

Monitoring of icebergs in Antarctic waters during the sixteenth Indian Antarctic expedition

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Abstract

Iceberg monitoring in the Antarctic waters during onward and return voyage of XVI Indian Antarctic Expedition has revealed concentration of icebergs in two well defined zones separated by an iceberg free zone. Distribution pattern and the analyses of size, shape parameters of these icebergs have shown that the majority of large size (>500 m) tabular icebergs are concentrated in the area close to the Antarctic shelf line whereas the pinnacled and or disintegrating icebergs (of <500 m class) are most frequently away from the shelf line and show relative abundance between south Latitude 53° and south Latitude 62°. The number of icebergs recorded in the return voyage is much more than those recorded during the onward voyage.

Introduction

The waters encircling the Antarctic continent are replete with icebergs which are a characteristic feature of the southern ocean. These are formed by calving of ice blocks from ice shelves or glacier tongues floating into Antarctic waters. The icebergs are carried away from the place of their origin by the prevailing currents. Monitoring of icebergs has been a part of the programme of Geological Survey of India (GSI) in Antarctica since the Second Indian Expedition when Kaul et. al. (1985) carried out core drilling and density profiling in an iceberg.

The iceberg monitoring was carried out as per the guidelines of Norsk Polar Institute (Norwegian Polar Research Institute). The study included recording the location, dimensions and morphological characteristics of the icebergs encountered during the cruise. The first iceberg was sighted on 30th December 1996 at south Latitude 53° 28' and east Longitude 31° 53'. The ship reached Polynya on 3rd January 1997 and a total of 155 icebergs were recorded. On 9th March 1997, the ship sailed off from India Bay, Antarctica (S Latitude 69° 56' and E Longitude 11°54') for the return voyage. A total of 298 icebergs were recorded during the return voyage. The last iceberg was sighted at 59° 24' S Latitude and 26 ° 26'E Longitude on 12th March 1997. (Table-1)

Distribution pattern

The distribution of icebergs in Antarctic waters assumes significance from the

point of view of navigation. Icebergs were monitored along the course of the ship upto a radius of 24 nautical miles with the help of the radar.

A total of 155 icebergs were observed between 30th Dec. 1996 and 4th January 1997. Out of these, 133 icebergs were visually sighted while 22 icebergs could be picked up only on ship radar due to poor visibility. A majority of the icebergs were found to fall within a narrow zone bounded by S Latitude 68° 40' and S Lat. 60°55'. Between S Lat. 53°28' and S lat. 56°57" there is a conspicuous absence of icebergs.

During the return voyage, a majority of the icebergs were found to fall within a narrow zone bounded by S latitude 68° 40' and S lat. 69° 48'. Another zone of concentration of icebergs was noticed between S lat 59° 0' - S lat. 60°55' Between S lat. 53°28' and S lat. 56°57" there is a conspicuous absence of icebergs

During the return voyage, a majority of the icebergs were found to all within a narrow zone bounded by S latitude 69°22' - S latitude 69° 47'. Between S lat. 63°44' to S lat 66°0', there is a conspicuous absence of icebergs. It is interesting to note that during the 2nd Indian Antarctic Expedition (1982-83) Kaul et. al. (1985) recorded the first appearance of iceberg at S Lat. 59° while in the 16th Indina expedition to Antarctica (1996-97), the first iceberg was recorded at S lat. 53°28' It is observed that there is a systematic northward shift in the iceberg zones, except a departure during the year 1990 (Table 1).

The concentration pattern can be attributed to the ocean currents. In the concentration zone of high latitudes, Antarctic Coastal Current carried the iceberg in an anticlockwise direction while in the concentration zone of lower latitudes, the Southern Ocean Current moves the icebergs in a clockwise direction (Fig. 1).

