II. GH74-1 CRUISE: APRIL 17–21, 1974

II. 1 Outline of the Cruise

Object and method

In March the general performance tests of all of the survey machinery and equipment were carried out in shallow sea off the Shimonoseki shipyard. However, practical tests had to be done in deep sea.

The first cruise of the vessel, in April 17–21, was undertaken for the tests of large winches with very long wire ropes and cables, operations of the deep sea television equipment, the sonic survey equipment such as PDR, 3.5 kHz sub-bottom profiler, air-gun and side-scan sonar, the gravity-meter and the satellite navigation system. At the same time, the cruise had another object to reconnoitre the geology of the Sagami-nada Sea area including Sagami Bay and its adjacent area.

The cruise course was set up between the area south of Bōsō Peninsula and the area on the eastern side of the Izu-Ogasawara Trench, as shown as Figure 3.

The course ran across the shelf, continental slope, deep sea trench greater than 9,000 m in depth and abyssal plain of 5,000–6,000 m in depth. It was planned that the practical tests of No. 1 and No. 2 winches were done in the deepest part of the trench; the deep sea television equipment was operated on the abyssal plain; No. 3 winch was tested in the trough at a depth of about 3,000 m; and the seismic reflection survey by air-gun and depth sounding by PDR were carried out during sailing between the testing stations. The satellite navigation system and the gravity-meter were operated throughout whole of the cruise.

Personnel

The vessel was commanded by Captain Seiji Toki with twelve officers, twelve crew and four cook/stewards. The scientific party consisted of eleven scientists and an engineer of the G.S.J. as shown in Table 1. For the practical tests of the winches, Mitsubishi staff composed of twelve engineers (technical leader-Mr. Hikota Seki) joined the cruise, together with three engineers of other companies which tested the air-compressor and deep sea television equipment.

Programme of the work

The cruise began on the morning on 17th of April and ended on the afternoon of the 21st. During the cruise, No. 1–5 winches, deep sea television equipment and the side-scan sonar were tested at A,B,C and D stations (Fig. 3). A geophysical survey using the air-gun was done during sailing from station to station. The programme of the work is shown in Table 2.

On the 19th, the vessel arrived at Kurihama Port to change some of the members of the scientific party. A synopsis of the daily log is as follows.

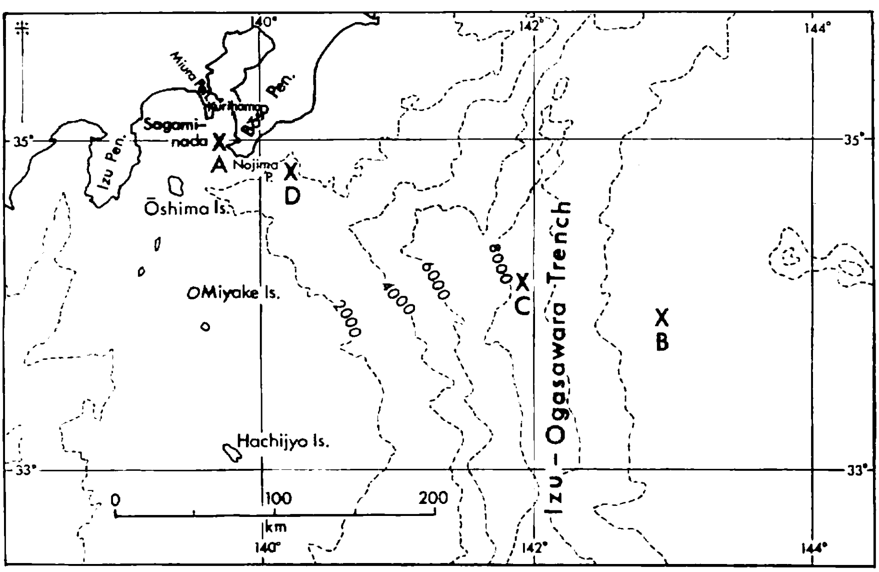


Fig. 3. Locations of practical tests of survey machinery and equipment in GH 74-1 cruise.

Table 1. G.S.J. scientific staff in GH 74-1 cruise.

