

SCIENTIFIC REPORT
OF
FIRST INDIAN EXPEDITION TO ANTARCTICA

TECHNICAL PUBLICATION NO. 1



DEPARTMENT OF OCEAN DEVELOPMENT
SOUTH BLOCK-NEW DELHI 110 011
INDIA

CONTENTS

FOREWORD	iii
PREFACE	v
PARTICIPANTS	viii
THE TEAM	ix
SECTION I (METEOROLOGY, INSTRUMENT & NAVIGATION)	
Hydrometeorological characteristics of snow and ice over Antarctica — K. N. KATYAL and D. S. UPADHYAY	1
An automatic recording weather station installed in Antarctica — E. DESA, R. G. PRABHU DESAI, M. R. NAYAK and S. TENGALI	18
The Antarctic winter — as recorded at <i>Dakshin Gangotri</i> — E. DESA, M. R. NAYAK, R. G. PRABHU DESAI and A. P. SELVAM	30
Position fixing in Antarctica — M. C. PATHAK	41
SECTION II (RADIOPHYSICS & PHYSICAL OCEANOGRAPHY)	
Radiowave transmission characteristics in Antarctica — A. SENGUPTA	46
Some physical characteristics of the Antarctic and western Indian Ocean — D. V. RAMA RAJU and Y. K. SOMAYAJULU	53
SECTION III (CHEMISTRY & ENVIRONMENTAL STUDIES)	
Chemical studies on the ice shelf, in a fresh water lake and in a polynya at Princess Astrid Coast, Dronning Maud Land, Antarctica — R. SEN GUPTA and S. Z. QASIM	62
Chemical oceanographic studies along a section from 32°S to Antarctica in the south western Indian Ocean — R. SEN GUPTA and S. Z. QASIM	69
On fluoride, bromide and iodide in the southwestern Indian Ocean sector of the Southern Ocean — FRANCISCA'P. DE SOUZA and R. SEN GUPTA	78
On the distribution of calcium, magnesium, sulphate and boron in the southwestern Indian Ocean region of the Southern Ocean — SUGANDHINI NAIK, R. J. NORONHA, P. V. SHIRODKAR and R. SEN GUPTA	87
Distribution of a few trace metals in a section in the south-western Indian Ocean — SUJATA SANZGIRY, ANALIA MESQUITA and R. SEN GUPTA	95
Measurement of aerosol particles along a section from 8°N latitude to Antarctica in the southwestern region of the Indian Ocean — R. SEN GUPTA and Q. Z. QASIM	100
SECTION IV (GEOLOGY, GEOPHYSICS, GEOMAGNETISM & GLACIOLOGY)	
Benthic foraminifera from the continental margin off Queen Maud Land, Antractica — M. V. SHANKARANARAYANA GUPTHA	106

Sedimentology of the sea bed sediments from Astrid Ridge Princess Astrid Coast, Queen Maud Land, Antarctica — H. N. SIDDIQUIE and N. H. HASHIMI	114
Rock samples collected from the Oasis mountain region, Antarctica — C. P. VOHRA	123
A preliminary study of the Antarctic magnetic data — R. V. IYENGAR and R. RAJARAM	130
Geochemistry of metapelite from <i>Dakshin Gangotri</i> — V. DIVAKAR RAO, P. K. GOVIL and V. BALRAM	136
Glaciological studies during First Indian Antarctica Expedition — C. P. VOHRA	138
Bathymetry and geomorphology of the approaches to <i>Dakshin Gangotri</i> , Princess Astrid Coast, Queen Maud Land, Antarctica — H. N. SIDDIQUIE and M. C. PATHAK	149
Petrochemical studies of the rock sample from <i>Dakshin Gangotri</i> , Antarctica — A. V. MURALI, K. R. KRISHNAMOORTHY and C. S. PICHAMUTHU	153
Indira Mount — an underwater mountain in the Antarctic Ocean — H. N. SIDDIQUIE, G. C. BHATTACHARYA, M. C. PATHAK and S. Z. QASIM	161
A geomorphologic, seismic and magnetic study of the Astrid Ridge, Dronning Maud Land, Antarctica — H. N. SIDDIQUIE, D. GOPALA RAO and M. V. RAMANA	166
SECTION V (BIOLOGY — FLORA, FAUNA & ECOSYSTEMS)	
Flora of <i>Dakshin Gangotri</i> in Antarctica — SAYEEDA WAFAR and A. G. UNLAWALE	182
Biological studies on the ice shelf and in a freshwater lake at Princess Astrid Coast, Dronning Maud Land, Antarctica — S. G. PRABHU MATONDKAR and HELGA R. GOMES	186
Some observations on the biological productivity of Antarctic waters — S. G. PRABHU MATONDKAR and S. Z. QASIM	191
Phytoplankton organisms collected during the First Indian Antarctic Expedition — J. I. GOES and V.P.DEVASSY	198
Zooplankton of the Antarctic waters — S. C. GOSWAMI	202
Benthic fauna of the Antarctic Ocean — quantitative aspects — A. H. PARULEKAR, Z. A. ANSARI and S. N. HARKANTRA.	213
Biochemical components of the benthic regions in Antarctic waters — X. N. VERLENCAR, S. Y. S. SINGBAL and A. H. PARULEKAR	219
Sea birds and marine mammals of the First Indian Antarctic Expedition — A. H. PARULEKAR .	224




