

SCIENTIFIC REPORT
FIFTEENTH INDIAN EXPEDITION
TO ANTARCTICA

TECHNICAL PUBLICATION NO. 13



DEPARTMENT OF OCEAN DEVELOPMENT
CGO COMPLEX, LODI ROAD
NEW DELHI -110003
INDIA
1999

Prepared by :
Under the supervision of:

Arun Chaturvedi
Sh M.K. Kaul, Director
Antarctica Division,
Geological Survey of India
NH-5 P, N.I.T., Faridabad-121 001.
and
National Centre for Antarctic &
Ocean Research
Department of Ocean Development
CGO Complex, New Delhi- 110 003.

Printed at: National Institute of Science Communication, CSIR
Dr K.S. Krishnan Marg, New Delhi- 110 012.



भारत सरकार
महासागर विकास विभाग
महासागर भवन, ब्लॉक 12, सी.जी.ओ. कॉम्प्लेक्स,
लोदी रोड, नई दिल्ली-110 003

DR A E MUTHUNAYAGAM
SECRETARY

GOVERNMENT OF INDIA
DEPARTMENT OF OCEAN DEVELOPMENT
MAHASAGAR BHAVAN BLOCK 12 C G O COMPLEX
LODHI ROAD NEW DELHI 110 003

FOREWORD

Indian polar research endeavours, have come a long way since the launching of the first Indian Antarctic Expedition in 1981. The Fifteenth Expedition with the participation of 30 scientists from 21 organisations of our country established another milestone on the path of polar scientific exploration by our country. A team of 49 members, under the leadership of Shri Arun Chaturvedi, carried out varied scientific experiments in the fields of atmospheric biological, geological glaciological, environmental and engineering sciences. This team with 30 scientists has the highest ratio of the scientific component in an Indian expedition, so far.

In the period of polar summer, all the organisations successfully completed the tasks set for them. Among some highlights of the summer-work, more than 3000 sq km area in inaccessible ranges of Fenns and Holtedahl mountains was geologically mapped for the first time. 10 days of continuous geomagnetic data was collected from Orvin mountains. Maitri and Dakshin Gangotri simultaneously. Study of albedo was initiated by SASE & MM wave experiments were conducted for ozone measurements.

During the wintering the major tasks accomplished include collecting 160 meters of ice-core from polar continental ice for palaeo-climatic studies, preparation of a complete GPS-route-map for convoys between Maitri and Dakshin Gangotri and solving the difficult problem of earthing of buildings and labs during polar winter. On the logistic front four major construction projects, building a garbage-incinerator complex, a gantry with winch for the new workshop, a mobile ice-core drill shelter and the structure of a balloon launching shelter were completed.

The present report contains 37 papers on various scientific engineering and logistic tasks undertaken during this expedition. A creditable job of compilation of this report has been done at Antarctica Division of Geological Survey of India. This technical publication would contribute significantly for the promotion of polar scientific research in our country.

(A.E. Muthunayagam)



NATIONAL CENTRE FOR ANTARCTIC & OCEAN RESEARCH
DEPARTMENT OF OCEAN DEVELOPMENT
(GOVERNMENT OF INDIA)
HEADLAND SADA, VASCO-DA-GAMA, GOA - 403 804, INDIA.

Tel: 91-(0)832-512313
Fax: 91-(0)832-512322

DR. P.C. PANDEY
Director

25 August 1999.

PREFACE

The quest for truth, the pursuit of scientific knowledge and the spirit to face challenges on the stride has been the motivating force behind the multi-disciplinary and multi-institutional scientific missions from India to Antarctica. The scientific campaigns of the XV Indian Antarctic expedition which has been meticulously documented in this report by the leader of the expedition, Shri Arun Chaturvedi, adds another milestone achieved in the annals of polar science in the country.

In addition to the ongoing projects, this expedition witnessed the initiation of several cutting edge experiments on contemporary issues of ozone depletion and global change. State-of-the-art instruments like Laser Heterodyne System and millimeter Wave Spectrometer were operated on an year round basis to measure the vertical and gross profile of ozone levels over Maitri station. Experiments on net energy balance of the ice mass through studies of albedo and snow drift patterns were also initiated. The Geological Survey of India also took up the arduous task of ice-core drilling which successfully retrieved cores meant for palaeo-climatic and palaeo-environmental studies. On the logistic front, this expedition mounted a clean-up operation of Maitri and its environs and commissioned a new garbage incinerator as required by the Environment Protocol.

This technical report is an outcome of a dedicated and coordinated scientific and logistic campaign carried out by a 49 member team of the XV Antarctic expedition. I am sure that this technical publication will make valuable contribution in the field of polar science and will serve as a source of information to the entire scientific community and the polar scientists in particular.