Name	Organization	Speciality
Eiji INOUE	G. S. J.	Geologist, Chief scientist
Atsuyuki MIZUNO	G. S. J.	Geologist, Vice-chief sci.
Junsuke CHUJŌ	G. S. J.	Geophysicist, DTV, Side-scan sonar
Eiichi HONZA	G. S. J.	Geologist, Air-gun, DTV
Masaaki KIMURA	G. S. J.	Geologist, Air-gun, 3.5 kHz
Toshio HIROSHIMA	G. S. J.	Geophysicist, Air-gun, 3.5 kHz
Takemi ISHIHARA	G. S. J.	Geophysicist, NNSS, gravity
Yoshihisa OKUDA	G. S. J.	Geologist, Air-gun, 3.5 kHz
Yasumasa KINOSHITA	G. S. J.	Geologist, Winch, DTV
Fumitoshi MURAKAMI	G. S. J.	Geophysicist, NNSS, gravity
Kaichi ISHIBASHI	G. S. J.	Topographer, PDR, echo-sounder
Ichitaro AOKI	G. S. J.	Engineer, equipment

Table 2. Progress of testing works in GH 74-1 cruise.

Tests of equipment	Times and days (upper: beginning lower: finish)	Areas and stations	Latitude (upper: beginning lower: finish)	Longitude (upper: beginning lower: finish)	Depths of water in m	Weather
Towing of air-gun and hydrophone	1245, 1440, on 17th	A station, south of Kurihama	30°05.0′ 34°47.6′	139°42.3′ 139°52.7′		b
No. 5 winch (lowering 1,000 m of wire rope)	1512, 1526, on 17th	Near A station	34°47.8′ 34°47.8′	139°58.7′ 139°58.7′	950	b
Towing of side-scan sonar	1530, 1630, on 17th	ditto	ditto	ditto		b
No. 4 winch (lowering 6,700 m of cable)	0550, 1540, on 18th	B station on east side of Japan Trench	33°51.6′ 33°56.0′	142°47.9′ 142°47.0′	about 6,000	bc
Deep sea television	1610, 2008, on 18th	ditto	34°04.8′ 34°15.2′	142°48.4′ 142°34.7′	5,436	bc
Seismic profiling by air-gun	2015, on 19th 0005, on 20th	Near B station	34°15.2′ 34°18.9′	142°34.7′ 142°21.5′		bc
No. 2 winch (lowering 9,000 m of wire rope)	0530, 1555, on 20th	C station at Izu-Ogasawara Trench	34°08.8′ 34°12.7′	141°48.3′ 141°51.2′	8,800	c
No. 1 winch (lowering 9,495 m of wire rope)	1630, on 20th 0025, on 21th	ditto	34°12.7′ 34°23.7′	141°51.2′ 141°59.7′	8,950	c
No. 3 winch (lowering 2,000 m of wire rope)	0820, 0950, on 21th	D station 20 mile south of Nojima-zaki	34°47.9′ 34°47.9′	140°14.6′ 140°14.6′	2,150	0

b: blue sky, bc: c: cloudiness

April 17 The vessel sailed from Chiba Port at 0.800 hrs. Arrived at A station off Nozima-zaki Cape and tested towing system of air-gun and hydrophon from 1245 to 1440 hrs. Tested No. 5 winch lowering wire rope from 1512 to 1526 hrs. Operated the side-scan sonar from 1530 to 1630 hrs. Sailed to B station. Weather was calm.

18 Arrived at B station at 0550 hrs. and tested No. 4 winch lowering the armoured cable from 0550 to 1540 hrs. Subsequently, lowered the deep sea television camera by No. 4 winch to the sea bottom and observed the surface of the bottom from 1610 to 2008 hrs. Left B station at 2015 hrs. and sailed for Kurihama Port with geophysical survey.

19 Arrived at Kurihama Port and changed persons by a sampan from 1130 to 1500 hrs. Arrived at A station at 1800 hrs and geophysical survey started by the air-gun. Weather was cloudy and sea condition was somewhat rough.

20 Finished the geophysical survey at 0240 hrs. and arrived at C station. Operated No. 2 winch until 1535 hrs. at the station, and subsequently No. 1 winch from 1630 to 0025 hrs. on 21st. Weather was cloudy and sea condition was rather rough.

