Stratigraphic Studies of Antarctic Ice

M.K. Kaul, S.K. Chakraborty and V.K. Raina

Geological Survey of India

ABSTRACT

For the stratigraphic studies of Antarctic ice which has an accumulation record of thousands of years various methods were attempted viz (i) direct measurement through a network of stakes (i) dif ferentiation of accumulated layers through difference in stratigraphic character (m) establishment of reference horizon through radioactivefall out and (iv) the O^{8}/O^{6} and D/H values of thee deposited snow and ice.

On the basis of stratigraphic and physical characters Antarctica ice core study revealed two cate gones (*i*) ice or depth hoar which shows compaction larger crystal grains greater hardness and dull grey to green colour and (*ii*) firn which is less compact with smaller grain size and white to off white colour In addition to these major stratigraphic layers 1.5 cm thic sandy layer about 36 cm below the ice surface was also accorded in one bore hole.

INTRODUCTION

I our methods were applied to calculate the rate of accumulation and age of the ice in various sector of Antarctica (*i*) direct measurement through a network of stakes (*ii*) differentiation of accumulated layers through difference in stratigraphic character, (*iii*) establishment of a reference horizon through radioactive fallout (artificial activity measurement) (In case of Antarctica 1954 or early 1955) and (*iv*). The O^{8}/O ratio of the deposited snow, giving the temperature at which snow has formed and thus delineating summer and winter layers.

It was possible to probe only a few meters of the surface of this ice cover

SAMPLING

Ice samples were collected with the help of CRREL machine which had the capacity of drilling up to a depth of 7 m Five bore holes were made-four on the ice shelf and one on the inland polar ice (Fig 1) and ice core examined Ice core collected from drill site was carried to India in a frozen state and delivered to the Physical Research Laboratory, Ahmedabad for radioactive fallout measurement and determination of O^{18}/O^{6}.

Ice core melt samples of each bore hole were also brought to India for O^{8}/O^{6} studies .These samples were collected in such a way as to represent various sections depthwise, along each bore hole.

STRATIGRAPHIC PROFILE

The Antarctic ice shows distinct stratigraphic characters each layer being characterized by different physical characters such as coarseness hardness compaction etc. The layers showing greater compaction, larger crystal grains, greater hardness and dull grey to green colour constitute

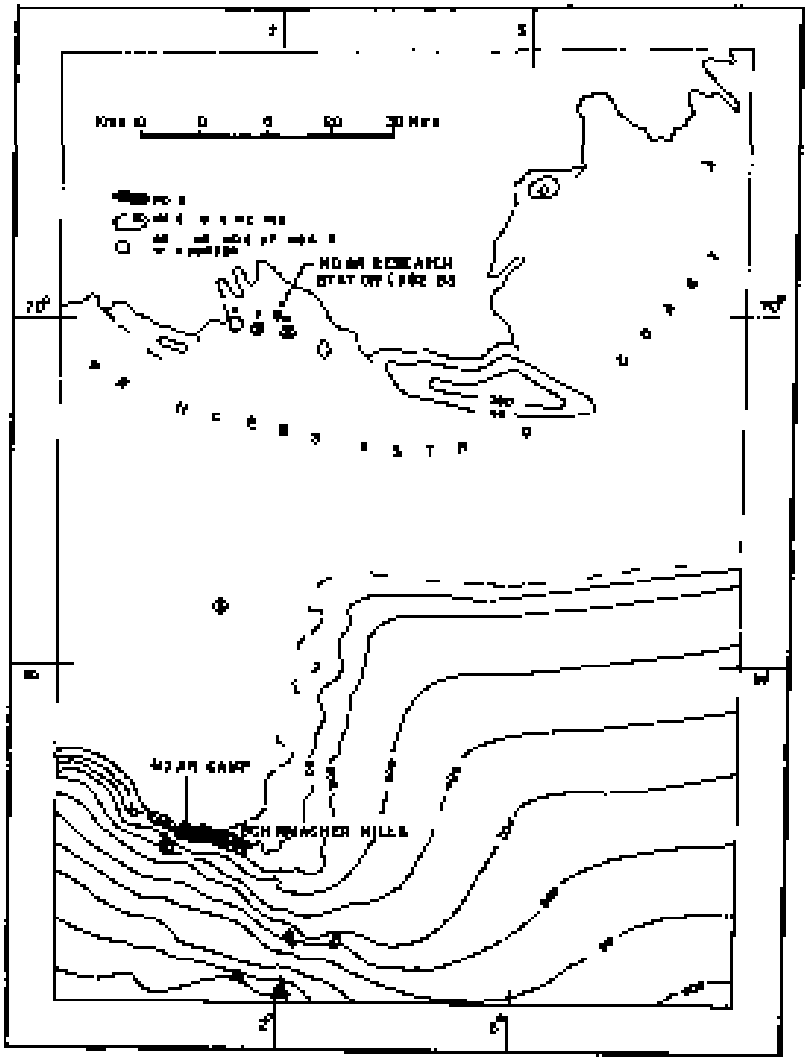


Fig 1 Location of ice drilling and sampling sites

TABLE I

The data pertaining to cores from drill sites (Also shown in the Figs 2 to 6)

