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NOTE

Historical temperature and salinity measurements on Lake Hoare, Taylor Valley, Antarctica

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Abstract

Measurements of temperature and salinity in the water taken in 1963 in Lake Hoare, Taylor Valley, Antarctica are presented. These values are much lower than in other lakes in the region, and may be of interest to researchers studying the change with time of the lakes.

Keywords

Lake Hoare, Taylor Valley, temperature and salinity measurements

Introduction

This paper summarises data from one of the previously unpublished parts of the VUWAE 8 expedition to Antarctica in 1963-64, from Victoria University of Wellington. Earlier papers gave the results from Lake Fryxell, Lake Bonney and Lake Vanda (Hoare *et al*., 1964, 1965; Hoare, 1966). These previously described lakes were remarkably warm, and showed strong stratification. However, the results from Lake Hoare were never published and I present the data in case it becomes relevant to future studies of changes in the climate of the Taylor Valley.

Location

Lake Hoare (77°38'S, 162°53'E) lies between the Canada and Suess glaciers in the Taylor Valley, Antarctica and abuts the Canada Glacier, which acts as a dam in the valley (Fig. 1). The lake is about 3.5 km long, its altitude is about 70 m above sea level, and it is permanently covered with about 4 m of ice. Lake Fryxell is on the east side of the Canada Glacier, at about 30 m above sea level.

Our measurements showed that Lake Hoare had east and west lobes which behaved differently. The East Lobe abuts the glacier and is distinctly cooler than the West Lobe. Prior to our expedition, maps showed the lake as being called Lake Chad, but a literature search showed that name to belong to its distinctly medicinal smaller neighbour. Our expedition leader originally proposed that one lobe should be named Lake House after our chemist, and the other Lake Hoare.

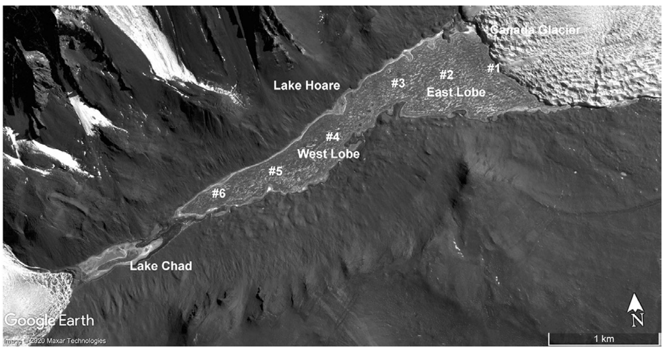

Figure 1 – Location of Lake Hoare and the sampling holes

Methods

Temperatures were measured using thermocouple wire and a Tinsley potentiometer, which, although 19th century technology, was sensitive in the microvolt range.

We used two thermocouples; one was about 20 m long, which had increased sensitivity by grouping six lengths of wire in series. The other was a single-junction wire that could reach down to 65 m. The accuracy was about ± 0.01°C for the six-junction thermocouple and ± 0.05°C for the long one.

We had a conductivity meter, details of which are lost in the mists of time. Our chemists used a wet chemistry method in the field to measure chloride, using samples that were obtained by pumping water at various depths from holes 3 and 5.

Depths were measured below the ice surface.

Results

Chloride

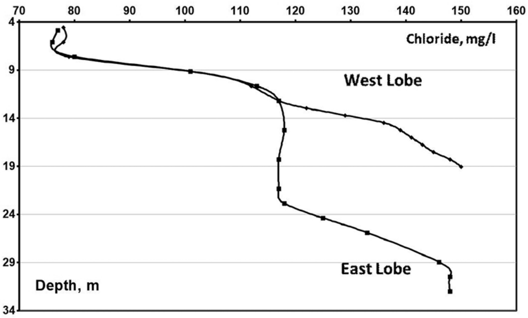

Figure 2 – Chloride versus depth

Chloride concentrations at holes 3 and 5 (one in each lobe) are very similar down to a depth of about 12 m, but the measurements then diverge (Fig. 2). The East Lobe has a constant concentration between 12 m and 22 m depth; concentration then rises with depth.

Conductivity

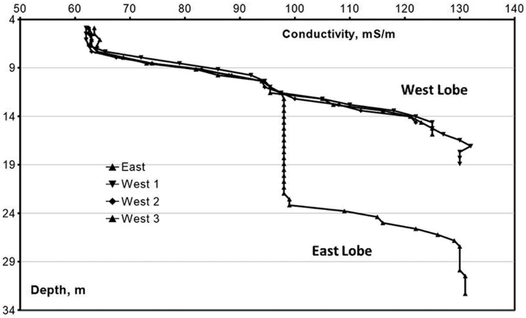

Figure 3 – Conductivity versus depth

Conductivitiy, which is a surrogate for density and salt concentration, more or less mimics the chloride concentration and shows the lateral homogeneity between the three holes situated in the West Lobe (Fig. 3).