21 Arrived at D station and operated No. 3 winch from 0820 to 0950 hrs. After the work, sailed for Chiba Port and returned to the port at 1700 hrs. Weather was very cloudy and sea condition was rough.

Position fixing and navigation

Position fixing and navigation through the cruise were done by the satellite navigation system together with Loran-C navigation system. Fiducial marks on the seismic records were registered at 10 minute intervals.

The satellite navigation was done by using a Navy Navigation Satellite System manufactured by Magnavox Co. A satellite position fix accuracy of 120 feet RNS is obtainable. This system also dead reckons in latitude and longitude based on doppler sonar and gyrocompass imputs. High accuracy fixes were obtained at intervals of 1–2 hours. Dead reckoned latitudes and longitudes had errors of 1–4 minutes when the doppler lost bottom lock.

II. 2 Results of Practical tests

No. 1 winch: The practical test of No. 1 winch was carried out at C station at a depth of 8,950 m in the trench. The work took seven and half hours. A 1 ton sinker with 9,495 m of the wire rope was lowered to the sea bottom. During the work, wire tension, wire-out speed, DCG voltage, etc. were measured at every 1,000 m of extension of wire rope. During the operation there were some light troubles in the shifter, the tension-meter and with two or three other parts, which were repaired and adjusted.

No. 2 winch: The operation of the winch was carried out at C station where the depth was 8,800 m in the trench and took ten and half hours. A 400 kg weight with 9,000 m of the wire rope was lowered to the sea bottom. The measurement and examination on several parts were done at every 1,000 m of the extension of the wire rope.

The operation went well except for adjustments to speed-meter, tension-meter, and air-damper of the wire etc.

No. 3 winch: The No. 3 winch was operated at D station at the depth of 2,150 m for a one and half hour lowering of 2,000 m of the stepped wire rope with 200 kg weight. The result was satisfactory.

No. 4 winch: The test of this winch was carried out twice at B station in a depth of 5,380 m. The total duration of the tests was thirteen and half hours. In the first test 6,700 m of the armoured cable with a 400 kg weight was lowered to the sea bottom. During the lowering of the cable the performance tests of the hydraulic system, the brake system, the shifter etc. were done at every 1,000 m of the cable extension.

In the second operation of the winch the frame equipped with a deep sea television camera, a light and a sonar pinger was lowered to the sea bottom at a depth of 5,380 m and observation of the sea floor was done by the television camera for forty minutes.

The results of the operation were fairly satisfactory and no important troubles occurred with the hydraulic system and the shifter of the winch.

No. 5 winch: The operation of the winch took place at A station on the continental slope where the depth was 950 m, and took only a fifteen minutes. The 1,000 m long wire rope with a 20 kg weight was lowered and the result was satisfactory.

Deep sea television: The operation of the deep sea television equipment and the sonar pinger unit was carried out at the same time as No. 4 winch was tested. A very satisfactory result was obtained. The result of the testing of the DTV operation will be reported by Dr. Junsuke Chujō below.

Side-scan sonar: The operation of the equipment was carried out at A station towing the fish-type transducer under 4–6 kts of ship's speed. The test was continued for about one hour with good result.

Air-gun and hydrophone: Towing of the air-gun and the hydrophone was done under 10.5 kts of ship's speed for two hours and no trouble occurred. However, the air-compressor and the recorder unit often had troubles during the seismic survey of the cruise.

Sub-bottom profiler, Precision Depth Recorder and Echo sounder: This equipment was operated throughout the cruise and the results of the operations were mostly satisfactory although adjustments were necessary.

Gravity-meter: Gravity readings taken at calm sea should be accurate within 1 milligal although we have no data to compare with. At rough sea there were abrupt changes of gravity varying from 10–20 milligals and corrections of horizontal acceleration were needed to obtain accurate gravity values. The gravity-meter drift during the 5 days was 1.1 milligals and the drift rate is a little greater than 1 milligal per month.

