IX. TECHNICAL NOTES ON DEEP SEA BOTTOM SAMPLING

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Introduction

During the present cruise in the eastern Central Pacific Basin, samplers of several types were used to obtain deep sea bottom samples including sediments, rocks and manganese nodules.

Samplings of surface sediment in the basin were examined by the Okean-70 grab at 21 of 34 sampling stations for obtaining undisturbed samples of sediments and nodules and particularly for estimating the population density of nodules. Satisfactory results were obtained from most stations.

Core samplings were carried out by piston corer and gravity corer at 4 stations to obtain data on the vertical distribution of manganese nodules and sediments and the historical change of the sedimentary environment.

Dredges of chain-bag dredge, cylinder dredge and large box dredge, were also used in the sampling operations. Among the three types, the chain-bag and cylinder dredges were used at several stations on seamounts and guyots at the periphery of the surveyed area for obtaining rock samples together with manganese crusts. They were also used at one station in the deep sea basin where rather consolidated sediments were expected to crop cut on sea floor from the profile of the 3.5 KHz PDR. The large box dredge is of wire net type. It was used at 4 stations for the purpose of bulk sampling of manganese nodules, but satisfactory results were not obtained in most cases.

During the sampling operation, the behavior of sampler, such as onbottoming, off-bottoming or in the collection of sea bottom sediments was always monitored by the tension recorder at a side of the winch controller, which was very useful for effective sampling.

The procedure, instrumentation and some technical problems on sampling are described in the following.

Grab sampling by Okean-70 grab

The Okean-70 grab used is shown in Figs. IX-1–5. Weighing about 360 kg, the grab has a bottom area of about 0.5 m^2 (0.7 × 0.7 m). It was newly manufactured, being modified from the Russian Okean-50 grab which was introduced by Inoue (1970), and was first tested during the present cruise.

The operation of the grab was fairly successful. The grab is advantageous in the sampling of undisturbed bottom sediments (Fig. IX-2) during rather short time.

The disadvantage was the unreliability of the closing and releasing mechanism and some disturbance of the samples obtained particularly around the margins of the grab.

The disturbance of samples, however seemed to be unevitable: it was caused by the rotation of the closing jaws (Fig. IX-3), and also by the movement of inside wire rope which plays an important role in closing the jaws. The former results in a downward

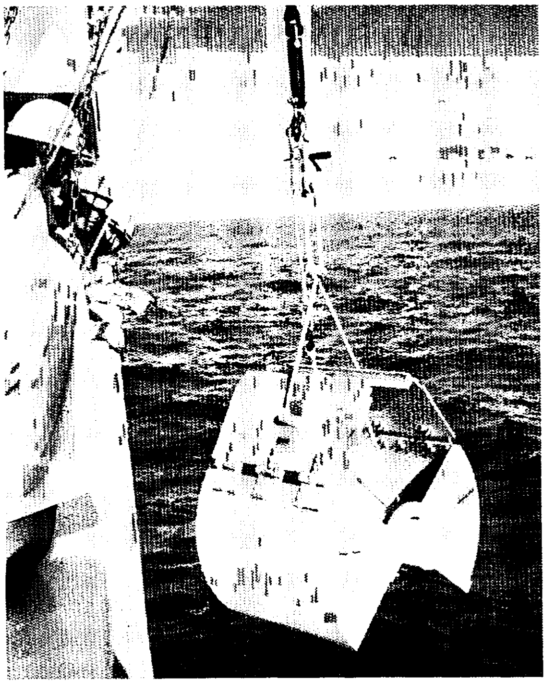


Fig. IX-1 Okean-70 grab in starting of lowering.

Fig. IX-2 Manganese nodules at the interface of sediments and bottom water, recovered by Okean-70 grab.

