Report of the Japanese Summer Parties in Dry Valleys, Victoria Land, 1963–1965☆

II. General Description and Water Temperature Data for the Lakes

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南極 Victoria Land の Dry Valley 調査報告

II. 調査の概要および湖の水温

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要　旨

1963–1965年の夏期3年にわたって，米国科学財団南極計画局の援助により，McMurdo 基地を中心として，主として Victoria Land のいわゆる Dry Valley の湖沼を中心に地球化学的，生態学的調査を行なった．この報告は，その調査の概要と湖の水温について記述したもので，Lake Vanda, Lake Bonney, Lake Fryxell, Lake Miers の4つの湖における温度成層に大きな違いがあることを示し，氷のシートを通しての太陽輻射，氷河の融氷水，および地熱の作用がこれに関与することを暗示している．

Introduction

Under the support of the activities of the U. S. Antarctic Research Program, National Science Foundation, three field parties were sent to McMurdo Station, Antarctica in order to make surveillance mainly in the Dry Valley region, Victoria Land. Principal investigation aimed at the ecological and limnological survey of the saline lakes in ice-free areas. This second report of the series presents the general description of the activities of three field parties sent in austral summers 1963–64, 1964–65 and 1965–66 and the water temperature data for the lakes Vanda, Bonney, Fryxell and Miers.

☆ 1st report: On the Evaporites Found in Miers Valley, Victoria Land, Antarctica.

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General Description of Activities of the Field Parties

1963–64

Field workers: Tetsuya TORII (Geochemistry), Chiba Institute of Technology,
Noboru YAMAGATA (Geochemistry), Institute of Public Health, Tokyo.
Tsurahide CHO (Physical Chemistry), Gakushuin University, Tokyo.
Yoshio YOSHIDA (Geomorphology), Ochanomizu Women's University, Tokyo.

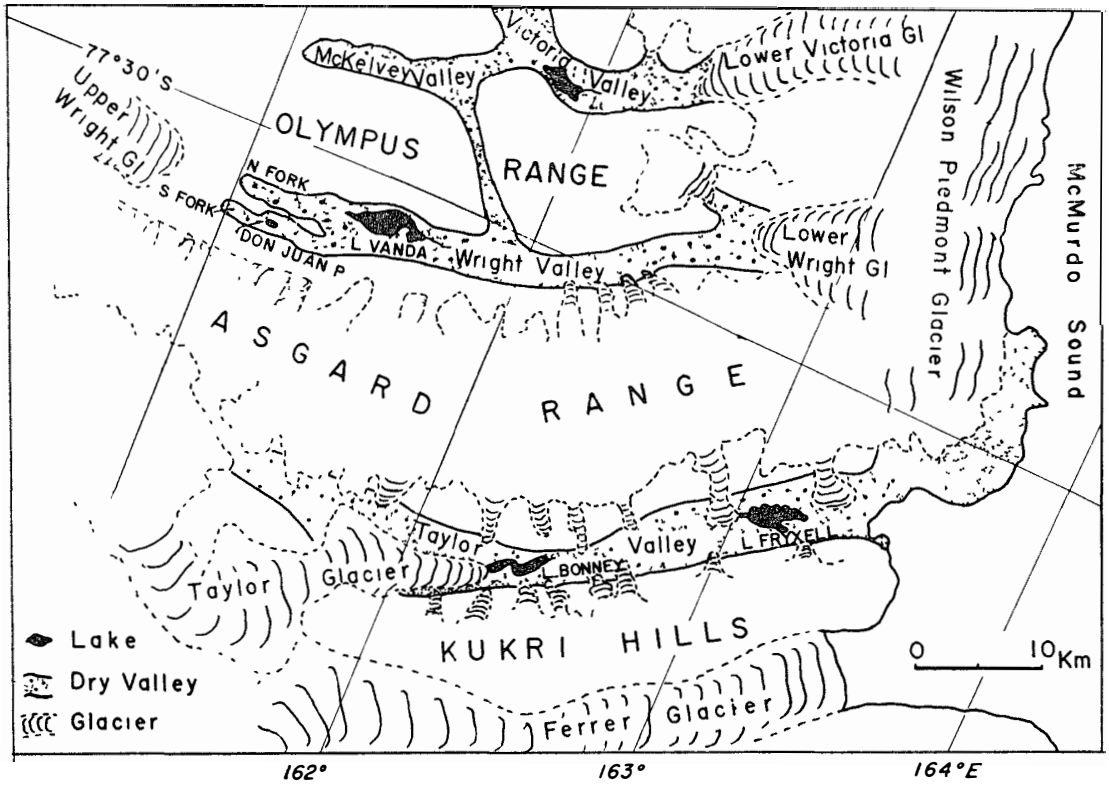

Fig 1 Dry Valley region, Victoria Land

Period of survey: December 23, 1963 – January 18, 1964.
(Arrival and departure at McMurdo Station)

Surveillance area:

1. Victoria Land: Lake Vanda, Don Juan Pond and an unnamed pond in Wright Valley. Lake Bonney and Lake Fryxell in Taylor Valley. Cape Bernacchi and Stranded Moraine.
2. Ross Island: Five ponds in Cape Evans. Four ponds in Cape Royds.

