

## **Monitoring of Icebergs in Antarctic Waters During the 24<sup>th</sup> Indian Antarctica Expedition**

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### **ABSTRACT**

During Indian Antarctic Expeditions, monitoring of iceberg is an important programme of GSI since very beginning. These icebergs originate from the ice shelf, formed during the last glacial maxima. Iceberg monitoring in the Antarctic Waters during onward voyage of XXIV 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 of large size (> 500m) tabular icebergs are concentrated in the area close to the Antarctic shelf line whereas the non tabular such as pinnacled, domed, wedge shaped and other types 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. During 1<sup>st</sup> Indian Antarctic Expedition the earliest encountered iceberg was at 58°50'S latitude while in the 24<sup>th</sup> Indian Antarctic Expedition, the first iceberg could be sighted as early as at 49° 11.7'S lat.

### **INTRODUCTION**

The Antarctic water and southern ocean encircling Antarctica are marked by the presence of varieties of icebergs with characteristic features. These are formed by calving of ice blocks from ice shelves or glacier tongue floating into Antarctic Waters. In the route of Indian Antarctic Expedition, the icebergs are mainly formed from the ice shelf. The icebergs are carried away from the place of their origin by the prevailing ocean currents of southern ocean. Monitoring of icebergs has been a continuous programme of Geological Survey of India (GSI), since very beginning. 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 Icebergs encountered during the cruise. The first Iceberg was sighted on 22<sup>nd</sup> December 2004 at 49° 11.7'S latitude and 24°12.2' E longitude. The ship reached Polynya on 29<sup>th</sup> December 2004.

### OBSERVATIONS

The distribution pattern of icebergs in Antarctic Waters has great significance from the point of view of navigation. These icebergs are a store house of millions of tones of fresh water. Icebergs were monitored visually along the course of the ship and with the help of radar in a radius of 24 nautical miles.

It is interesting to note that during the 1<sup>st</sup> Indian Antarctic Expedition the first encountered iceberg was at 58°50'S latitude while in the 24<sup>th</sup> Indian Antarctic Expedition, the first iceberg could be sighted as early as at 49° 11.7'S lat. It is observed that there is a systematic northward shift in the iceberg zones (**Table 1, Fig. 1**). It has also been observed that there is a regular shift of icebergs position in East to north-east direction between 50°S to 54°S latitudes (**Fig. 2**). This shift in positions of icebergs can be related with the Sub-Antarctic front (SAF) and Antarctic Circumpolar Current (ACC) which flow in the clockwise direction.