(P.C. PANDEY)

CONTENTS

	<i>Page</i>
Foreword	iii
Preface	v
The team	xi
Addresses of participating organisations	xiii
Summary	xv
<i>Arun Chaturvedi</i>	

ATMOSPHERIC SCIENCES

Three-Station Magnetometer Experiment at Antarctica During Jan-1996 to Determine the Velocity of Disturbed-Time Overhead Auroral Current Systems	1
<i>Ajay Dhar, Arun Patil, S. Sankaran and Girija Rajaram</i>	
Study of Total Magnetic Field Intensity Variation (F) at Maitri, Antarctica Variations Over 1922-1996	21
<i>Arun Patil, Ajay Dhar, S. Sankaran, and Girija Rajaram</i>	
Meteorological Studies Carried Out during the 15 th Indian Scientific Expedition to Antarctica, 1996	39
<i>A.S. Rasal and D.R. Mahor</i>	
Design and Development of Indigenous Shipborne Acoustic Sounder for Remote Sensing of the Abl over Ocean	63
<i>H.N. Dutta, N.C. Deb, A.K. Kaushik and G.S. Dhillon</i>	
Warm Spell over Schirmacher Region of East Antarctica during February, 1996	71
<i>N C. Deb, Manoj K, Srivastava, Risal Singh, P.K. Pasricha and H.N. Dutta</i>	

BIO-SCIENCES

Abundance, Viability and Culturability of Antarctic Bacteria	79
<i>Loka Bharathi, M.J.B.D. De Souza, S. Nair and D. Chandramohan</i>	

	<i>Page</i>
Studies on Moss Inhabiting Invertebrate Fauna of Schirmacher Oasis <i>Bulganin Mitra</i>	93
Algal Colonization of Schirmacher Oasis, Antarctica <i>S.P. Shukla, R.K. Gupta and A.K. Kashyap</i>	109
Adaptability Studies of Some Medicinal Aromatic Plants in Antarctica <i>M.K. Pant and Narendra Kumar</i>	117
Solar Drying in Antarctic Environment <i>M.K. Pant, A.B. Dhaulakhandi and Narendra Kumar</i>	123
A Note on Experimental Study of Natural Radiation on the Vegetable Seeds in Antarctica <i>M.K. Pant</i>	129
Developing A Long Term Monitoring Programme for Birds and Mammals in the Indian Ocean and Antarctica <i>Yash Veer Bhatnagar and Sathyakumar</i>	131
Daily Monitoring and Aerial Census of Penguins and Seals in Antarctica <i>Yash Veer Bhatnagar and Sathyakumar</i>	163
A Note on Bird Surveys at Various Nesting Sites <i>Yash Veer Bhatnagar</i>	181
Some Observations on the Controversy of "Stray-Penguins" in Schirmacher Range Area <i>Arun Chaturvedi and Dr A.C.P. Tripathi</i>	185

EARTH SCIENCES

Geology of Parts of Orvinfjella, Central Dronning Maud Land, East Antarctica <i>K. V. Krishnamurthy, M.P. Gaur and Arun Chaturvedi</i>	193
Vlf-Em and <i>In situ</i> Conductivity Measurements in Schirmacher Range, East Antarctica <i>A. Shivaji and P. Gnaneshwar</i>	227

CONTENTS

ix

	<i>Page</i>
Snow Albedo and Energy Exchange Studies on Antarctic Ice Shelf (Dakshin Gangotri)	241
<i>Punit Vashisth</i>	
A note on Monitoring of Icebergs during Voyages of 15 th Indian Antarctic Expedition	259
<i>M.P. Gaur, K. V. Krishnamurthy, Amar Singh and Arun Chaturvedi</i>	
Annual Cycle of Permafrost Migration in Schirmacher Oasis	265
<i>Arun Chaturvedi, Amar Singh and S. Venkateswarlu</i>	
Drilling for Polar Continental Ice-Cores Between Nunataks Veteheia and Tallaksenvarden in East Antarctica	281
<i>Arun Chaturvedi, Amar Singh and M.J. Beg</i>	
Thermal Variations within a Glacier from the Surface to the Bed-Rock	303
<i>Arun Chaturvedi and Amar Singh</i>	
Trend of Depositional Patterns on Ice Shelf near Dakshin Gangotri Station	313
<i>Arun Chaturvedi, Amar Singh and M.J. Beg</i>	
A Confirmation of Polar Glacial Recession by Monitoring the Snout of Dakshin Gangotri Glacier in Schirmacher Range	321
<i>Arun Chaturvedi, Amar Singh, M.P.Gaur, K.V. Krishnamurthy and M.J.Beg</i>	

