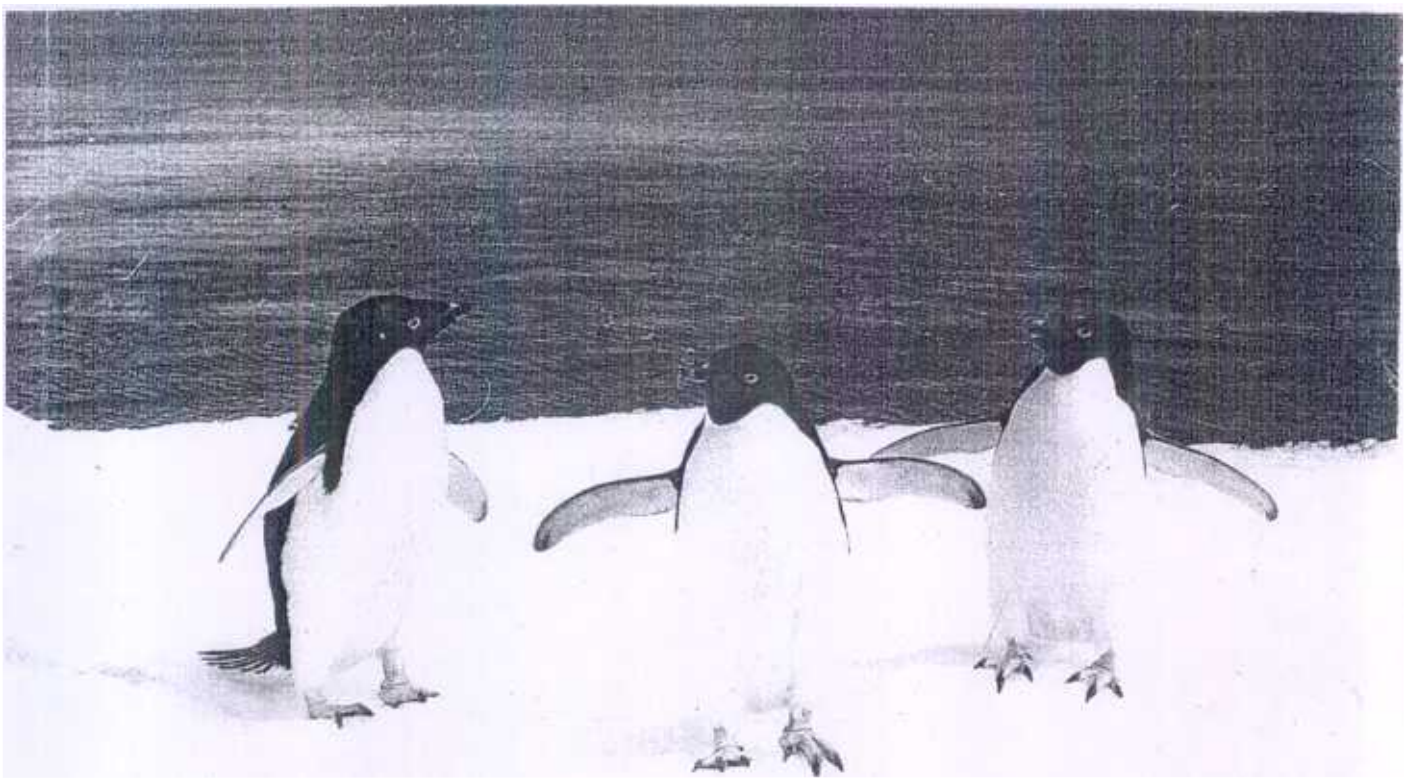
ANNUAL REPORT
1984-85



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DEPARTMENT OF OCEAN DEVELOPMENT
GOVERNMENT OF INDIA
NEW DELHI

ANNUAL REPORT
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GOVERNMENT OF INDIA
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1

INTRODUCTION

Certain uses of the ocean and its resources are traditional and these go back to the earliest days of human settlements along the coast. For several centuries, the people of India have been using the seas surrounding the Indian sub-continent for transport and communication and for food. However, the intensity of ocean use has increased with the number of users, most dramatically, in the present century. New ocean resources are being developed and their application is accelerated. The most striking example is the exploitation of fisheries, oil and gas. Another is the potential that lies ahead of the mining of polymetallic nodules and polymetallic sulphides deposits from the deep ocean. The extraction of sand and gravel from the shallow seabed is already an important industry. On the horizon is the direct extraction of energy from the tides, thermal and salinity gradients and from the waves. The use of tidal energy is already an established feature in a few countries. The importance of the influence of the ocean on weather and climate is now fully recognised. The dimensions of some ocean phenomena vastly exceed the national domains, and it is not uncommon for local events to be driven by processes operating in distant parts of the ocean: the timing and strength of the monsoon in India depend at least partially on the behaviour of Somali Current.

The new Ocean Regime established by the United Nations Convention on the Law of the Sea 1982, which has already been signed by 139 countries including India and ratified by fourteen countries assigns much of the world ocean to exclusive economic zones where coastal States have jurisdiction over the exploration and exploitation of resources and for other economic purposes. The wise use of these resources, both living and non-living, now pertaining to the coastal states will require scientific knowledge, that is often not readily available. The need for scientific research in the offshore areas and the need for understanding the oceanographic processes is widespread and provides strong justification for enhanced national efforts.

Recognising the importance of the oceans in the economic development and the progress that the Indian science has already made, the Government of India established the Department of Ocean Development in July 1981 directly under the Prime Minister. The main functions of this Department are: planning and coordinating oceanographic surveys to map and locate the availability of non-living and living marine resources, research (including fundamental research) and development of uses relatable thereto, management of ocean data and resources, development of manpower and marine technology. The Department has also been entrusted with the responsibility of looking after the marine environment on the high seas. The policy objectives of the ocean development were announced in both

Houses of Parliament in November 1982.

The main thrust areas in the ocean sector have been Antarctic research, promotion of surveys and optimum utilisation of living and non-living resources, harnessing of renewable resources of energy and the exploration of polymetallic nodules from the deep seabed.

The Department acquired two sophisticated oceanographic research vessels, ORV *Sagar Kanya* in June 1983 and FORV *Sagar Sampada* in December 1984. These vessels are among the most modern oceanographic research vessels with advanced facilities for working in the fields of physical, chemical, biological, geological and geo-physical oceanography and meteorology. Sagar Sampada is a multipurpose vessel with long endurance and operational range capable of working in the exclusive economic zone of India and beyond. It can also operate in the Southern Indian Ocean upto 60°S latitude to provide a good support to India's Antarctic programme.

Within a short span of three years, the Department of Ocean Development, with a small complement of staff, has made considerable progress in the field of ocean development and has taken steps to enhance the country's capabilities in ocean sciences. It has also provided inputs to several institutions in the country. The activities of the Department have encompassed various efforts ranging from fundamental and resource-oriented research and surveys to despatch of four scientific expeditions to Antarctica and the establishment of a permanently-manned station there.

2

MARINE PROGRAMMES HANDLED BY THE DEPARTMENT

The work of the Department during the year 1984-85 can broadly be divided under the following headings:-

2.1 Antarctic Research

Till recently, there has been little interest in Antarctica except among the scientists and those countries undertaking scientific researches there. International interest in Antarctica's marine and mineral resource potential has grown during the late 1970s. During the last few years, this interest has increased considerably. Recent Antarctic studies have aroused interest of both developed and developing countries to know more and more about the resources of Antarctica and to exploit the living resources of the surrounding seas for the benefit of mankind.

The Department of Ocean Development has so far sent four scientific expeditions to Antarctica. During its three previous expeditions, a good deal of information, data and material have been collected. By virtue of the scientific activities carried out in Antarctica, India has been admitted as a Consultative Member of the Antarctic Treaty in September, 1983. India also joined the Scientific Committee on Antarctic Research in October, 1984.

2.2 Living Resources

India with a long maritime history of the exploitation of living resources from the sea, occupies the eighth position in the world for the total annual catch of fish. As per the need-based futuristic studies, the projected fish requirements of India's population by the year 2000 AD are estimated to be 11.4 million tonnes. At present 56% of the total annual catch of about 3 million tonnes of fish is harvested from the seas. India with an extensive coastline of nearly 6000 km and a vast exclusive economic zone of over 2 million sq km exploits about 46% of the total catch of the living resources from the Indian Ocean.

Systematic survey and exploration of marine living resources in the exclusive economic zone of India and in the open ocean space using the oceanographic research vessels ORV *Sagar Kanya* and FORV *Sagar Sampada* is one of the major objectives of the Department. Preservation and protection of the marine environment as well as monitoring of pollutants also form part of its functions.

Deep Sea Mining

India has been recognised as a pioneer investor in deep seabed mining by third United Nations Conference on the Law of the Sea. The first phase of the deep seabed mining

programme was oriented towards survey, exploration, collection and laboratory investigation of the polymetallic nodules with a view to studying the feasibility of commercial exploitation. India's application for the allocation and allotment of a pioneer area (mine site) has been filed with the United Nations. The mine site is expected to be allotted soon after the rules regarding the registration of pioneer investors are established by the Preparatory Commission for the International Seabed Authority and for the Law of the Sea Tribunal.

Associated with the deep seabed survey is the development of technology for retrieving and processing of polymetallic nodules from the deep seabed. The Department is taking appropriate steps to acquire a manned submersible with technology transfer, and also to develop the technology for mining and processing of the polymetallic nodules.

2.4 Acquisition of Research Vessels

FORV *Sagar Sampada* is the latest addition to our country's capability for the exploration of oceans. It is a multipurpose vessel with a long endurance and operational range, capable of working in the Southern Indian Ocean upto 60°S latitude. It will provide a good support to the Antarctic Research programme. The vessel was delivered to us on 6 November 1984 in Denmark. It arrived in Bombay on 24 December 1984 after undergoing several trial cruises in the North Sea.

2.5 Manpower Planning

Trained manpower is the most important factor for the ocean development. As in many other developing countries, progress is limited by the shortage of trained scientists and technicians and by a lack of scientific equipment and facilities. In fact, the quality of basic and applied marine research and technology tends to be directly related to (a) the extent of national commitment to a marine research programme, (b) the calibre of scientists and engineers planning and executing the research projects and (c) adequacy of the infrastructure and working facilities.

The problems of ocean science and engineering are not simple and those engaged in marine studies will need advanced University education. Recognising the fact that further education and training will prove to be a good investment for the nation, the Department has taken steps to promote the development of manpower resources through various educational institutions and research organisations.

2.6 Legal Regime

With the establishment of a new international Ocean Regime under the United Nations Convention on the Law of the Sea, 1982, the national laws and regulations need to be reviewed, updated and strengthened, more particularly in the field of marine scientific research and protection and preservation of marine environment. The Department has already initiated this process.

2.7 Promotion of other activities

During the year the Department has supported different kinds of activities and also provided help to many institutions in organising symposia, seminars, workshops, exhibitions in different parts of the country.

This Annual Report gives a summary of different activities undertaken by the Department during the year 1984-85 in the following chapters.