II. 3 Results of the testing of deep sea television and No. 4 winch

by Junsuke Chujō and Yasumasa Kinoshita

Introduction

The Hakurei-Maru is equipped the deep sea television. The main parts were manufactured by Hydro Products Division of Dillingham Corporation, U.S.A. and its correct name is the Single Wire Deep Submergence Television System (DTV).

This DTV is the first deep sea television in Japan, and was first tested during this cruise.

DTV consists of four parts as follows:-

1. DTV console and electronics on board.
2. TV camera, lights, underwater electronics and frame.
3. Coaxial cable.
4. Winch.

Figure 4 shows a schematic picture of the DTV operation. The DTV is used

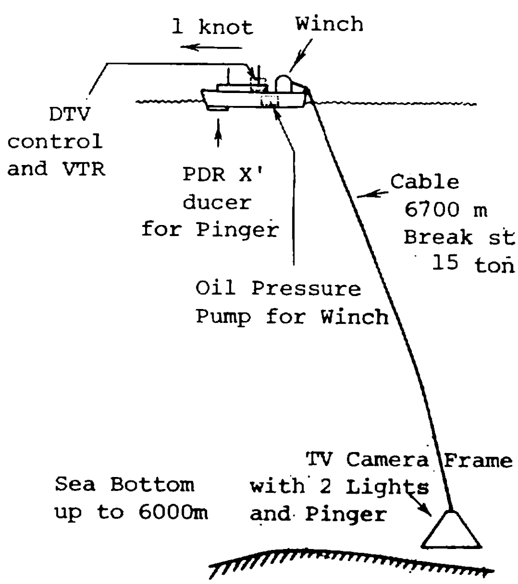


Fig. 4. Schematic diagram of DTV operation. DTV camera is lowered by the coaxial armoured cable up to 6,000 m deep. The ship tows and runs slowly as 1 to 2 kts.

to observe the sea bottom topography and geology up to a depth of 6,000 meters.

The DTV was tested and used at B station where was located on the east side of the Izu-Ogasawara Trench.

At first the cable and winch were tested without the electronic instruments as this was the first trial of DTV. After the full DTV equipped was used.

During the first trial a 400 kg iron block was attached to the end of the cable instead of the DTV frame, which weights 600 kg including the weights of 3 legs of the frame. The cable end was insultated electrically by a water tight plug and the insulation resistance was checked for water leakage.

For the second trial the full DTV equipped observation began from 1610, April 18th and ended at 2008. The position was 34°04.8′N, 142°48.4′E in the eastern of the Izu-Ogasawara Trench at a depth of 5,430 meters. The weather was cloudy, the sea state was calm with a 0.5 to 1.0 meter sea wave height. The wind direction was 90°–80° from the bow and the wind velocity was 6 m/sec.

Test of No. 4 winch and the cable

The DTV can be used in a depth of up to 6,000 meters and the coaxial cable is 6,700 meters long. The DTV system was purchased from Hydro Products and the serial number of cable is C-1555 (Special RG213U) which is manufactured by Vector Cable Co. Its diameter is 17.2 mm, the unit weight is 1.1 kg/m in air and 0.87 kg/m in water. The total weight is 7.28 tons in air and 5.69 tons in water. The outside armour coating consists of 22 steel line elements of 2.0 mm diameter with left winding. That of the inside consists of 22 steel line elements of 1.5 mm diameter with right winding. The breaking strength is 15.9 tons. The cable resistance for DC is 3.4 ohm/1000 feet and 75 ohm for the whole length. The characteristic impedance is 50 ohm. The transmitting loss is 14 db over the hole length at 100 kHz and 4 db/1000 feet and 88 db over the whole length at 4 MHz which is the upper limit of video frequency.

No. 4 winch is the electro-hydrauric winch used for the coaxial cable and consists of the winch body, power unit, starting device and control panel. The winch body is installed on the afterdeck, and the power unit and the starting device are located in the winch room in the vicinity of No. 1 and 2 winches. The main control panel is installed in the winch control room on the boat-deck. The winch can be controlled both from the winch control room and from the winch body itself or by a portable control set.

The power unit has two motors of 75 KW 3 phases 1150 RPM induction motor for the main pump use and a motor of 7.5 KW 3 phases 4 poles 1750 RPM induction motor for the auxiliary pump. Winding capability is a standard 6,500 kg×75 m/min and a maximum of 8,000 kg×60/min.