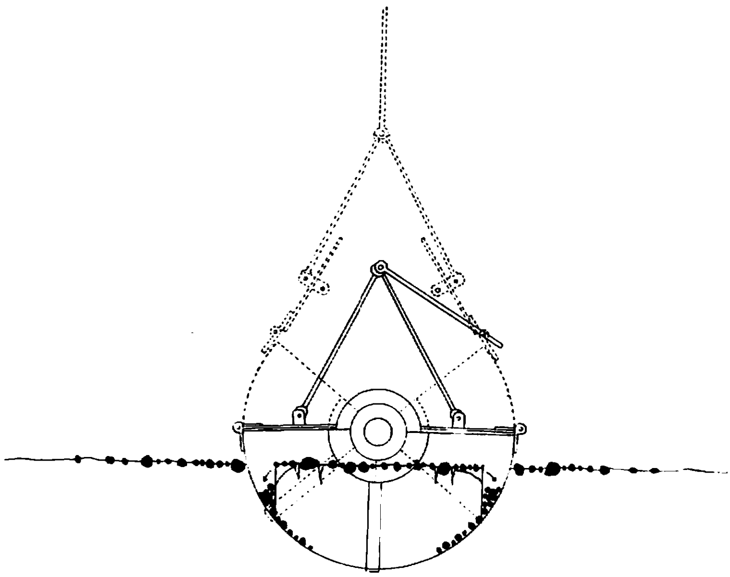


Fig. IX-3 Schematic diagram of disturbance of samples in Okean-70 grab.

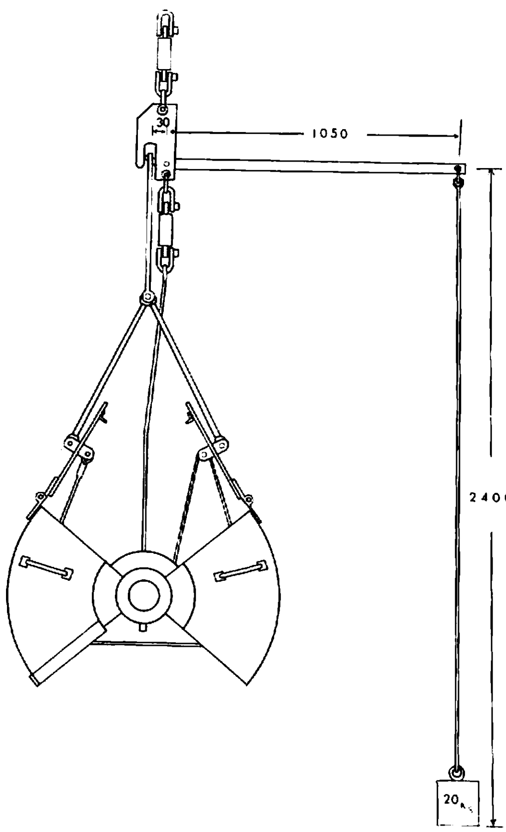
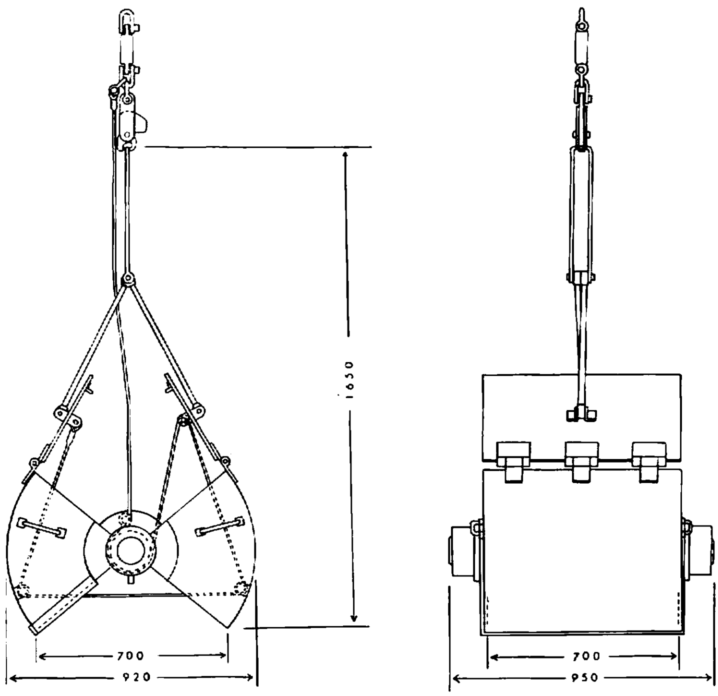


Fig. IX-4 Okean-70 grab with tripping arm.

Table IX-1 Working table of Okean-70 grab.

