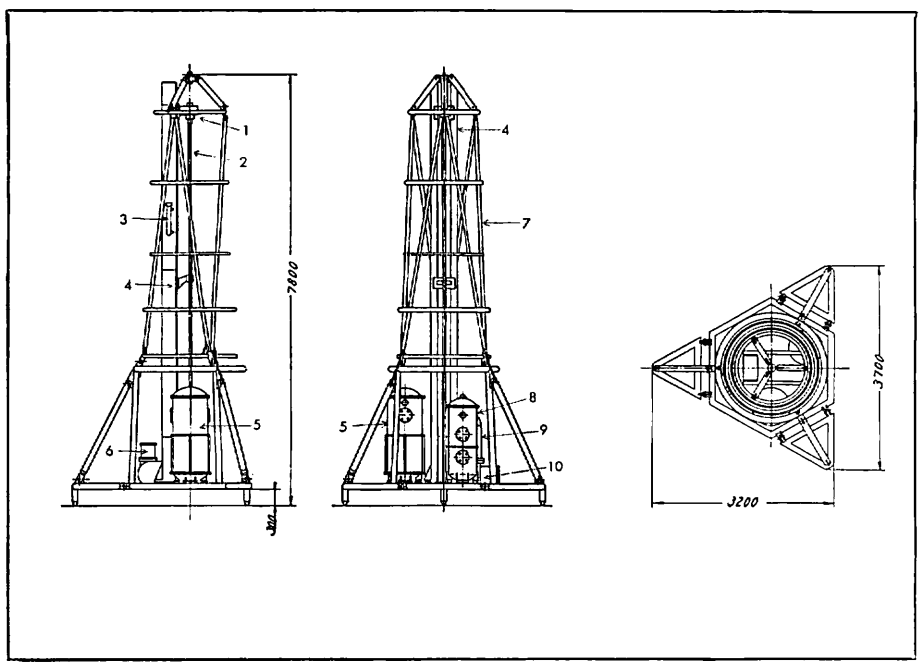

Fig. XI-1 Schematic representation of MD500H machine. 1 : drill head with water pump, 2 : double tube core barrel, 3 : pinger, 4 : guide frame, 5 : battery unit tank, 6 : pressure balancer, 7 : frame, 8 : control unit tank, 9 : submerged DC motor, and 10 : reduction gear.

Table XI-1 Specifications of the MD500H

Model	MD500H Marine Drill
Method	Submerged core drill, cycle one automatic drilling by DC motor and batteries.
Water depth	500 m in maximum.
Sea current	3 knots in maximum.
Length of a stroke	630 cm.
Rock core	44 mm in diameter and 600 cm in length.
Drill head	Bit thrust pressure 450 kg in maximum and torque of 377 rpm.
Water pump	28 lit./min.
Control system	Automatic including sonic control system.
Motor	DC submerged motor 3 kw.
Battery	48 v.
Dimension	7.8 m in height, 3.2 m in length and 3.7 m in width.
Weight	3, 300 kg in air and 2, 200 kg in water.

sonic equipment on board.

The MD500H which has been designed to satisfy these points has the specification shown in Table XI-1. A characteristic of the machine is to use a fully-automatic, battery-sustained system. Therefore lowering and raising of the machine is easily and quickly done, because only one wire rope is required and no other cables are needed.

A sonar control system is applied to the operation of the machine. Some of the drilling conditions of the machine on the sea bottom, i.e. the inclination of the machine, operation of the motor, the start and finish of drilling, the back-up of the core barrel, and possible water leaks inside the tanks are checked by this system. Also the motor can be started and stopped by remote control from the deck of the ship by the system. The position of the machine on the sea bottom can be shown on the oscillograph of a sonic position detecter in the ship by 28 kHz sonar-pinger.

METHODE OF OPERATION

For drilling work we have applied the no-anchoring method, which was developed during the tests of the MD300PT in 1975 (KINOSHITA *et al.*, 1977), as shown in Fig. XI-2. This method is to avoid overturning the machine on the sea bottom as a result of the drag on the wire rope between the machine and the ship. The wire rope must be slack between the weight on the sea bottom and the ship. Throughout the drilling time, the ship is carefully manoeuvred to keep the wire rope perpendicular on the sea surface. If the tension of the wire rope increases suddenly, the wire rope should quickly be extended until the tension decreases. This method has been applied many times with no failures.

