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REPORT ON DETAILED BATHYMETRIC AND SEDIMENT SAMPLING SURVEY OF LAKE PUKAKI

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INTRODUCTION

From 15-21 April 1971 a detailed bathymetric survey was carried out over an area from Jack Steel Stream to south of Lake View Cottage from the west shore of Lake Pukaki eastwards to 2000m offshore.

Twenty-six bottom sediment samples were obtained, 18 from the deepest section of the lake adjacent to the western shore from a position north of Te Kohai Island to the delta. The remaining eight samples were collected from the southern bay near the lake outlet. Two short cores (53 cm and 20 cm long) were obtained from the deepest part of the lake.

EQUIPMENT AND METHODS

A 15 ft fibreglass cabin boat powered by a 35 h.p. outboard motor was used. Sounding records were obtained using a Furuno F850 echo sounder operating at 50 kHz. The transducer was mounted overside. Five temperature observations were made using a bathythermograph. These observations gave temperature records throughout the water column and were used for temperature-dependent corrections to the echo soundings.

Bottom sediment samples were collected using a small pipe dredge. Additional samples were taken from the catcher of the corer used. The two cores were obtained using a 4 ft long 3 in. diameter gravity corer with 27 kg of lead attached.

The sampling equipment was handled with a small winch powered by a 2 h.p. petrol motor.

BATHYMETRIC SURVEY

Eighteen traverse lines were run in a series of six boxes from the western shore. The boat was run at low speed and simultaneous position fixes of the boat using two theodolites on shore were made at 2-minute intervals and at turning points. Positions were triangulated from four theodolite positions on the shore. The sounding traverses give good detail of the bottom configuration of the survey area (*see* Fig. 1).

Only the deep contours have been shown in Fig. 1 and these have been drawn at half-metre intervals. The sounding records have been read to the nearest

metre, but half-metre readings have been interpolated and plotted to give a more detailed picture of this area.

The contours show that the lake bottom in the area slopes steeply from the western shore to a near flat basin floor within 300m at the south end of the area off Lake View Cottage and within 500m at the north end of the area.

A typical profile of the bottom out from the shore shows that the lake bottom drops steeply, the gradient becoming less as it merges with the flat basin floor. The flat area ranges from 150-200m in width and the bottom then rises very gradually to the east, for example only 1m in about 1800m off Lake View Cottage.

The depth in the area examined in detail just reaches 70m and this is indicated by a closed contour. The basin floor is almost flat, the gradient from the east to the deepest point being near constant, with no trace of a specifically defined deep hole.

BOTTOM SEDIMENTS

A total of 45 bottom sediment samples have been collected. Twenty-six from the present survey and 19 from the August 1969 survey giving good coverage of the lake from the delta to the outlet area (*see* Fig. 2). The sampling stations are concentrated near to the western shore, the deepest part of the lake, and in the southern bay adjacent to the lake outlet. Table 1 shows the results of mechanical analysis on the samples. At Stn L207 off Boundary Station two attempts were made with a pipe dredge but no sample was obtained.

Seven attempts at coring were made at Stns L210, L211, L212 (2), L221, L222 and L223. Sediment smear on the barrel indicated that penetration varied from 45 cm to 91 cm, all fine grey sticky mud.

The longest core was obtained from Stn L211 and measured 53 cm long. The short core from Stn L212 measured 20 cm.

The mechanical analysis of the sediments (Table 1) shows the sediments to be fine with only 16% of the samples having >1% by weight coarser than 64 μ ; 84% of the samples have 70% or more by weight of material <8 μ .

TABLE 1. Lake Pukaki. Grain size analysis % by weight. Samples from Stns L110-L127 August 1969, L197-L223 April 1971. (* see lower portion for continuation of values)