Several ponds in craters in the vicinity of McMurdo Station.

Itinerary:

December 25 – Survey of ponds in craters, McMurdo Station.
26 – Reconaissance flight to Wright and Taylor Valleys.
28 – Camp I at Lake Vanda.
30 – To Camp II at Don Juan Pond.
31 – To Camp III at Lake Bonney.
January 2 – To Camp IV at Lake Fryxell.
7 – To McMurdo Station.
9 – Survey at Cape Evans.
10 – Survey at Stranded Moraine.
11 – Visit to South Pole Station.
12 – Visit to Byrd Station.
14 – Survey at Cape Royds.
15 – Survey at Lake Vanda.

1964–65

Field workers: Tetsuya TORII (Geochemistry), Chiba Institute of Technology, Chiba.
Tsurahide CHO (Physical Chemistry), Gakushuin University, Tokyo.
Yoshio YOSHIDA (Geomorphology), Hiroshima University, Hiroshima.
Zenkichi HIRAYAMA (Logistics Technology), Nihon University, Tokyo.
Junta SUGIYAMA (Microbiology), University of Tokyo, Tokyo.

Period of survey: December 27, 1964 – January 29, 1965.

Surveillance area:

1. Wright Valley: Lake Vanda, Don Juan Pond and three unnamed ponds.
2. Taylor Valley: Lake Bonney and Lake Fryxell.
3. Miers Valley: Lake Miers.
4. Koettlitz-Blue Glacier Region: Lake Porkchop, Lake Penny, Ward Lake, Lake Keyhole, Purgatory Pond, Colleen Lake and Rivard Lake.
5. Ross Island: Five ponds in Cape Evans and four ponds in Cape Royds.

Itinerary:

December 30 – Camp I at Lake Vanda.
31 – January 4 – Survey at Lake Vanda.
January 5 – Camp II at Don Juan Pond.
7 – Camp III at Lake Bonney.
11 – Camp IV at Lake Miers.
14 – Back to McMurdo Station.
16, 19 – Survey at Cape Evans.
18 – Survey at Cape Royds.
21 – Camp V at Lake Fryxell.
24 – Back to McMurdo Station.
29 – Reconaissance flight to Koettlitz Glacier.

1965–66

Field workers: Tetsuya Torii (Geochemistry), Chiba Institute of Technology, Chiba.
Noboru Yamagata (Geochemistry), Institute of Public Health, Tokyo.
Makoto Shima (Geochemistry), Institute of Physical and Chemical Research, Tokyo.
Akito Koga (Hot Spring Chemistry), D. S. I. R., Taupo, New Zealand.

Period of survey: November 25, 1965 – December 21, 1965.

Surveillance area:
1. Wright Valley: Lake Vanda and Don Juan Pond.
2. Taylor Valley: Lake Bonney.

Itinerary:
December 1 – Collection of snow and ice at McMurdo for search of cosmic dust.
3 – Camp I at Lake Vanda.
4 – 13 – Survey at Lake Vanda.
14 – Camp II at Lake Bonney, east lobe.
17 – Camp III at Lake Bonney, west lobe.
19 – Back to McMurdo Station.

Water Temperature Data for the Lakes

1. Lake Vanda

The location of coring is shown in Fig. 2. The total of 20 holes were drilled,

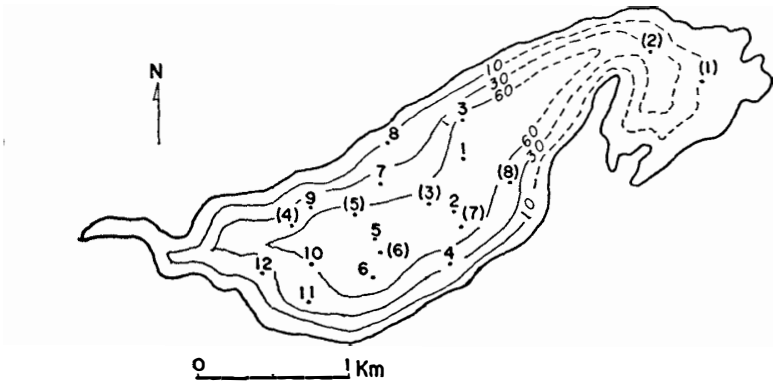

Fig. 2. Location of holes in Lake Vanda. Open figures indicate hole number December 1965 and figures in parentheses hole number 1964–65.