PRIME MINISTER
INDIA

FOREWORD

What a wonderful opportunity the First Indian Antarctic Expedition gave to a young team of our scientists. Drawn from seven different research institutions, they worked on common objectives of significant national importance. This is a fine example of inter-disciplinary cooperation in Indian science.

The expedition gave them the opportunity to work at sea and on the icy continent, in most unpredictable and hostile weather conditions. The number of tasks completed and the amount of scientific data generated clearly showed that with dedication and a pioneering spirit Indian scientists can accomplish more than what is initially expected. It also proved India's capability to undertake Antarctic explorations of a high order leading to long-term gains to our national economy.

This technical report presents and discusses the scientific findings of the First Indian Antarctic Expedition. It gives some idea of the quality of scientists and science in India. May it imbue our young people with wider vision and inspire them to greater tasks.


(Indira Gandhi)

New Delhi
August 4, 1983

PREFACE

Antarctica — the seventh continent of the earth is known to be the stormiest, windiest, coldest and the most inaccessible of all the other continents. It has an area of $14 \times 10^6 \text{ km}^2$, most of which is covered with ice. The thickness of the ice cover varies from a maximum of 4.5 km to a minimum of 800 m (average thickness 1.6 km). It has about 512,000 square kilometres of landmass which is free from ice. If the Antarctic ice cover were to melt, the world oceans would rise by about 50 to 60 metres.

The Antarctic continent is 990 km away from Cape Horn — the southernmost tip of Argentina, which is the nearest land area to Antarctica. Antarctica's highest point (Vinson Massif) is 5140 m above the mean sea level.

Antarctica is attracting a world-wide attention because of the tremendous biological bounty teeming in its surrounding seas and the likelihood of vast hydrocarbon and polymetallic nodule deposits in its continental shelf. The regime presently governing the activities on the ice continent was created by the 1959 Antarctic Treaty.

The importance of scientific research in Antarctica can broadly be described as follows:

- (i) Antarctica is an important location for observing the interaction of the earth's magnetic field and charged particles from the sun. It is perhaps the only place in the southern hemisphere from where observations on simultaneous activity in the ionosphere and the earth's magnetic field can be made. It provides relative freedom from man-made sources of electrical interference (noise). Hence, it forms an ideal environment for conducting studies on radio-wave propagation and radio-noise-levels both in the ionosphere and the lower atmosphere.
- (ii) The north and south poles maintain the heat budget of the world in balance. The heat transported through the atmosphere and the oceans to the poles is dissipated in space in the form of long-wave radiation. The cold air going from Antarctica, when meets the warm air in the atmosphere of the lower latitude, changes into moisture-bearing clouds. Thus, Antarctica regulates the global climate and more particularly of the southern hemisphere.
- (iii) The Indian, Atlantic and the Pacific Oceans meet around Antarctica forming a distinct body of water which girdles the earth and is uninterrupted by any landmass. The mixing process between cold and warm water in this body of water demarcates the area of Antarctic convergence which has its own physical, chemical and biological characteristics.
- (iv) Antarctica provides a unique, unpolluted and stable environment for carrying out scientific observations. It is far away from all sources of environmental contamination and thus remains an unpolluted datum point from which global changes due to pollution could be monitored.
- (v) Unlike the Pacific and the Atlantic Oceans, which communicate to both north pole (Arctic) and south pole (Antarctic), the Indian Ocean has its northern boundaries closed with landmass. It, therefore, communicates only to the Antarctic Ocean and south pole from which it derives much of its fertility and energy.
- (vi) Many important oceanographic features of the Indian Ocean are governed by the Antarctic Ocean. Hence, to understand the processes occurring in the Indian Ocean, the knowledge of at least that part of the Antarctic Ocean which joins the Indian Ocean, becomes very necessary.

