

## Monitoring of Ice Bergs in Antarctic Waters During the Twentieth Indian Antarctica Expedition

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### Abstract

Iceberg monitoring in the Antarctic Waters during onward and return voyage of XX Indian Antarctica 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 large size (> 500 m) tabular icebergs are concentrated in the area close to the Antarctic shelf line where as the pinnacled and or disintegrating icebergs (of < 500 M class) are mostly concentrated in the area away from the shelf. The concentration pattern of the Antarctic icebergs can be attributed to the ocean currents in the Southern Ocean.

### 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 tongue 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 programme of Geological Survey of India (GSI), since V LAE (1985). The iceberg monitoring has been carried out under the International Iceberg Monitoring Programme as per guidelines formulated by Norsk Polar Institute (Norwegian Polar Research Institute). The study included recording the location, dimensions and morphological Characteristics of the Iceberg encountered during the cruise. The first Iceberg was sighted **on 4<sup>th</sup> January 2001** at South latitude 50° 48.9' and East longitude 12° 51.7'. **The ship reached Polynya on 12<sup>th</sup> January 2001** and a total of **376** Icebergs were recorded. On 8<sup>th</sup> March 2001, the ship sailed off from India Bay, Antarctica (S latitude 69° 56' and E longitude 11° 54') for the return voyage. A total of 402 icebergs were recorded during the return voyage. The last Iceberg was sighted at South latitude 49° 39.8' and East longitude 16° 9.1'.

### 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 376 icebergs were observed between 4<sup>th</sup> January and 12<sup>th</sup> January 2001. Out of these, 311 icebergs were visually sighted while 65 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° to 69° 44'. Between S latitude 53° 20' and 55° 45' 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° 22' and S latitude 69° 30'. Between S latitude 63° 16' and S latitude 64°, there is a conspicuous absence of icebergs. It is interesting to note that during the 2<sup>nd</sup> Indian Antarctica Expedition (1982-83) Kaul et. al. (1985) recorded the first appearance of iceberg at S latitude 59° while in the 20<sup>th</sup> Indian Antarctica Expedition (2000-2001), the first iceberg was recorded at S latitude 50° 48'. It is observed that there is a systematic northward shift in the iceberg zones, except a departure during the year 1990 (Table 1).

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

Expedition	Departure from 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°	-	-
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'

(Contd.)

Table 1: First and last sighting of icebergs and their location during various expeditions (*Contd.*)

Expedition	Departure from Goa	First sighting onward voyage	Location	Last sighting return voyage	Location
XIII	8.12.93	25.12.93	47° 22'	20.3.94	53° 24'
XIV	17.12.94	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'
XVII	-	-	-	-	-
XVIII	14.12.98	5.1.99	53° 51.06'	-	-
XIX	-	-	-	-	-
XX	31.12.02 (from Cape Town)	4.1.01	50° 48.9'	14.3.01	49° 39.8'

- Data Not Available

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

### 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. 1) are rectangular in shape, flat topped and show characteristic horizontal bending (Fig. 2). They are white in colour and show a typical luster 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 (Fig. 4). Pinnacled icebergs are those with broader base and narrow conical top. A few grounded icebergs (Fig. 3) were noticed near the ice shelf, which are more or less immobilized because of restricted movement. Wave action and wind action causes unequal weathering and disturbs the equilibrium of the icebergs and results in its tilting and overturning. During the 20th IAE journey it was observed that 30% of the icebergs were weathered or partly weathered.



*Fig. 1: An aerial view of DG glacier protruding tongue in Schirmacher Oasis, CDML, East Antarctica.*



*Fig. 2*



*Fig. 3*



*Fig. 4*

## 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 30 m. 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 I-10 m to 50 m, Class II-50 m to 200 m, Class III-200 m to 500 m, Class IV-500 m to 1000 m and Class V > 1000 m. During on ward voyage, icebergs of class I constitute 11.7% of the total number of icebergs sighted and found to be localised mainly in to first zone of iceberg. This is attributed to the gradual disintegration of icebergs away from their provenance in the iceshelf area of Antarctic coast. The class II type were more frequent between S lat 59° to S Lat. 61° and between S lat. 65° and S lat. 68° and constitute about 24% of the total icebergs sighted. The icebergs of the class III type were seen between S Lat. 58° and lat. 60° and between S Lat. 62° and S Lat. 65° and constitute 28% of the total icebergs sighted. The icebergs of the class IV and class V type are seen mainly near the Antarctic Shelf and constitute 18% respectively of the total number of icebergs.

During the return voyage an increase in the number of icebergs was recorded. Class I type constitutes 7.2%, class II-31%, Class III-16.4 % and a cluster of 182 icebergs (class IV & V) constituting 45% of the total icebergs recorded near the Antarctic Shelf ice.

The icebergs generally do not survive at latitudes lower than the northern limit of Antarctic Sea ice, near 48° S. in recent Indian Expeditions, a marked increase in the number of icebergs has been recorded. Global warming may be a factor for the breaking away/collapse of Antarctic ice shelves which account for the increase in frequency of the icebergs.

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## References

- Jayapaul, D, Chaturvedi, A and Kaul , M.K. (2001). A study of Antarctic icebergs and their role as indicators of global environmental change. Geological Survey of India Spl. Pub. 53, 2001, PP 409-412.

Kaul, M.K., Chakraborty, S.K and Raina, V.K. (1985). Iceberg studies in Antarctic waters. Tech Pub. No. 2 DOD, New Delhi, PP 87-90.

Ravindra, R, Shrivastava, V.K., Sharma, B.L., Dey, A and Bedi, A.K. (1994). Monitoring of icebergs in Antarctic waters and a note on the secular movement of Dakshin Gangotri Glacier. Tech Pub. No. 6, DOD, New Delhi, PP 239-249.

Jayapaul, D, Chaturvedi, A, Ravikant V and Asthana, R. (2000). Monitoring of ice bergs in Antarctic Water during the sixteenth Indian Antarctic Expedition. Tech Pub. No. 1 +, DOD, New Delhi, PP 247-252.