Ablation on the Antarctic Shelf Ice

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ABSTRACT

The antarctic climate is directly related to the melting of its ice .The monitoring of the melt pattern was carried on the shelf ice near the Indian base research station Wind was found to be the most important agent influencing ablation of antarctic ice whereas solar radiation played a subordinate role

INTRODUCTION

The icy continent of Antarctica is regarded to be in a state of equilibrium at present, which means that the input in the form of snow and ice more or less neutralises the wastage due to melt This phenomenon has far reaching consequences on global climate. The monitonng of the melt pattern in this region is, therefore, of great importance as far as the balance of the ice sheet is concerned. During the Second Indian Antarctic expedition valuable data in this context was collected.

STAKE FIXATION

A network of fifteen stakes was established on the shelf ice near the base research station Each stake 4 5 m long was drilled into the ice by means of hand-auger, up to an average depth of about 3 m. The stakes were fixed in three rows of five stakes each. Each row was about 90 m apart and the mean distance between each stake was also about 90 m. The location of the stakes is plotted on a map, showing their position with reference to the hut erected during the expedition (Fig 1).

STAKE MONITORING AND MICRO-RELIEF

Fixation of stakes was earned out on 5th January, 1983 and they were monitored on 12th and 29th January, 1983 and on 6th and 14th February, 1983. The stake measurements are given in Table I.

Monitoring of stakes on the shelf ice needs a little more caution because of the development of prominent weathering crust on its surface Shelf ice-is replete with cusps and crusts. The measuring surface of ice in contact with the stake is as such crunchy and not uniform unlike the ice constituting the inland polar ice. The measurements, by tape, may not represent the actual depletion because of non-uniformity of the surface. In the present case a fixed line was observed on the stake ice intersection for all measurements and this line was kept as a permanent reference line, instead of a portion of ice encircling the stake as is done in normal stake measurements Such a method offsets any discrepancies arising out of personal bias in monitonng of such surface.

ABLATION PROCESSES

Out of the processes which influence the ablation of Antarctica ice, the most important appears to be the wind. The surface winds act as a strong agent of transport of ice and snow as fine