The drum core of the winch is grooved to fit a cable of 17.2 mm outside diameter and this 6,700 m cable is wound on 87 lanes in 16 layers. The slip ring is mounted at the end of the drum shaft and connects with the electric power and video signal even during winding.

Table 3. Loading test No. 4 winch. Terminal load: 400 kg.

Wire length	Notch	Hydraulic pressure kg/cm²				Current (A)	Tension (kg)	Reading value of wire speed (m/sec)	Calculated value of wire speed (m/sec)
		Machine		Power unit					
		hi	low	hi	low				
2000m (wind up)	2	63	23	65	15	20	2500	0.22	0.22
	6	65	26	65	15	30	2500	0.8	0.87
	10	70	29	75	15	60	2600	1.2	1.43
2000m (wind down)	2	45	23	45	20	15	2300	0.4	0.465
	6	43	21	40	20	15	2300	0.98	1.0
	10	40	18	35	20	25	2200	1.55	1.54
3500m (wind up)	2	82	24	80	15	20	3800	0.22	0.232
	6	82	25	90	15	45	4000	0.75	0.78
	10	88	27	90	15	70	4100	1.20	1.233
3500m (wind down)	2	60	23	65	15	20	3750	0.38	0.385
	6	58	20	60	20	25	3600	0.95	0.945
	10	55	18	55	20	20	3500	1.45	1.43
5000m (wind up)	2	65	22	100	20	18	3400	0.18	0.17
	6	60	24	70	18	30	3500		
	10	72	28	75	15	58	3500		
5000m (wind down)	2	45	23	50	20	18	3000		
	6	43	20	45	20	18			
	10	38	18	30	18	18			

One of the distinctive features of No. 4 winch is the slacking device for over-tension. When over-tension is added by the DTV frame to the towing cable the brake is released automatically by the present brake oil pressure in order to prevent breakage. In the first wind test a 400 kg iron weight was attached to the cable end instead of DTV frame. When the cable paid out 2,000 m the burst oil pressure circulation suddenly dropped. The system was then stopped and was adjusted again. After that the characteristics of the winch were measured at 2,000 m, 3.500 m and 5,000 m depth intervals both winding-up and winding-down for oil pressure, electric current, tension and so forth as shown in Table 3. After delivery from the manufacturer the cable was wound on the winch drum at the ship yard. At this time the cable was pretensioned for about 1 ton. When this cable was used at sea, the tension was increased during paying out. As the whole cable weighs 5.8 tons in water a half weighs 2.9 tons and the cable wedged into the lower winding layers on the drum on the Fig. 5. Such wedging occurred only at the first lowering and not the second. At a depth of 5,000 m the key, which connects the sieve of the wire shifter and the gears of the cable length meter, was broken by the shocks and vibrations of wedging. In order to avoid this the cable was paid out to a length of 6,280 m to the lowest layer on the drum, and towed faster. However, the end part of the cable trawled along the sea bottom and plus kinks were made at several points.