Shape

The icebergs encountered during the cruise were seen to exhibit different shapes and forms. The shape depends upon the distance travelled and the degree of disintegration caused by wind and wave action. The icebergs can be broadly classified under two types tabular and weathered. The tabular type (Fig 2) are rectangular in shape, flat topped and show characteristic horizontal banding. They are white in colour and show a typical lustre due to their relatively large content of entrapped air (kaul et. al. 1985). These are dominant near the shelf and also show development of caves.

The weathered icebergs are more irregular in shape and are in various stages of disintegration. Pinnacled icebergs are those with broader base and narrow conical top. A few stranded icebergs were also noticed in the pack ice and are more or less immobilised because of restricted movement. Such icebergs were noticed closer to the Antarctic shelf. Wave action and wind action causes unequal weathering and disturbs the equilibrium of the iceberg and results in its tilting and

overturning. It was observed during the onward journey that over 60% of the icebergs were weathered or partly weathered.

Size

The icebergs vary in size from a few meters to a few kms. The height of the icebergs above the water line is generally 15 m to 30m. The reduction in size is mainly due to the processes of melting and mechanical weathering. The icebergs were divided into five classes on the basis of their largest dimension

CLASS LARGEST DIMENSION

I	10m-50m
II	50m-200m
III	200M-500M
IV	500m- 1000m
V	> 1000m

During onward voyage, icebergs of Class I were found to be localised mainly in the first zone of iceberg with a few sporadically scattered in the 2nd zone of iceberg. This can be attributed to the gradual disintegration of icebergs away from their provenance in the shelf ice area of Antarctic Coast. These constitute 5.8% of the total number of ice bergs sighted. The class II type were more frequent between S Lat. 59° and S Lat. 61° and between S Lat. 64° to S Lat. 67° and constitute about 48.3% of the total icebergs sighted. The icebergs of the class III type were seen between S Lat. 57° and S Lat. 59° and between S Lat. 60° and S Lat. 60° and S Lat. Class III type were seen between S Lat. 57° and S Lat. 59° and between S Lat. 60° and S Lat. 63°. These constitute near the Antarctic Shelf ice. These constituted 25.8% of the total number of icebergs.

It is significant to mention that there was a marked increase in the number of icebergs recorded during the return voyage. Class I type constitutes 1.3%, class II 88.75%, Class III 9.95% and a cluster of 67 icebergs (Class III & IV) near the Antarctic shelf ice.

Global warming may be a factor for the breaking away/collapse of the Antarctic ice shelves which account for the increase in frequency of the icebergs. Recent report in the media on catastrophic collapse of Antarctic ice shelves that fringe the northern edges of the Antarctic Peninsula, the Minor Wordie ice shelf on the Western coast of the Antarctic Peninsula and the Larsen ice shelf on the eastern coast of the peninsula has evoked concern. According to Christopher Doake of the British Antarctic Survey, each ice shelf rather than being a passive homogeneous structure has its own pattern of strain which it distributes across the surface to maintain its own stability and an ice shelf can best be compared to a medieval stone arch lying on its side. The structure remains stable unless and until the keystone at the apex of the arch is removed. The keystone may take centuries to erode, but once past a critical point, the whole arch collapses rather quickly. In the same way, once a sequence of fracturing and iceberg calving

breaches the compressive arch of strain that hold the ice shelf together, nothing can stop it breaking tip with astonishing speed.

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TABLE -1 : First and last sighting of icebergs and their location during various expeditions