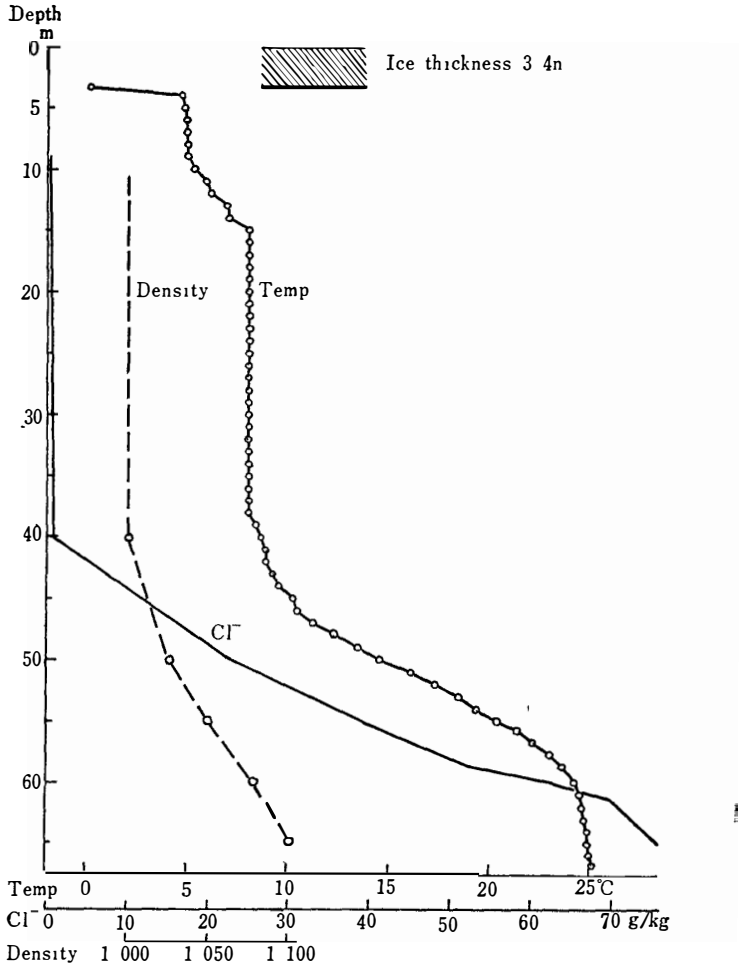

Fig. 3. Temperature profile in Lake Vanda, Hole 65V6 (January 3 1965)

Table 1. Temperatures (°C) in Lake Vanda December 31, 1964 –January 4, 1965.

Depth m	Hole number								Mean
	65V1	65V2	65V3	65V4	65V5	65V6	65V7	65V8	
4		5 1*	4.7	3 6	0.1	4 7	2.0	4 2	*4.5m
5	4 6	5 1	4 7	4 8	4 7	4.8	4 7	4 7	4.8
6	4 7	5 0	4 7	5 0	4.8	4 8	4.7	4.7	4.8
7	4.7	4 8	4 7	5 0	4 8	4 9	4 7	4 7	4 8
8	4.7	4.7	4 7	5 0	4 8	4 9	4 7	4 7	4.8
9	4 7	4 7	4 7	5 3	4 8	4 9	4 7	4 7	4 8
10	5 3	4 7	5 2	5 3	5 0	5 3	5 1	5 0	5.1
11		5 6	5 7	6 1	5 6	5.9	5 9	5.9	5 8
12		6 0	6 0	6 1	6 0	6 1	6 1	6 0	6 0
13		6 8	6 6	7 0	6 4	6 9	6 7	6 8	6 7
14		7.0	7 0	7 2	7.0	7 0	6 9	6 9	7.0
15		8 1	7 7	8 0	8 0	8.0	8 0	8 0	8 0
16		8 2	8 0	8 0	8 0	8 0	8 0	8.0	8.0
17		8 2	8 0	8 0	8.0	8 0	8 0	8 0	8 0
18		8 2	8 0	8 0	8 0	8 0	8 0	8 0	8 0
19		8 2	8 0	8 0	8.0	8 0	8 0	8 0	8.0
20		8 2	8 0	8 0	8 0	8 0	8.0	8.0	8 0
21		8 2	8 0	8 0	8 0	8 0	8 0	8.0	8.0
22		8 2	8 0	8 0	8 0	8 0	8 0	8 0	8 0
23		8 2	8 0	8 0	8 0	8 0	8 0	8 0	8.0
24		8.2	8 0	8 0	8 0	8 0	8 0	8 0	8 0
25		8 2	8 0	8 1	8 0	8.0	8 0	8 0	8 0
26		8.0	8 0	8 1	8 0	8 0	8.0	8.0	8 0
27		8.0	8 0	8 1	8 0	8 0	8 0	8 0	8 0
28		8 0	8 0	8 1	8 0	8 0	8 0	8 0	8 0
29		8.0	8 0	8 1	8 0	8 0	8 0	8 0	8 0
30		8 0	8 0	8 1	8 0	8 0	8.0	8 0	8 0
31		8 1	8 0	8 1	8 0	8 0	8 0	8 0	8 0
32		8 1	8 0	8 1	8 0	8 0	8 0	8 0	8.0
33			8 0	8 1	8 0	8 0	8 0	8 0	8 0
34			8 0	8 1	8 0	8 0	8 0	8 0	8 0
35			8 0	8 1	8 0	8 0	8 0	8 0	8 0
36			8 0	8 1	8 0	8 0	8 0	8 0	8 0
37			8 0	8.1	8 0	8 0	8 0	8 0	8 0
38			8 2	8 1	8 0	8 0	8 0	8 0	8 1
39			8 4	8 3	8 3	8 4	8 3	8 3	8 3
40			8 6	8 7	8 6	8 7	8 7	8 6	8 7
41			8 9	8 9	8 9	8 9	8 8	8 8	8 9
42			9 0	9 0	8 9	8 9	8 9	8 8	8 9
43			9 3	9 3	9 2	9 3	9 3	9 1	9 3
44			9 6	9 7	9 7	9 6	9 5	9 5	9 6
45			10 2	10 4	10 3	10 3	10 2	10 2	10 3
46			10 4	10 4	10 4	10 5	10 4	10 3	10.4
47			11 0	11.2	11 0	11 3	11 2	11 1	11 1
48			11 9	11 9	11 7	12 3	12 1	11 9	12 0
49			13 1	13 6	12 8	13 5	13 5	13 4	13.5
50			14 6	14 7	14 8	14 6	14 6	14 6	14 7
51			16 0	16 0	15 9	16 1	15 8	15.8	15 9