HUMAN PHYSIOLOGY AND PSYCHOLOGY

Serum Immunoglobulins during Summer Stay in Antarctica : Role of Opioids	337
<i>G.Sundaresan, Lakshmikantha A. Karani and Usha Sachdeva</i>	
Serum Immunoglobulins and Cortisol during Winter Stay in Antarctica : Effects of Naltrexone Administration	345
<i>G.Sundaresan and Usha Sachdeva</i>	
Exposure to Antarctic Summer Affects the Immunoglobulin Rhythm but not the Oral Temperature Rhythm	353
<i>G.Sundaresan, Lakshmikantha A. Karani and Usha Sachdeva</i>	

	<i>Page</i>
Alteration of Immunoglobulin and Temperature Rhythm during Winter Over Stay in Antarctica <i>G.Sundaresan and Usha Sachdeva</i>	361
Role Stress Profiles of Scientists and Defence Personnel in Fifteenth Antarctic Expedition <i>D. Dutta Roy and N.C. Deb</i>	371
A Note on Job Satisfaction Level of Scientists and Logistic Personnel in Antarctic Expedition <i>D, Dutta Roy and N.C. Deb</i>	377

ENGINEERING AND LOGISTICS

Communication during the Summer of 15 th Antarctica Expedition <i>M.K. Dhaka</i>	381
Antarctic Communication —An Insight <i>M.K. Dhaka</i>	385
Tele Condition Monitoring of Gensets at Maitri Station <i>R.N. Sarwade and P. Y. Dabeer</i>	389
Electrical Earthing and Electrostatic Protection at Antarctica <i>R.N. Sarwade and P.K. Dey</i>	401
A Note on the Refrigeration System at Maitri <i>P.K. Dey and P.Y. Dabeer</i>	409
A Medical Report for the Wintering Period of 15 th Indian Antarctic Expedition <i>Dr. A.C.P. Tripathi and Dr. Romesh Lal</i>	413
Technical Report of the Army Team in 15 th Indian Antarctic Expedition <i>Maj. V.D. Abraham, SM</i>	417

THE TEAM

SI No.	Name	Organisation
Winter Component (December 1995-March 1997)		
1.	Sh Arun Chaturvedi Leader & Station Commander	Geological Survey of India
2.	Sh Amar Singh	'Geological Survey of India
3.	Sh G. Sundaresan	All India Institute of Medical Sciences
4.	Sh N.C. Deb	National Physical Laboratory
5.	Sh A.S. Rasal	India Meteorological Department
6.	Sh Dev Raj Mahor	India Meteorological Department
7.	Sh S. Sankaran	Indian Institute of Geomagnetism
8.	Sh Abhay Joshi	Defence Electronics Applications Lab.
9.	Sh Prabhu D. Dandriyal	Defence Electronics Applications Lab.
10.	Sh P.Y. Dabeer	Research & Development Estt. (Engrs)
11.	Sh P.K. Dey	Research & Development Estt. (Engrs)
12.	Dr A.C.P. Tripathi	Indo-Tibetan Border Police
13.	Dr Romesh Lal*	Lady Hardinge Medical College
14.	Maj V.D.Abraham, Dy. Leader	Indian Army
15.	Capt Rajesh R. Bhat	Indian Army
16.	Sub Baldev Singh	Indian Army
17.	Nb/Sub G.S. Bhandari	Indian Army
18.	HMT P.D.S. Bhai	Indian Army
19.	HMT B.K. Sharma*	Indian Army
20.	HMT R.P. Jat	Indian Army
21.	Hav K.N. Ramalingam	Indian Army
22.	Hav Iqbal Singh	Indian Army
23.	Hav Ram Lakhan Prasad	Indian Army
24.	Hav Mahipal Singh	Indian Army
25.	Nk Suresh Malviya	Indian Army
26.	CT Bharat Prasad	Indo-Tibetan Border Police

(*March 1996-March 1997 : Inducted as replacements for two wintering members).