3

ANTARCTIC RESEARCH: SCIENTIFIC EXPEDITIONS

Having successfully laid down the foundation of scientific research in Antarctica during the first expedition in 1981-82, and having continued this effort during the second expedition in 1982-83, the Department of Ocean Development organised the third expedition during the Antarctic summer of 1983-84. In addition to carrying out investigations and observations on diverse scientific disciplines, a permanently-manned station in Antarctica was built during this expedition to carry out scientific work on the Antarctic environment throughout the year.

Third Indian Expedition to Antarctica (1983-84)

The third expedition left Goa by a specially chartered Finnish vessel, *Finnpolaris*, on 3 December 1983 and landed on Antarctica on 27 December, 1983. A team of 83 persons, which included two women scientists, was chosen from different organisations of the country. Dr. H.K. Gupta, Director, Centre for Earth Science Studies, Trivandrum was selected as the leader of the expedition and Lt. Col. S.S. Sharma of the Defence Research and Development Organisation as the deputy leader. The team also included 12 persons who stayed back in Antarctica and continued experiments during the Antarctic winter.

Results of Third Indian Expedition

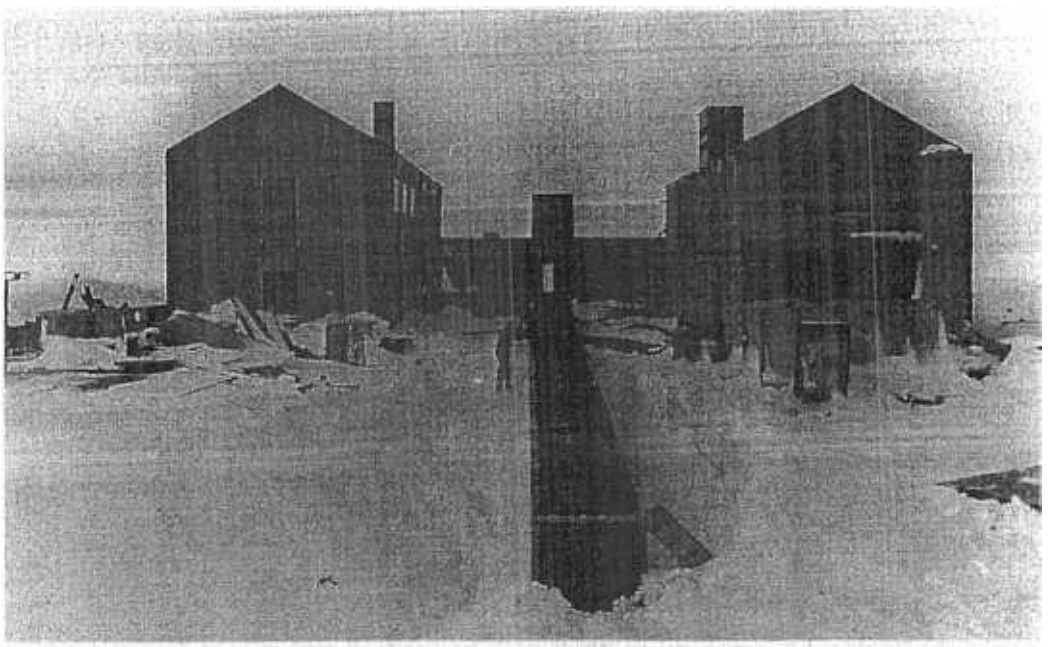
Site Selection for Permanent Station

After consulting all the available material, such as aerial photographs, regional maps, recommendations of the second Indian Antarctic Expedition, and after a detailed survey, a site for the location of the first Indian permanent station in Antarctica was selected on 27 December 1983. The coordinates of the location were 70°05' 37" South latitude 12°00' 00" East longitude. As measured by the Soviet scientists, the thickness of ice shelf in this region is about 150 metres. The site is reasonably close to the ice shelf edge and is free from crevasses. It is smooth and has a good view of Wohlthat mountain range to the south.

The major responsibility of setting up of the permanent station was given to the Indian Army engineers. The construction job in Antarctica is mostly handled by the personnel in uniform by almost all other countries which have set up permanent stations.

3.2.2 Permanent Station: *Dakshin Gangotri*

After the site selection, a base camp was established on 28 December at the site



A view of the double-storeyed permanently-manned station in Antarctica under construction. In the middle of the picture, the pipeline under fabrication is for the disposal of waste after its chemical treatment.

A view of the temporary camp with Skiddo snow scooter used by the Indian team in Antarctica during the construction of the building.

construction. Towards the end of January 1984, the superstructure of the permanent station was completed. On 26 January, 1984, Republic Day was celebrated with great enthusiasm at the new station with Soviet and East German participation.

The permanent Indian station — a pre-fabricated timber structure — is specially designed for Antarctic conditions and can withstand winds upto 100 knots. The two double storeyed blocks, with sloping roof forming loft for storage, are connected by a single storey corridor. The structure rests on a raft foundation extending 2 m beyond the perimeter of the super-structure in all directions for achieving uniform distribution of load. The raft foundation, with an area of 620 sq. m. is buried at a depth of one metre. The building is totally self-contained including workshops, laboratories, surgical room, toilet, communication room, living quarters, recreation facilities, library etc. It is also provided with an ice melting plant and the entire waste material is chemically treated and is disposed of safely without affecting the Antarctic environment.

3.2.3 Scientific and other related work of the Third Expedition

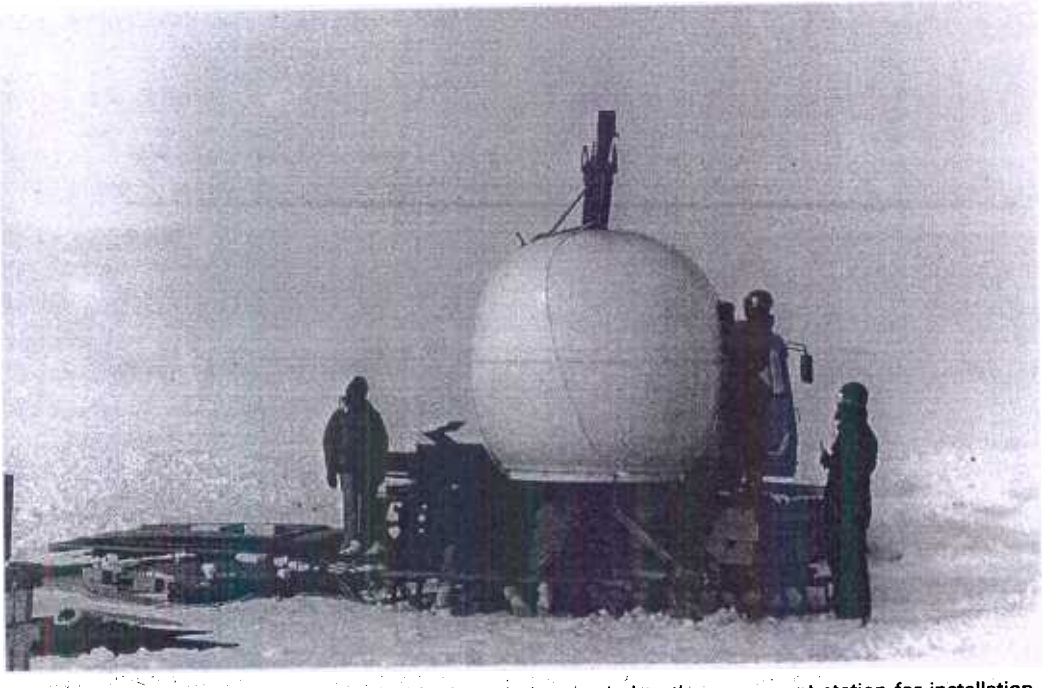
Several scientific programmes of contemporary interests that may have far-reaching significance were undertaken during the Third Indian Scientific Expedition to Antarctica by a team of sixteen scientists belonging to various disciplines of science. Most of the scientific programmes were in continuation of the scientific studies carried out during the first two expeditions, although some new programmes were also initiated during the expedition. The scientific work was also carried out along the voyage to and from Antarctica at the sites of mooring of the ship, at the Base Station and at the Schirmacher Hill region. The various scientific programmes included studies on meteorology, marine biology, microbiology, upper atmosphere, chemistry and glaciology.

(a) Meteorology: In the field of meteorology, as in the previous two expeditions, the primary objective was the collection of as much scientific data as possible concerning the meteorological parameters over the seas between India and Antarctica and over Antarctica itself. The weather of Antarctica influences, to a great extent, the weather over the Indian sub-continent. A detailed study of these meterological parameters over Antarctica may help in understanding the vagaries of weather over India, particularly the monsoons on which our country is critically dependent. The meterological parameters were monitored on board the ship, at the Base Camp and at the Schirmacher Hill region.

(b) Communication: Two satellite communication terminals of the INMARSAT system were installed, one at the base Station *Dakshin Gangotri,* and the second in the nearby *Portacabin,* being the alternate camp. These systems provided telephone and telex links on a global basis. The system was also extended for the use of Telefax and Slow Scan TV transmissions.

A number of radio-communication links, essential for the success of the expedition, were

Large and powerful snow-mobile (Piston bully) in operation. Four of such vehicles were used during the construction of the permanent building.



Satellite Communication System (SATCOM) dome being carried to the permanent station for installation.

established. These included from ship to base camp, from snow vehicles to the ship and the base camp, from mobile parties to the ship and the base camp, from Schirmacher Hills to the ship and the base camps, from ground to the helicopters, and finally from the base camp station to India.

An amateur radio station was also successfully operated throughout the expedition and some 1400 contacts were made. These included several Indian cities, international contacts, and contacts with the other stations in Antarctica.

