

# Glaciological Observations during the 22nd Indian Antarctic Expedition

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## **OBJECTIVES**

A five-member summer team was sent by GSI in the 22<sup>nd</sup> Indian Antarctic Expedition. The overall tasks were divided into four broad categories: Geological, Glaciological, Geomorphological and Ice Core Drilling (Ice core drilling is described separately). The assignments in the field of glaciology were as follows:

1. Observing fluctuations of polar ice margin.
2. Accumulation studies on the ice shelf.
3. Iceberg monitoring during voyage.

## **FLUCTUATIONS OF POLAR ICE MARGIN**

The snout of Dakshin Gangotri Glacier in Schirmacher Range is being observed for the past two decades. It is persistently displaying a recession. From 1983 to 1995, the rate of retreat was observed as 7 m per decade. For a more precise quantification of this data, 19 peripheral points were marked around the snout in February 1996. This was the seventh year in succession to monitor these points. The observations are given in Table 1.

Taking the positions of year-1996 as the baseline, the observations for 2002 and 2003 are plotted in Fig. 1. It is obvious from the above plots that the snout is retreating strikingly at all the observation-points. Within these 7 years, the snout has retreated by 11.82 m at PoinM4, 10.28 m at Point-15, 8.52 m at Point-9 and 7.69 m at Point-2. The overall average rate of retreat is 4.76 m in 7 years, which translates into a projected rate of 6.80 m per decade. This validates the earlier observations of the recession (1983 to 1995) at a rate of about 7 m per decade. However, by comparing the position of year-2003 to that of year-2002, the overall average recession within a year is observed to be 1.21 m, which is much higher than the average of

Table 1

Field Obs. No.	Obs Pt No.	Latitude (South)		Longitude (East)		Feb 1996 Origin- posi- tions	Position inFeb- 2002	Position in Feb- 2003	Overall Recess ion writ 1996		Yearly Recess- ion wrt 2002
1	1	70	45.566	11	34.614	200	322	391	-122	-191	-69
2	2	70	45.548	11	34.626	450	1125	1219	-675	-769	-94
3	3	70	45.534	11	34.640	100	310	370	-210	-270	-60
4	4	70	45.526	11	34.653	200	435	466	-235	-266	-31
4-A	5	70	45.513	11	34.670	200	390	427	-190	-227	-37
4-B	6	70	45.514	11	34.674	250	405	443	-155	-193	-38
5	7	70	45.505	11	34.681	700	853	856	-153	-156	-3
5-A	8	70	45.510	11	34.628	110	230	309	-120	-199	-79
5-B	9	70	45.504	11	34.695	110	345	408	-235	-298	-63
6	10	70	45.490	11	34.113	150	410	506	-260	-356	-96
7	11	70	45.480	11	34.712	150	600	814	-450	-664	-214
8	12	70	45.469	11	34.687	500	796	871	-296	-371	-75
9	13	70	45.429	11	34.646	200	835	1052	-635	-852	-217
10	14	70	45.427	11	34.573	400	659	832	-259	-432	-173
11	15	70	45.434	11	34.507	200	483	546	-283	-346	-63
12	16	70	45.422	11	34.445	350	799	894	-449	-544	-95
13	17	70	45.428	11	34.374	100	585	799	-485	-699	-214
14	18	70	45.412	11	34.356	150	1000	1332	-850	-1182	-332
15	19	70	45.406	11	34.289	650	1338	1678	-688	-1028	-340