Expedition	Departure Goa	First sighting onward voyage	Location	Last sighting return voyage	Location
I	6.12.81	-	58° 50'	-	57° 32'
II	1.12.82	-	59°	-	-
III	3.12.83	23.12.83	55° S	-	-
IV	4.12.84	-	-	-	-
V	30.11.85	16.12.85	-	-	-
VI	26.11.86	15.12.86	55°41'	-	56° 15-
VII	25.11.87	13.12.87	55° 42''	-	-
VIII	29.11.88	16.12.88	52° 29'	-	55° 15'
IX	30.11.89	17,12.89	51°23'	-	55°30'
X	27.11.90	17.12.90	60° 19'	4.3.91	64° 42'
XI	27.11.91	15.12.91	51° 12'	.	-
XII	5.12.92	20.12.92	50° 19'	-	47° 3'
XIII	8.12.93	25.12.93	47° 22'	20.3.94	53°24'
XIV	7.12.94	7.1.95	57° 44'	10.3.95	56° 56'
XV	7.12.95	27.12.95	53° 45'	2.3.96	53° 16'
XVI	12.12.96	30.12.96	53° 28'	12.3.97	59° 24'

-Data Not Available

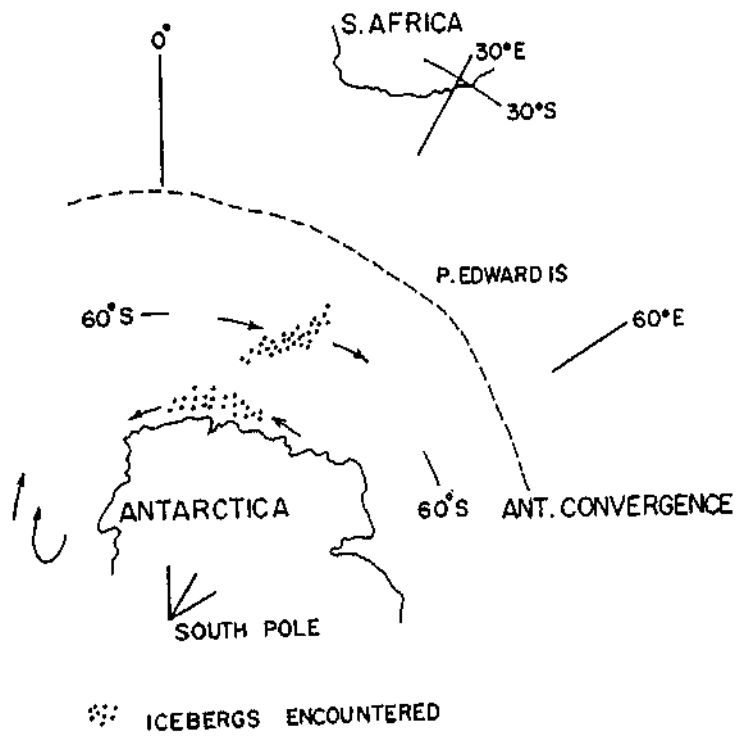


Fig. 1 Concentration of icebergs in Antarctic waters observed during sixteenth expedition to Antarctica 1996-97

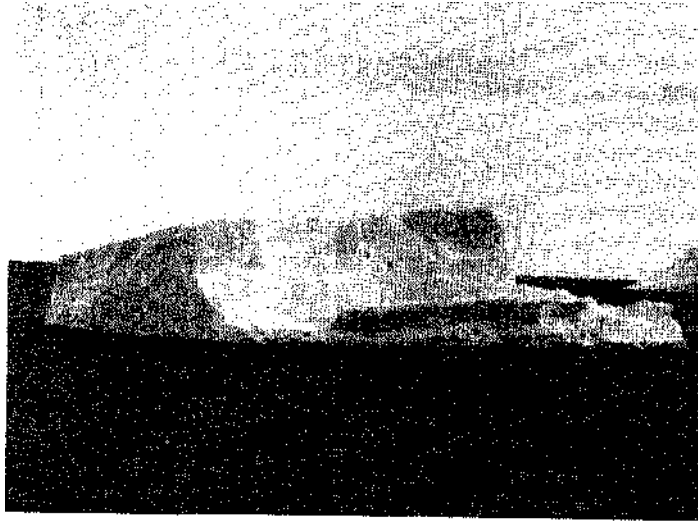


Fig 2. Tabular Iceberg