Depth m	Hole number								Mean
	65V1	65V2	65V3	65V4	65V5	65V6	65V7	65V8	
52			17.2	17.2	17.0	17.3	17.2	17.2	17.2
53			18.1	18.4	18.3	18.5	18.3	19.0	18.4
54			19.4	19.2	19.2	19 4	19.2	19 5	19.3
55			20.3	20.5	20.5	20.4	20.3	20.3	20.4
56			21.1	21.1	21 3	21.4	21.1	21.1	21.2
57			22.0	21.9	22.0	22.2	22.0	21.8	22.0
58			22.7		22.8	23 0	22.8	22.8	22.8
59			23.3		23 6	23.6	23.5	23.4	23.5
60			24.2		24.2	24.2	24.1		24.2
61			24 3		24.5	24.5	24.5		24.5
62			24.5		24.7	24.6	24.5		24.6
63			24 7		24.7	24.7			24.7
64			24 8		24 9	24.9			24.9
65					24.9	24.9			24.9
66					25.0	25.0			25.0
66.8						25.1			

Table 2. Temperatures (°C) in Lake Vanda. December 4–13, 1965.

Depth m	Hole number												Mean
	66V1	66V2	66V3	66V4	66V5	66V6	66V7	66V8	66V9	66 V10	66 V11	66 V12	
4	4.2	4.2	4.2	4.1	4.2	4.1	4.2	4.6	4.5	4.3	4.3	4.6	4 3
5	4.3	4.2	4.2	4.2	4.3	4.2	4.3	4.7	4.6	4.6	4.6	4.6	4.4
6	4.3	4.2	4.2	4 3	4.3	4.2	4 3	4.7	4.6	4.6	4.6	4.6	4.4
7	4 3	4 2	4.2	4 3	4.3	4.3	4.3	4 7	4 6	4.6	4.6	4.6	4 4
8	4.3	4 2	4.2	4.3	4.3	4.3	4.4	4.7	4 6	4.6	4.6	4.6	4.4
9	4 8	4.2	4.9	4.7	4.3	4 6	4.4	5 2	5 2	5.1	5 5	5 5	4.9
10	5.5	5.5	5.6	5.5	5.5	5.5	5.5	5.5	5.5	5 5	5.6	5.6	5 5
11	5.6	5.5	6 0	5.9	5.5	5.7	5 8	5.8	5.6	5 5	6 1	6.1	5.8
12	6 1	6.0	6.5	6.6	6.1	6.2	6 2	6.2	6.5	6.1	6.7	6.7	6.3
13	6 7	6.5	6.6	6.7	6 5	6.5	6.7	6.7	6 7	6 6	6.7	6 8	6 6
14	7 7	7.7	7.7	7.7	7 6	7 7	7.7	7 7	7.7	7.7	7.7	7 7	7.7
15	7 7	7.7	7.7	7.8	7.7	7.7	7.7	7.9	7 9	7.7	7.9	8.0	7.8
16	7.9	7.7	7.8	7.9	7.7	7 7	7.9	7.9	7.9	7.8	7 9		7.9
17	7.9	7.7	7.8	7.9	7.7	7 7	7.9	7.9	7.9	7.9	7.9		7.9
18	7.9	7.7	7.9	7.9	7.7	7.7	7 9	7.9	7.9	7.9	7.9		7 9
19	7.9	7.7	7.9	7.9	7 7	7.7	7.9	7.9	7 9	7.9	7 9		7.9
20	7.9	7 7	7.9	7 9	7 7	7.7	7.9	7.9	7 9	7.9	7.9		7.9
21	7.9	7.7	7.9	7.9	7.7	7 7	7.9	7.9	7.9	7.9	7.9		7.9
22	7 9	7.7	7.9	7.9	7 7	7.7	7.9	7.9	7.9	7.9	7 9		7.9
23	7.9	7 7	7 9	7 9	7.7	7.7	7 9	7.9	7.9	7.9	7.9		7.9
24	7.9	7.7	7.9	7.9	7.7	7.7	7.9		7 9	7 9	7.9		7.9
25	7.9	7 7	7.9	7 9	7 7	7.7	7.9		7.9	7.9	7.9		7 9
26	7 9	7.7	7.9	7 9	7 7	7.7	7.9		7.9	7.9	7.9		7.9
27	7.9	7.7	7.9	7.9	7 7	7.7	7.9		7 9	7.9	7.9		7.9
28	7.9	7 7	7.9	7 9	7.7	7 7	7 9		7.9	7.9	7.9		7.9