Stn No.	Depth (m)	<8 μ	<2 μ	4-2 μ	8-4 μ	16-8 μ	32-16 μ	64-32 μ	>64 μ
L116	8	80.30	-	-	-	15.00	3.33	0.56	0.81
L210	8	28.56	-	16.93	11.63	8.55	13.68	4.45	- *
L214	8	45.64	-	39.59	6.05	1.51	4.54	7.57	- *
L111	9	5.93	-	-	-	20.63	59.84	13.41	0.19
L209	10	72.96	-	46.79	26.17	20.29	5.23	1.31	0.21
L220	12	67.27	-	57.88	9.39	6.88	7.51	11.26	7.07
L213	14	90.08	-	77.90	12.18	3.85	5.13	-	0.94
L219	15	82.41	-	69.05	13.36	5.73	3.82	6.36	1.68
L218	16	82.28	-	68.39	13.89	90.03	2.08	5.55	1.06
L127	16	83.78	-	-	-	4.00	5.00	6.00	1.21
L124	19	91.63	60.26	17.61	13.76	4.40	0.55	3.30	0.11
L215	22	88.86	-	75.61	13.25	6.02	3.61	1.20	0.29
L216	27	90.65	-	71.25	19.40	6.06	3.03	-	0.25
L217	31	91.43	-	79.44	11.99	4.80	1.20	2.40	0.18
L126	35	92.68	-	-	-	5.20	1.30	0.65	0.17
L208	40	82.18	-	56.15	26.03	9.64	5.78	1.93	0.47
L112	47	32.49	-	-	-	34.20	29.31	3.91	0.09
L113	53	86.06	48.11	22.55	15.40	9.90	1.65	2.20	0.20
L198	53	98.36	-	76.50	21.86	1.60	-	-	0.04
L115	57	65.81	-	-	-	23.93	9.57	0.48	0.20
L123	58	95.36	57.93	24.28	13.15	2.53	1.01	1.01	0.08
L125	58	94.91	-	-	-	4.92	-	-	0.17
L206	60	92.68	-	64.80	27.88	4.13	1.55	1.55	0.09
L205	63	92.53	-	69.73	22.80	7.42	-	-	0.01
L204	65	91.20	-	71.20	20.00	6.67	1.82	-	0.32
L114	65	82.81	-	-	-	14.23	1.14	1.71	0.11
L119	65	84.36	46.61	18.88	18.87	12.58	2.86	-	0.19
L117	66	81.74	-	-	-	15.26	0.73	2.20	0.10
L203	66	75.96	-	59.39	16.57	17.68	4.42	1.66	0.28
L119	66	95.57	-	83.12	12.45	2.49	1.87	-	0.07
L118	67	83.12	-	-	-	13.63	1.57	1.57	0.12
L122A	67	85.27	-	-	-	11.13	1.01	2.53	0.06
L122B	67	85.50	-	-	-	8.52	5.86	-	0.12
L120	68	85.40	-	-	-	11.24	3.21	-	0.14
L202	68	79.48	-	60.73	18.75	17.12	3.26	-	0.15
L200	68	88.37	-	74.48	13.89	11.58	-	-	0.05
L201	69	94.39	-	77.65	16.74	2.79	2.79	-	0.04
L211	69	87.50	-	47.16	40.34	8.30	1.19	2.97	0.05
L212	69	90.32	-	66.28	24.04	7.55	1.37	0.69	0.07
L221	69	86.27	-	62.21	24.06	10.31	0.69	2.75	0.05
L222	69	90.37	-	67.18	23.19	8.18	1.36	-	0.08
L223	69	81.08	-	55.03	26.05	13.03	5.86	-	0.03
L121	69	90.24	-	-	-	7.16	1.53	1.02	0.04
L197	70	90.30	-	62.36	27.94	8.86	0.68	-	0.15

		64-89 μ	89-125 μ	125-178 μ	178-250 μ	250-353 μ	353-500 μ	500-700 μ	700-1000 μ	1000-1400 μ	1400-2057 μ
L210	8	3.01	9.15	17.16	9.73	3.76	1.31	0.47	0.17	-	-
L214	8	9.45	13.39	8.92	3.49	1.47	0.92	0.62	0.96	0.61	0.92
L110	10	19.45	36.99	32.68	9.57	1.10	0.22	0.03	-	-	-