Drill Site	Thickness of core	No of layers	Thickness of ice layers	Thickness of firn layers	Location
1	5 20 m	10	5 20 cm	3 12 5 cm	on shelf ice
2	5 62 m	13	2 30 cm	2 120 cm	on shelf ice
3	5 65 m	5	2 5 cm	45 285 cm	on shelf ice
4	3 00 m	21	2 25 cm	1 18 cm	on shelf ice to inland polar ice
5	160 m	6	0 5 21 cm	-	inland polar ice

the ice or depth hoar and the ones showing lesser compaction, smaller grains and white to off-white colour form the firn. In each core length various zones of either of these two types have been depicted, as shown in Figs 2 to 6. The number of layers encountered in each bore hole and their thickness have been tabulated in Table I.

A very interesting feature in the stratigraphic profile of core from drill site 5 was the occurrence of a 1.5 cm thick sandy layer about 36 cm below the ice surface. The intervening firn layers which are closely foliated range in thickness from 1 to 30 cm.

The variation in the density values of the ice core in all the five bore holes has been depicted in Table II.

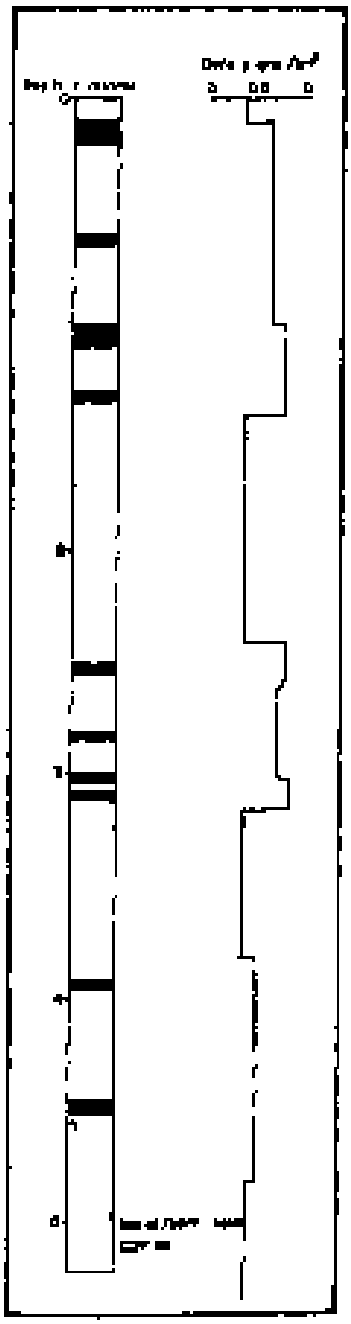


Fig. 2 Stratigraphic and density profile of Antarctic ice at Drill site 1

