Experiment on Artificial Augmentation of Ablation on the Shelf Ice, Antarctica

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ABSTRACT

The melting rate of snow /ice can be changed substantially by altering the albedo of its surface Such an experiment was carried out on the Antarctic shelf ice during the present expedition using coal dust as the medium resulting in enhanced melting of the ice

INTRODUCTION

The melting rates of snow or ice can be changed substantially by altering the albedo of its surface. Such an experiment was carried out by using coal dust as the medium.

THE METHOD

Two contiguous plots were demarcated near the Base camp measuring 4 m x 3 m each. Three aluminium stakes measuring 1 5 m were drilled in each plot for monitoring the melt. One plot was maintained as a control for comparison and on the other coal dust was manually spread through a 30 mesh sieve (Fig 1). The spray was made uniform as far as possible giving norm of spread as 2 kg/m^2 (approximately). The thickness of the dust was about 2 mm The prevailing wind disturbs the process of spreading and it is a difficult job to maintain the uniformity in the spray. In the present case caution was taken and temporary barriers were maintained during the actual spray operation.

ABLATION

The experiment was started on 9. 1. 83 and the stakes were observed every 24 hours till 12.1.83 The final observation of the plot was done on 16 .1. 83. The stakes were observed simultaneously in both the plots Melting, as observed, is given in Table I.

The total average melt in the coal sprayed plot was 39 cm as against 3 cm in the control plot, for about a week, giving thereby a melt of 5.60 cm and 0 .43 cm per day for the respective plots. The density of the shelf ice in the top section of a few centimetres has been worked out on an average to be 0.50 gm/cm^3.The total water yield from the experimental plot and control plot during the period from 9.1.83 to 16.1.83 is of the order of 19.5 and 1.5 cm, respectively. The augmentation of the melt by artificially changing the albedo of the ice surface by coal dust is therefore thirteen times.

CHANGE IN MICRO-RELIEF

Interesting changes were observed in the surface micro relief of the coal dust sprayed plot. The weathering crust, which is so conspicuously developed on Antarctic shelf ice, was initially horizontal, was seen to have developed into sloping, small, ridges within a day.

The crests of the ridges were elongated along the 12^0 direction, the length varying from 5 to 38 cm. These ridges subsequently became prominent, attaining an average height of 7 cm in this

Fig 1 Photograph showing coal dust spray on the experimental plot

small experimental plot. The ridges did not retain coal dust as on the previous day, which had fallen down due to wind or melting. After three days, these small ridges disappeared Clots of coal dust were seen interstitial in the ice crystals. The blackness of the surface had also diluted and attained a lighter hue. On the fifth day of observation one stake had fallen down in the coal dust plot and otners in both plots tilted. On the seventh day a conspicuous rectangular pit with a black bottom, and vertical sides about 40 cm deep developed, which stood in contrast to the white exposure of the control plot retaining more or less its original elevation (Fig 2).

TABLE I

Observations on melting of two plots (Stake reading in cm)

	Experimental Plot									Control Plot								
Stake No	9 1 83	10 1 83	Melt	11 1 83	Melt	12 1 83	Melt	16 1 83	Total Melt	9 1 83	10 1 83	Melt	11 1 ;83	Melt	12 1 83	Melt	16 1 83	Melt	Total Melt
1	100	112	22	132	10	122	10	F*	42	72	76	4	75 5	15	76	05	78	2	8
2	94	112	18	120	8	130	10	F*	36	60	62 5	2 5	61	15	63	2	62	1	7
3	84	104	20	112	8	123	11	F*	39	80	82	2	83 5	15	85	15	86	1	6
Average									39										7

F* Fallen stake

Fig 2 Photograph showing d mun on of surface of coal dust sprayed plot n contrast o the concept

THE THICKNESS OF SPRAY

Though the change in the reflectivity of ice surface significantly alters the melting pattern of the surface as seen in the present case the thickness of the sprayed cover also has a bearing on it There is always an optimum thickness of this cover beyond which insulation is affected and melting retarded. In the present case a thickness of 2 mm was retained which augmented the melt Simultaneously three separate spots were spread with 1 cm 2 cm and 3 cm thickness of the same coal dust in the same manner. This cover acted as insulator and resulted in the formation of tables covered with coal dust. But on their leeward side because of wind action coal dust got drifted which augmented the melt of the surface and resulted in bowl shaped depression.

CONCLUSIONS

Spraying of coal dust on the Antarctic ice shelf resulted in a dramatic augmentation in ablation. The extent of melting was observed to be many times more than recorded on the Himalayan ice. The phenomenon accompanying the melting are strikingly different. While in the Himalayan ice there is profuse development of rills of melt water which wash down a part of the spray in case of Antarctica the melt water released percolated into the ice pack. The changes in the micro relief in the former case is also controlled by these flowing rills. In the Antarctic shelf ice the agent which plays vital role in the conditioning of the micro relief is the wind.