Sl No.	Name	Organisation
Summer Component (December 1995-March 1996)		
27.	Sh Ajay Dhar, Dy. Leader	Indian Institute of Geomagnetism
28.	Sh A. Patil	Indian Institute of Geomagnetism
29.	Sh K.V. Krishnamurthy	Geological Survey of India
30.	Sh M.P. Gaur	Geological Survey of India
31.	Dr H.N. Dutta	National Physical Laboratory
32.	Sh Anil K. Kaushik	Department of Electronics
33.	Dr Bulganin Mitra	Zoological Survey of India
34.	Sh Yash Veer Bhatnagar	Wildlife Institute of India
35.	Dr M. Suresh Kumar	National Environ. Engineering Research Institute
36.	Sh Manoj K. Pant	Defence Agriculture Research Lab.
37.	Dr S.P. Shukla	Banaras Hindu University
38.	Dr P. Gnaneshwar	Osmania University
39.	Sh A. Shivaji	Osmania University
40.	Sh S. Bose	Jadavpur University
41.	Sh S.K. Samanta	Jadavpur University
42.	Sh M.K. Dhaka	Defence Electronics Applications Lab.
43.	Dr R.N. Sarwade	Research & Development Estt. (Engrs)
44.	Sh Puneet Vashist	Snow & Avalanche Study Estt.
45.	Sh M.S. Rawat	Coast Guard
46.	HMT R.K.S. Yadav**	Indian Army
47.	L/Hav S.S. Bhal Singh**	Indian Army
48.	Dr P. Surendra†	Central Industrial Security Force
49.	Sh T.V.P. Bhaskara Rao	D.O.D.-Observer

(**Members scheduled for wintering team, returned after summer, due to injuries).

(†Member scheduled for wintering team, returned after summer, due to personal reasons).

ADDRESSES OF PARTICIPATING ORGANISATIONS

1. Geological Survey of India, Antarctica Division, NH - 5 P, N.I.T. Faridabad- 121 001.
2. Indian Institute of Geomagnetism, Nanabhoy Moos Road, Colaba, Mumbai- 400 005.
3. India Meteorological Department, Mausam Bhawan, Lodhi Road, New Delhi- 110 003.
4. National Physical Laboratory, Dr K.S. Krishnan Marg, New Delhi- 110 012.
5. All India Institute of Medical Sciences, Department of Physiology, Sri Aurobindo Marg, Ansari Nagar, New Delhi- 110 029.
6. Zoological Survey of India, 'M' Block, New Alipore, Calcutta- 700 053.
7. Wildlife Institute of India, Post Box 18, Chandrabani, Dehradun- 248 001.
8. Snow & Avalanche Study Establishment, Manali, Himachal Pradesh.
9. Defence Agriculture Research Laboratory, Post Box 40, Goraparao, Haldwani- 263 139.
10. National Environmental Engineering Research Institute, Nehru Marg, Nagpur- 440 020.
11. Department of Electronics, Electronics Niketan, CGO Complex, New Delhi- 110 003.
12. Banaras Hindu University, Department of Botany, Varanasi- 221 005.
13. Jadavpur University, Department of Geology, Jadavpur, Calcutta.
14. Osmania University, Centre for Exploration Geophysics, Hyderabad- 500 007.
15. Defence Electronics Application Laboratory, Post Box 54, Dehradun- 248 001.
16. Research & Development Establishment (Engineers), Dighi, Pune- 411 015.

17. Indo-Tibetan Border Policy Block-2, CGO Complex, Lodhi Road, New Delhi.-110 003.
18. Lady Hardinge Medical College, Department of Surgery, Paharganj, New Delhi.
19. Directorate of Military Operations (M02), Army Headquarters, Sena Bhawan, New Delhi,
20. Coast Guard Headquarters, National Stadium Complex, New Delhi-110 001.
21. Central Industrial Security Force, Block-13, CGO Complex, New Delhi-110 003.

SUMMARY

Arun Chaturvedi

Expedition Leader

The 15th Indian Antarctic Expedition team was flagged off on board ship MV Brinknes from Marmugao Port, Goa on 6th December 1995 by the then Hon'ble Minister of State, Department of Ocean Development, Shri Eduardo Faleiro. It comprised 47 members, out of which 30 were scientists. The scientists represented 16 different institutions and each organisation had a specific programme. Thirteen logistics personnel from Indian Army, 2 doctors (one each from ITBP and CISF) and 2 cooks (one each from ITBP and Coast Guard) supported these. This was the highest ratio of scientific to logistic component in any Indian expedition. Twenty-one members of the team were for the polar summer period and were due to return with the previous wintering team from Antarctica. Twenty-six members were scheduled to stay back in the icy wilderness to maintain the Indian Antarctic Station, Maitri, for one full year and to conduct various scientific experiments. Unfortunately, two members of the army unit sustained serious injuries while performing expedition duties and had to return with the summer team. One doctor from the CISF had personal problems, could not cope up with the task of facing an year of isolation on the remote continent, and opted to go back with the summer team. The Director, Dept. of Ocean Development was kind enough to respond immediately to our requirements and arranged to send two replacements for the winter team through a German ship before the freezing of the Southern Ocean. These were a doctor from LHMC and one HMT from the army. These replacements proved to be invaluable during some difficult situations of polar wintering.

The Tasks

Atmospheric Sciences : Indian Institute of Geomagnetism, India Meteorological Department, National Physical Laboratory with Department of Electronics.