ROCK SAMPLING

Using the machine, undersea drilling was carried out on the banks north of

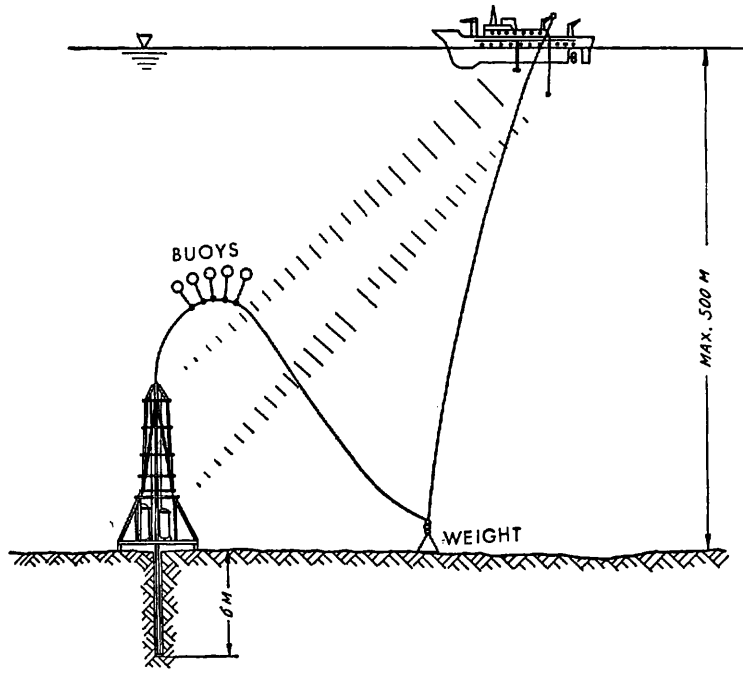

Fig. XI-2 Drilling method (see text).

Hachijo Island for two days during cruise GH79-4. Four drilling sites were selected at water depths of 131 to 249 m on the top and uppermost slope of the Shin-kurose Bank and the top of the Kurose Bank. The drilling time was set at 45 minute throughout, and the back-up time of the core barrel was 3 minutes. The bit thrust pressure was adjusted to 200 and 250 kg, the weight and the buoy attached on the wire rope were 100 kg and 107 kg respectively, and a diamond bit and a metal-chip bit were used. The motor of the machine was started and stopped automatically by a self-timer and also remotely controlled by the sonar control system.

The duration between lowering and raising the machine was 97 to 109 minutes.

The weather and sea conditions during the work were not rough; the wind blow SSW-SW at a maximum speed of 3 m/sec, and wave height was 0.5 m. The

Table XI-2 Undersea drilling

No. of site	Position (Lat. & Long.)	Water depth(m)	Penetration (cm)	Core length(cm)	Drilling time(min.)
St. 1570 (H11)	33-29.8'N 140-12.5'E	167	20 or 30	0	45
St. 1571 (H12)	33-34.0'N 139-53.5'E	249	250	186	41
St. 1572 (H13)	33-33.7'N 140-04.0'E	180	200	134	46
St. 1573 (H14)	33-21.5'N 139-41.0'E	131	130	55	45

drilling progress is summarized in Table XI-2.

Remarks on operation

St.1570 (H11). At a water depth of 167 m on the flat sea floor on top of the Shinkurose Bank. Penetration of the core barrel was 20–30 cm and no core was recovered. The motor stopped when the bit first met hard rock, after penetrating the soft sediments. The cause is thought to be due to the use of a metal chip bit and a bit thrust pressure unsuitable for hard rock. 250 kg pressure might be too high for cutting rock and caused an overload on the motor.

St.1571 (H12). At a water depth of 249 m on the uppermost slope of the Shinkurose Bank. Penetration of the core barrel was 250 cm and recovery of rock core was 186 cm. The bit thrust pressure was set at 200 kg and a diamond bit was used instead of a metal-chip bit. The operation of the machine and its control with the sonar control system were satisfactory. A core of sandy limestone was obtained.

St.1572 (H13). At a water depth of 180 m on the flat top of the Shinkurose Bank. Penetration of the barrel was 200 cm and recovery of rock core was 134 cm. The bit thrust pressure was set at same pressure as at St.1571 and a diamond bit was used. The reason for the rather short penetoration of the core barrel was slices of rock becoming jammed in the core barrel. Increasing the power of the water supply unit of the machine will resolve this problem. The sonar control system gave trouble. The operation of the ship to keep its position without anchoring at the drilling site was well done under the condition of a rather strong current of 2 knots. The rock core consists of calcareous-algal sandstone.

St.1573 (H14). At a water depth of 131 m on the top of the Kurose Bank (submarine caldera). Penetration of the core barrel was 130 cm and recovery of the rock core was 55 cm. Before the drilling work, a rock coring (RC59) was carried out at the drilling site to observe the sea bed conditions. No rock core was obtained and the core tube was bent as a result.