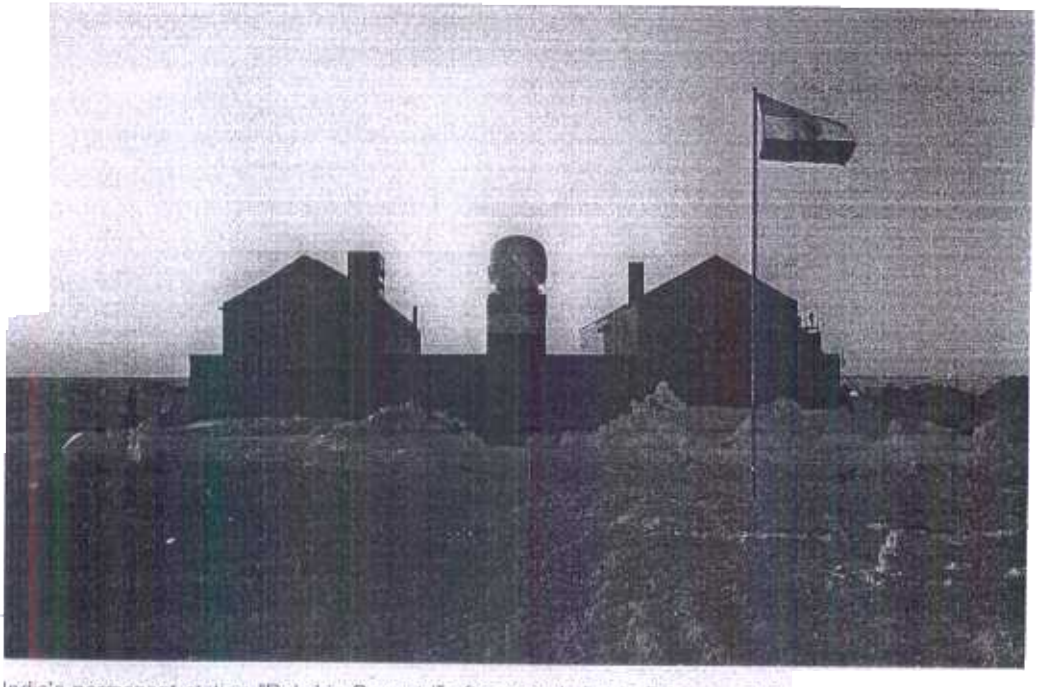
(c) Geology: A detailed geological map of the entire Schirmacher Hill region, some 35 sq. km area, was prepared on 1:25000 scale. The dominant rock types of the area have a high grade quartzo-feldspathic gneisses and their variants have intercalated metabasics. The details of the structure, intrusives, etc. were examined in detail. Tectonically, the rocks have suffered multiphase deformations, with a prominent zone of shearing present along the entire range. In the western part of the range, sulphide mineralization occurs in a 200 m thick band of rusty gneiss which is rich in base metal and graphite. A large collection of samples was made for detailed laboratory studies. Sample collection was also undertaken in the Wohlthat Mountain region.

(d) Magnetic surveys: Total intensity measurements of the earth's magnetic field were carried out at the Schirmacher Hill region and on the ice shelf, using several Proton Precession Magnetometers. Necessary diurnal corrections were made in the data. A total of 5 line kilometres at the station intervals of 6 m were covered over the interesting geological contacts in the Schirmacher Hill region. The preliminary results correlate well with the geological inferences of possible mineralization.

Over the shelf, a total of 60 line kilometres were covered at the intervals of 250 m (40 line km) and 1 km (20 line km). The data are being processed and these would be interpreted in terms of flexure/upwarping of the sea floor.

(e) Biology of krill and other zooplankton: The Antarctic seas are very rich in zooplankton, particularly krill. The shrimp-like krill is known to be a very rich source of protein and possibly the most easily exploitable Antarctic resource. During the expedition, zooplankton samples for the study of distribution, abundance and biological studies were collected from the Polynya (ice free water bounded by icebergs) leading to Antarctic shelf. Moreover, several stations in the sea were worked along a north-bound transect from the Antarctica to Mauritius. Samples were collected from 3 depths within the euphotic zone and were analysed for standard parameters. These studies would be helpful in estimating the krill biomass values.

(f) Observations on sea birds: During the course of the expedition, observations were made on sea birds of the southern ocean between Mauritius and the Antarctic continent. Broadly, the species identified could be divided into two categories: birds observed enroute



India's permanent station "Dakshin Gangotri" after completion in February, 1984

Scientific investigation at the Wohlthat Mountain range.

and those found in Antarctica all, 30 species of birds belonging to 22 genera and seven families were identified.

(g) Biological and Microbiological Studies: Schirmacher Oasis Fresh Water Systems: A preliminary survey was carried out on five fresh water systems in the above oasis. Using a rubber raft and standard oceanographic samplers, water at different depths was analysed for temperature, pH, chlorophyll **a** and productivity in the water column using $NaH^{14}CO_3$. The fresh water systems in the Schirmacher Oasis were found to be highly productive.

Coastal and Shelf Studies: Diurnal and seasonal variations on phytoplankton activity in the shelf waters were investigated. Chlorophyll **a** and primary productivity were studied routinely along with the other parameters at several depths in the 150 m water coloumn.

Oceanographic Studies: Fifteen stations were occupied on the north-bound transect from Antarctica to Mauritius between 69°S and 35°S. Samples were collected at three depths within the euphotic zone. A marked variation in the chlorophyll **a** and ATP values across the two convergence zones was noticed.

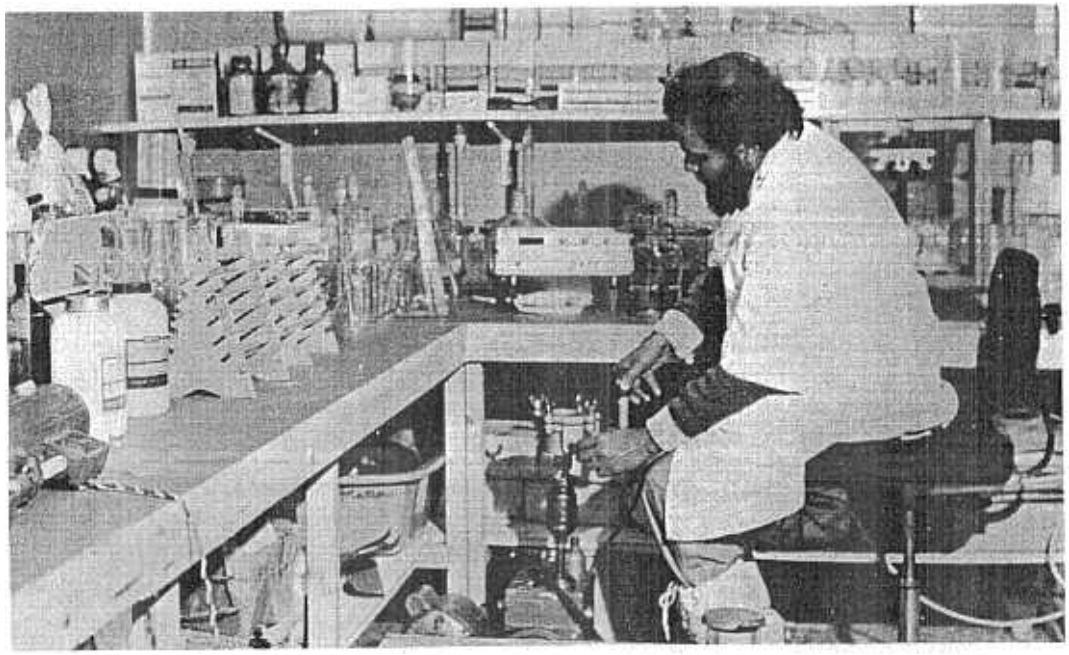
(h) Hydrochemical Studies: Schirmacher Oasis Fresh Water Lakes: Nutrient levels were determined in two fresh water lakes to investigate the biological productivity of the lakes.

Oceanographic studies: A hydrographic station was established in January 1984 off Lazarev, the abandoned Soviet Station. Water samples from standard depths down to 2000 m were collected. On board, analyses were carried out for dissolved Oxygen, pH, alkalinity, salinity, nitrite, nitrate, phosphate and silicate.

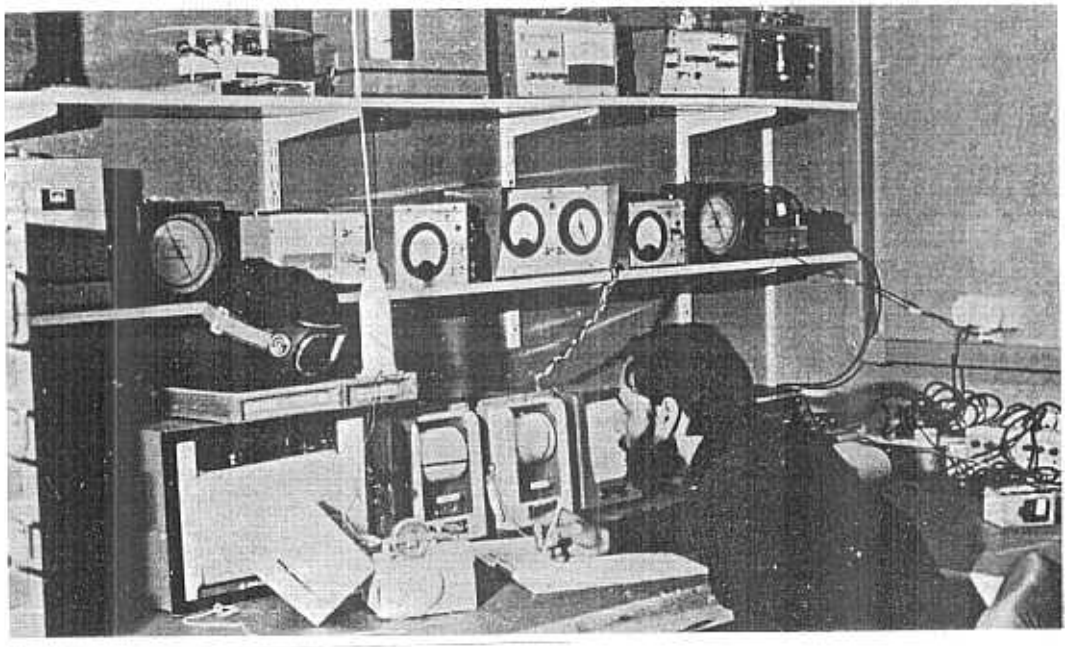
(i) Study on Ionized and Unionized Atmosphere: Studies of ionospheric layer is extremely important for radio communication and has been continued since the first Expedition. During this expedition, a Riometer tuned to 20 MHz was used. Additionally, a microbarograph was used to measure the surface wind pressure fluctuations. These experiments were continued during the winter at the Base Station.

(j) Chemical Studies: Investigations on soil chemistry, vegetation and trace elements were conducted at the Schirmacher Hill region. Since the Antarctic climate is characterized by extreme cold and aridity, soils are formed under the conditions of low precipitation and almost complete absence of higher plant life. Several samples of soil, lichen and snow/ice were collected for chemical studies and for making comparisons with similar studies elsewhere.

(k) Isolation of Bacteria and Fungi: Productive lake sites and soil samples assayed for microbial flora indicated the presence of rich microbial population. Plates grown in the Schirmacher Hill region were used for further isolation. About one thousand morphologically distinct colonies were taken for further purification in the laboratory.



Biological Laboratory inside the Permanent Station



Meteorological Laboratory inside the Permanent Station

A well equipped biological laboratory was set up at the Base Station for conducting the work during the winter months.

(l) *The Runway Site:* A new site for runway was identified at a distance of 2 km east of *'Dakshin Gangotri'*, and the machanical properties of the ice/snow were assessed.

(m) *Photography:* Large numbers of still and movie photographs were taken by the team members.

(n) *Philately:* Some 2000 philately mail covers were marked with special catchets at *'Dakshin Gangotri'* Base Station.

Three doctors, belonging to the services, took care of the health requirements of the expedition and worked extremely well and established excellent medical facilities on board.

(o) *Return Voyage:* After establishing the Indian permanent station *Dakshin Gangotri* in a record time and conducting scientific investigations and achieving most of the objectives planned for the Antarctic summer months of 1983-84, the expedition returned to India via Mauritius on 29 March 1984 leaving behind a 12-member team for continuing the work during the Antarctic winter. Braving extremely difficult conditions, this team in Antarctica accomplished its task fully. The team was felicitated on arrival by the Prime Minister on 6 June 1984.