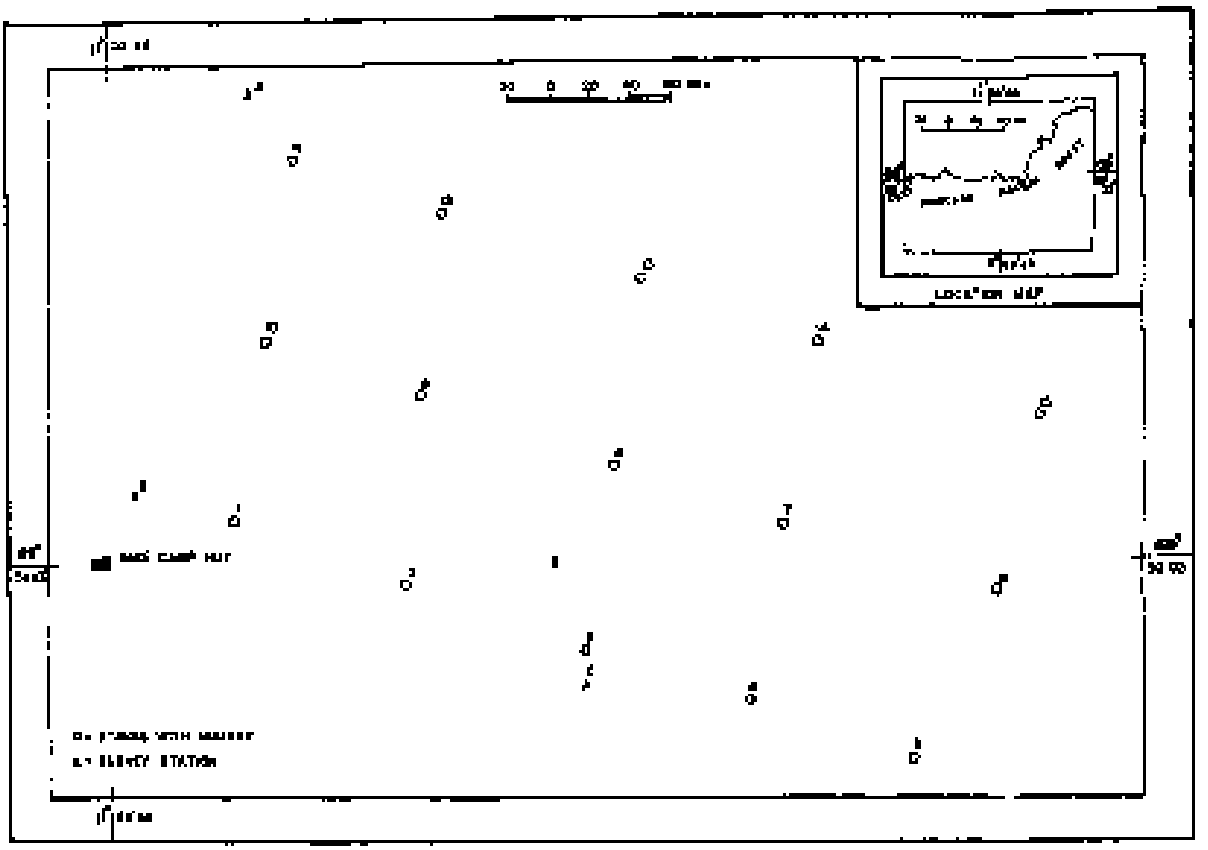

Fig 1. Location of stakes fixed during the Second Antarctic expedition on shelf ice, Princess Astrid Coast, Antarctica

powder, and this process of deflation is responsible for lowering of the glacier surface. Simultaneously this mass of powdered snow gets accumulated with the dimunition of wind speed resulting in the elevation the ice surface at that place. Hence melting due to solar radiation plays a subordinate role in ablation. Whereas in absence of winds the heat exchange becomes dominant. Nonetheless, wind is always dominant and hence an effective agent of ablation. From this it is apparent that any ablation or accumulation monitored on the surface of shelf ice is primarily due to wind effect and secondarily due to actual melting or precipitation. It has been noticed that on the same plot of shelf ice, some stakes show ablation and others accumulation at different periods of observation, as shown in Table I, the stake measurement chart. The ablation, however, dominates. Average ablation recorded was of the order of 14.25 cm during the period of observation extending for 45 days and average accumulation for the same period was 1.8 cm. In terms of water equivalent, the loss and gain in this small plot was respectively 108 cm and 13.5 cm.

THE PATTERN OF ABLATION

The stake recordings were converted into centimetre of water equivalent after taking into account 0.5 gm/cm^3 as the mean density of the shelf ice in its upper part. Isopleths were then drawn for the entire plot covered by the stakes. These line were drawn separately for ablation and accumulation. A conspicuous vicissitude in the trend of these parameters has been recorded during the period of observation.

5th to 12th January, 1983

The central portion shows a substantial waste, which goes on decreasing towards the periphenes and again increasing on the south-west corner of the plot (Fig 2). The microrelief has obviously turned into a depression with the snow and ice scooped out from the centre.

13th to 29th January 1983

During this period the depression appears to have been filled as is revealed by lower values, giving thus a complete reversal of the relief vis-a-vis the above period. The southwest corner shows higher values of depletion (Fig 3).

30th January to 6th February 1983

This records a period of accumulation on the plot except in the eastern part of the plot where depletion is observed (Fig 4). The middle portion shows a zone of equilibrium where wastage and accumulation are compensated.