- (vii) The glaciers of Antarctica comprise about 90 per cent of the earth's ice. Thus, the continent holds about 75 per cent of the freshwater reserve of the earth in a solid state.
- (viii) Antarctic Ocean supports biological communities of few species with large populations and short food chain magnifications. It is among the richest biological provinces on the earth. The important organism regulating the simple food chain in the Antarctic waters is the shrimplike "krill".
- (ix) In the mesozoic era, the super-continent of Gondwanaland had a common landmass of five continents, namely, Africa, Antarctica, Australia, India and South America. Later, the continents drifted apart with the oceans in between. Thus, Antarctica holds the master key to the earth's history.
- (x) Geologists believe that some of the richest deposits of several minerals, oil, gas, polymetallic nodules, etc. could be found in the Antarctic landmass and in the surrounding sea-bed. Thus, Antarctica is a continent of great scientific value.

The primary objective of the First Indian Expedition to Antarctica was to initiate some of our own research programmes in the fields noted above. Only a few islands separate the sub-continent of India from the continent of Antarctica. In other words, there is a single and continuous sheet of water connecting India with Antarctica with no sizeable landmass in between. It is, therefore, very desirable that some of the scientific disciplines are probed from the Indian view point.

The expedition code-named 'OPERATION GANGOTRI', was undertaken in an ice-breaker M. V. POLAR CIRCLE chartered from its owner A/S. G. C. Reiber, Bergen, Norway. Twenty one scientists, technicians and naval personnel were selected after their physical and mental examination. The team members came from seven different institutions. The ship sailed from Mormugao harbour on 6 December 1981, and after covering a distance of 21 thousand kilometres, returned to Mormugao harbour on 21 February 1982. The duration of the expedition was 77 days.

This report presents the results of the scientific investigations carried out during the First Expedition. It includes studies on meteorology, geomagnetism, radio-wave propagation, geology, glaciology, chemistry and microbiology of the Antarctic ice and the study of a freshwater lake. The oceanographic part includes physical, chemical, biological, geological and geophysical observations on a part of the Southern Ocean adjoining the Indian Ocean.

The report is by no means complete. It is rather of a preliminary nature. However, we hope that it will provide future guidelines for research programmes to be undertaken during the subsequent Indian expeditions to Antarctica.

I would like to express my deep sense of gratitude to Shrimati Indira Gandhi, Prime Minister of India, for her initiative and interest in the expedition; to Prof. Nurul Hasan, Vice-President, Council of Scientific and Industrial Research, for his advice and help; to the Cabinet Secretary, Shri Krishnaswamy Rao Sahib, for the most valuable support he gave throughout in the coordination and execution of the plans of the expedition; to Dr. G. S. Sidhu, Director General, Scientific and Industrial Research, for his considerable help from time to time; to the Department of Ocean Development (DOD) for providing funds to undertake the Expedition and particularly to Shri K. Saigal, Additional Secretary and Shri J. L. Sarin, Director, DOD, for their untiring efforts in speedily implementing the programme in record time of 3 months; to Shri R. Rajamani, Joint Secretary to the Prime Minister, for his continued advice and efforts in developing an action plan.

I would also like to thank the Chief of the Naval Staff for providing men and material which gave maximum support to the scientific work carried out on land and at sea and to Dr. V. V. R.

Varadachari, Director, National Institute of Oceanography, Goa, and his colleagues for providing base facilities and for coordinating with different institutions.

My thanks are also due to A/S. G. C. Reiber, for making M. V. POLAR CIRCLE available on charter and to Captain J Fjortoft and his officers and men for their help and hospitality during the expedition.