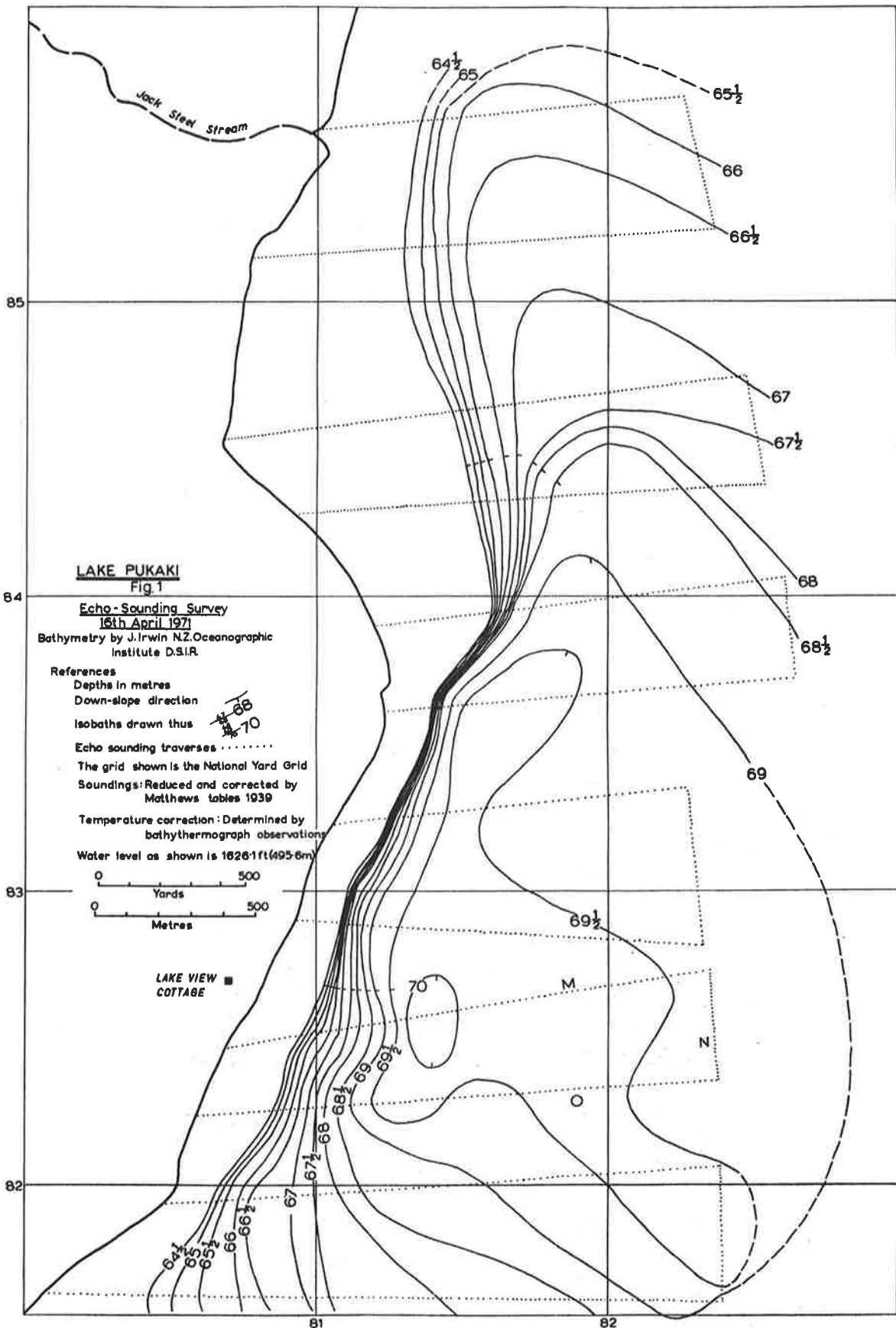


Fig. 1. The bottom configuration of the survey area. Lines M N O show the position of the echo sounder trace.