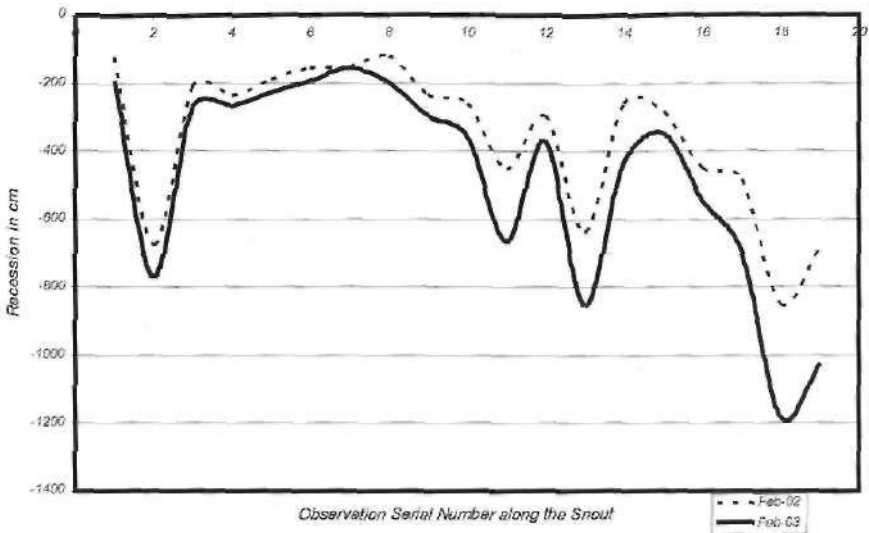


Fig. 1: Recession of DG glacier in 2002-03 wrt 1996

Observation Serial Number along the Snout      ^^ Feb-03

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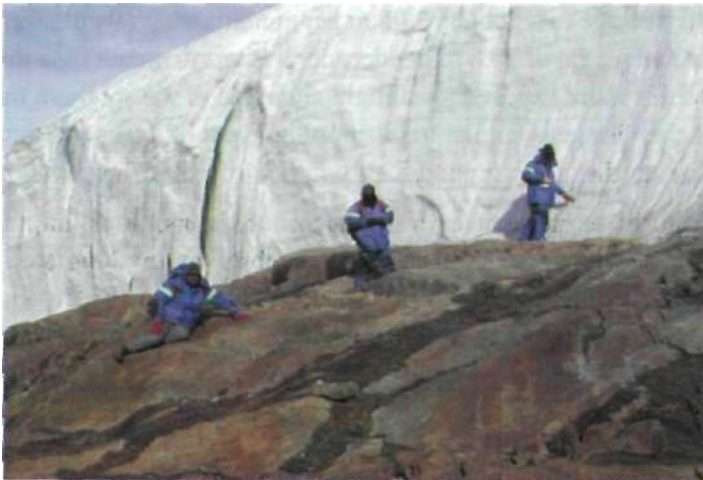
0.70 m per annum rate. Thus, the recession appears to be gaining acceleration as compared to earlier decades. Further, there is a clear divide between the western wall of the snout (represented by Points 1 to 8) and the northern wall (represented by Points 9 to 15). If only the northern wall is taken into account, the average recession is 2.05 m per annum; which would translate into a projected retreat of 20.5 m per decade. It is worth mentioning that the northern wall is more exposed to sunlight and most of the southern margin of Schirmacher Range is similar to this northern wall of the snout; thus it is more representative of the ground reality in Schirmacher Range.

To confirm the inferences from the snout observations, an attempt was made in the year 2001 to extend the area of observation along the southern ice margin of Schirmacher Range. This was done by marking 18 more peripheral points, along continental ice-Schirmacher Range interface, starting from the westernmost part of Schirmacher Range up to the snout of Dakshin Gangotri glacier, covering a distance of 9 line-km. These points were observed two years later, during the current season of year 2003. It was found that only 10 out of 18 original points have survived, the rest having been buried either by falling icy escarpments or covered up by wind-deposited snow-ramps. The data from these 10 points are presented in Table 2.

**Table 2—Recession of Polar Ice Front along the Southern Edge of Schirmacher Range**

Points	Latitude (S)	Longitude (E)	28-Feb-01 in m	7-Feb-03 in m	Retreat in m
XX6	70 44.874	11 28.562	2.67	7.78	-5.11
XX7	70 44.932	11 28.905	2.53	5.24	-2.71
XX8	70 45.225	11 31.120	2.50	6.52	-4.02
XX10	70 45.300	11 31.614	3.30	8.91	-5.61
XX11	70 45.417	11 33.135	1.84	5.27	-3.43
XX12	70 45.428	11 33.289	1.08	2.78	-1.70
XX13	70 45.407	11 33.478	1.58	2.96	-1.38
XX14	70 45.403	11 33.619	1.02	2.66	-1.64
XX15	70 45.424	11 33.733	4.06	4.42	-0.36
XX17	70 45.631	11 34.739	<b>0.94</b>	<b>1.54</b>	-0.60

The above observations confirm that the polar ice margin is retreating not only at the snout of Dakshin Gangotri Glacier, but all along the Schirmacher Range. The maximum recession within two years is 5.61 m (**Photo-1**). The



*Photo-1: Recession of Polar Ice Front along the Southern edge of [Schirmacher Range within two years. The person on left shows the observation marker, the person in the middle shows the position of the Ice Front in 2001 and the person on right shows the position of the Ice Front in 2003*

overall average rate of retreat is 2.66 meters in two years; i.e. a projected rate of 13.3 m per decade. The snout recession rate for the last one year is 1.21 m, i.e. a projected recession rate of 12.1 m per decade. Thus, the recession of DG Glacier snout is in conformity with the recession of the continental ice front all along the southern edge of Schirmacher Range.