Members of the first Indian wintering party in Antarctica

The late Prime Minister Smt. Indira Gandhi with the members of the Third Expedition after their return to New Delhi (6 June 1984).

Dr. (Miss) Aditi Pant & Dr. (Miss) Sudipta Sen Gupta Members of the Third Expedition

3.3 Fourth Indian Expedition to Antarctica (1984-85)

The fourth Indian Expedition to Antarctica was sent during the year. MV *Finnpolaris,* the same Finnish vessel, which was chartered for the third expedition, was again procured with appropriate modifications to accommodate men and material for the fourth expedition. This expedition sailed from Goa on 4 December 1984, reached Mauritius on 10 December and after a halt of 3 days left Mauritius on 13 December and landed in Antarctica at 9 PM (IST) on 28 December 1984.

A team of 83 members was chosen from the different organisations of the country and included for the first time, a scientist from a friendly country Mauritius. Dr. Bimalendu Bhushan Bhattacharya, Professor and Head, Department of Applied Geophysics, Indian School of Mines, Dhanabad, was selected as the Leader of the expedition and Shri D.K. Pandey, Senior Geologist of the KDM Institute of Petroleum, Dehradun, as the Deputy Leader. Lt. Col. Padmanabhan Kumaresh of the Crops of Engineers, Indian Army, who has been designated as Station Commander will be the leader of the 12-member second wintering party of the fourth expedition.

The team also includes some members selected for the South Pole expedition, which will be undertaken under the leadership of Lt. Col. J.K. Bajaj during the fifth expedition in 1985-86. These persons will carry out detailed reconnaissance of the area with the help of helicoptors and vehicles. They will also test the vehicles, communications equipment and set up fuel and food dumps on the route upto a selected point beyond the Wholthat mountains during the fourth expedition.

Objectives of the Fourth Antarctic Expedition

Logistics

The primary task of the fourth expedition would be: (a) to carry out essential repairs and a thorough maintenance of the services of the permanent station; (b) to construct additional covered space for parking vehicles and for the storage of equipment: (c) to construct a small field station on rocks in the hills of *Dakshin Gangotri;* and (d) to establish a direct H.F. communication link between the Indian mainland and the Antarctic continent. This link will be in addition to the Satellite link being used extensively at present between India and Antarctica through telephone, telex and slow scan TV.

Scientific

On the scientific side, the expedition will conduct geophysical surveys for ascertaining the mineral potential of the area and will continue the scientific studies initiated during the earlier three expeditions in the fields of geology, meteorology, biology, communications, glaciology, oceanography and environmental studies, the details of which are as follows:

(a) Geophysics

So far, on the previous expeditions, geophysical surveys were limited to operation of magnetometers. A bigger input on geophysical surveys is planned during the fourth expedition. Specially, the following experiments would be conducted:

(i) Magnetic profiles: Using magnetometers, a fairly large area hitherto unknown would be covered.

(ii) Radio echosounding: Radio echosounding will be carried out to estimate the thickness of the ice at a number of locations.

(iii) Electromagnetic surveys: Electromagnetic surveys will be conducted to determine the thickness of ice as well as for investigating the geophysical structure in Antarctica.

(iv) Seismic surveys: Seismic prospecting will be carried out for mapping the basement configuration, locating possible high velocity sediments under the ice cover, and for finding out the crustal structure.

(v) Heat flow measurements: Heat flow would be measured at a number of critical sites.

(b) Meteorology

Monitoring of meteorological parameters will be done during the voyage to Antarctica, and also the site of the ships location in Antarctica and at *Dakshin Gangotri.*

(c) Geology

During the third expedition, the Schirmacher hill range has been mapped on 1:25000 scale. Certain areas have been found interesting for mineral potential. Detailed investigations will be carried out in this area so as to evaluate:

(i) Nature of mineralisation (ore types on the surface and sub-surface).

(ii) Extent of mineralised zone (shape, size, strike length and dip of the ore body, thickness etc.)

(iii) Controlling factors of mineralisation (structural, lithological etc.)

(iv) Bed rock geochemistry and nature of wall rock alteration.

(v) The structural evolution of the shear zones.

(vi) The physico-chemical environment of mineralisation.

(vii) The crustal evolution of the region in the light of plate tectonics.

(d) Environment

Work on aerobiological sampling will be continued and investigations of the effects of man-made changes in the Antarctic environment will be studied.

(e) *Terrestrial life of Antarctica*

Collection of primitive forms of life occurring in Antarctica will be continued.

(f) *Oceanographic studies*

Studies in oceanography will be continued during the voyage to and from Antarctica and along the Antarctic coast. In addition, studies on krill as also microbiological investigations will be continued.

(g) *Communication studies*

Work initiated during the first three expeditions w be continued

(h) *Studies on human adaptability*

Studies on the effects of continuous day light/darkness/over long periods on the human metabolism will be carried out. The effects of living isolation in a small group will also be studied.

The composition of the team for the fourth Indian Expedition to Antarctica 1984-85 is as follows:

Sl.No.	Name & Initials	Organisation
	Aibara, Peolar P D	IN
2.	Appachu, Nb/Sub M G	EME
3.	Bajaj, Lt. Col. J K	EME
4.	Balakrishnan, P K	IN
5.	Bhattacharya, Prof. B B	ISM
6.	Bhoojedhur, Dr. S	Mauritius
7.	Bhukanlal, Shri	IMD
8.	Bisna Ram, CK (O) L	IN
9.	Chand, CK (O) R	IN
10.	Chandra, Maj. D	ENGRS
	Chauhan, Lt. P	IN
12.	Chauhan L. Cdr. A S	IN
13.	Dahiya, Lt. B S	IN
14.	Desai, Maj. J M	ENGRS
15.	Dabholkar Dr. D A	SIIR

Sl.No.	Name & Initials	Organisation
16.	Dhillon, Wg. Cdr R P S	IAF
17.	Doraiswamy, N K	ENGRS
18.	Gajria, Capt. K T	ENGRS
19.	Handa, Wg. Cdr M.R.	IAF
20.	Harish, Sgt. V P	IAF
21.	Harnal, Capt. A	ENGRS
22.	Hyda, Mech, S	IN
23.	Ingole, Mr. B.	NIO
24.	Jagdish, Maj. M P	ENGRS
25.	Joshi, Sqn, Ldr. D P	IAF
26.	Kalaichelvan, Sgt.	IAF
27.	Kalamdev, Poel (R)	IN
28.	Khan, Lt. A A	IN
29.	Khanna, L. Cdr. A K	IN
30.	Khanna, Flt Lt. V M	IAF
31.	Krishnamurthy, Capt G P	ENGRS
32.	Kumar, Flt. Lt. Ajith	IAF
33.	Kumar, CK (O) A	IN
34.	Kumar, Mr. G	PUNWIRE
35.	Kumar, Shri M S	IMD
36.	Kumar, Maj. Naresh	AMC
37.	Kumar, Sqn Ldr Ranjit	IAF
38.	Kumaresh, Lt. Col. P	ENGRS
39.	Kute, Shri A R	DRDO
40.	Mallikarjuna, Flt Lt E	IAF
41.	Manaise, L Cdr A S	IN
42.	Mandal, Sgt K M	IAF
43.	Manoharan, Shri M	NIO
44.	Mathews, Sqt J T	IAF
45.	Mishra, Nb/Sub S N	EME
46.	Mittal, Dr G S	NGRI
47.	Pande, Shri D.K.	ONGC

Sl.No.	Name & Initials	Organisation
48.	Patel, Sgt H S	IAF
49.	Patil, Capt A S	ENGRS
50.	Phand, Hav S	ENGRS
51.	Pillai, Spr K G	ENGRS
52.	Prasad, Hav L	ENGRS
53.	Prashar, Lt. D P	IN
54.	Puri, Mr A	BHEL
55.	Rama Rao, Hav	ENGRS
56.	Robin, L Cdr Apa	IN
57.	Sangewar, Shri C V	GSI
58.	Sarpotdar, Maj S P	DRDO
59.	Shankar, Capt R	ENGRS
60.	Shekhar, L/Hav S	ENGRS
61.	Shivaji, Dr. S.	CCMB
62.	Simoes, Sqn Ldr I M	IAF
63.	Singh, Dr A	ARA
64	Singh, JWO B	IAF
65.	Singh, N K Balbir	ENGRS
66.	Singh, POR 'TEL C	IN
67.	Singh, Hav Dayal	ENGRS
68.	Singh, L/Nk Kedar	ENGRS
69.	Singh, Hav Shamshers	ENGRS
70.	Sinha, Mr M P	FD
71.	Somanna, Maj K C	EME
72.	Sriwath Reddy, Mr K N	NGRI
73.	Suregaonkar, L/Nk A	ENGRS
74.	Suri, Mr A K	NPL
75.	Sutar, L/Nk A	ENGRS
76.	Thimmaiah, L/Nk B P	ENGRS
77.	Tripathi, Maj R K	AMC
78.	Venkatarayudu, Mr M	NGRI
79.	Verlencar, Dr X N	NIO

Sl.No	Name & Initials	Organisation
80	Verma, Cdr G	IN
81.	Verma, Dr S K	NGRI
82.	Vijayan, Flt Lt E K	IAF
83	Wastrad, Lt Col R G	DRDO

3.4 Participating Institutions during the Fourth Indian Expedition

Geological Survey of India.
2. Indian School of Mines, Dhanbad.
3. KDM Institute of Petroleum Exploration (ONGC), Dehradun.
4. National Geophysical Research Institute, Hyderabad.
5. Birbal Sahni Institute of Palaeobotany, Lucknow.
6. National Institute of Oceanography, Goa.
7. India Meteorological Department.
8. National Physical Laboratory.
9. Amateur Radio Association.
10. Bharat Heavy Electricals Limited.
11. Shriram Institute for Industrial Research.
12. Punjab Wireless Systems Limited, Chandigarh.
13. Centre for Cellular & Molecular Biology, Hyderabad.
14. Defence Research and Development Organisation.
15. Films Division, Government of India.
16. Indian Army.
17. Indian Air Force.
18. Indian Navy.
19. School of Agriculture, University of Mauritius, Mauritius.

3.5 First Indian Scientific Expedition to the South Pole

Having successfully despatched four scientific expeditions to Antarctica and in the light of the experience gained and data and information collected during these expeditions, a decision was taken by the Government to undertake an expedition to the South Pole during the fifth Indian Antarctic Expedition (1985-86). During the fourth expedition, however, a great deal of preparatory work will be carried out such as the reconnaisance of the area,

testing the performance of the vehicles, communication and navigation systems to be eventually used during the South Pole expedition. This work will be performed by six/seven personnel who form a part of the fourth Indian expedition. One of them will return to India for further planning and preparation while the others will stay behind at the permanent station in Antarctica during the Antarctic winter.