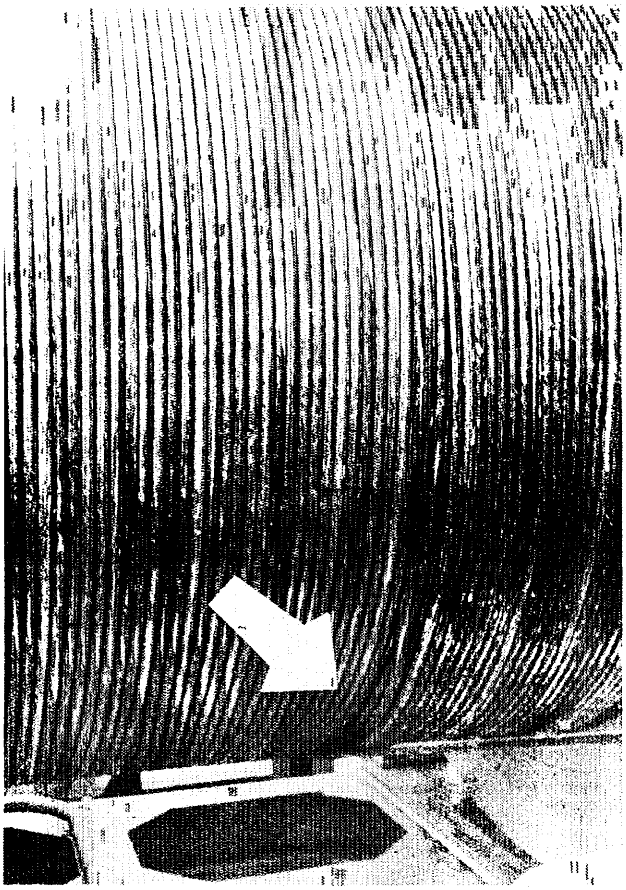


Fig. 5. Cable wedging into the lower layer. DTV cable is 6,700 m long and 17.2 mm in diameter. Its breaking strength is 15.9 tons and it weighs 5.8 tons in water. At the first use when the cable is winded down and the tension increases, the cable wedges into the lower layer by the self weight as shown by the arrow. After the second use this trouble is avoided.

Later the kinks will be repaired by the cable manufacturer. On this test the cable was insulated by a dummy plug and the resistance held more than 5 Megaohm.

On the second test, the complete DTV equipped and frame was lowered to a depth of 5,500 m. The operation was begun at 1610 and the cable was paid out at 1.5 m/sec. At 1705 the cable was paid out 2,500 m and the tension was 2.5 tons. At 1735 the cable was paid out 5,000 m and the tension was 4.6 tons. At 1750 the cable was 5,436 m and the DTV started to record sea bottom pictures and switched on the towing brake. After that the cable length is controled under monition of the CRT of the DTV. At 1815 DTV observation was finished and was wound up at 1.0 m/sec with a tension of 4.6 tons. After completely taken in the cable length meter showed a reading of −15 m, indicating that the cable parmanently elongate by 15 m. This elongation probably occurred only during the initial use and it is anticipated to decrease with further use.

Test of DTV

The block diagram is shown in Fig. 6. The DTV uses the underwater TV camera TC-125-40-ASP and its image tube is a 7262A visicon. The resolution for horizontal scanning is 350 lines under equipping 6,700 meters cable.

The resolution is limited by impedance of the coaxial cable, and not the optical system. The focal length of the lens is 12.5 mm and its focal ratio is F 1.4. Picture angles are 38° for a horizontal direction, 30° for a vertical one, 46° for a diagonal one in water and 53°, 41° and 64° in air respectively. The vessel is made of stainless steel 17-4PH and the camera window is covered with an acryl plate with an endurance pressure up to a depth of 12,000 m. It weighs 10.8 kg in water and 14.8 kg in air.

Underwater lights use two Thallium Iodide lights LT-7s, which are 250 watt each. Light colour is greenish-blue and the peak wave length is 0.53 microns. This peak is very close to 0.52 microns for minimum absorption in water and moreover it fits the characteristics of using visicon. The light intensity is 4,000 candles each including the reflector.

The light cannot be used in air in order to avoid burning, and also it has to be cooled for more than 5 minutes after long time use.

The onboard console of the DTV consists an onboard interface, monitor and two power supplies. The onboard interface includes the video amplifier circuit and the separation circuit for the video signal and direct current of lighting.

Two power sources are the constant current power supplies HP-895A connecting in series. In a stational state the voltage of the first (upper) power supply and the second (lower) one are 271V and 167V respectively and totaly 438V. The currents are 1.72A and 1.66A. The reason why the first one has a larger current of 0.06A is that it also supplies the onboard video amplifier.

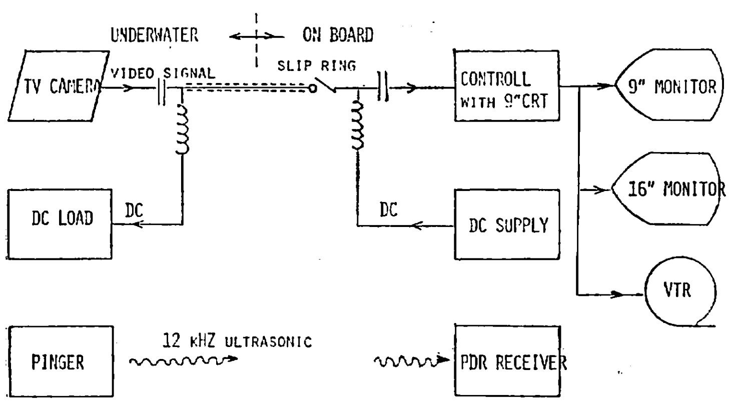


Fig. 6. Block diagram of DTV.