Depth m	Hole number												Mean
	66V1	66V2	66V3	66V4	66V5	66V6	66V7	66V8	66V9	66V10	66V11	66V12	
29	7 9	7 7	7 9	7.9	7 7	7 7	7.9		7 9	7.9	7 9		7.9
30	7 9	7.7	7.9	7.9	7.7	7.7	7.9		7 9	7.9	7.9		7 9
31	7 9	7.7	7 9	7.9	7.7	7.7	7 9		7 9	7.9	7.9		7.9
32	7 9	7.7	7.9	7.9	7 7	7.7	7 9		7.9	7 9	7 9		7.9
33	7.8	7.7	7.9	7.9	7.7	7.7	7 9		7 9	7.9	7.9		7.9
34	7.8	7.7	7 9	7 9	7.7	7.7	7.9		7.9	7.9	8 0		7.9
35	7.8	7 7	7.9	7.9	7 7	7 7	7.9		7.9	7 9	8.0		7.9
36	7.8	7.7	7.9	7 9	7.7	7.7	7.9		7 9	7 9			7 9
37	7 8	7.7	7 9	7 9	7 7	7 7	7 9		7 9	7.9			7.9
38	8 2	8.2	8 2	8 2	8.2	8.2	8.2		8 3	8 2			8 2
39	8.6	8 6	8 6	8 7	8 6	8 6	8.6		8 6	8.6			8 6
40	8 8	8.8	8 8	8.7	8 7	8.7	8.8		8 8	8 8			8 8
41	8 8	8.8	8.8	8.8	8 8	8.8	8 8		8 9	8 9			8 8
42	9 2	9 0	9.1		9.0	9 0	9 1		9 2	9 2			9.1
43	9 4	9 3	9.3		9 2	9 3	9 4		9.5	9 4			9.4
44	9 9	9.8	9 9		9 6	9.7	9.8		9 9	9.9			9.8
45	10.0	10.0	10 1		9 9	10 0	9 9		10 1	10 0			10.0
46	10 6	10.5	10 7		10.5	10 5	10 6		10 7	10 6			10 6
47	11.7	11 7	12.0		11 7	12.1	11.7		12 0	11.8			11.8
48	13 2	13.2	13 6		13.3	13 5	13 3		13.6	13 3			13 4
49	14 6	14 6	14 8		14 8	14.8	14.8		14.9	14 7			14.8
50	16.1	16.1	16 2		16.0	16 1	16 2		16 3	16 1			16.1
51	17.3	17.1	17.3		17.2	17 1	17.3		17 6	17 3			17 3
52	18.6	18.2	18 4		18.3	18 5	18 4		18.6	18.3			18 4
53	19.6	19.3	19.6		19 5	19 5	19.6		19.8	19 4			19 5
54	20.6	20 3	20.6		20.6	20 6	20 6		20.7	20 5			20 6
55	21 4	21.4	21.4		21.4	21.4	21 5		21.7	21.4			21.5
56	22.3	22 2			22.2	22 1	22.3		22 5	22 2			22 3
57	23.1	22.9			23.0	23.0	23.1		22.9	22.9			23.0
58	23.9	23.5			23.6	23.6	23 8			23 3			23.6
59	24.5	24.1			24 2	24 1	24 3						24.2
60		24.3			24.5	24 5	24 6						24.5
61		24.5			24.6	24 5	24.6						24.5
62					24.6	24.6	24 7						24.6
63					24 7								
64					24.7								
65					24 9								

of which 8 holes in 1964–65 and 12 in December 1965. The water temperature was measured by a thermistor which has a very small heat capacity. The results are summarized in Tables 1 and 2. Figure 3 shows the temperature profile for 1964–65 together with those for density and chlorinity*.

Two sharp thermoclines occur just beneath the ice sheet and at about 50m, and the third, less sharp break, at 12m. The temperature gradient shown in Fig. 4 clearly indicates the presence of such thermoclines. In the deepest part of the

* Report on the chemical composition of lake water will appear in the next issue.

Lake (65–66m) the temperature shows the presence of warm water (25°C) and the temperature stratification is quite characteristic (Fig. 5). Horizontal distribution of temperature was found surprisingly uniform (Tables 1 and 2), even near the edges of the lake. This contradicts with the report by ANGINO *et al.* who observed a thermal dome centering somewhere around 66V5.