The steady increase in chloride concentration and conductivity with depth in much of the lake indicates stratification, as observed in the other lakes measured on this expedition (House *et al.*, 1966).

There is a layer of constant conductivity in the East Lobe, from 12 m to 22 m depth, corresponding to the measurements of chloride in that lobe. In Lake Vanda (Hoare, 1968) a similar observation of the salinity and temperature measurements was attributed to convection in the water.

Temperature

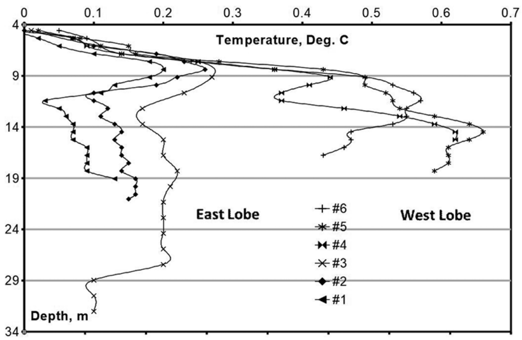

Figure 4 – Temperature versus depth

Despite the lake not being very warm, clear thermal stratification is observed (Fig. 4).

A weak maximum of temperature is observed in all locations in the depths below 7m.

The East and West lobes are similar in temperature to each other, to a depth of about 9 m. However, below this depth the West Lobe is about half a degree warmer than the East Lobe. In the East Lobe, the temperature decreases toward the glacier in the deeper waters. Note that these are very small, but real, temperature differences.

Data tables

Because this is a record of historical measurements a numerical summary of the results is presented in Tables 1 and 2. The tables do not contain the raw data because the number of observations makes this impractical; instead, the raw data was used to interpolate the values at a uniform set of depths. Given the high precision of the data and the small range of observed values the tables contain all the available information.

Measurements were made in late December 1963. Locations of the sampling holes for chloride measurements have been lost but are immaterial because of the lateral uniformity of the conductivity and temperature measurements.

Table 1 – East Lobe chloride, conductivity and temperature with depth below surface (interpolated data)

Depth m	Chloride mg/L	Conductivity #3 mS/m	Temperature #3 °C
5	77	63	0.01
7	79	64	0.12
9	101	82	0.27
11	114	96	0.22
13	118	98	0.17
15	118	98	0.20
22	118	98	0.20
24	125	110	0.20
26	133	125	0.20
28	144	130	0.20
30	148	130	0.10
32	148	131	0.10

Table 2 – West Lobe chloride, conductivity and temperature with depth below surface (interpolated data)

Depth m	Chloride mg/L	Conductivity #3 mS/m	Temperature #3 °C
5	78	62	0.02
7	79	63	0.17
9	101	80	0.48
11	113	95	0.53
13	122	107	0.59
15	137	124	0.64
17	144	130	0.61
19	150	130	0.59

Discussion

Lake Hoare is different from the other lakes described by this expedition, primarily because it is dammed at one end by a glacier. This can obviously cause a cooling effect.

The salt concentrations are relatively low, possibly because the Canada Glacier retreated during the ancient dry spells that allowed lakes Bonney, Fryxell and Vanda to accumulate the very large concentrations they have in their lower depths. Lake Hoare would then have drained into Lake Fryxell, losing the opportunity to accumulate salts by evaporation. We see maxima of only 30 mg/L of chloride in this lake, but maxima of 4000 mg/L in Lake Fryxell.

The lake shows qualitatively the same solar heating effects described in the nearby Lake Bonney (Hoare *et al.*, 1964), but to a much lesser extent. Attempts to fit a quantitative model to this data showed that the observations are consistent with a solar heating model. The presence of a glacier in contact with the water to an unknown depth and the narrow range of temperature caused attempts at modelling to be abandoned.

Data in this paper shows a lack of mixing between the waters in the East and West lobes below a depth of about 12 m from wherever the surface was in 1963. The contours in a map drawn from 1994 data in Doran *et al.* (1996) suggest a sill at 14 m below the ice surface at that time, thus separating the lobes. The difference between 12 m and 14 m depth for the sill may be because the lake level is likely to have risen over the 30 years between our work and Doran's, as has happened at other lakes in the valleys.

It is remarkable that despite this lack of mixing, the water at the bottom of both lobes has similar values of chloride and conductivity. This is unlikely to be a coincidence, but it has proved to be quite difficult to come up with probable imagined sequences of evaporation and flooding that would lead to this situation.

Perhaps another student can get more extensive data on these waters and suggest the history of the lake?

References

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