

CORRESPONDENCE

The Editor,

Journal of Glaciology

SIR,

The temperature of the Sukkertoppen ice cap

We are very interested to read the paper by C. Bull in the October 1963 issue of the *Journal of Glaciology*, in particular the section classifying the ice cap as temperate.

The analysis of the results from the Cambridge West Greenland Glaciological Expedition 1958, mentioned in Dr. Bull's paper, is nearing completion. A small part of the expedition's field work was the measurement of ice temperature in the glacier Lyngbrae which flows north from the Sukkertoppen ice cap. Borings in the upper part of the glacier near the foot of the ice fall extended deeper than the crest of the winter cold wave. The readings show clearly that the glacier at these points was *not* temperate. From them we infer that the ice cap itself was probably "arctic" in this region. However, this does not accord with Dr. Bull's findings.

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SIR,

The chemistry of ice-shelf brines

Brine soaking of ice shelves has been reported in the Antarctic by Stuart and Bull (1963) in the Ross Ice Shelf near Scott Base, and by Dubrovin (1960) near Lazarev Station. The phenomenon has also been reported in the Ward Hunt Ice Shelf, Ellesmere Island (Marshall, 1960; Lyons and Leavitt, 1961). The purpose of this communication is to describe the chemistry of the brine from the Ross Ice Shelf.

The brine was sampled in the summer of 1962-63 from a hole one kilometre east of Scott Base and 1.5 km. from the seaward edge of the ice shelf. The ice core containing the brine was allowed to melt and the melt water was collected in a polythene bottle. The samples were returned to New Zealand for analysis. The chemical analysis is shown in Table I, together with that of sea-water for comparison.

TABLE I. CHEMICAL COMPOSITION OF CORES FROM HOLE NUMBER 2

Sample number	Depth below	Depth below	Chemical composition of melted core					Minimum temperature (Fig. I)	
	top of ice shelf	surface of brine	Na ⁺	K ⁺	Na ⁺ /K ⁺	SO ₄ ⁻²	Cl ⁻		Cl ⁻ /SO ₄ ⁻²
	cm.	cm.	g./l.	g./l.		g./l.	g./l.	g./l.	°C.
S 13	407-458	107-158	1.3	0.05	26	0.221	2.3	10.4	-9.3
S 14	458-505	158-205	1.7	0.06	28	0.316	3.3	10.4	-9.3
Sea-water (for comparison)			9.1	0.33	27.5	2.3	16.5	7.2	—

It can be seen from the data presented in Table I that the sample is depleted in sulphate with respect to sea-water. Analyses by Dittmar (1884) have shown that, apart from variations in salinity, sea-water has practically a constant composition all over the world.

The most probable origin for this brine is sea-water percolating through the cold firn of the ice shelf where ice separates from it, producing a brine considerably more saline than sea-water.

Thompson and Nelson (1956) have studied the concentration of brines and the deposition of salts from sea-water under frigid conditions. When sea-water is cooled, ice first separates together with small quantities of calcium carbonate, but except for becoming more concentrated, the chemical composition remains practically unchanged until a temperature of 8.2°C. is reached, at which point hydrated sodium sulphate begins to crystallize. As temperatures are lowered the composition changes rapidly as sodium sulphate is removed from solution.

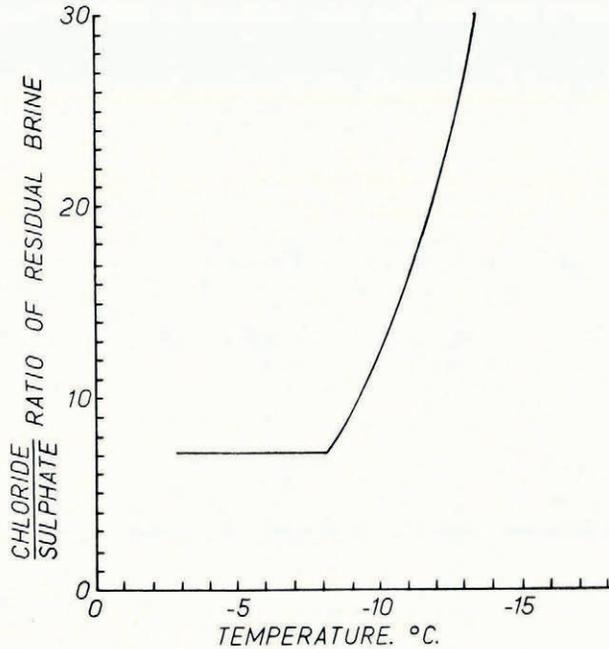


Fig. 1. Plot of $\text{Cl}^-/\text{SO}_4^{--}$ ratio of residual brines in equilibrium with ice and crystallized salts as a function of temperature. Calculated from experimental data given by Thompson and Nelson (1956)