TABLE I

Stake measurements (cm)

Stake No	5 12 Jan 83		13 25 Jan 83		30 Jan 6 Feb 83		7 14 Feb 83		Ablation (Total in cm)	Total loss in water equivalent (cm)	Total accumulation (cm)	Total gain in water equivalent (cm)
	ab	ac	ab	ac	ab	ac	\b	ac				
1	8	-	27	-	-	4	1	-	36	18	4	2
2	6	-	2	-	-	3	15	-	23	12 5	3	1 5
3	3	-	0	-	-	2	6	-	9	4 5	2	1
4	3	-	1	-	-	0	8	2	12	66	2	1
5	1	-	4	-	3	-	-	2	8	4	2	1
6	5	-	3	-	0	-	9	-	17	85	0	0
7	0	-	4	-	0	-	9	-	13	65	0	0
8	8	-	1	-	-	2	-	1	9	45	3	15
9	4	-	3		0		1		8	4		
10	4	-	5	-	0	-	4	-	13	65	-	-
11	2	-	1	-	-	3	7	-	10	5	3	15
12	3	-	4	-	1	-	8	-	16	8	-	-
13	2	-	5	-	-	3	9	-	16	8	3	15
14	4	-	4	-	-	5	9	-	17	85	5	25
15	3	-	0	-	-	0	4	-	7	35	-	-
								Av	14 25	108 0	18	13 5