Before a stational state the second power supply has a lower voltage and it takes about 10 minutes. During this time there is an increase of Mercury vapour in the Thallium Iodide lamp coupled with an increase in brightness and voltage. When one light is used the first power supply is used. Its power is nominally 250W and actually 360W in a stational state. The power of the camera is 8W and is connected in series with the lights. The total power of the underwater part requires less than 800W in a stational state, but the capacity of the power source requires 10,000W because Thallium Iodide lamps use a very large instantaneous load at the initial stage of switching on. VTR, the video tape recorder is a Sony AV-4750 which is a half-inch black and white tape of open reel type available for 1 hour of recording together with the microphone.

This operation of the DTV went well but a few adjustments were necessary, e.g. alignment of lights and progress direction of picture.

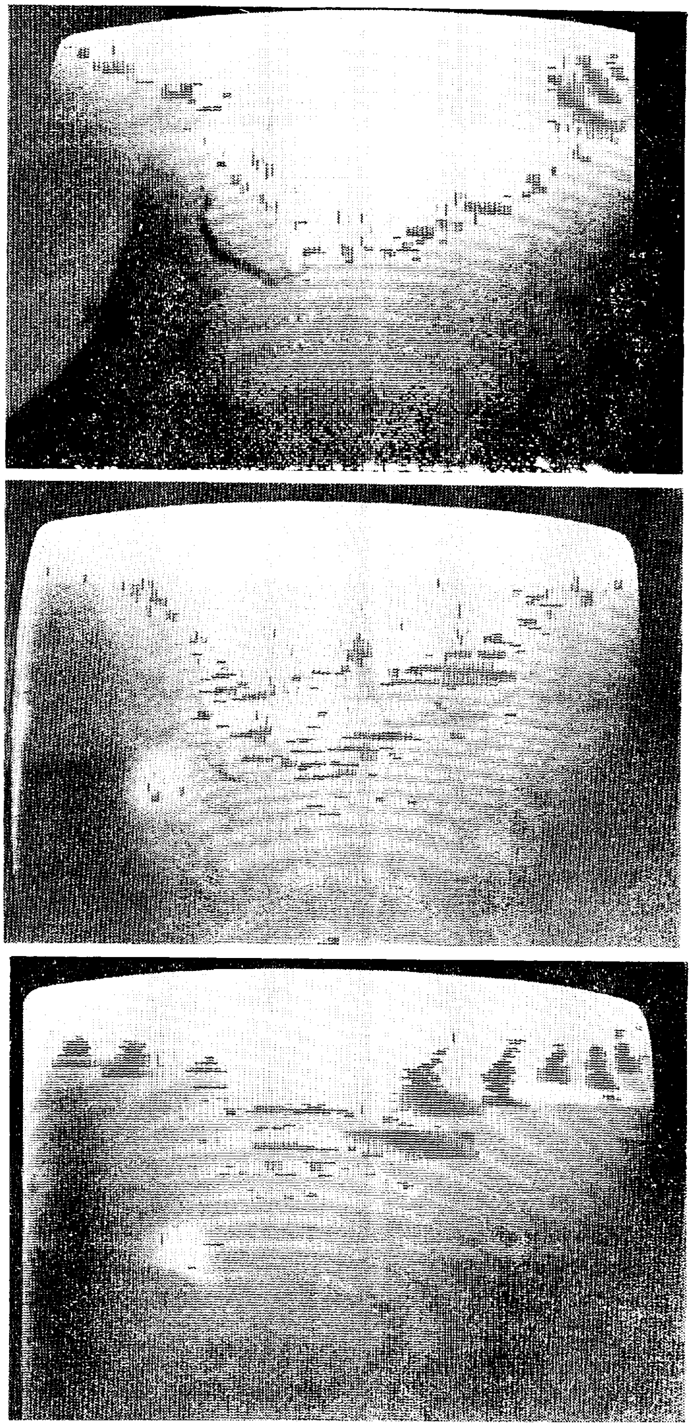
Pictures of DTV

Pictures of the DTV are illustrated three CRT monitors. The first monitor is a 9″ CRT mounted on the console of the DTV and is used by the operator who watches this for operation and records his voice. The second monitor is a 16″ CRT used by the geologist. The third one is mounted with the winch control console and the winchman operates the No. 4 winch watching this monitor. The pictures in this paper were taken from the still mode of the VTR reproduction. The DTV camera was mounted 90 cm high at the lens from the legs of the frame. The pinger 12 kHz was done 1.55 m high at the transmitting surface. The height of lens when pictures were taken was estimated to be about 2 m from the seabottom. Denoting the height as h, the angles of the camera in a horizontal direction at 38°, a vertical direction at 30° and a diagonal direction at 46° in water corresponded to the distances of 0.689h, 0.536h and 0.849h respectively providing the camera axis is perpendicular to the sea bottom.

DTV observation was made for about 20 minutes between 34°05′0N, 142°49′0E to 34°08′1N, 142°49′5E over a distance of 560 meters. The bow heading kept northeast but the vessel drifted to the north due to wind. The speed for the bottom was 0.6 knots or 30 cm/sec through the EM log showed 0.5 kt for the water. The water depth was 5,445 m at the starting point.

The sea bottom material was generally coarse and there were abundant gravels and boulders. The sea bottom had a gentle relief probably, in part due to current ripples. When the legs of frame touched the bottom a slurry of dust was raised suggesting sandy material. Many of the boulders present appeared to be breccia. Fig. 7-a is a picture of a boulder. Its long axis from left-up to right-down is about 35 cm and with a short axis of 21 cm. The boulder seemed rather high from the pictures taken when the VTR was moving. Its shape is angular especially the right-down edge and left side look like chipped edges. The tone of brightness is similar to the bottom material. A special feature is the white colour of the right-down part.