St. No.	Hit Positon N W	TIME			Depth (m)	Wire Length (m)	Wire Length /Depth	Releasing Mechanism
		Lowering h m	Hoisting h m	Total Working h m				
115 G39	08°-00.2 166°-56.7	01 32	01 18	02 50	5,190	5,321	1,025	Seki's Trigger
117 G40	06°-01.7 166°-55.7	01 28	01 26	02 54	4,950	4,980	1,006	〃
119-1 G41-1	05°-59.6 169°-00.7	01 25	01 17	02 42	5,710	5,816	1,018	〃 Failing
119-2 G41-2	05°-59.6 169°-00.7	01 21	01 17	02 38	5,730	5,837	1,018	Seki's Trigger Failing
121 G42	08°-10.6 170°-27.4	01 32	01 23	02 55	5,450	5,510	1,011	Seki's Trigger
124 G43	09°-20.1 168°-50.8	01 31	01 32	03 02	5,200	5,231	1,006	Tripping arm
126 G44	09°-30.3 167°-03.5	01 29	01 16	02 45	5,030	5,052	1,004	〃
129 G45	10°-00.1 167°-37.0	01 37	01 09	02 46	5,210	5,259	1,009	Seki's Trigger
130 G46	09°-01.3 167°-50.9	01 22	01 29	02 51	5,270	5,318	1,009	〃

131 G47	08°–52.5 167°–23.0	01 16	01 04	02 20	5,190	5,228	1,007	〃
132 G48	07°–00.1 167°–49.3	01 14	01 05	02 19	5,100	5,164	1,012	〃
133–1 G49–1	07°–16.3 168°–08.1	01 18	00 55	07 13	5,250	5,277	1,005	〃 Failing
133–2 G49–2	07°–16.3 168°–08.1	01 14	01 06	02 20	5,230	5,275	1,009	Seki's Trigger
134–1 G50–1	07°–13.2 169°–34.7	01 20	01 12	02 32	5,570	5,587	1,003	〃 Failing
134–2 G50–2	07°–10.8 169°–36.8	01 30	01 12	02 42	5,580	5,624	1,009	Tripping arm
136 G51	08°–29.4 170°–25.5	01 17	01 05	02 22	5,330	5,338	1,002	〃
142 G52	08°–34.2 169°–02.9	01 13	01 01	02 14	5,150	5,189	1,008	〃
143 G53	10°–00.0 168°–42.1	01 16	01 04	02 20	5,152	5,260	1,021	〃
144 G54	10°–00.3 168°–11.1	01 16	01 04	02 20	5,300	5,337	1,007	〃
145 G55	09°–55.8 170°–40.3	01 11	00 58	02 09	4,930	4,969	1,008	〃
146 G56	13°–06.9 173°–59.3	01 20	01 12	02 32	5,610	5,660	1,009	〃



(a) (b)

Fig. IX-5 Okean-70 grab with Seki's trigger.

movement of sediments along the inside walls of jaws and the appearance of some cracks in the upper part of the samples, and the latter results in partial dislocation of the inner part of the samples.

For releasing mechanism, both the Seki' trigger and tripping arm systems were used in the present cruise. The tripping arm system (Fig. IX-4) enabled fairly successful sampling at the 9 stations. The Seki' trigger (Fig. IX-5) was, however, not workable at 4 stations among the total 12. This seems to have resulted from the lever becoming unhooked at the time of hitting the bottom, and the mechanism has therefore to be modified for reliable sampling.

The working table of the Okean-70 grab is shown in Table IX-1. In operation, the time spent for lowering and hoisting was about $1^{h}20^{m}$–$1^{h}30^{m}$ and $1^{h}00^{m}$–$1^{h}20^{m}$ respectively at a depth of between 5,000 and 5,500 m, and total working time was $2^{h}30^{m}$–$3^{h}00^{m}$. The ratio of wire length to water depth by PDR was calculated to be about 1–2%, owing to the vertical holding of the wire during lowering. Bottom hitting and closing or non-closing of the jaws were very well monitored by the tension recorder on board as shown in Fig. IX-6.

The Okean-70 grab played an effective and important role in obtaining surface sediments with manganese nodules on the deep sea floor, which enabled a detailed study on the ore deposits, though there still remain some technical problems to be solved as yet.