Biological Sciences : All India Institute of Medical Sciences, Zoological Survey of India, Wildlife Institute of India, Defence Agriculture Research Laboratory, Banaras Hindu University.

Earth Sciences : Geological Survey of India, Jadavpur University, Snow & Avalanche Study Establishment, Osmania University.

Environmental Science : National Environmental Engineering Research Institute.

Engineering & Logistics : Defence Electronics Application Laboratory, Research & Development Establishment (Engineers), Indo-Tibetan Border Police, Lady Hardinge Medical College, Indian Army, Coast Guard, Central Industrial Security Force.

The Voyage

Soon after sailing from Goa on 6th December 1995, a meeting of all the expedition members was organised on board and they were briefed about the do's and don'ts of the voyage. In the same gathering, the Leader nominated Sh Ajay Dhar and Maj. V.D. Abraham as Deputy Leaders of the expedition for better co-ordination. This was intimated to and accepted by the DOD. The ship crossed the equator on 10th December. It touched the harbour of Port Louis in Mauritius on 14th December to pick up two chartered helicopters, their crew and some essential cargo. It sailed from Mauritius on 18th December 1995.

All the members of the expedition, except the Leader and 4 other members, were accommodated in a living module separate from the main superstructure of the ship, MV Brinknes. It is put on record that this living module had very cramped cabins, no working tables or chairs, insufficient water pressure in the bathrooms, unreliable air-conditioning system and the drinking water supply with a peculiar odour. The Leader and the DOD-Observer tried to get from the Captain of the ship whatever solutions were possible during the voyage, but most of the infrastructural deficiencies could not be resolved. The credit goes to the members of the team that despite severe limitations of living and working space, they conducted their experiments and endured with those difficulties, which could not be managed during the voyage. On board scientific programmes of AIMS, BHU, DEAL, GSI, IMD, WII, RDEE were completed. A SODAR instrument of NPL was established at the bow of the ship but it was damaged by bad weather and could function only for a part of the journey.

The ship crossed 40 degree South latitude on 23rd December. This sailing period was utilised for discussing in detail the scientific projects and logistic requirements of all the institutions. A detailed programme of disembarking and off-loading was worked out. Members were familiarised with projects of others by arranging lectures on scientific projects. Indoor games and tournaments also fostered the team spirit. On 27th December the first iceberg proclaimed our entry into the cold waters of the Antarctic Ocean and two days later, the ship

encountered pack ice. On the last day of the year '95, the ship reached the coastal waters of the polynya. On the same day, the helicopters were taken out from the holds and were made operational.

The Polar Summer

On the New Year day of 1996, the first helicopter sortie to Maitri took off and all the requirements of the old winter team, along with precious letters from their homes, were delivered. Detailed discussions were held with the Station Commander regarding summer camp requirements. On 2th January, 20 members and their equipment were transported and the summer camp was established. On 5th January, another camp was established at Dakshin Gangotri for IIG and SASE. Antarctic blizzards delayed the mountain camp for GSI and IIG, which could be established only on 13th January in Holtedahll range of Orvin Mountains. The fast ice remained thick during the first half of January, forcing the ship to remain in the open waters of polynya. On 18th January, a large crack in the fast ice permitted the ship to reach the ice shelf for the first time and on the same day, two PB-330 snowmobiles, trailers, a Mantis crane were off-loaded. With this, our army team set out to work on the shelf, digging out and repositioning the fuel-tankers and containers. The Republic Day was celebrated at Maitri in the presence of guests from Russian polar station, members of German 'Geomaud' expedition, along with ship and helicopter crew of Philipino, Norwegian, Swedish, Ukrainian and Australian nationalities.

On 28th January, a powerful blizzard struck the mountain camp, trapping the six camping members in MFC tents. Gale-force winds raged for the next five days and no help could reach them. On 3th February, the weather permitted a sortie and all the six members, including the DOD-Observer, were immediately rescued. Two tents out of the three were destroyed by the blizzard, but the members had braved it out and survived in good shape!

On 4th February, our winter team took over the station, along with all the life-support systems and the old winter team was flown to the ship. From the very next day, we started a new era in Maitri, abolishing the traditional separation of winter and summer teams, by sharing the kitchen and other facilities of the main station with the summer members. This gave a wider sense of belonging to all the team members and was a great boost to the team spirit.

The mountain camp was closed on 11th February. A Maitri-DG route reconnaissance sortie was taken on the 16th and on 18th February, the first training-convoy was organised by the old winter team. This convoy had a good going but in a freak accident near Dakshin Gangotri, the crust of ice broke down and two vehicles with their trailer loads were trapped in a water channel below.