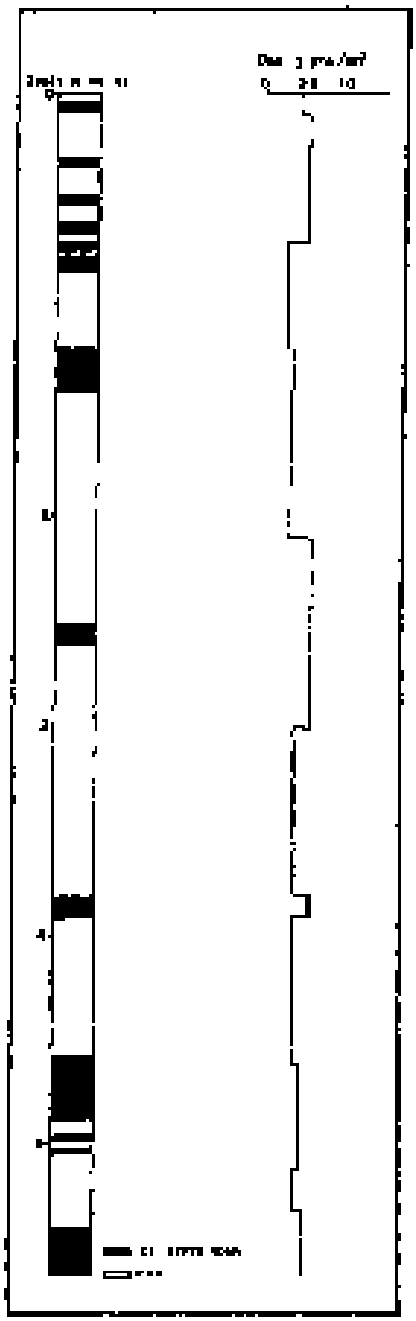


Fig 3 Stratigraphic and density profile of Antarctic ice at Drill site 2

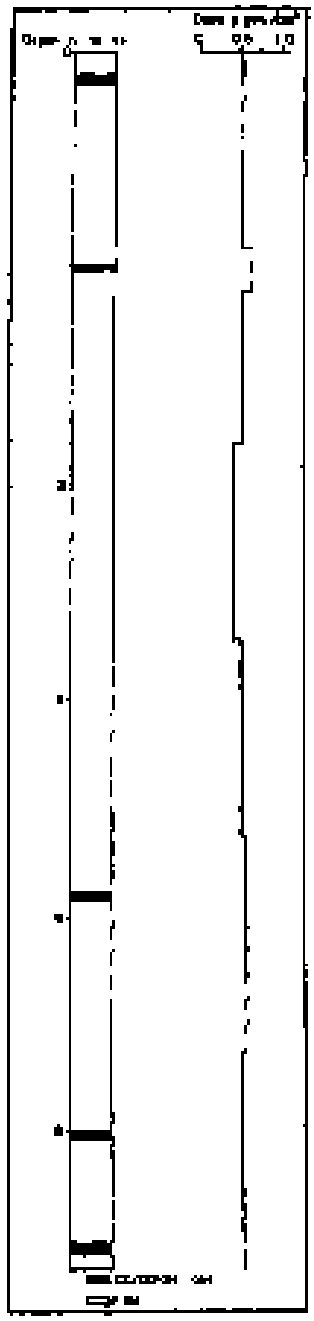


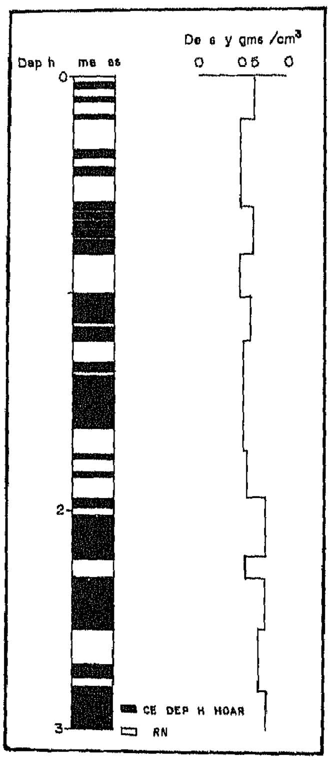
Fig 4 Stratigraphic and density profile of Antarctic, ice at Drill Site 3

TABLE II

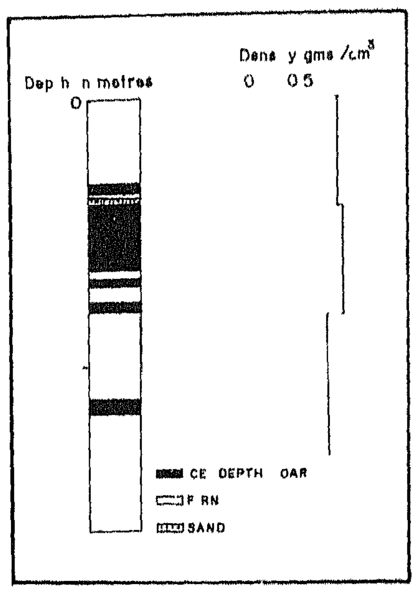
Ice density determined at various depths in for dull sitt s

Dnll S te	Mın mum Dens ty	Mıxın u n Dens ty	Ave ˌe De ty	Re k
1	0 44	0 90	0 (8	[illegible]
2	0 41	0 63	0 48	
3		—	0 51	
4	0 51	0 85	0 (7	[illegible]
5	0 75	0 85	0 81	[illegible]

(De ty [illegible])



Fg 5 Strat graphic and density profle of Antarct c ce atDr1 1Ste4



Ig 6 Strat grar phic nd density profile of Antartt c ce at Dr 11 Site 5

CONCLUSIONS

The stratigraphy and density profiling shows a marked change in physical properties of the ice from the shelf onwards to inland polar ice The higher values of density and distinct physical characters of the ice at bore hole site 4 indicate that this location is the transition /one between the inland polar ice and the shelf ice where these two types merge