The total distance between the Indian permanent station and the south pole is about 2500 km. The actual expedition to the South Pole may have to cover a total distance of about 3000 km each way from the permanent Indian station to the South Pole because of certain deviations which will be unavoidable. At present, the best vehicles available with the indian permanent station in Antarctica are the Piston Bully and four such vehicles have already been used since December 1983. Two additional vehicles will be deployed for the South Pole expedition.

During the first Indian expedition to the South Pole scientific studies have to be undertaken would be of a limited number disciplines like glaciology, meteorology and communication system. Air cover is expected to be provided to the expedition members upto a distance of about 250 km from the permanent Indian station. MI-8 and Chetak helicopters are expected to be utilised for this purpose.

Detailed plans for the south pole expedition are expected to be finalised after the return of the summer party of the fourth Antarctic expedition in March-April 1985.

3.6 Procurement of Ice Breaker (Polar Research-cum-Supply Vessel)

With a view to strengthening the institutional and logistic support including technical and other requirements of the Indian Antarctic Research programme, the Department has initiated several measures. The need for acquiring/constructing an Ice Breaker (Polar Research-cum Supply Vessel) with a view to eliminating dependency on chartered vessels for future Antarctic expeditions was examined by a Task Force set up specifically for this purpose. The Task Force after careful consideration has finalised the user specifications of the vessel on the basis of the experience gained from the three Antarctic expeditions. The Department has initiated action for procuring an Ice Breaker.

3.7 Antarctic Study Centre

The department is planning to set up an Antarctic Study Centre fairly quickly. The objectives of the proposed Study Centre fall into two categories, namely (i) management and scientific research, and (ii) logistic support to expeditions and to the Indian permanent station(s) in Antarctica. To achieve the above objectives, a two-tier structure consisting of a main Research Centre and a logistic support base will be established. The Antarctic Study Centre will function as an attached office of the Department of Ocean Development with sufficient delegated powers so as to ensure speedy implementation of the programmes. Negotiation with the state Governments are underway to select the most suitable place for this Centre.

3.8 India joins the Scientific Committee on Antarctic Research

The Scientific Committee on Antarctic Research (SCAR) is one of the high-powered bodies under the International Council of Scientific Union (ICSU) charged with the responsibilities of advising on different Scientific programmes carried out in Antarctica. The SCAR is an indispensable element of the Antarctic Treaty System.

To carry out scientific research in Antarctica, many nations, members of the SCAR, have established special polar research institutes responsible for the field operations, the running of permanent bases and for planning and coordinating scientific programmes. The Indian National Committee on Antarctic Research (INCOMAR) functions under the auspices of the Indian National Science Academy. India's application for membership of the SCAR was submitted on 28 March 1984. It was considered at the SCAR meeting held in Bremerhaven (FRG) from 24 September to 5 October 1984, at which time India was admitted as a full member of SCAR.

There are in all five categories of membership of the SCAR and the membership in each category depends upon the overall involvement of the country concerned in the work of the SCAR. As a full member of the SCAR, India expects to play a very important role in projecting its scientific programmes.

SCAR maintains permanent working groups in the main Antarctic scientific disciplines. Each national committee may nominate a member of each working group of SCAR. The working groups of SCAR are: Biology, Geodesy and Cartography, Geology, Human Biology and Medicine, Logistics, Meteorology, Oceanography, Solid Earth Geophysics, and Upper Atmosphere Physics. In addition, the SCAR executive has established three groups of specialists, which comprise named individuals, who are not necessarily representatives of national committees.

At the XVIII meeting of SCAR in Bremerhaven, Argentina, Australia, Belgium, Chile, France, Federal Republic of Germany, German Democratic Republic, Japan, New Zealand, Norway, Poland, South Africa, USSR, UK and USA participated as full members. India participated as an observer in the beginning of the session, but was later on elected as a full member of SCAR. Brazil also followed the same procedure. China, Sweden and Uruguay participated throughout as observers.

One of the important items during the SCAR meeting was a workshop on "Energetics and Dynamics of the Middle and Upper Atmosphere at High Southern Latitude". The question of enlargement of the membership of the SCAR, report to the United Nations Secretary General on the "Question of Antarctica", publication policy of SCAR, the international programme BIOMASS, the relationship between SCAR and the Scientific Committee on Oceanographic Research (SCOR) were considered.

India's Antarctic research activities, and the establishment of a manned station in Antarctica in the shortest possible time were noted with appreciation.

3.9 Antarctic Mineral Resource Regime

There is a wide range of opinion and speculation concerning the likely location and extent of hydrocarbon and other mineral deposits in Antarctica. At present, there is no clear proof that deposits suitable for commercial exploitation really exist. The exploration for hydrocarbons in the continental margins around Antarctica is considered to be a possibility within foreseeable future but commercial exploitation may take quite some time. The exploration and exploitation of metallic minerals and fossil fuels on land appear much less possible in the foreseeable future. Much of the geology of Antarctic has remained poorly known because almost 98% of the land surface is mantled in ice to some 1600–4500 metres in thickness. The depth of the Antarctic continental shelf varies from 400 to 800 metres on the seaward edge as compared to world average of 133 metres. The geography, geology and extreme conditions of cold and ice present an enormous challenge for carrying out scientific investigations, exploration and exploitation activities on the continent and in its surrounding waters. The present ignorance of the structure of much of the Antarctic land and continental margin, coupled with the hostile environment and the extent of ice cover, means that the exploratory phase is likely to be prolonged in most areas, before exploratory drilling or exploitation can be considered.

The technology for exploration and exploitation of mineral resources in Antarctica is yet to be fully developed although there are indications that this will be undertaken soon. The concepts behind such potential technology are being developed actively by some developed countries. There are, however, conflicting opinions on how far technology development might permit exploratory drilling and exploration within the next 10 to 20 years. The economic viability of the Antarctic resource exploitation, particularly hydrocarbon and minerals is somewhat uncertain at present.

However, the Antarctic Treaty Consultative Parties have been working on the establishment of a mineral regime for Antarctica. Five meetings of the informal working group have so far been held for this purpose. India started participating in the work of the group after it acceded to the Antarctic Treaty in September 1983 and attended the informal working group meeting held in Washington from 18-27 January 1984 and in Tokyo from 22-31 May 1984. This group had identified the essential elements for a possible mineral regime, which is intended to provide a regulatory framework for the exploration of mineral resources in the Antarctic region, while, at the same time, preserving the integrity of the Antarctic Treaty of 1959. In view of the complexities of the issues and jurisdictional problems involved, the establishment of an acceptable mineral regime for the Antarctic resources is likely to take some time.

3.10 Antarctic Marine Living Resources

The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), which was concluded in 1980, supplements the Antarctic Treaty of 1959 which does not deal with the resource exploitation. Eighteen States and the European Economic Community have signed this Convention. Of these, fifteen States have ratified the same. The

Convention entered into force in April 1982. India's accession to this Convention is under consideration.

The objective of the Convention is 'Conservation of Antarctic marine living resources'. Conservation includes 'rational use' of the resources. To implement the objectives of the Convention, a permanent Commission at Hobart, Tasmania, and a Scientific Committee have been established. The Commission, which is an inter-governmental organisation has a broad array of functions which include, *inter alia,* the facilitation of research, formulation, adoption and revision of conservation measures, and implementation of the system of observation and inspection. The original signatories to the Convention are members of the Commission. An acceding State is entitled to membership during such time as it is engaged in research or harvesting activities in relation to Antarctic marine living resources. India's capabilities in this regard are expected to be considerably enhanced and its activities accelerated with the acquisition of Fisheries Research and Oceanographic Vessel (FORV) *Sagar Sampada* in December 1984.

3.11 Antarctica and the United Nations

In its resolution 38/77 of 15 December 1983, the General Assembly of the United Nations requested the Secretary General to prepare a comprehensive, factual and objective study on all aspects of Antarctica, taking fully into account the Antarctic Treaty system and the other relevant factors. The Assembly also requested the Secretary General to seek the views of all Member States in the preparation of the study and requested those States conducting scientific research in Antarctica to lend assistance for the purpose of carrying out such a study.

Fifty-four Member States, including India, responded to the Secretary General's request. On the basis of the information supplied by the Member States, the Secretary General's report on the Question of Antarctica was presented to the thirty-ninth session of the General Assembly. This study deals with the physical, legal, political, economic and scientific aspects of the question of Antarctica. It also provides an analysis of the Antarctic Treaty system in practice.

When the report of the Secretary General was considered at the thirty-ninth session of the General Assembly, Malaysia with some other countries proposed that the United Nations should establish a sub-committee on Antarctica to examine the subject in greater detail so as to arrive at a consensus on the objectives of a regime in Antarctica and the machinery to achieve such objectives. The Antarctic Treaty Consultative Parties opposed the idea of a United Nation's committee because they did not see the need for a forum on Antarctica in competition with the Antarctic Treaty system. India along with the other Consultative Parties emphasised that any attempt to undermine the Antarctic Treaty system or seeking to alter it drastically could lead to international discord and instability. India emphasised that the Treaty system should be broadened by the accession of more States. The conduct of scientific research and other activities in Antarctica should be for the benefit of all mankind.

4

DEEP SEA-BED MINING

4.1 Polymetallic Nodules

The deep sea-bed is one of the potentially most rewarding frontiers that has challenged mankind in its quest for knowledge and material achievement. Resources of the deep sea-bed promise to make an enormous contribution to the world's resource base if their potential is realised. At the present time, the resources of the deep sea-bed are of immediate interest in the form of manganese nodules which lie on the surface of the ocean floor and contain numerous metals – copper, nickel, cobalt, manganese, iron, molybdenum, vanadium and titanium. In addition to the potential for increasing the world's resource base, these minerals are particularly intriguing because they lie beyond the limits of national jurisdiction. According to the new Ocean Regime established under the United Nations Convention on the Law of the Sea 1982, the area of the sea-bed and ocean floor and the subsoil thereof, beyond the limits of national jurisdiction, as well as its resources, are the common heritage of mankind and can only be exploited in accordance with the international regime.

The total reserve of polymetallic nodules in the world oceans is estimated to be several trillion tonnes. About 15 million sq. km. of the Indian Ocean have nodules of different size and quality. The nodules are supposed to be formed at a rate of 10 million tonnes per year. The economics of a manganese nodule mining project is a crucial factor in the development of these resources. Currently the economics can at best be estimated as an order of magnitude. New technology requires to be developed and tested for exploring and mining the manganese nodules from deep sea-bed and at depths ranging from 3500 to 6000 m. Several methods based on dredging techniques are being developed for mining the nodules from the deep sea-bed: the hydraulic system, air lift system, continuous line and bucket system are known to be economically important and can be employed for the recovery of nodules.

Recognising the importance of deep sea-bed resources to the economic development of the country, the research and the development efforts have been concentrated to achieving knowledge and to develop expertise for the exploration and exploitation of nodules from the deep sea-bed. A number of national laboratories and organisations have been involved and their services utilised in the process of survey and prospecting for the resources in the Indian Ocean. As a result of intensive survey, extending over 4 million sq. km. in the Central Indian Ocean area and site specific activities, India qualified to become pioneer investor in deep sea-bed mining. India is the only developing country to acquire such a status . Our country shares this privilege with three developed countries namely France, Japan,

USSR, and four other multinational consortia. India has submitted an application for the registration and allotment of a pioneer area extending upto 150,000 sq. km. in the Central Indian Ocean for further exploration and exploitation of resources. More intensive survey work has been undertaken in the area identified as the application area, at lesser grid intervals.