We sought the help of heavier vehicles from the nearby Russian station, Novo. and after about a week of struggle with thin ice and freezing waters, all the vehicles and the loads were successfully retrieved. During this difficult week of rescue operations, the marooned convoy-members, who included some scientists and the DOD-Observer among the army team members, were given the option of shifting to the ship by helicopters. But it speaks of their courage and dedication that not a single member availed of this offer and all stayed back with the task till it was completed. They reached the ship on 24th February.

On the same day, a great mishap was averted on the ice shelf. Some members of the army team were waiting on the shelf to be lifted in the ship by the crane-bucket. All of a sudden, a huge chunk of shelf crashed into the sea, throwing one member of the old wintering team, Maj. Meena, into bone-chilling waters. A member of our team, Maj. Abraham, who was inside the bucket of the crane, showed a great presence of mind, got the crane lowered to water-level and saved the life of Maj. Meena. For this act of bravery, Maj. Abraham was later awarded the Sena Medal.

By the second half of February, the scientists of the summer-team had completed their experiments and were gradually de-inducted from Maitri. These flying operations were combined with the transportation of frozen food from ship to Maitri, saving a lot of valuable flying hours. It is worth recording, that our expedition finished all the expedition tasks in the lowest-ever figure of 183 flying-hours only. Since, this was the first time that commercial helicopters were hired by a global tender, our meticulous planning has resulted in a substantial economic saving to the nation.

All the Scientists participating in the expedition could successfully complete their experiments and the collection of samples and data. The results of their projects are presented in this report in the form of scientific papers. The paper from NEERI participant could not be included due to some late-stage corrections and modifications and this is likely to be published in the next expedition report. The members of Jadavpur University had a three year detailed geological mapping project in Schirmacher range. Since this was their second year only, they have preferred to submit their paper only at the end of the project and it would be published in the 16th expedition report. One paper from NIO, which could not be published in the 13th expedition report, has been included here. Some highlights of the scientific work during the polar summer-are: geological mapping of more than 3000 sq. km by GSI team in inaccessible Fenris and Holtedahl ranges of Orvin mountains; first time a simultaneous geomagnetic data generation from Dakshin Gangotri, Maitri and Holtedahl range by IIG for about 10 days; successful project of providing earthing to all

the labs at Maitri in a permafrost region by RDEE; insulation-earthing-test running of the liquid nitrogen plant by NPL & RDEE.

After achieving all the scientific and logistic targets set for this expedition, permission was obtained from the Secretary, DOD and the ship sailed back from Antarctica on 27th February 1996.

The Polar Winter

The departure of the ship signalled the impending arrival of polar winter. We took stock of the rations, medicines, supplies, spares and fuel available at Maitri. Maj. Abraham very efficiently organised a continuous stream of convoys between Maitri and Dakshin Gangotri. It goes to his credit that our team performed 9 convoys before the polar night and shifted almost all the stores from the shelf to Maitri, before the darkness enveloped us.

Scientific experiments of AIIMS, NPL, IMD, IIG, GSI and RDEE continued throughout the polar winter. For the first time, a GSI team succeeded in drilling through the entire thickness of a glacier upto the bedrock. In two boreholes, GSI team generated 160 metres of ice core for palaeoclimatic studies. IMD team launched 51 Ozonesonde ascents and 15 radiometer ascents. NPL participant recorded about 900 MB of digital data for atmospheric boundary layer conditions. IIG member could delineate 57 days of magnetic storms by continuous monitoring. AIIMS scientist studied the circadian rhythm fluctuations and modulation of human immune system. RDEE continued to provide earthing to all the labs even during polar winter and monitored the signatures of the gensets.

The team from DEAL provided excellent communication facilities to all the members. They persistently went out to the e-mail hut, 50 m away from the station, even in fierce winds during the polar nights, to get the letters of members from their families back home. They also made operational 4 GPS instruments lying idle in the station and, in collaboration with the Army team, produced a detailed point-to-point route map for convoys between Maitri and Dakshin Gangotri. The logistic team from the Indian Army, maintained all the life support systems in peak condition throughout the year. They also completed 4 construction projects within a polar winter, erecting an ice-core drill shelter, a garbage incinerator, the structure of a balloon launching shelter and a gantry with winch in the new workshop. They also dismantled the vehicle-stores in the A-block, old workshop in front of the station and systematically shifted it all to locations in the new workshop. A great logistic input was also provided by the ITBP-cook of the team, who served all the members untiringly, with a personal touch, during the wintering.

Both our Doctors from ITBP and LHMC provided excellent medical, dental and psychological support to the team. The Russian team at the neighbouring polar station, Novolazarevskaya, was unfortunate enough to winter over without the services of a medical man. Our Doctors visited them from time to time and provided the needed medical cover. The Leader of the Russian team at Novo and the Director of the Russian Arctic and Antarctic Services had sent messages of gratitude for the help received from the Indian Doctors.