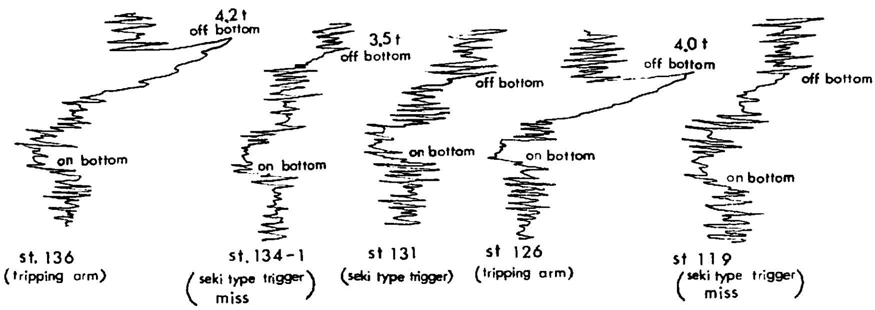


Fig. IX-6 Tension records in operations of Okean-70 grab.

Core sampling

The piston core used has a 6 m aluminium core barrel with inside diameter of 68 mm, weighing 400 kg (Fig. IX-7). During operation, the free fall distance was set up to 5 m from the bottom. The piston corer was successfully operated at 2 stations (Sts. 114 and 138), where cores of 4.61 m and 5.66 m in length were obtained, and at one station (St.

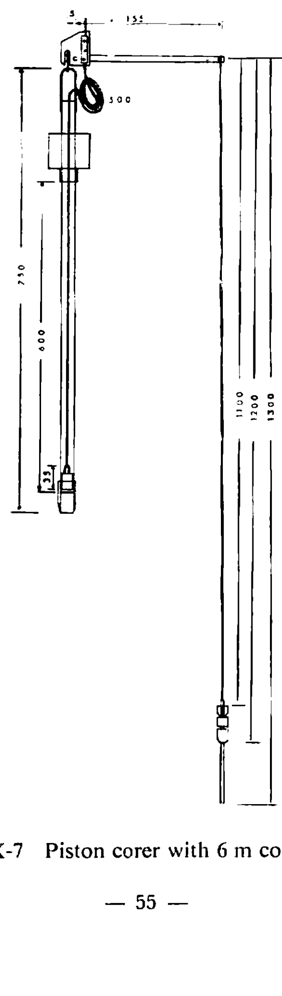


Fig. IX-7 Piston corer with 6 m core tube.

Table IX-2 Working table of corers.

St. No.	Hit Positon N W	Time			Depth m	Wire Length m	Wine Length /Depth	Corers
		Lowering h m	Hoisting h m	Total Warking h m				
114 P12	08°–09.7 164°–50.0	01 59	01 27	03 16	5,000	5,009	1,0018	Piston corer
138 P14	08°–11.0 170°–09.7	01 24..	01 11	02 35	9,256	5,492	10,000	Piston corer
147 P15	16°–08.8 177°–10.9	01 24	01 05	02 29	5,310	5,356	10,086	Piston corer (Flow in)
127 PG13	10°–00.1 167°–02.8	01 34	01 22	02 56	5,230	5,267	10,070	Gravity corer

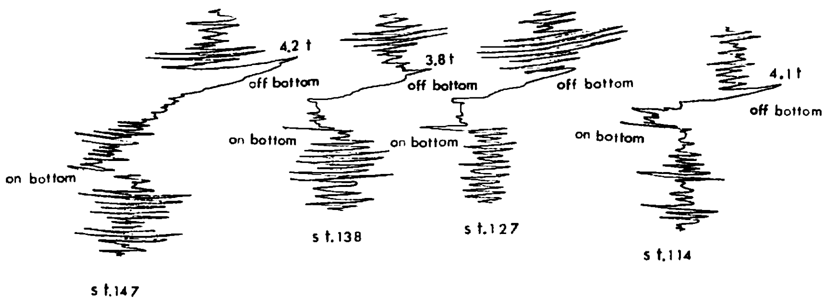


Fig. IX-8 Tension records in operations of corers.

147) the core sample became disturbed by flowing in the core barrel, when the core catcher hit gravel at some depth beneath the sea bottom.