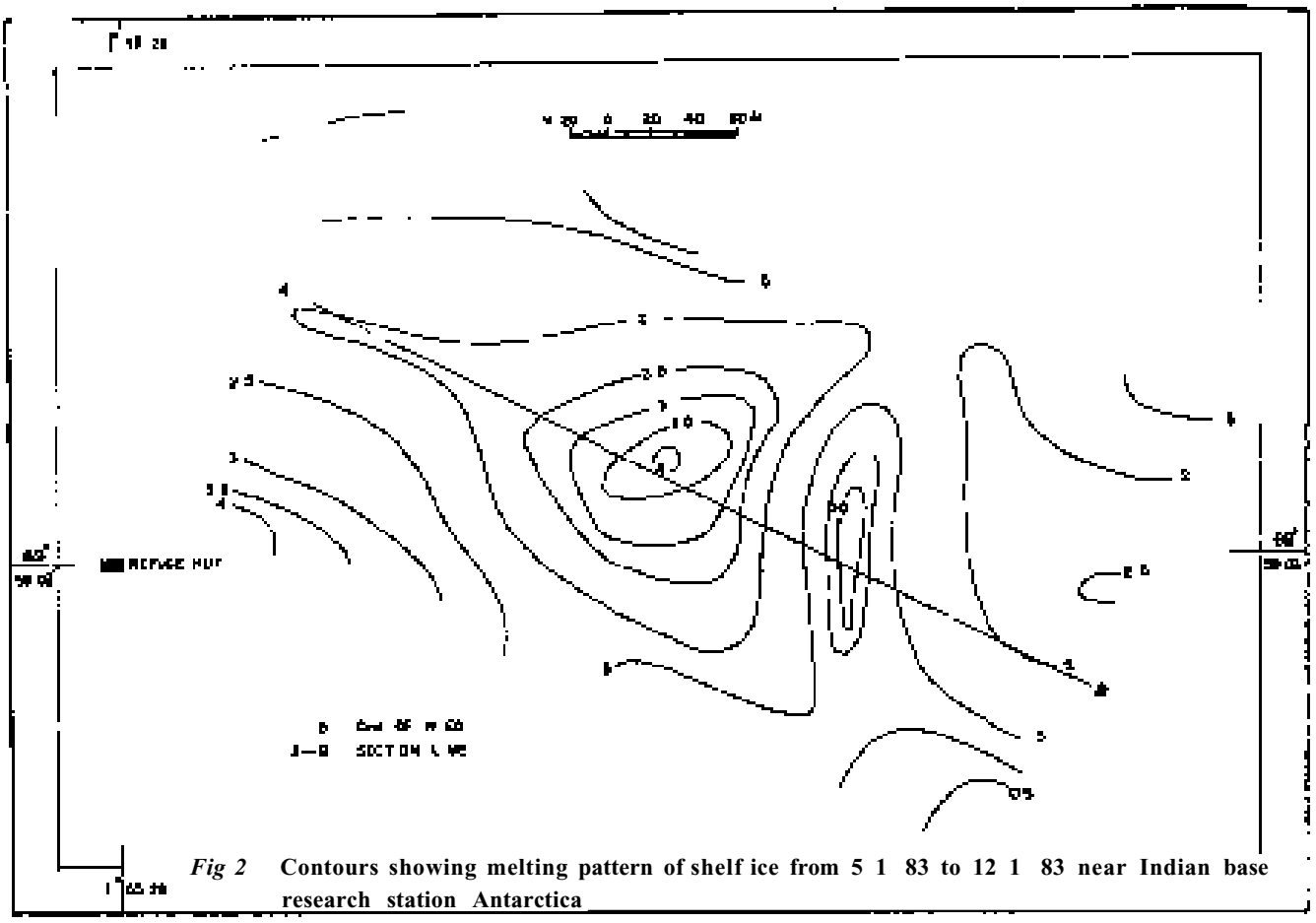

Fig 2 Contours showing melting pattern of shelf ice from 5 1 83 to 12 1 83 near Indian base research station Antarctica