### **ACCUMULATION STUDIES ON THE ICE SHELF**

GSI had laid a network of 16 stakes on the shelf and these were being monitored since 1985 on yearly basis. This network was about 2 km away from the area of activities near old Dakshin Gangotri station on the ice shelf. While vacating the berthing site at India Bay during the wintering period, the logistics team of the previous expedition, mistakenly parked all fuel tankers and trailers inside the area covered by the network of stakes. The obstructions caused by these movable objects, resulted in huge accumulation of snow inside the network area and this observation-area, so carefully preserved during the last 16 years, was lost to scientific studies.

A new network of stakes (**Photo-2**) was required and it was installed



*Photo-2: Installation of a new Network of Stakes on the Ice Shelf*

by the GSI team in this expedition. A total of 16 stakes have been put covering an area of 560 m x 560 m. For the first time, precise GPS readings of all the stakes have also been recorded. This would help not only in accumulation/ablation studies but also in finding out the direction and velocity of movement of these stakes. The initial readings of the stakes, as in January 2003, are given in Table-3; the annual data for comparison would be generated from next year.

**Table 3 - Location and position of a new stakes Network on Ice Shelf installed in 2003**

Stake Number	Latitude (South)			Longitude (East)			29-Jan-03 exposed cm
	degrees	minutes	seconds	degrees	minutes	seconds	
1	70	04	34.6	12	01	27.0	302
2	70	04	34.9	12	01	49.5	304
3	70	04	35.1	12	02	09.0	291
4	70	0*	30.2	12	02	10.3	340
5	70	04	24.8	12	02	11.8	306
6	70	04	24.1	12	01	51.3	296
7	70	04	23.6	12	01	32.4	306
8	70	04	28.7	12	01	29.1	293
9	70	04	29.5	12	01	48.8	287
10	70	04	18.9	12	01	34.5	306
11	70	04	18.0	12	01	52.1	309
12	70	04	17.1	12	02	13.7	317
13	70	04	16.1	12	02	30.1	297
14	70	04	25.5	12	02	30.9	310
15	70	04	30.2	12	02	31.1	310
16	70	04	35.4	12	02	31.6	303

## **ICEBERG MONITORING DURING VOYAGE**

The recording of icebergs in the Southern Ocean was hampered this year. During the onward voyage, the weather was foggy all through the cold waters. During the daytime, the visibility was poor and at night, it was obviously nil. The navigation crew did not permit any expedition member to handle the radar of the ship. Regarding the monitoring of the icebergs, it was told that the crew was recording the icebergs and the members could note it down later. This was the only option available and it was followed.

The first iceberg was sighted at 55° 43' South latitude and 12° 38' East longitude. A total of 131 icebergs were recorded by the ship crew till the Antarctic coast. Poor visibility did not permit the classification of these bergs into different shapes and sizes.

During the return voyage, there was a lot of uncertainty regarding the date of sailing back. The Captain of the ship shifted the vessel 200 km away from the coast apprehending treacherous conditions of pack ice. Standing at this location, interactions took place between the ship-Captain and the Department of Ocean Development. Finally, the permission to sail back towards Cape Town was granted by the DOD at this point, much beyond the zone of pack ice. So by the time the ship started actual sailing back, it had already crossed the major zone of icebergs. The crew, thereafter, did not monitor the remaining icebergs encountered, as it was not considered necessary by them. However, a watch was kept by the GSI team for the last sighting of icebergs and the last one was recorded at 53° 19' South latitude and 15° 08' East longitude.

## **ACKNOWLEDGEMENTS**

The work was carried out under the direction of Sh R. Ravindra, the then Director of Antarctica Division, GSI and the report has been compiled under the supervision of Dr S. Mukerji, the present Director. The authors are grateful to them for the guidance. Dr A. Hanchinal, the Leader of the 22<sup>nd</sup> expedition, is thanked for his help in providing the logistics for observations.