It could not be distinguished whether the boulder is a itself or adhered benthos, but it is probably a rock judging from the shape. It is difficult to say what the



a

b

c

Fig. 7. DTV pictures, a and b showing boulders on deep sea floor and c showing a deep sea benthos.

boulder is composed of, but there is little possibility of it being a ferromanganese nodule as manganese nodules generally have circular edges and the author has never seen white parts on such nodules. We found only two boulders with white parts in this 560 m observation, on which twenty to thirty boulders were observed.

Fig. 7-b shows other boulders. The right boulder has a vertical axis of 35cm and a horizontal axis of 56.5 cm. The left boulder is larger than the right one, though its upper margin is not definite. The boulders in this picture are similar to that of the previous picture in that the shapes are angular and the colour tones are almost same as the bottom sediments. The shape suggests that of a talus breccia under a scarp. During this observation almost all of the boulders had angular deges and the same colour tone as the bottom sediments. Only one exception was found which had a darker colour.

Fig. 7-c shows the benthos in the center of the picture. It shows vaguely six legs (some bodies found have five or seven legs), and its size is about 19 cm. It seems to be a starfish, but if so five radiations are standard, and the size of 19cm is rather large. The white spot on the right-up dragging white tail to the scanning direction is caused by the electric afterimage moving around rapidly on the CRT monitor. They are a kind of micro organism, although it is not determined whether it is luminous or not. It is certain that they are not bubbles by their movement. They are found only near the sea bottom and several occur in groups. The dim light at the left center of the picture is the reflection of the CRT during copying.

Conclusion

This observation was carried out on the east side of the Izu-Ogasawara Trench where red clay was shown to be distributed by the North Pacific Sediments Chart published by Scrips Institution of Oceanography. However, from the DTV pictures, it was found that the sea bottom is very coarse and there are many boulders which have a maximum size of 60 cm and an angular shape. There is little possibility of them being ferromanganese nodules. As no sampling was made the lithology of the boulders is unknown.