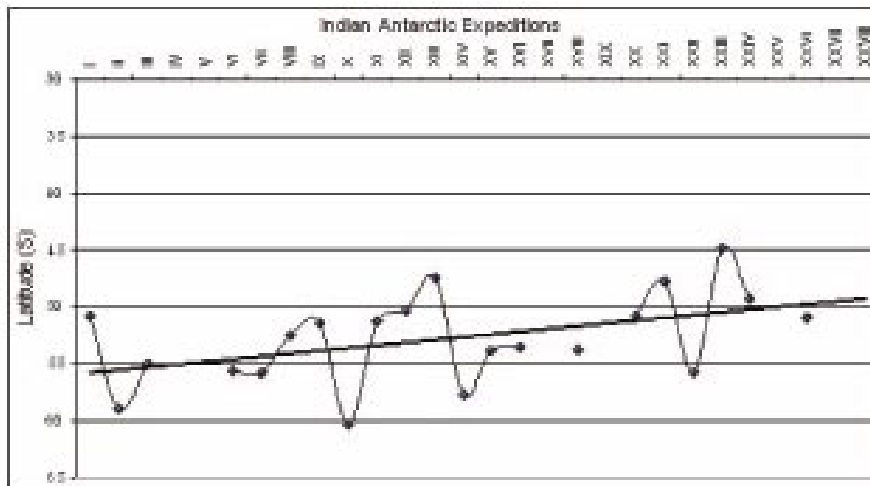


Fig. 1: First sighted iceberg during Indian Antarctic Expeditions

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

Expedition	First sighting onward voyage	Location	Last sighting in return voyage	Location
I	-	58° 50'	-	57° 32'
II	-	59°	-	-
III	23.12.83	55°	-	-
IV	-	-	-	-
V	16.12.85	-	-	-
VI	15.12.86	55°41'	-	56°15'
VII	13.12.87	55°42'	-	-
VIII	16.12.88	52°29'	-	55°15'
IX	17.12.89	51°23'	-	55°30'
X	17.12.90	60°19'	4.3.91	64°42'
XI	15.12.91	51°12'	-	-
XII	20.12.92	50°19'	-	47° 3'
XIII	25.12.93	47° 22'	20.3.94	53° 24'
XIV	7.1.95	57° 44'	10.3.95	56° 56'
XV	27.12.95	53° 45'	2.3.96	53° 16'
XVI	30.12.96	53° 28'	12.3.97	59° 24'
XVII	-	-	-	-
XVIII	5.1.99	53° 51.06'	-	-
XIX	-	-	-	-
XX	4.1.01	50° 48.9'	14.3.01	49° 39.8'
XXI	11.01.02	47°47.8'S & 16°21.95'E	22.03.02	48°55.73' &
XXII		55°43'S & 12°38'E		53°19'S & 15°08'E
XXIII		44°47'S & 17°51'E		
XXIV		49°11.7' S & 24°12.2' E		