The gravity corer was used at one station, where a core of only 30 cm length could be recovered. The recovering of only a short core was probably caused by the hole of the check valve of the corer being too narrow so that when the corer hit bottom, water contained in the core barrel did not flow out from the check valve. The gravity corer is 500 kg in total weight with a core barrel of 1.5 m length.

The working table of the corers is given in Table IX-2, and the tension records at each station are shown in Fig. IX-8.

Sampling by chain-bag and cylinder dredges

The specifications of the dredges are illustrated in Figs. IX-9, 10. In practical use both types of dredge were attached with a 3 m length chain, with installing a lead of 210 kg in weight at their ends and were dragged (Fig. IX-11). They were used at 5 stations on seamount slopes or deep sea hills to collect rock and manganese nodule samples. At all the stations the operation was successful. At these stations bottom sediments were also sampled. The working table and tension operation records are shown in Table IX-3 and Fig. IX-12, respectively.

Sampling by large box dredge

The large box dredge of wire net type used in the present cruise was originally designed and developed for the C.L.B. (Continuous Line Buckets) system to mine manganese nodules in N.R.I.P.R. The dredge has the length of 150 cm and a height of 60 cm with a 50 cm high stabilizer. It has a sleigh type design, and is characterized by a steel frame,

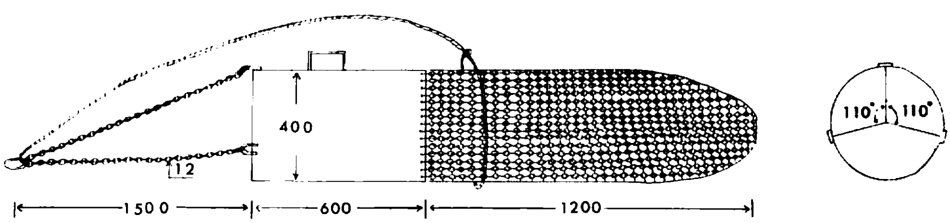


Fig. IX-9 Chain-bag dredge.

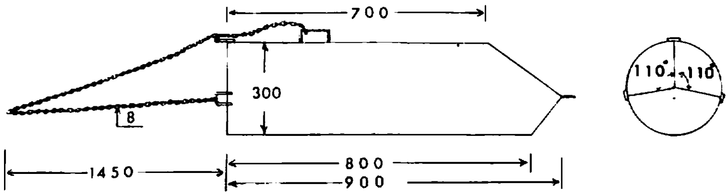


Fig. IX-10 Cylinder dredge.

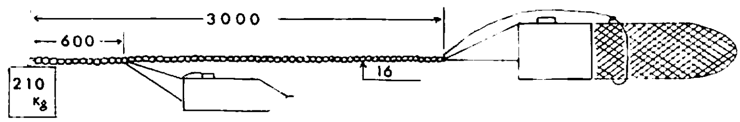


Fig. IX-11 Operation system of dredges.

Fig. IX-12 Tension record in operation of dredges at St. 128.

covered by a wire net, with cutting plate at the lower side of front and bar screen at the bottom, the latter of which plays the role of screening finer sedimentary material (Figs. IX-13, 14).

The apparatus is also provided with a single shot camera and instrument for measuring the behavior of itself at its rear end (Fig. IX-15).

Tests with the present dredge were carried out 4 times as shown in Table IX-4 by means of the towing system as shown in Fig. IX-16. The results were, however, not so good.,

Table IX-3 Working table of

St. No.	on bottom / off bottom	Lat. N	Long. W	Depth m	Wire length m	Wire length /Depth
111	on bottom	10°-08.7	165°-19.8	1,340	1,554	1.159
D50	off bottom	10°-03.9	165°-19.7	1,320	1,583	1.199
112	on bottom	09°-50.9	164°-27.0	2,900	3,003	1.035
D51	off bottom	09°-51.6	164°-44.9	2,650	3,302	1.246
113	on bottom	08°-20.6	164°-23.7	1,660	1,930	1.162
D52	off bottom	08°-20.1	164°-22.7	1,530	2,058	1.345
128	on bottom	10°-21.6	166°-58.9	2,880	2,936	1.019
D55	off bottom	10°-21.8	166°-59.0	2,850	3,114	1.092
141	on bottom	08°-15.7	168°-50.2	4,800	4,925	1.026
D58	off bottom	08°—16.1	168°-50.5	4,800	5,056	1.053