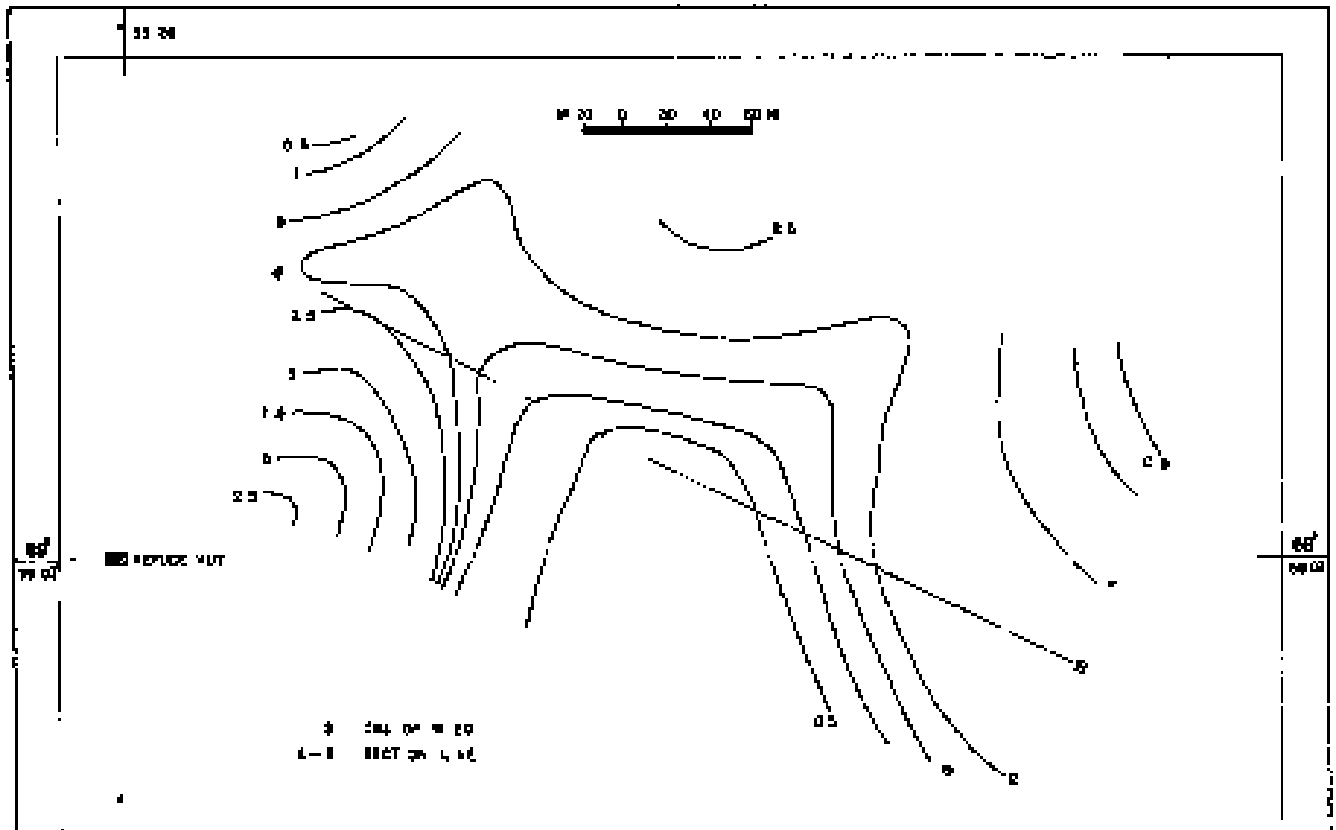

Fig 3 Contours showing melting pattern of shelf ice from 5. 1. 83 to 29 1 83 near Indian base research station Antarctica.