- Data Not Available

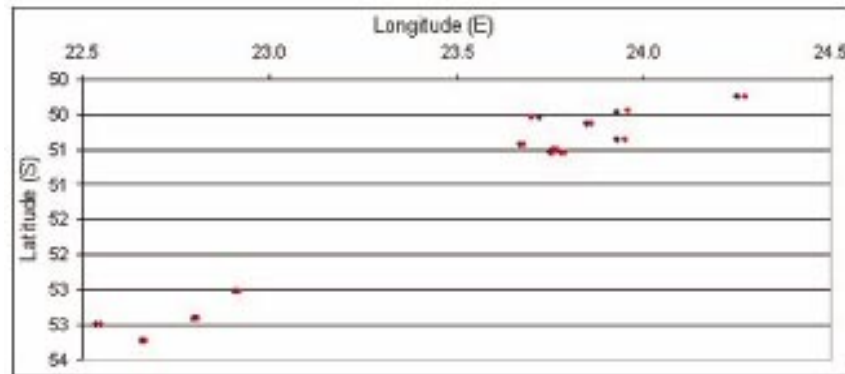


Fig. 2: North / North-east shift of icebergs

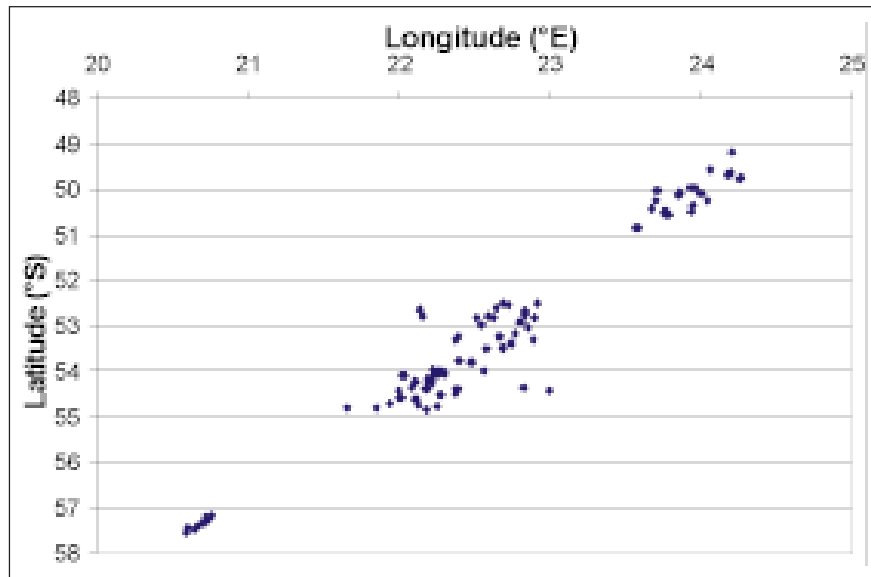


Fig. 3 : Position of icebergs during onward journey to Antarctica

The concentration pattern (**Fig. 3**) can be attributed to the ocean currents. There are two distinct concentration zones of icebergs separated by an intervening zone of no icebergs. The concentration zones at high latitudes are affected by Antarctic coasted current which carries icebergs in an anticlockwise direction while in the concentration zone of lower latitudes, the Southern Ocean Current moves the icebergs in a clockwise direction after Weddell sea gyre (Klinck and Nowlin, 1986; Klinck and Nowland, 2001).

### **Shape of the Icebergs**

The icebergs observed during the journey were seen to exhibit different shapes and forms (Jayapaul et al., 2000 and Jayapaul et al., 2001). They are like finger prints and no two icebergs are similar to each other. The different shapes of these icebergs depend largely upon the distance traveled 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 is rectangular in shape, flat topped and show characteristic horizontal bending. They are white in colour and show a typical luster due to their relatively large content of entrapped air (Kaul et al., 1985). This type of icebergs is common near the ice shelf and also shows development of caves. The weathered icebergs are more irregular in shape according to various stages of disintegration, such as non tabular, wedge, blocky, domed and pinnacled (with increasing weathering effects). Pinnacled icebergs are those with broader base and narrow conical top. A few grounded icebergs were observed near the ice shelf. Wave action and wind action causes unequal weathering and disturbs the equilibrium of the icebergs and results in its tilting and overturning (Ravindra et al., 1994). During the onward journey it was observed that more than 80% of the icebergs were weathered or partly weathered.

### **Size of Icebergs**

The icebergs show wide range of sizes and vary from a few meters to a few kms. The height of the icebergs above the water line is generally 10m to 30m. The reduction in size is mainly due to the processes of melting and wave and current action. On the basis of size, the icebergs were divided into five classes by taking their largest dimension;

Class I - 10m to 50m,

Class II - 50m to 200m,

Class III - 200 m to 500m,

Class IV - 500m to 1000m,

Class V > 1000m.

During on ward voyage, icebergs of class I constitute about 15% of the total number of icebergs sighted and found to be localized mainly in the northern latitudes. This is attributed to the rigorous disintegration of icebergs away from their place of origin, in the ice shelf area of Antarctic

coast. The class - II type was more frequent between 55° to 60° S latitudes and between 65° and 69° S latitudes. This class constitutes about 25% of the total icebergs sighted. The icebergs of the class III type were seen between 55° to 61° S latitudes and between 62° and 66° S latitudes. This class constitutes 30% of the total icebergs sighted. The icebergs of the class IV and class V type are seen mainly near the Antarctic ice shelf and constitute 20 and 10 % respectively of the total number of icebergs.

### CONCLUSION

Large variations have been observed in the size and shape of the icebergs. The tabular icebergs are mainly concentrated in the ice shelf area of Antarctica. There is gradual increase of disintegration and weathering of icebergs towards the northern latitudes. The distribution pattern of icebergs responds to the dynamics of southern ocean currents. There is a general northward shift of first sighted icebergs since 1982. Two distinct zones of icebergs have been observed, which is separated by a zone of no iceberg. There is a continuous shift of icebergs position in north-east direction between 50°S to 54°S latitudes. This can be related with the Sub-Antarctic front (SAF) and Antarctic Circumpolar Current (ACC).

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