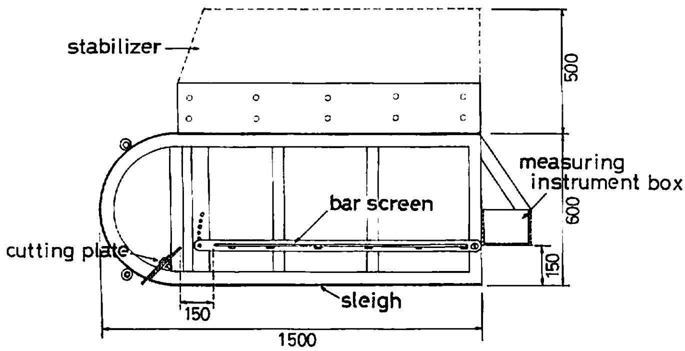


Fig. IX-13 Diagram of large box dredge.

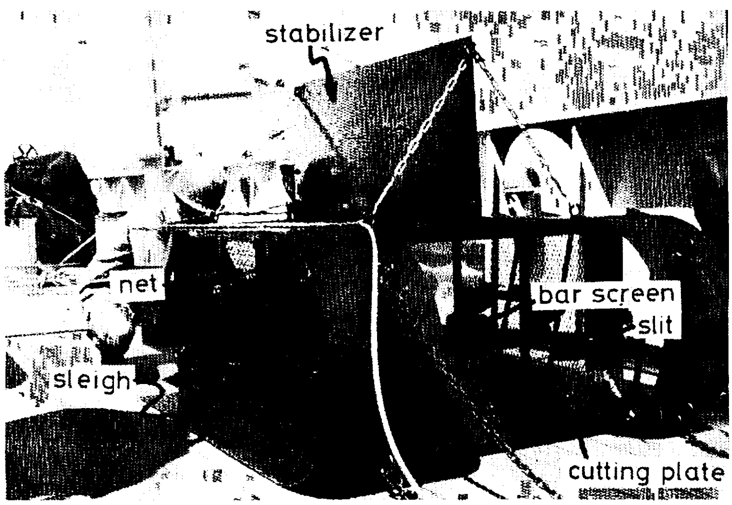


Fig. IX-14 Fontal view of large box dredge.

chain-bag and cylinder dredges.

Wire angle	Towing direction	Towing distance mile	Lowering time h m	Towing time h m	Heaving up time h m	Total working time h m
40°	S	5	0 26	0 26	0 24	01 02
09° 30°	NE	2	0 37	0 54	0 47	02 18
20° 28°	SE	1.2	0 23	0 45	0 27	01 35
15°	NNE	0.3	0 41	0 22	0 44	01 47
10° 24°	SW	0.5	01 01	0 59	01 15	03 15

Table IX-4 Working table

St. No.	on bottom / off bottom	Lat. N	Long. W	Depth m	Wire length	Wire length /Depth
122	on bottom	08°-09.6	170°-26.7	5,470	5,635	1.030
D53	off bottom	170°-26.7	170°-26.4	5,470	5,662	1.035
125	on bottom	09°-20.2	168°-51.8	5,200	5,227	1.005
D54	off bottom	09°-20.1	168°-51.9	5,200	5,249	1.009
135	on bottom	07°-33.0	170°-00.8	5,470	5,539	1.013
D56	off bottom	07°-32.3	170°-00.5	5,430	5,582	1.028
139	on bottom	08°-10.3	170°-25.0	5,460	5,530	1.013
D57	off bottom	08°-10.3	170°-24.2	5,470	5,580	1.020