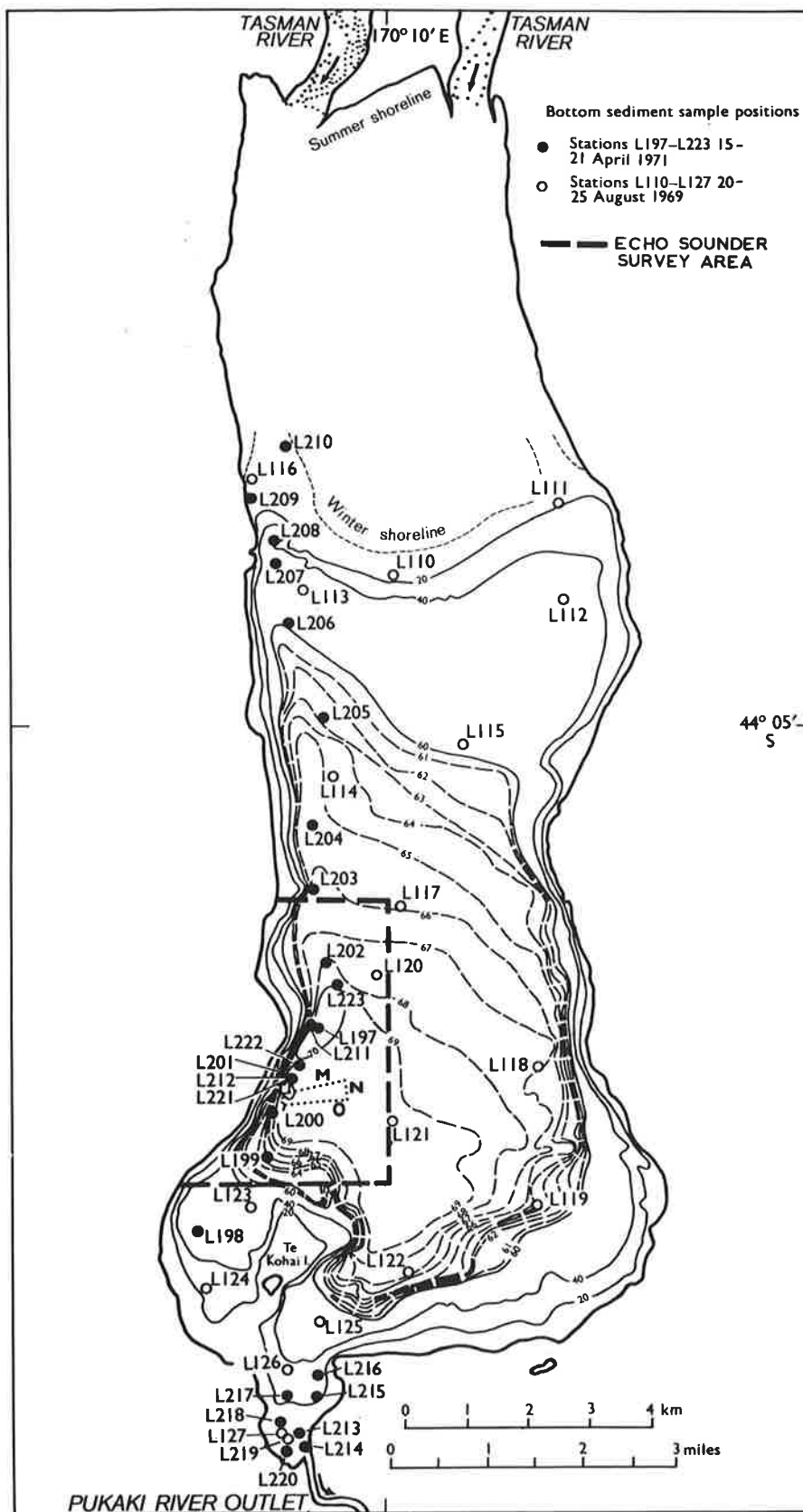


Fig. 2. Lake Pukaki showing sketch bathymetry (m), sediment sampling stations in 1969 and 1971, echo sounder survey area and position of echo sounder trace along lines M N O.

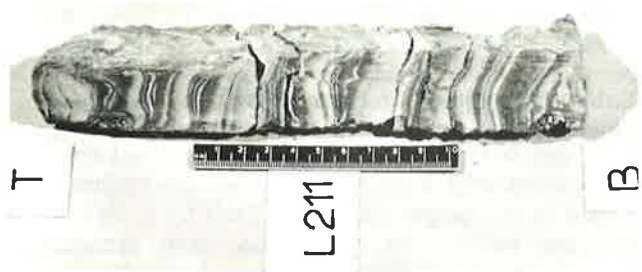


Fig. 3. Bottom 20 cm quartered section of core from Stn L211, Lake Pukaki, 21 April 1971, showing dark and light layering.

Samples with less than 70% by weight of sediment with grain size $< 8 \mu$ are from either on the delta at the north end (Stns L110, L111, L112, L115 and L210) or near the lake outlet (Stns L214 and L220). Also samples with greater than 1% by weight $> 64 \mu$, L110 and L210 are on the delta and L218, L127, L220, L214 and L219 are near the outlet. These samples with coarser grain size are from shallower water except L112 (47 m) and L115 (57 m) which are down lake from the delta area.

In the main body of the lake from off the delta to Te Kohai Island the proportion $< 8 \mu$ is nearly constant, and the proportion of material between $4-2 \mu$ increases down lake.