In addition to all the scientific and logistic duties, the entire team volunteered to participate in the environmental clean up of the Indian polar station and its surroundings. We organised regular collective "Shramdan" sessions on a weekly basis to improve the ecological status of the station. The half-a-dozen old food dumps around the station were cleared and the entire rations were shifted to a new containerised food stores created by us. This has also helped in classification of the food items and in stocktaking for preparing future demand-lists. Over the years, the lofts of the station had gradually become dump-yards with all sorts of items stored there and forgotten. We examined each and every item, sorted them, classified them and prepared an inventory of items available in each segment of the loft. In the process, almost one container-load of items, not in use, were backloaded. The Indian station was inspected by a Norwegian Environmental Team under the terms of the Antarctic Treaty in December 1996. We presented a fairly clean station and the surroundings, which were appreciated by the visitors. Their suggestions for further improvement in various sub-systems were communicated to the Department of Ocean Development.

Back to the Motherland

The 16th Indian Antarctic Expedition team, lead by Dr A.L.Kopper, was given a warm welcome at Maitri on 4th January 1997. This marked the end of the prolonged isolation of wintering for our team. We had prepared the summer camp for the new team, equipping it with all the supplies for their comfortable stay. Continuing the tradition we had established last year, we shared the dining and other facilities of the main station with the new team. About a month of overlap period was spent in imparting training to the new team about maintenance of life support systems. Finally on 11th February 1997, we handed over the responsibility of the Indian station to the new wintering team and shifted to the ship, MV Polar Bird. In the second half of February, a training convoy was arranged for the new wintering team. On 9th March 1997, the ship sailed back from Antarctica. On the way, however, there were some minor engine problems

and the ship had to touch the port of Durban, South Africa, to pick up some oil supplies. This slightly delayed the arrival of the ship and finally we touched the sacred soil of the motherland at Marmugao Port, Vasco in the morning hours of 5th April 1997.

Acknowledgements

Any expedition of this magnitude is first and foremost, a team effort. The responsibilities assigned would be enormous unless shared by the fellow expeditioners. The biggest contribution to the success of this expedition was definitely given by the highly motivated members of this team. I am thankful to all the members of 15th Indian Antarctic Expedition for their cohesive efforts and dedication to the tasks. Sh Ajay Dhar, Dr G.Sundaresan, Capt Rajesh Bhat, Sh Prabhu Dandriyal, Sh Amar Singh and Sh Abhay Joshi voluntarily shouldered greater burdens during the expedition and I am personally grateful to them.

We are thankful to Dr A. E. Muthunayagam, Secretary, DOD for the supervision during the expedition. The guidance received from Dr P.C. Pandey, Centre Director, NCAOR during the post-expedition processing and publishing of this report is thankfully acknowledged. All the members of the expedition expressed their appreciation for the sincere help received from the DOD-Observer, Mr T. V.P. Bhaskara Rao. We were lucky to have a very considerate and active Observer from the DOD, who participated in all the expedition activities, not only on board ship but even in the mountains, camps and convoys and thus had a genuine first-hand experience of all the hostile polar elements. The co-operation extended by Dr A.Mitra and Sh P.S.Singh throughout the expedition is gratefully acknowledged.

I am personally thankful to the Director General, GSI for his kind permission to lead this expedition. The guidance received from Sh M.K Kaul, Director, Antarctica Division, GSI throughout the expedition and also during the post-expedition tasks was a constant source of support; I am indebted to him. A great help was received from Mr MJ.Beg, Geologist, Antarctica Division, GSI during the compilation of the report, I express my sincere thanks to him.



1. Construction of Ice-Core Drill Shelter by the Army members
(Photo: Rajesh Bhat)



2. Monitoring of Dakshin Gangotri glacier snout by Survey of India and GSI
(Photo: A.C.P.Tripathi)



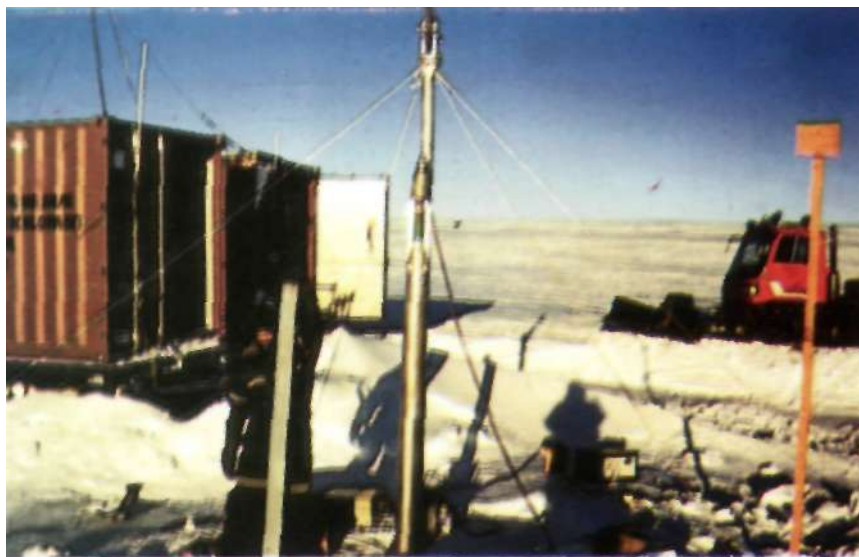
*3. Construction of the structure of Balloon Launching Shelter by the Army members
(Photo: Rajesh Bhat)*