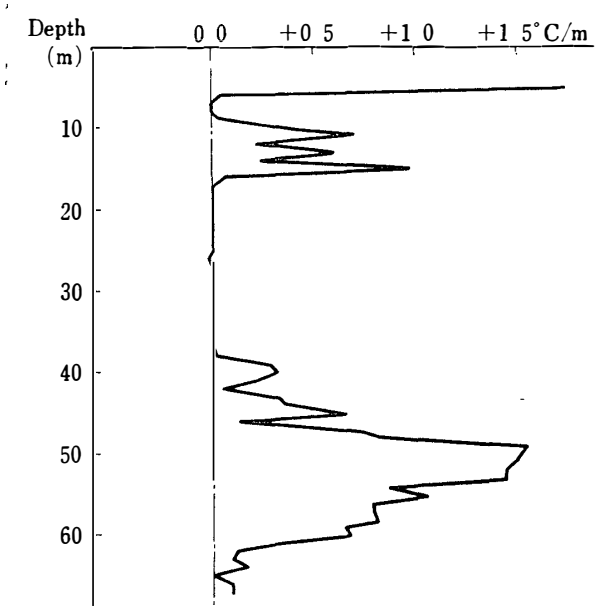

Fig. 4. Temperature gradient in Lake Vanda, January 1965.

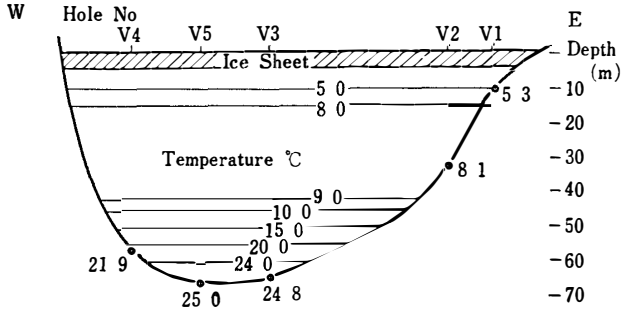

Fig. 5. Temperature stratification in Lake Vanda, January 2–3, 1965.

2. Lake Bonney

The location of coring is shown in Fig. 6. Temperature data are tabulated in Tables 3 and 4. The lake consists of east and west lobes, the connection being made through a shallow channel. Another characteristic of this lake is the supply of melt waters from the adjacent glaciers Taylor and Rhone inflowing at the end of west lobe (Photo 2). This makes the temperature profile quite different between the two lobes (Fig. 7).

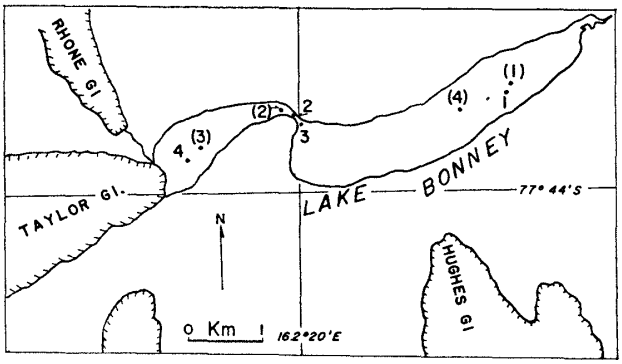

Fig 6. Location of holes in Lake Bonney. Open figures indicate hole number December 1965 and figures in parentheses hole number 1964–65

Table 3. Temperature data (°C) in Lake Bonney taken on January 8–10, 1965.

	Hole number			
	B3 West lobe	B2 Channel	B4 East lobe	B1 East lobe
Ice thickness (m)	3 9	4 2	4 15	4 2
Bottom (m)	20 5	12	32 4	32 2
Temperatures				
Underneath ice	0 1	0 1	0 0	0 0
Depth (m) 4	0.1	—	—	—
5	0 1	0 1	0 0	0 0
6	0 1	0 6	1.5	0 [illegible]
7	0.4	2 7	2 9	2 7
8	0 9	2 9	4.3	4 1
9	1 1	2 0	5 3	4 9
10	0 6	1.8	5 9	6 0
11	0 3	1 5	6 5	6 6
12	0 3	1.2	7 0	7.0
13	0 0		7.1	7 2
14	−0.9		7 3	7 2
15	−1 5		7 2	7.1
16	−2 2		7 0	6 9
17	−2 2		6 8	6 7
18	−2 2		6 4	6 2
19	−2 6		5 8	5 6
20	−2 8		5 2	4 9
21	−3 0 (bottom)		4 7	4 3
22			4 2	3 7
23			3 6	3 0
24			2 8	2 2
25			2 2	1 9
26			1 5	1 3
27			0 8	0 6
28			0 2	−0 1
29			−0 5	−0.7
30			−1.1	−1 2
31			−1 7	−1.9
32			−2 2	−2 6
Bottom			−2 6	−2 7