The survey work involved 176 ship days. ORV *Sagar Kanya* and a chartered vessel were employed for this purpose.

Considerable headway has been made in the indigenous fabrication of boomerang grabs based on the tests carried out at National Metallurgical Laboratory and in improving the design of the dredges for the collection of bulk samples of polymetallic nodules based on the model tests carried out at Central Water and Power Research Station(CWPRS), Pune.

The effective implementation of the polymetallic nodules programme depends upon the establishment of a complete system to transform the nodule to commercially valuable form of metals. It is a high risk and capital and technology intensive venture. Major components of the system are (a) mining, (b) transportation, and (c) processing. The mining system comprises of three components: collector, lift system and surface system. In some countries the different types of collector systems have been tested both on land and in the deep sea on a small scale. Although the basic capabilities of the collectors have been proved, their feasibility is yet to be established particularly on a larger capacity. As regards lifting of the nodules, two systems, namely, the airlift and the hydraulic are being tested. The final choice of the system will, however, depend upon the scale of operations, reliability, maintenance, availability of the components etc. The techno-economic viability and the feasibility studies of deep sea-bed mining are to be carried out. The Department proposes to utilise for this purpose the expert services available in consulting organisations like the Engineers India Limited and Metallurgical and Engineering Consultants (India) Limited.

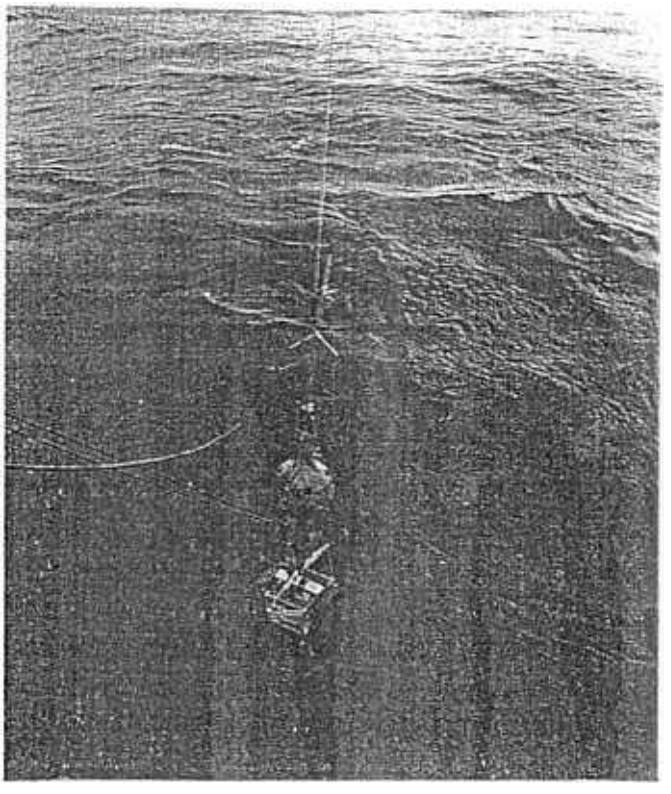
Research and development work and the development of metallurgical process routes and the extraction of metal values from the polymetallic nodules was carried out in several institutions like the Regional Research Laboratory, Bhubaneswar, National Metallurgical Laboratory, Jamshedpur, Hindustan Copper Limited, Khetri, Hindustan Copper Limited, Ghatsila and Hindustan Zinc Limited, Udaipur. Hydrometallurgical and pyrometallurgical process routes were tried for extracting the metals from the nodules. Ammoniacal leaching-cum-solvent extraction and electro-winning process was developed by the Regional Research Laboratory, Bhubaneswar. A semi-pilot processing plant with a capacity of 250 kg. of nodules per day was fabricated and installed by the Regional Research Laboratory, Bhubaneswar. Thus a modest progress in all the different aspects of deep sea-bed mining has been made. However, India's activities in this sphere are still in the initial stages. In view of the technological lead of the developed countries, it is necessary to intensify research and development work in this sector. The Department has taken necessary action in this regard.

4.2 Underwater Technology

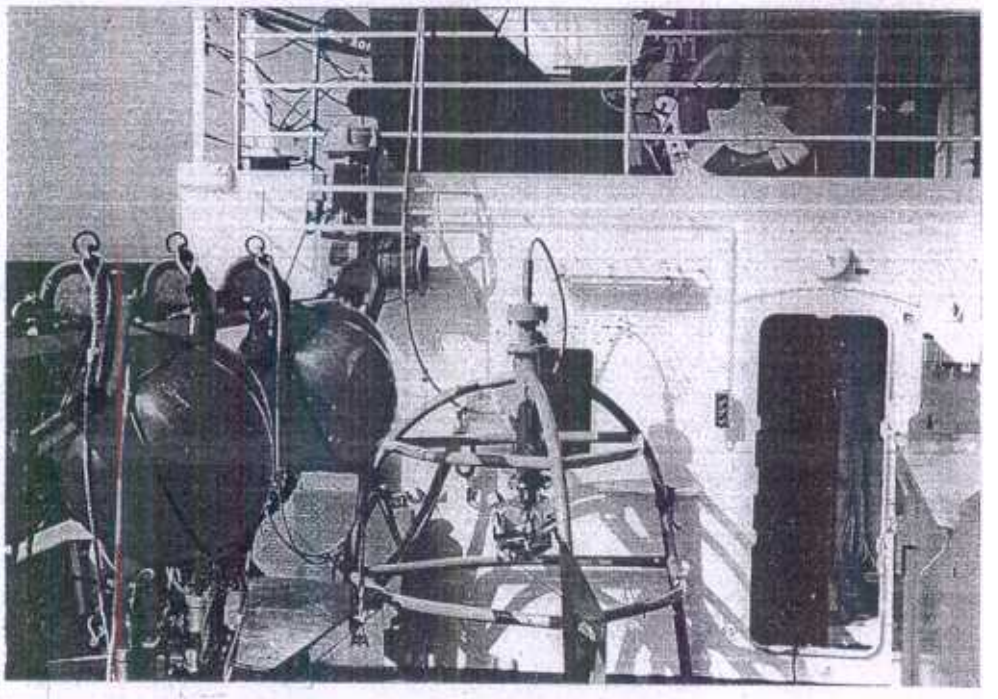
Since many centuries, to know more and more about the deeper parts of the ocean, man is trying to device better and better methods for making observations. For underwater operations in the open seas, submersibles, diving systems and sophisticated instrumentation devices have been developed for exploring and studying the seabed and the deeper layers of the water-mass.

For exploring polymetallic nodules from the deep sea-bed, underwater technology and submersibles capable of operating in depths ranging upto 6000 m will be required. Submersibles will also be required for providing support to the mining activities and also to conduct on-the-spot inspection and repair work, should an occasion arise. Submersibles will also be useful in conducting scientific investigations in shallow areas of the sea and to accomplish various types of works in excellent and safe conditions.

It is, therefore, proposed to build manned submersibles, one with the capability of operating upto a depth of 500 m and another upto 3000 m. Preparatory work for this Project has already been completed.



Boomerang grab being lowered for launching



Airgun array and frame for deep seismic survey in ORV *Sagar Kanya*.

After having considered the desirability and feasibility of acquiring a submersible with complete design, fabrication and operation system, action was initiated to acquire a submersible with the capability of operating at 500 m depth together with the transfer of technology relating thereto. An offer of a Swiss firm was considered but could not be finalised because of the inability of the firm to ensure satisfactory transfer of technology and to accept the normal conditions of the contract for this type of venture. Fresh offers were, therefore, invited on a global basis. The contract for acquiring a submersible operating at a depth of 500 m is expected to be finalised in the coming months. The impact of this project would be: (a) availability of sophisticated submersible and diving systems for scientific research and inspection, and (b) building up of technological capability for making submersibles within the country.

4.3 Development of Marine Technology

The exploration and exploitation of the resources of the oceans involve high technology inputs. The increasing utilisation of the ocean and its resources during the last few years has led to the development of sophisticated new technologies. At present there are no specialised agencies or industrial units exclusively devoted to the development of marine technology in India. Therefore, there is an urgent need for promoting self-reliance in design,

construction and fabrication of sophisticated equipment and systems required for harnessing the ocean resources.

Pursuant to the report of the Working Group for the Seventh Five Year Plan for the Department of Ocean Development, the Department examined during the year the desirability and feasibility of setting up of an Institute of Marine Technology in India. Detailed structure and functions of the Institute are being worked out.

4.4 Preparatory Commission for the International Sea-Bed Authority and for the International Tribunal for the Law of the Sea

The Preparatory Commission for the International Sea-bed Authority and for the International Tribunal for the Law of the Sea was established pursuant to the Resolution I adopted by the third United Nations Conference on the Law of the Sea on 30 April, 1982. The Commission is required to make preparations for the convening of the International Sea-bed Authority and the Law of the Sea Tribunal as soon as the United Nations Convention on the Law of the Sea enter into force after the requisite number of ratifications have been deposited. The Commission is also entrusted with the responsibility for implementing the Resolution II Governing Preparatory Investment in Pioneer Activities relating to Polymetallic Nodules. The conditions for convening the Preparatory Commission having been met on the day the Convention was opened for signatures on 10 December 1982, the first session of the Commission was called in March-April 1983 at Kingston, Jamaica. The second part of the first session was held in Kingston, Jamaica from 15 August to 9 September 1983, at which the organisational and procedural matters were settled. India was elected as one of the vice-chairmen of the Commission.

The first part of the second session of the Commission was held in March-April 1984 and the second session was concluded in Geneva on 5 September, 1984.

The Commission has already established certain guidelines for the registration of "Pioneer investors" applications in terms of the Resolution II of 30 April 1982. But the complete set of rules relating to the registration of applications and allotment of mine sites are yet to be established. A major problem concerning the registration of pioneer investors relates to the resolution of conflicts relating to overlapping claims to deep sea-bed areas for which applications have been made. According to an understanding reached on 5 September 1984, all applicants were required to meet on 17 December 1984 to exchange the coordinates of their applications areas and, in case of any overlap, efforts would be made by the parties concerned to settle them through negotiations.

A meeting of the four pioneer investors, who have filed their applications with the Preparatory Commission, namely, India, France, Japan and the USSR, took place in Geneva from 3-6 December 1984, for the purpose of establishing the modalities for the exchange of coordinates of their application areas for ascertaining overlaps, if any and also to arrive at an

understanding with respect to the question concerning the confidentiality of the coordinates. The representatives of these countries also met in Geneva from 16-20 December 1984 for signing the Agreement on the Preservation of the Confidentiality of data concerning the application areas of the deep sea-bed and the Memorandum on the Procedures for the Exchange of Coordinates of Application areas between the first group of applicants and to exchange coordinates of their application areas in accordance with the Understanding reached at the Preparatory Commission in September 1984. The Special Representative of the United Nations Secretary General was also present at these meetings. After exchanging the coordinates of the application areas, it has been established that in the case of India's application for registration as pioneer investor, there is no overlap whatsoever in the area identified as its application area. Other countries having overlaps in their application area have agreed to undertake further consultations and negotiations with a view to resolving overlaps in accordance with the Understanding of September 1984.