The rock drilling work was carried out under the same conditions of the bit thrust pressure and drilling time at the previous 2 stations and a diamond bit was used. Jamming occurred once again, but a core of

using the MD500H drill

Total working time(min.)	Day and time	Weather	Wind speed	Wave height (m)	Current speed (kt)
109	July 26, 1979 09:27–11:16	Fine	3 m/sec	0.5	—
102	July 26 14:38–16:20	Fine	2.5 m/sec	0.2	—
101	July 27 09:56–11:37	Fine	0 m/sec	0.3	2
97	July 27 14:55–16:32	Fine	3 m/sec		1.7

pumice-bearing conglomerate and breccia was obtained. The sonar control system worked satisfactorily. Although the weather and sea conditions were almost calm, a current was flowing in northeast direction at 1.7 knots.

The total core length obtained was 375 cm throughout the drilling work of two days.

PRELIMINARY NOTE ON ROCK CORES (Plate XI-2)

H 12 Core length: 186 cm

Top of core—63 cm; Calcareous, coarse sandstone containing granules and many fragments of various organic remains.

63-116 cm; Yellowish-grey, calcareous, fine sandstone or sandy limestone including Bryozoa, algae etc. An erosional plane exists at 66 cm.

116-138 cm; Yellowish-grey, sandy limestone.

138-142 cm; Calcareous, coarse sandstone loosely consolidated.

142-158 cm; Calcareous medium to coarse sandstone containing many fragments of Bryozoa, calcareous algae, Pelecypoda etc.

158-186 cm; Limestone.

H 13 Core length: 134 cm

Top of core—60.5 cm; Greyish-brown, calcareous, granule conglomerate and sandstone including many fragments of organic material.

60.5-102.5 cm; Sandy, algal limestone.

102.5-109 cm; Coarse sandstone consisting of shell fragments.

109 -134 cm; Algal limestone.

H 14 Core length: 55 cm

Top—55 cm; Yellowish-brown, pumice-bearing calcareous breccia consisting of volcanic rock fragments.

The H 12 and H 13 cores seem to have been deposited in a shallow sea near shore and look like beach rocks. The rock of core H 13 might have been formed near shore when the sea level was lower during the Quaternary, while H 12 is composed of material carried from near shore into deeper water on the slope.

The material of H 14 consists mostly of volcanic rock fragments and includes a few organic remains. It is thought that the submarine caldera formed later than the Shinkurose Bank, and that the caldera sank rapidly beneath the sea surface, although the top of the caldera was probably above sea level during the Quaternary.

CONCLUSIONS

The submerged rock drill MD500H was reasonably successful. However drilling operations were not completed because of jamming of the core barrel. The resolution of this technical problem requires an increase in power of the water

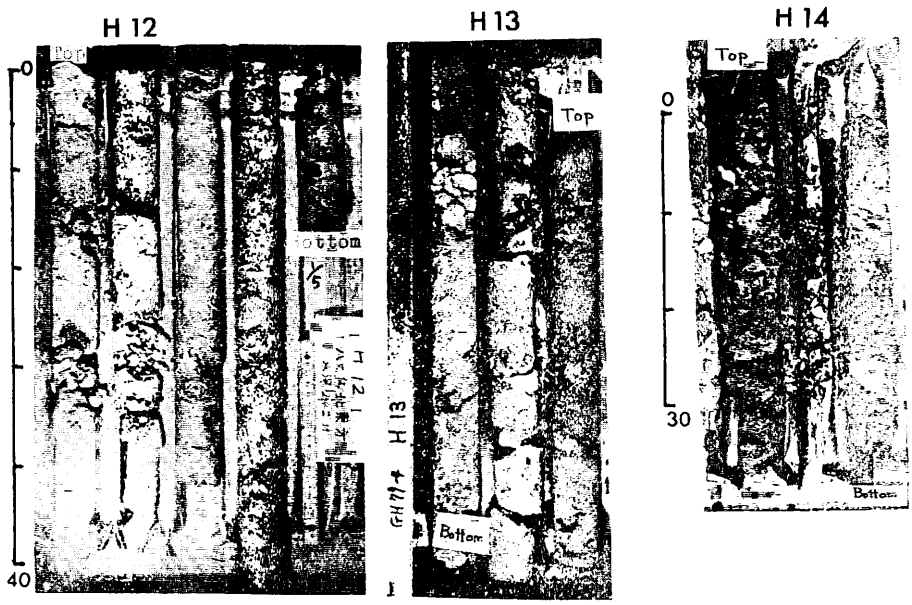

Plate XI-2 Rock cores recovered by the MD500H drill.

supply unit of the machine and selection of suitable bit and bit thrust pressure for the rock to be drilled.

The rock cores recovered at three sites will provide some important information towards understanding the history of the sea level change in the Quaternary.

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