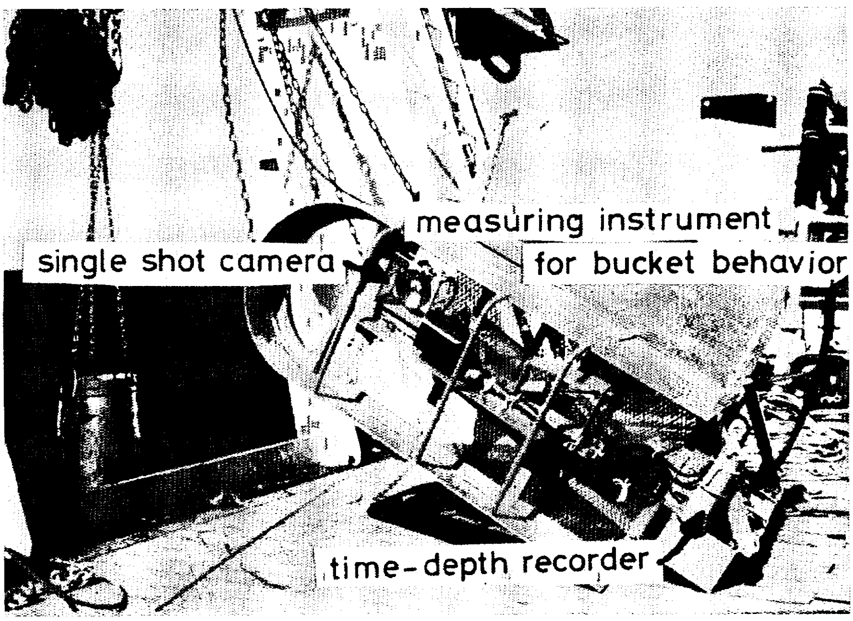


Fig. IX-15 Side view of large box dredge.

and rather large amounts of manganese nodules were recovered only at one station (St. 122), and also the single shot camera, for photographing the sea floor when the dredge hit the bottom, did not work, because of sea water leaking into the housing containing the switch circuit. The instrument for measuring the behavior of the dredge worked well throughout lowering, hitting, dragging and hoisting. Its result may serve in redesigning the apparatus hereafter, in conjunction with a comparative study of analyses of tension records of the wire rope.

The unsuccessful sampling of a large amount of nodules is tentatively concluded as follows.

1) The dragging speed of the bucket on the sea bottom is more than 0.8 m/sec. in the C.L.B. system, therefore a trial test in the laboratory, which was successful, was carried

of large box dredge.

Wire angle	Towing direction	Towing distance mile	Lowering time h m	Towing time h m	Hoisting up time h m	Total working time h m
10° 8°	SE	0.5	01 28	0 38	01 15	03 21
6° 5°	SW	0.2	01 10	01 14	01 13	03 37
8° 11°	SSE	1	01 32	00 53	01 16	03 41
7° 5°	E	0.8	01 26	01 02	01 13	03 41

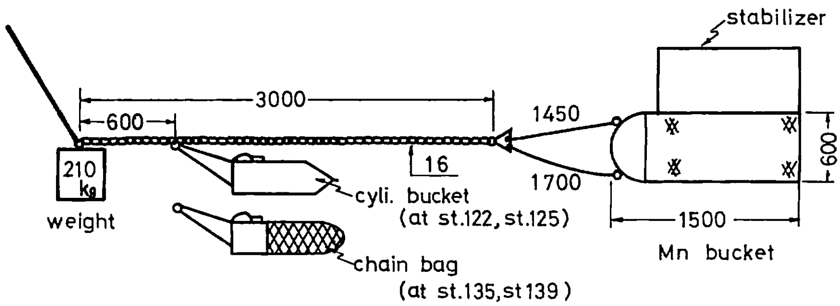


Fig. IX-16 Schematic diagram of towing system of large box dredge.

out at a similar speed. However, the dragging speed of the bucket at St. 122 was approximately 0.2 m/sec., remarkably slower than that of trial test. Also the wide space of the anterior slit was not adequate for nodule sampling.

2) During hoisting of the dredge, pitching up and down of the vessel was transmitted to the bucket through the wire, creating a current, so that the collected samples were flushed out.

In consideration of the above-mentioned factor, the bucket was improved for operations at Sts. 125, 135 and 139; by, a) closing the anterior slit, b) attaching a fish net to the rear of bucket for preventing flushing out, and c) attaching a flushing prevention plate to the mouth of bucket. These modification gave improve of results at the stations, particularly in catching nodules in the rear net. Accordingly, the wire net box type bucket has to be modified for effective sampling hereafter.