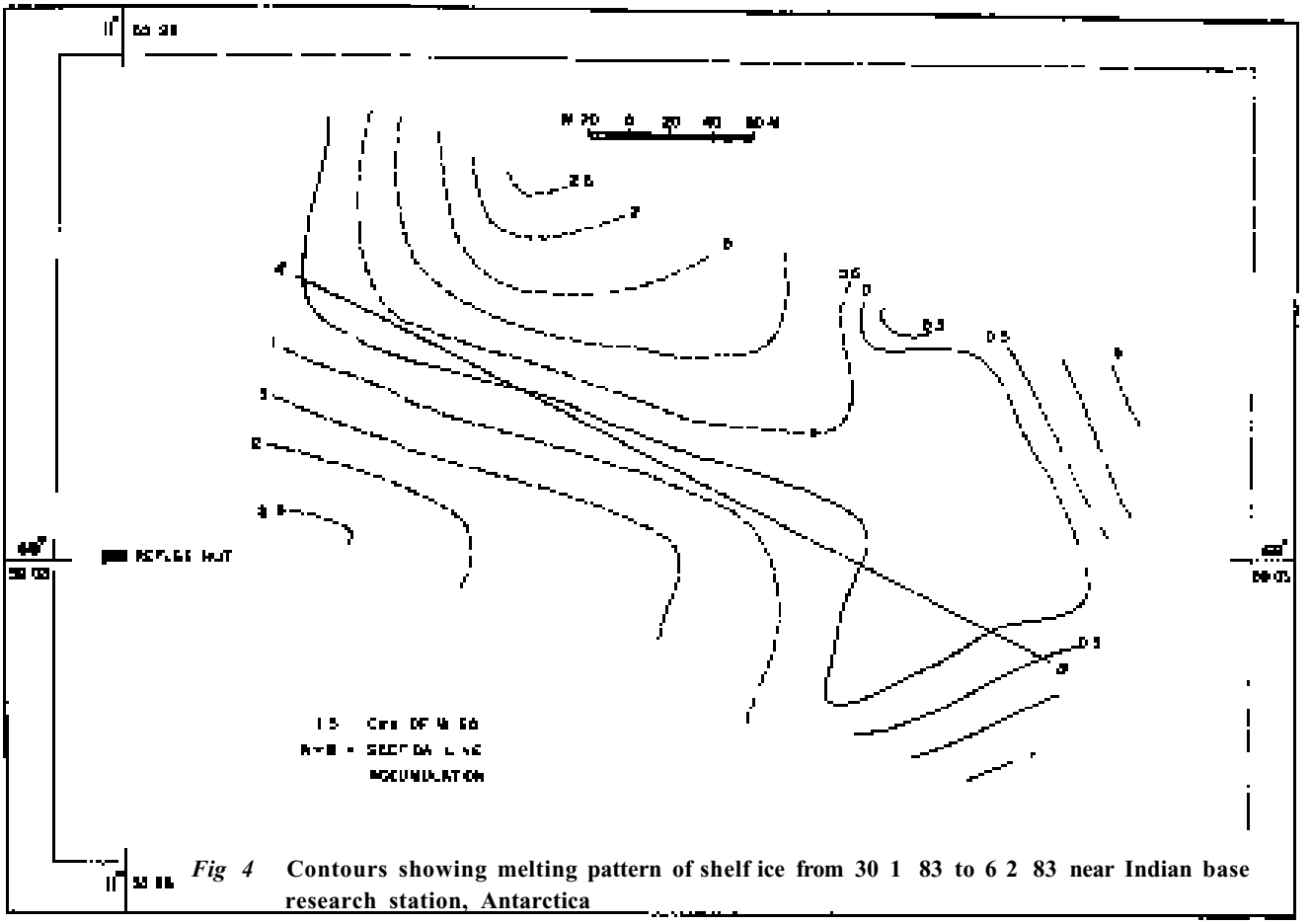

Fig 4 **Contours showing melting pattern of shelf ice from 30 1 83 to 6 2 83 near Indian base research station, Antarctica**