5

ACQUISITION OF NEW RESEARCH VESSELS AND SHIP MANAGEMENT

Till recently, all oceanographic work was carried out by one vessel – R.V. *Gaveshani.* With the arrival of a new vessel, the ORV *Sagar Kanya,* it has been accelerated. This ship has a very wide range of capabilities for conducting studies in practically all disciplines of oceanography. *Sagar Kanya* has been recognised as one of the most modern oceanographic research vessels in the world. Equipped to carry out geological, geophysical, meteorological, biological, physical and chemical oceanography, the vessel can operate in all parts of the Indian Ocean. The ship has a very modern design and is equipped with most sophisticated equipment. Since its arrival, it has completed a series of cruises in the Indian Ocean. It is also being used for the survey of polymetallic nodules.

Another new fishery and oceanographic research vessel FORV *Sagar Sampada* arrived at Cochin on 30 December 1984 after the completion of her maiden test cruises from Denmark.

FORV *Sagar Sampada* is a multipurpose vessel with a long endurance and operational range capable of working in the exclusive economic zone of India and beyond, and also in the South Indian Ocean upto 60° South latitude. It will provide a good support to the Antarctic Research Programme. Its tuna long lining and deep sea trawling upto 1000 m depth, would go a long way in the assessment of fishery resources in the economic zone and also in other parts of the Indian Ocean. The ship is also the first research vessel with a helipad and helicopter hanger on board. The vessel will be used by the Institutes of the Indian Council of Agricultural Research (ICAR). The Central Marine Fisheries Research Institute at Cochin will be the main coordinating agency for the ship-board work. This Institute is the nodal organisation for marine fisheries research in the country with trained manpower and expertise in several disciplines. The ship has been regarded as a national facility available to all other user agencies in the country.

Sagar Sampada has been acquired as a part of the Danish assistance programme at a cost of Rs. 17 crores. It is designed to carry out marine fishery research including biological, physical, geological and chemical oceanographic observations as the major disciplines. The main particulars of the ship are as follows:-

(a)	Length overall	71.50 m
(b)	Length b.p.	63.00 m
(c)	Breadth Moulded	16.40 m

(d)	Depth to main deck - Deck 4	9.00 m
(e)	Depth to freeboard deck - Deck 3	6.40 m
(f)	Draught	5.60 m
(g)	Deadweight	1140 tons
(h)	Gross Tonnage	2661 tons
(i)	Net Tonnage	798 tons
(j)	Speed at 2285 BHP	13.40 knots
(k)	Accommodation for 59 persons-crew and scientists.	

The main physical, chemical and biological laboratories are established in one common laboratory and located at the main deck to ensure optimal working conditions and easy access to the trawl deck and midship hydrographic winch area. The vessel is equipped with wet and dry fish laboratories. It also has a common laboratory for handling the water samples, Carbon^{14} laboratory, acoustic detector room, meteorological buoy, and EDP system, aquarium rooms etc. In addition, a drawing office with copying facilities, dark room, archives, electrotechnical and mechanical workshops for the service to all instruments and equipment on board and a special system of weighing machines have also been provided. The ship has freezing and chilling facilities to deal with 50-100 tonnes of fish on board.

A draft cruise programme of 5 cruises commencing from January 1985 to 15 July 1985 has been prepared by the Working Group of Central Marine Fisheries Research Institute (ICAR), Cochin. The cruises will be undertaken in priority areas—west and east coasts of India—including the Andaman Seas to assess the fishery potential of the exclusive economic zone. The major technical programmes envisaged during the cruises are pelagic and bottom trawling, tuna long lining, oceanography, acoustic surveys, meteorological data collection, biochemical and physiological investigations, post-harvest technology and fishing gear research. Based on the endurance of the vessel, each cruise has been planned for about 35 days. Seventeen different organisations of the country will be taking part in these cruises.

In subsequent cruises extending upto 60° South latitude for the Antarctic krill, the Integrated Fisheries Project of the Ministry of Agriculture will be associated. Similarly, the Central Institute of Fishery Technology will undertake the processing aspect of krill.

FORV *Sagar Sampada*

6

CRUISES OF RESEARCH VESSELS

Two research vessels—RV *Gaveshani* (CSIR) and ORV *Sagar Kanya* (DOD) were utilised during the year for marine surveys and research. The area of operation of these vessels covered the Arabian Sea, Bay of Bengal and the Central Indian Ocean down to 20°S latitude. Besides the scientists from the National Institute of Oceanography, Goa, scientists from ten other research institutions, two Defence Research and Development laboratories, three industries and twenty educational institutions participated in the cruises. The availability of ORV *Sagar Kanya* with its most modern and sophisticated facility provides the scientists of our country an opportunity for the study of the dynamics of oceans and associated oceanographic phenomena.

These vessels also took part in the experiments for the collection of sea truth in conjunction with the remote sensing data.

A beginning has also been made for the collection of time variable oceanographic data from the moored buoys. The start-treck drifting up launched in the Central Indian Ocean provided environmental data for about seven months,

Both RV *Gaveshani* and ORV *Sagar Kanya* participated in the President's review of the fleet.

ORV *Sagar Kanya* carried out extensive studies relating to the monsoons in the Arabian Sea. The vessel was also employed for the surveys of polymetallic nodules in the Central Indian Ocean. Nearly 84% of the ship time available was utilised.

Cruise 7A (18–21 February 1984: Bombay to Marmagoa)

The cruise was planned to test the deep sea winch and depth transponders of DRS-5 streamer. Fourteen scientists from the National Institute of Oceanography, four from the National Geophysical Research Institute, five from the India Meteorological Department, two from the Naval Physical Oceanographic Laboratory and one each from the Centre for Earth Sciences Studies and Cochin University participated. Winch was tested with a box corer at two locations at a depth of 3600 m and below, off Bombay.

Cruise 7 (23 February to 25 March 1984: Marmagoa to Marmagoa)

The cruise was planned for the survey of polymetallic nodules and surface and upper air

meteorological data from the intertropical convergence zone in the Central Indian Ocean. Fourteen scientists from the National Institute of Oceanography, four from National Geophysical Research Institute, Hyderabad, five from the India Meteorological Department, two from the Naval Physical and Oceanographic Laboratory, Cochin and one each from the University of Cochin, Centre for Earth Sciences Studies, Cochin and Government Polytechnic, Panaji, Goa, participated in the cruise. During the cruise, 29 stations were worked. Bathymetric and magnetic gravity data were collected along the tracks covering the Carlsberg Ridge, Central Indian Ocean Ridge and the Geoidal Low. In addition, sea floor mapping was also carried out using a side scan sonar, off the west coasts of India. The cruise covered a distance of over 13,000 line km.

ATNAV Cruise (17–20 May 1984: Marmagoa to Marmagoa)

The cruise was planned off Marmagoa at a depth of 80 m for testing the Acoustic Navigation (ATNAV) system to be installed on board the vessel. 15 scientists from the National Institute of Oceanography, 5 from the National Geophysical Research Institute and 1 from the Survey of India participated.

Cruise 8 (23 May to 6 July 1984: Marmagoa to Marmagoa)

This cruise was organised for the survey of polymetallic nodules in the Central Indian Ocean. The cruise team included 16 scientists from the National Institute of Oceanography, 5 from the National Geophysical Research Institute and 6 from the India Meteorological Department.

Cruise 9 (12 July to 26 August 1984: Marmagoa to Visakhapatnam)

The major objectives of this cruise were oceanographic studies of the Bay of Bengal with special reference to circulation, heat and salt balance during the south west monsoon period and a study of atmosphere and oceanic boundary layer, dynamics of monsoon depressions and withdrawal phase of the south west monsoon. In all 97 stations were worked during this cruise.

Cruise 10 (1 September to 10 October 1984: Madras)

The objectives of this cruise were oceanographic studies of the Bay of Bengal with special reference to circulation, heat and salt balance during the south west monsoon period and the study of atmosphere and oceanic boundary layer, dynamics of monsoon depressions, and the withdrawal phase of the south west monsoon. In all, 66 stations were covered.

Cruise 11 (20 October 1984 to 10 December 1984)

The main objective of this cruise was to carry out sampling at 25 km interval, sea-bed

photography, bathymetry and echosounding in order to obtain more information on the nodule rich zone in the Central Indian Ocean Basin. Among the participants, 18 (both scientists and technicians) were from the National Institute of Oceanography, 3 from the National Geophysical Research Institute and 1 each from Jadavpur University and Kerala University.

A trial cruise of first 4 days was organised to check the operation of Underwater Acoustic Navigation System, the function of the Deep Sea Winch and to calibrate the EM Log.

During the main cruise of 45 days a total of 12,790 line km. of bathymetric, 9,528.54 line km of magnetic and 7,217.24 line km of gravity data were collected. A total of 490 boomerang grab operations were carried out at 70 stations out of which 139 operations were for photoboomerang.

The sampling indicated the following:

(a) Abundance ranged from less than 1 kg/m^2 to maximum of 13.17 kg/m^2. More than 100 operations showed abundance greater than 5 kg/m^2.

(b) Higher abundance of nodules was observed in red clay type of sediments and low in calcareous oozes.

(c) A good correlation between the nodules recovered from grab and corresponding photographs was observed. The maximum coverage observed in some photographs was more than 50%.

Cruise 12 (21 December 1984 to 3 February 1985)

The objectives of Cruise 12 were to decipher the continent ocean boundary off the west coast of India, determine the northward extension of the Laccadive Ridge and estimate the sediment thickness in the shelf margin basin, collect long cores from the deep sea in order to study the nature of variation in paleo-climate and paleo-upwelling.

The major component of the participants, scientists and technicians were from the National Institute of Oceanography. In addition, 2 from the Oil and Natural Gas Commission, 6 from the National Geophysical Research Institute, 1 from the Centre for Earth Sciences Studies and 1 student from Andhra University also participated.

Extensive geophysical data were collected during the 45 days (4980 line km of echosounding, 3368 line km of multi-channel seismics, 4980 line km of magnetics).

The Survey indicated — (i) a maximum thickness of 2.5 to 3 km sediment in the shelf margin basin, (ii) the presence of a sub-surface basement high parallel to the shelf

edge, (iii) a prominent paleoshelf edge about 10 to 15 kilometres east of the present shelf edge, (iv) oceanic crust at a depth of 4200 metres. The presence of the basement high and thickness of the sediment are extremely significant from the view point of hydrocarbon prospects and merit further investigation.

The geological programme of the cruise was equally successful and resulted in the recovery of deep sea cores, grab samples and dredge hauls. Three cores from various depositional environments were collected (i) a 6 metre long core from a water depth of 3900 metres in the vicinity of the Carlsberg Ridge, (ii) a 5.5 metre core from the Laccadive Sea from a water depth of 2500 metres, (iii) a 3.5 metre core from 4300 metres in the northern Arabian Basin.