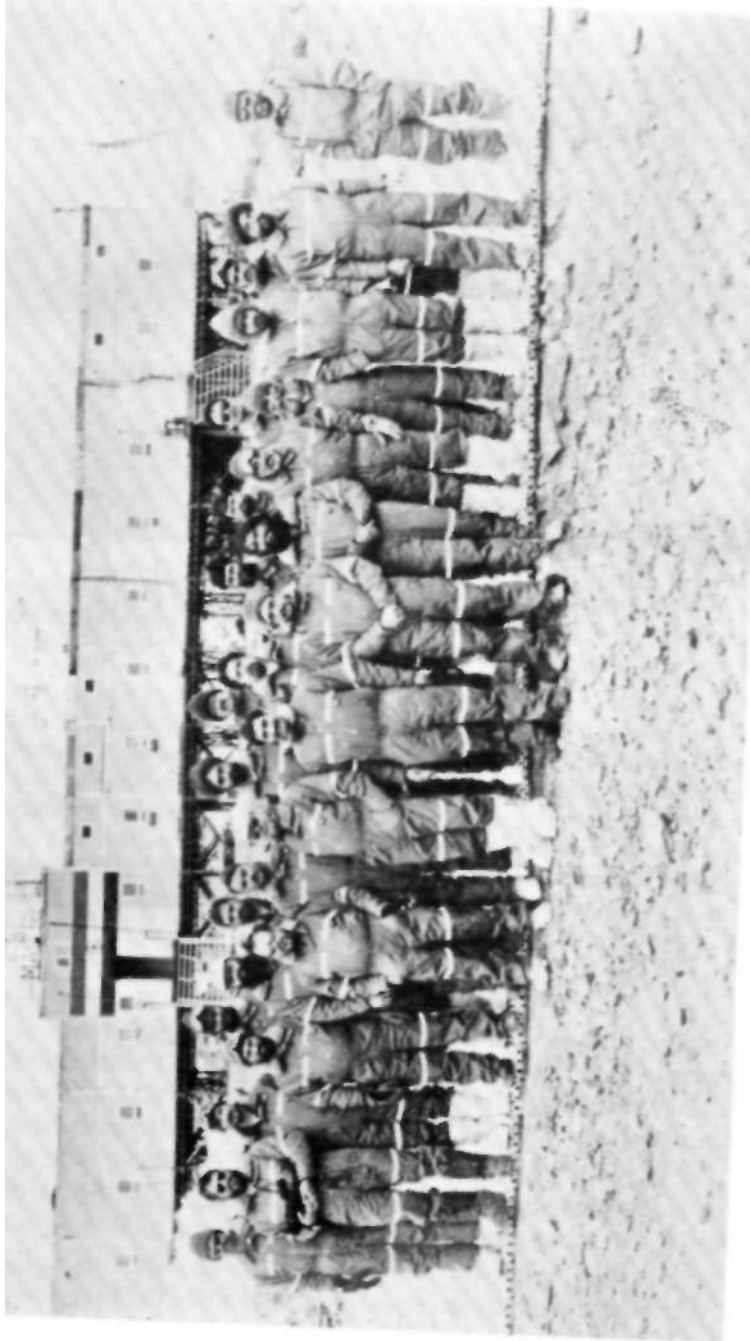
*4. Ozonesonde launching by IMD team in peak cold conditions,
(Photo: Arun Chaturvedi)*



5. Successful completion of the Gantry-erection and Winch-installation by Army members (Photo: V.D.Abraham)



6. Drilling for ice-cores on continental blue ice sheet by GSI team (Photo: Amar Singh)



7. Members of the wintering team of the 15th expedition, in front of Maitri station



8. The Leader of the Russian team from Novo station expressing thanks to Indian team on a visit to Maitri. Also present are his wife, the DOD-Observer (16th IAE) Sh. R. Ravindra and the Station Commander Maitri (Photo: G. Sundaresan)