From the $\text{Cl}^-/\text{SO}_4^{--}$ ratio of the Ross Ice Shelf brine it is evident that the minimum temperature to which it has been subjected during its passage through the frozen firn of the ice shelf was -9.3°C . This result is in agreement with temperature measurements at the same depth in the brine layer in a nearby thermohm station situated a horizontal distance of 400 m. to the north (unpublished results of A. J. Heine).

The density of this brine would have been 1.1 g./cm.^3 (Thompson and Nelson, 1956), the sea-water having lost three-quarters of its original water. This poses an interesting hydrostatic problem, for if the brine were to flow downward through the firn it would move to a region of higher temperature and thus ice would melt until the concentration of the brine was reduced to that appropriate to the ice-brine equilibrium at that temperature. We thus have an inverted density gradient imposed by a temperature gradient.

There are several reports of the occurrence of hydrated sodium sulphate on the ice, especially in regions of ablation (e.g. Debenham, 1952). This is probably the hydrated sodium sulphate which has crystallized from the freezing sea-water and which has moved up to the surface as the ice above it has ablated.

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SIR,

*Advance of a Patagonian glacier**

The Glaciar Bruggen (or Pio XI) is a very active tidewater outlet of the southern Patagonian icefield. More is known of its variations than of any other glacier on the Pacific side of the icefield.

In 1830 H.M.S. *Beagle* sailed to the head of Fiordo Eyre, and King (1839, p. 337) reported a

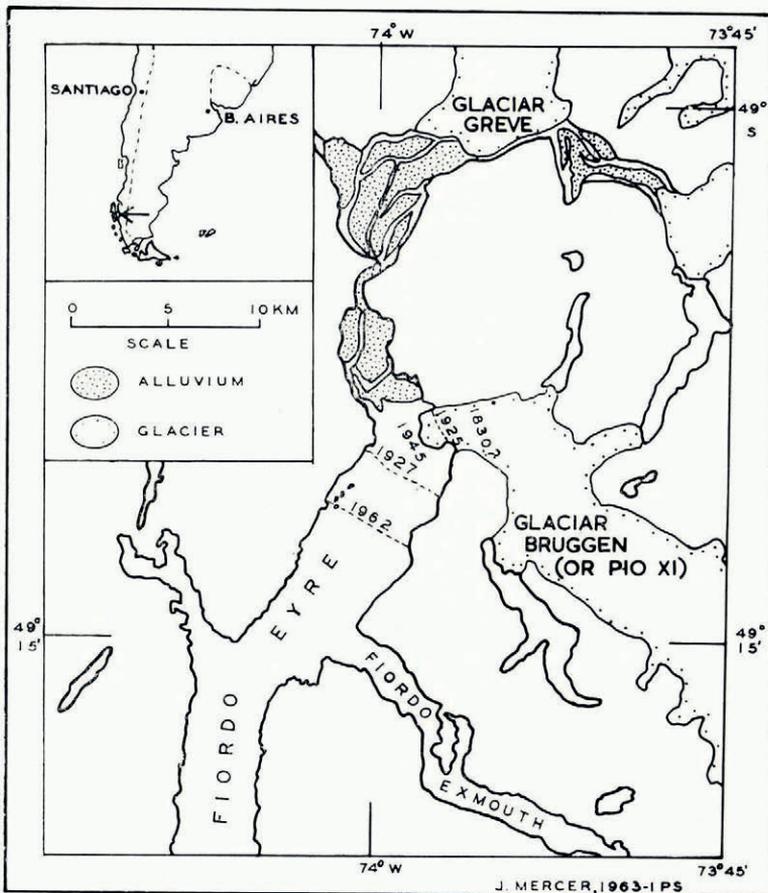


Fig. 1. Map showing the position of the Glacier Bruggen and the positions of its front †

* Institute of Polar Studies, The Ohio State University, Contribution No. 43.

† Map source: Instituto Geográfico Militar de Chile. 1954. Isla Angamos. 1:250,000. [Numbered] 4975.