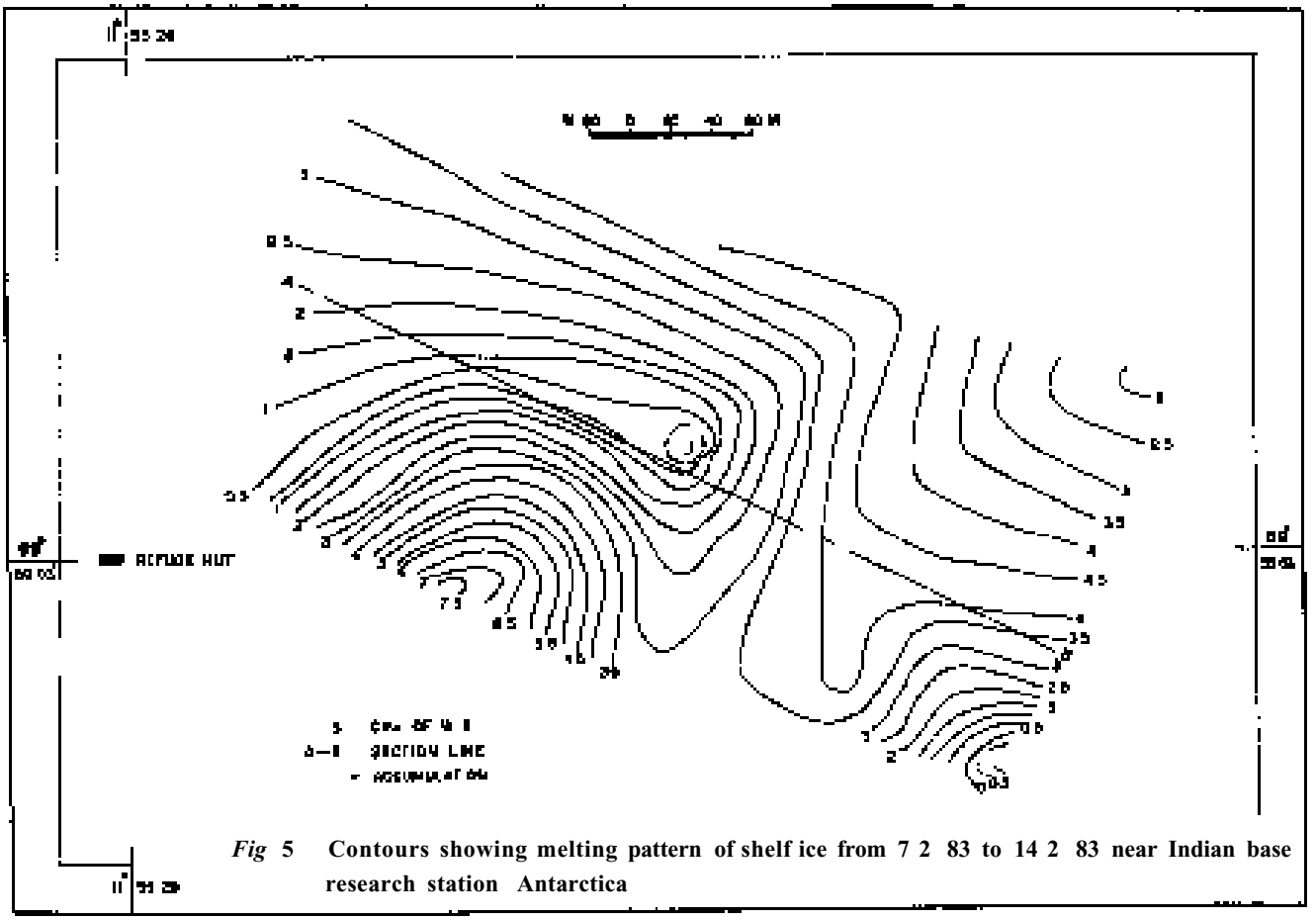

Fig 5 **Contours showing melting pattern of shelf ice from 7 2 83 to 14 2 83 near Indian base research station Antarctica**

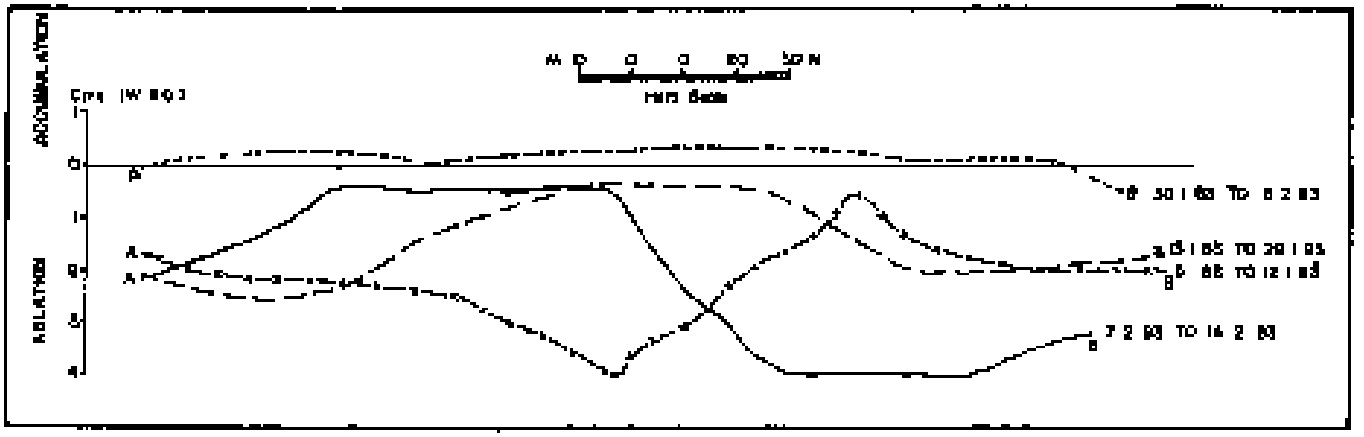

Fig 6 Profiles showing melting pattern along A — B (see Figs. 2 to 5) of shelf ice around base reasearch station Antarctica

7th to 14th February 1983

In the southwestern part depletion is greater than that in the central part and the overall picture appears to be like that observed for the period 13th to 29th January 1983 except that the zone of less depletion has shifted northwestward (Fig 5).

CONCLUSIONS

A profile transverse to the plot for each period (Fig 6) of observation very strikingly reveals the shifting pattern of ablation. This reflects that these two parameters on the shelf ice are in a dynamic state of change What is happening on this plot will be happening on the entire shelf on account of prevailing wind and other meteorological factors. Though this process may not have long ranging effect on the balance of the shelf ice at Antarctica because depletion at one place results in accumulation at other place yet this would hold good only as far as grounded ice shelves are concerned. While in case of floating ice shelves which are comparatively in state of disequilibrium any attempt for assessing the state of balance of Antarctic shelf ice has to reckon this important observation.