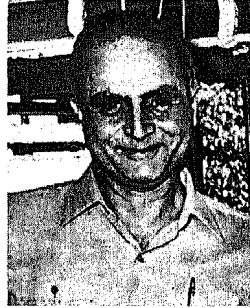
**Department of Ocean Development S. Z. Qasim
South Block
New Delhi 110 011
August 1983.**

The views expressed in this publication are those of the authors of each paper and not of the Department of Ocean Development.

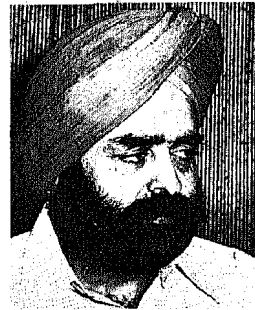
PARTICIPANTS

NAME	FIELD	ORGANISATION
Dr. S. Z. Qasim LEADER	Marine Biology	Dept. of Environment
Shri C. P. Vohra DEPUTY LEADER	Glaciology	Geological Survey of India
Shri H. N. Siddiquie DEPUTY LEADER	Marine Geology	National Institute of Oceanography
Dr. A. Sengupta	Radiophysics	National Physical Laboratory
Shri A. K. Sharma	Meteorology	India Meteorological Department
Shri K. N. Katyal	"	"
Shri R. V. Iyengar	Geomagnetism	Indian Institute of Geomagnetism
Cdr. D. S. Brar	Photography	Indian Navy
Surg. LCdr. S. J. Thomas	Medicine	"
LCdr. K. D. S. Sandhu	Pilot	"
LCdr. K. S. Samra	"	"
LCdr. D. K. Chandani	"	"
Shri M. R. Mahapatra	Technician - electrical	"
Shri G. V. Shirsat	Technician - mechanical	"
Shri J. S. Saini	Medical attendant	"
Shri S. G. Prabhu Matondkar	Marine Microbiology	National Institute of Oceanography
Shri D. V. Rama Raju	Physical Oceanography	"
Shri M. C. Pathak	Marine Survey	"
Dr. E. Desa	Marine Instrumentation	"
Dr. A. H. Parulekar	Marine Biology	"
Dr. R. Sen Gupta	Chemical Oceanography	"

THE TEAM



S. Z. Qasim



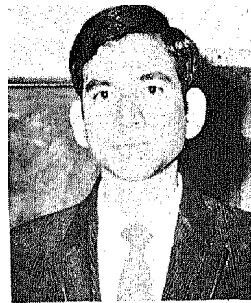
C. P. Vohra



H. N. Siddiquie



A. Sen Gupta



A. K. Sharma



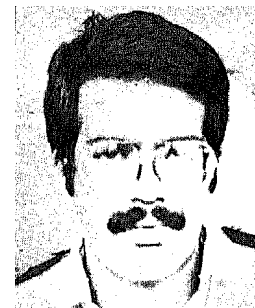
K. N. Katiyal



R. V. Iyengar



D. S. Brar



S. J. Thomas

THE TEAM

(Continued)



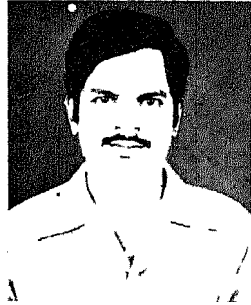
K. D. S. Sandhu



K. S. Samra



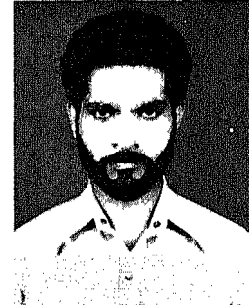
D. K. Chandani



M. R. Mahapatra



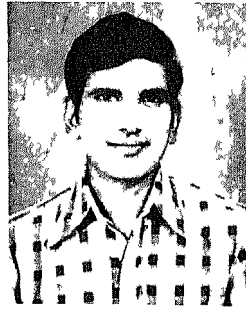
G. V. Shirsat



J. S. Saini



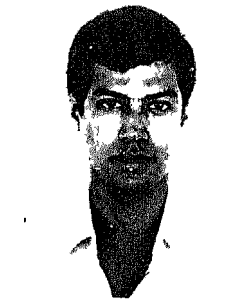
S. G. Prabhu Matondkar



D. V. Rama Raju



M. C. Pathak



E. De Sa



A. H. Parulekar



R. Sen Gupta