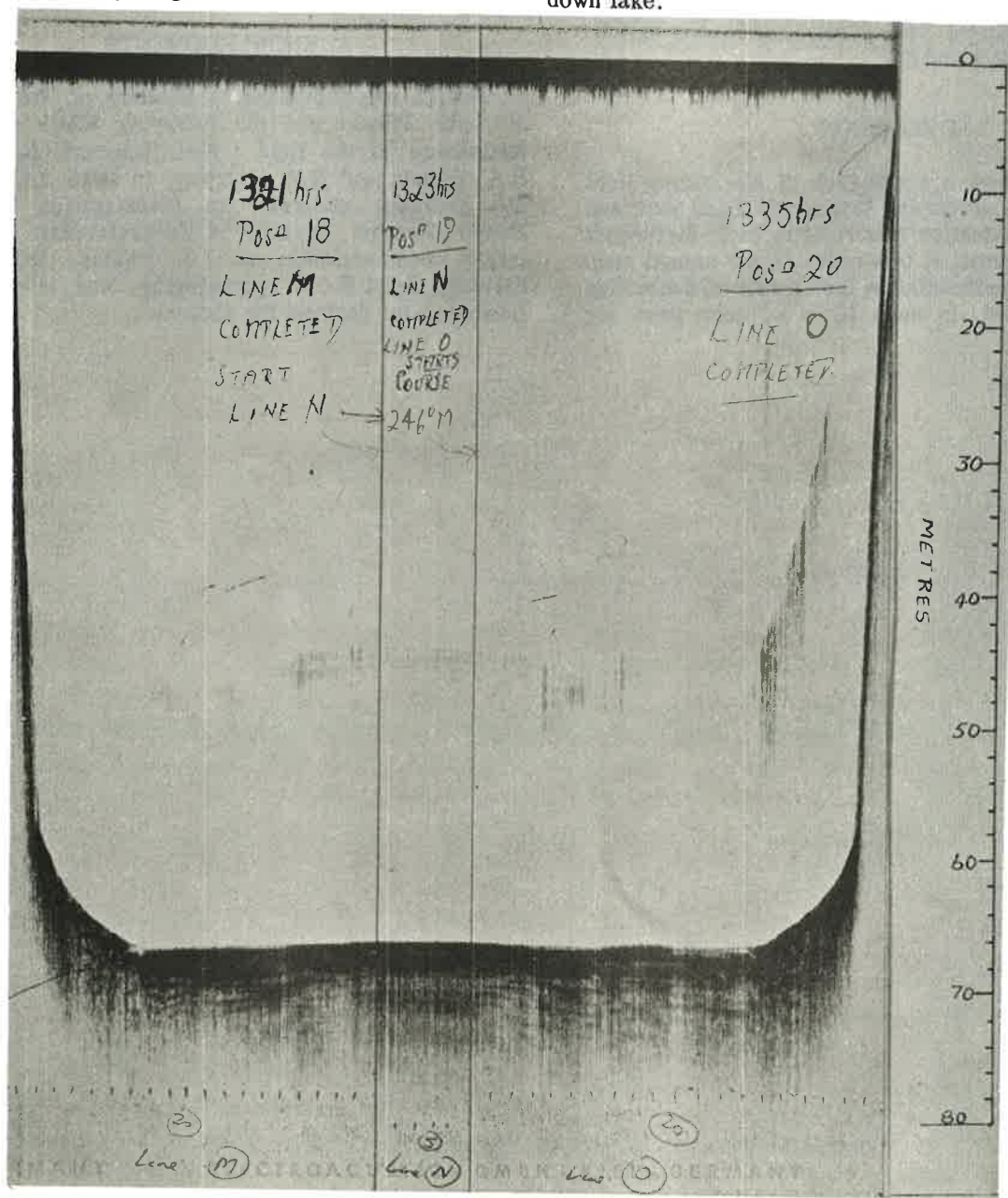


Fig. 4. Echo sounder trace of lines M N O (see Figs 1, 2) showing sediment layering, Lake Pukaki, 16 April 1971.

The two cores showed distinct dark and light layers. The core from Stn L212 being short at 15 cm long showed much distortion but that from Stn L211 (Fig. 3, showing a quartered section of the lower 20 cm of the core) shows less distortion and that the layering is near horizontal.

SEDIMENT LAYERING

The extensive sediment layering Profile M.N.O. (Fig. 4) indicates that sedimentation has continued undisturbed for a substantial period of time. Maximum depth of layering shown on the echo sounder record is 4m. This does not imply that this is the maximum thickness of sediment. (The position of Profile M.N.O. is shown on Figs 1 and 2.)

DISCUSSION

The cores show a succession of alternating light and dark layers of varying thickness. Each dark and light pair (or graduation from light to dark) represents a sedimentary event. If this event is the annual summer and winter sedimentation then a rate of deposition can be estimated. In each 10 cm of core there are

roughly 25 sedimentary events large and small. The sedimentation rate on this assumption is 40 cm per 100 years or 140 cm per 100 years if only the seven major events per 10 cm are considered. However, available hydrological records show an average of four major floods per year. If each major sedimentary event (7 per 10 cm of core) is not the seasonal cycle but correlates with a major flood then the sedimentation rate is 560 cm per 100 years. Thus for each 1000 years that sedimentary conditions have remained similar to those obtaining at present, a sediment thickness between 4 and 56 m would have been laid down. The above assumptions only provide a general indication of possible sediment thickness.

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