Table 4. Temperatures (°C) in Lake Bonney. December 15–18, 1965

Depth m	Hole number			
	66B1	66B2	66B3	66B4
5	1.5	0 8	0.7	0.7
6	1 7	1 7	1.1	0 9
7	3 8	3.6	3.1	1.1
8	4.8	4.2 (7.5m)	2 1	1.1
9	5.5			0.8
10	6 1			0 4
11	6 6			−0.2
12	6 8			−0 5
13	7 0			−0.8
14	7 0			−1.3
15	6 8			−2.0
16	6.6			−2.4
17	6 2			−2.6
18	5.7			−2.7
19	5.2			
20	4 7			
21	4 1			
22	3.5			
23	2 8			
24	2 3			
25	1.6			
26	1.0			
27	0 3			
28	−0 3			
29	−0 9			
30	−1.6			
31	−2 2			
32	−2 5			

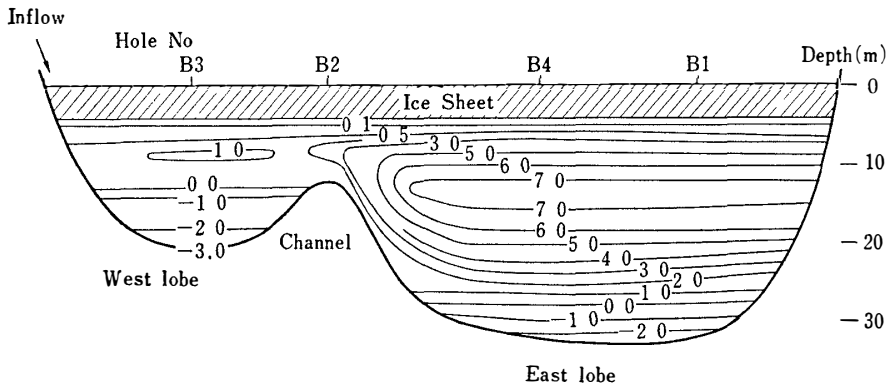

Fig 7. Temperature profile in Lake Bonney in January 1965. (°C) (5km in length)

As shown in Fig. 8 and Tables 3 and 4, the maximum temperatures were observed somewhere around the depth of 14m in the east lobe and the deviations of the depth due to the differences in both location and time are very small. The

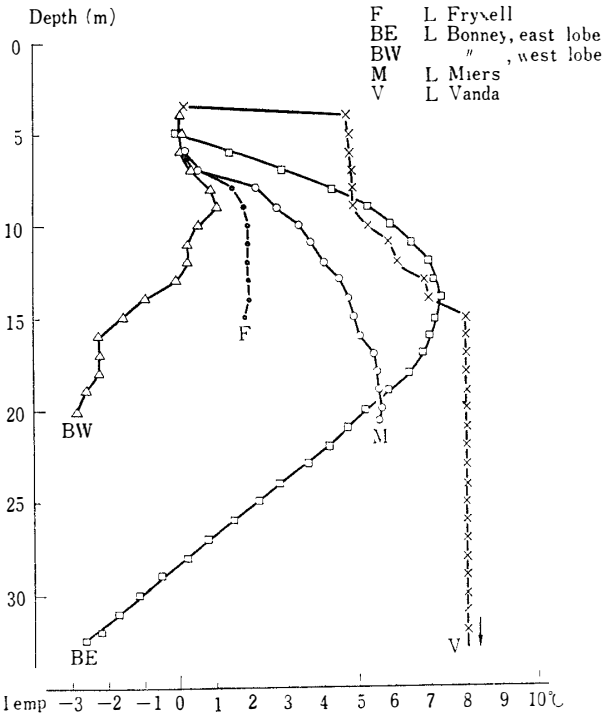

Fig. 8. Temperature profile in the lakes in Dry Valley, Victoria Land.

maximum temperatures in the west lobe, about 1°C, are much lower than those in the east lobe, about 7°C. This would seem to be affected by the inflowing water from the glaciers.

3. Lake Fryxell

The location of coring is shown in Fig. 9 and the temperature data are tabu-

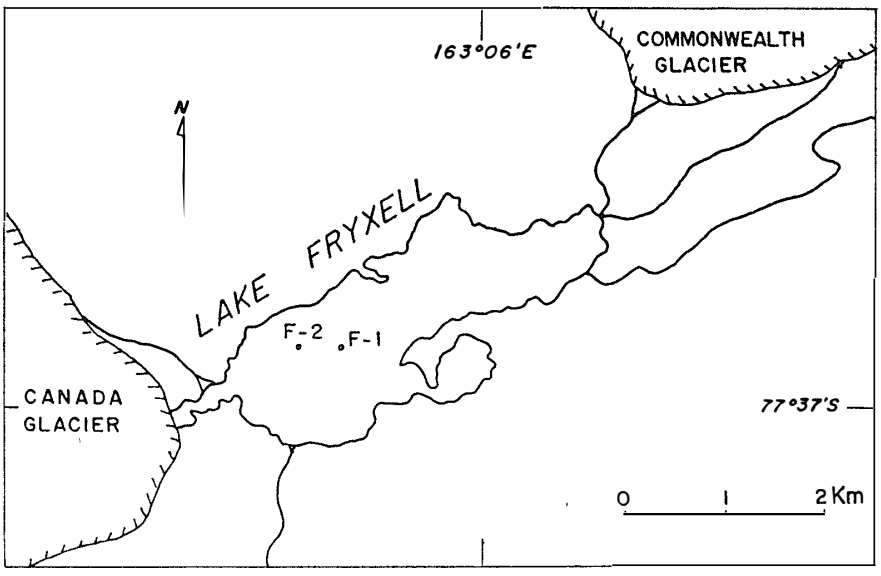

Fig. 9. Location of holes in Lake Fryxell (1964–65).

Table 5. Temperature data (°C) for Lake Fryxell (January 22–23, 1965) and Lake Miers (January 12, 1965).

	Hole number				
	Lake Fryxell			Lake Miers	
	F1	F1′	F2	M1	M2
Bottom (m)	15.3	15.3	11 2	20.6	16.7
Surface	0 0	0 0	0 1	0.1	0.1
Underneath ice	0 0	0 0	0. i		
Depth (m) 4	0.0	0 0	0 1		
5	0 1	0 1	0 1		
6	0 1	1.2	0.2	0.2	0 5
7	0.6	1.4	1.4	0.6	1.5
8	1.6	1.5	1 6	2.2	2 3
9	1 9	1.8	2.0	2.8	2.9
10	2 0	1.9	2.0	3.4	3.3
11	2 0	2.0	2.1	3.7	3.6
12	2.0	2.0	2 1*	4.2	3.9 11.2m*
13	2 0	2 0		4.5	4 2
14	2.0	1.9		4.7	4 7
15	1.9	1.8		4.9	4.9
16	(1.9)	(1.8)		5.1	5.2
17	(1.9)	(1.8)		5.5	5.4* 16.5m*
18				5.5	
19				5.6	
20				5.7	
20 6				5.6	

lated in Table 5. This lake has also inflowing waters in summer from the adjacent glaciers, Canada and Commonwealth. The maximum temperature of 2.0°C is observed somewhere around 12m depth and a small decrease in temperature with the increase in depth.

4. Lake Miers

Two holes were drilled in Lake Miers (map is shown in the previous paper). Hole M1 showed the maximum depth of 20.6m and the maximum temperature of 5.7°C at 20m. Temperature profile for Hole M1 is shown in Fig. 8.

5. Summary

Four lakes under investigation differ from each other in their characteristics. The temperature stratification could not be interpreted without the knowledge of other physical and chemical features of the lakes. Several factors can be taken into consideration which would make the different temperature profile, namely, the action of ice sheet as a natural solar energy trap, inflow of glacier meltwater

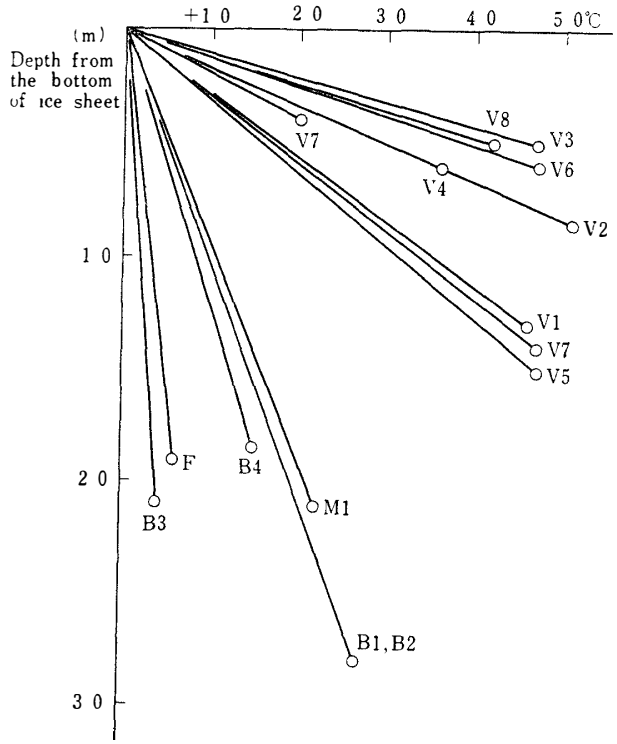

Fig. 10. Temperature gradients just beneath the bottom of ice sheet Figures indicate hole numbers for 1964–65.

and geothermal heat transfer from the bottom.

One of the different features of the four lakes is demonstrated in Fig. 10, indicating different temperature gradient just beneath the bottom of ice sheet. This may reflect the difference in storage of heat among the lake bodies, suggesting the order of increasing heat storage: Lake Fryxell and Lake Bonney < Lake Miers < Lake Vanda.

Temperature stratification and other characteristics will be discussed in connection with density of water, etc., in the future report.

References

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