Additional samples were a grab sample from 4300 metres and a dredge haul from 200 metres. The core samples varied from foraminiferal ooze to laminated pelagic clays. The dredge sample was usually interesting and contained the presence of corals, molluscs and limestones at 200 metres.

Six more cruises extending upto June 1985 have been planned for ORV *Sagar Kanya*. During these cruises, physical oceanographic studies of the western continental shelf and continental margin of India, biological and oceanographic studies in the exclusive economic zone (EEZ) are planned.

7

CHARTERING OF SHIPS

(i) RV *Gaveshani,* CSIR research vessel which collected the first sample of nodules from the deep sea-bed in 1981 and which was used for further surveys of polymetallic nodules in accessible basins and areas, has a limited endurance. Therefore, it can not be used for extensive surveys lasting 5–7 weeks. ORV *Sagar Kanya,* on the other hand, has all the facilities for survey of polymetallic nodules and has the desired endurance. However, if this vessel is deployed entirely for the surveys for polymetallic nodules, which need to be conducted at close grid intervals, it would adversely affect the cruises of other disciplines of marine science. The new FORV *Sagar Sampada* will be mainly utilised for the surveys and exploration of living resources and to support the Antarctic programme. In order to meet targets for the survey and collection of the bulk samples of polymetallic nodules *GA REAY*—a ship from the United Kingdom has been chartered.

(ii) M.V. *Finnpolaris* was chartered from O.Y. Finnlines Ltd. Finland for undertaking the fourth Indian Expedition to Antarctica, which sailed on 4 December 1984.

8

MARINE ENVIRONMENT

8.1 Marine Pollution

(a) India has a very long coastline of more than 6000 km. Our coastal waters are extremely rich in food and mineral resources and hence their protection becomes an obvious necessity. There are a number of factors responsible for the pollution of our coastal waters. These include sewage discharge from large cities, industrial waste, harbour waste, dumping of garbage and agricultural waste etc. The magnitude of oil pollution in the marine environment is also increasing rapidly, particularly in the coastal waters. Oil pollution arises from tanker accidents, deballasting operations and tank washings, refinery effluents, municipal and industrial wastes, losses from the pipelines and offshore production platforms. The input of petroleum and petroleum products to the marine environment from different sources has been estimated to be quite considerable. Therefore, a study of the health of the oceans becomes essential to understand the effect of many of the potential toxic substances.

Studies on marine environment have been undertaken since mid-seventies by various institutions in the country. The Department of Ocean Development has recently been entrusted with the responsibility to look into various aspects of marine pollution other than those which are land-based. The Department has decided to establish a network of 20 stations along the coast-line for monitoring pollution and other ocean parameters along the Indian mainland and its islands. A Committee on Control of Marine Pollution to deal with the different aspects of the problem has been constituted. Specialised equipment and vessels required for this purpose will be acquired shortly.

(b) Under the United Nations Environmental Programme, an Action Plan for the protection and management of the environment of South Asia Sea Region has been drawn up. A proposal for the establishment of a regional convention, on the pattern of similar conventions functioning in other regions, has also been mooted. However, the basic elements of this proposal are being worked out. India and some other countries of the region have endorsed the idea of an Action Plan. The Department of Ocean Development has been acting as a focal point for coordinating and implementing the proposed Action Plan.

8.2 Remote Sensing

Remote sensing of the oceans, using aircrafts and satellites, has been recognised as a potentially powerful tool in oceanography and particularly for coastal zone management.

Basically, remote sensing consists of measuring reflected, scattered or emitted electromagnetic radiation of different frequencies emanating from the surface of the object of study. Various branches of oceanography, such as physical, chemical and biological, marine geodesy, marine pollution monitoring, sea-ice dynamics, boundary layer meteorology, and climate dynamics, have benefited a great deal from the data collected through remote sensing. From a more practical point of view, maritime activities such as shipping, offshore mining and oil drilling, require effective short-term and long-term forecasting system. Such forecasts have been greatly hampered because of the paucity of data over large stretches of the ocean. With the advent of remote sensing it has now become possible to collect high density and high frequency data on a synoptic and global scale.

The Department has a project on Remote Sensing which is being undertaken by the National Institute of Oceanography, Goa which covers the studies on sea surface temperature, salinity, chlorophyll concentrations, marine pollution etc. A sum of Rs. 29 lakhs has already been spent for this project.

9

ENERGY FROM THE SEA

Oceans are known to be a source of immense energy. In the Indian context, and from the point of view of source potential, technology development and other benefits, the most promising are (i) tidal energy, (ii) energy from ocean thermal energy conversion (OTEC), and (iii) wave energy. The technology for exploiting tidal energy is already available and several organisations are involved in the tidal energy development programme. The Department of Ocean Development has an active programme on (a) wave energy, and (b) ocean thermal energy conversion (OTEC). Both these sources of energy are renewable and pollution-free. These can contribute to the power production in remote islands and coastal towns. India has an excellent OTEC potential and some of the most promising sites are known to be located in the islands of Lakshadweep and Andaman and Nicobar. The wave energy programme, OTEC and related activities are being carried out at the Ocean Engineering Centre of IIT, Madras and at the National Institute of Oceanography, Goa.

A Wave Regulator buoy has been installed successfully by the IIT, Madras, off the Madras harbour on 5 September 1984. It is collecting periodic wave data in a very precise form. These data, in addition to being of vital importance for the Wave Regulator System Project, will be of immense help to the Madras port also.

Wave Rider Buoy being launched off Madras coast.

10

MANPOWER DEVELOPMENT

During the next 5 to 7 years, about 1000 additional scientists, engineers and technicians would be required to man the ocean development programmes. This need is expected to be met by strengthening the existing courses in the universities and in the Indian Institutes of Technology (IITs), by introducing new need-based syllabi in the educational institutions, by organising in-house training, and by providing fellowships, associateships and new positions in the universities and technical institutions. Organisations such as the Council for Scientific and Industrial Research, the Indian Council for Agricultural Research, the Bhabha Atomic Research Centre, the IITs, the Universtiy Grants Commission, the Geological Survey of India, Universities, and many other training institutes, are participating in the effort to build up an adequate manpower of scientists and engineers for newer and more effective programmes in the ocean sector.

During the year 1984-85, a sum of Rs. 7.8 lakhs was spent (upto December 1984) by the Department on various research projects and fellowships intended to promote studies in marine biology, marine chemistry, marine geology, marine geophysics, aquacultural engineering, manganese nodules etc.

11

MARINE RESEARCH AND DEVELOPMENT FUND

A marine research and development fund (MRDF) has been created in the Department as a part of its effort to encourage meaningful ocean-related activities in different institutions including private bodies in the country. In promoting research and development programmes in the ocean sector, the support of a variety of organisations (universities, scientific institutions, industrial units) is needed.

R&D Projects of relevance are selected by the Department after they are scrutinised by experts in the field. Assistance provided includes grants for purchase of equipment, holding exhibitions, organising symposia, conferences, workshops, etc., and for bringing out publications. During the past two years, financial assistance has been provided to a variety of organisations in the country.

Subjects considered for the support under the fund include physical and chemical oceanography, marine biology, marine geology, marine geophysics, ocean engineering, marine ecology, meteorology, marine instrumentation, etc. Besides purely scientific projects, assistance is also extended to projects which have politico-geographic or social dimensions of the Indian Ocean and Antarctica.

Financial support to the extent of Rs. 35 lakhs has been provided (upto December 1984) by the Department to the following institutes and organisations during the year 1984-85:

Berhampur University, Orissa.

2. Jawaharlal Nehru University, Delhi.
3. Indian Institute of Geomagnetism, Bombay.

Mangalore University, Mangalore.

5. National Academy of Sciences, Allahabad.
6. Indian Institute of Technology, Kharagpur.
7. Central Salt and Marine Chemicals Research Institute, Bhavnaga
8. Indian Academy of Sciences, Bangalore.
9. Central Institute of Fisheries Education, Bombay
10. Physical Research Laboratory, Ahmedabad.

12

COLLECTION AND MANAGEMENT OF OCEANOGRAPHIC DATA

Data pertaining to the Indian Ocean collected by many national agencies engaged in ocean sciences, as also those available outside the country, will have to be obtained and stored at one place and disseminated from this centre. Such a responsibility has been entrusted to the Indian National Oceanographic Data Centre set up as a national facility for oceanographic data and information management at the National Institute of Oceanography (NIO), Goa. Sensitivity of the oceanographic data will be examined by a committee before these are released for dissemination.

13

OCEAN COMMISSION

At the request of the Department of Ocean Development the Indian Institute of Management, Ahmedabad prepared a detailed report on the structure of the proposed Ocean Commission. After examining the report, it was considered that the structure of the Ocean Commission proposed by the Institute needed to be brought closer to the structure of other similar bodies such as Atomic Energy, Space, Electronic Commission etc. established by the Government. Therefore, the Department has initiated action to revise the proposal in the light of the structure of other Commissions.

14

COLLABORATION AND ASSISTANCE TO OTHER COUNTRIES OF THE INDIAN OCEAN REGION

At the request of Government of Mauritius, a Mauritian scientist Dr. S. Bhoojedhur of the School of Agriculture, University of Mauritius, Mauritius, was included as a member of the fourth Indian expedition to Antarctica. Mauritius has been closely watching with interest the efforts made by India in the Antarctica, as all the four expeditions sailed to Antarctica after calling for a few days at Port Louis, Mauritius for refuelling and for taking provisions etc.

15
EXHIBITIONS AND FAIRS

Oceans cover more than seventy-one percent of the earth's surface. They constitute an important source of food and minerals and have been used for ages for communication and for other purposes. There is, however, not much awareness among the general public about the potential of the oceans. During the last few years, ocean sciences, ocean engineering and technology, exploration and exploitation of the living and non-living resources of the oceans and their significance in the economic development have come to be recognised. As compared to the magnitude of the task involved, our efforts to popularise marine sciences are still in the initial stages.

With a view to bringing the development in ocean sciences to the knowledge of common man, the Department launched a scheme of exhibitions and mass communication on the programmes of ocean development. The Department also participated in the India International Trade Fair from 14-27 November 1984. A hall on a permanent basis has been taken from the Trade Fair Authority for exhibition purposes. A number of items like models of ships, Indian Antarctic Permanent Station, photographs depicting various oceanographic research activities, panels and charts were exhibited.

The Department also participated at the Gwalior Trade Fair which was inaugurated in the first week of January 1985. The Science and Technology pavilion focussed attention on the ocean sciences and the Antarctic Research programme. The Departments' tablean entitled 'India Explores Antarctica' was awarded the Second Prize at the Republic Day Parade, 1985.

A national seminar on "Growing Focus on Antarctica" was organised in collaboration with the Jawaharlal Nehru University, New Delhi and India International Centre. Scientists from different parts of the country participated in this seminar. The Department also participated in a national symposium on the 'Integrated Studies on Deep Sea Fans in the Bay of Bengal' sponsored by the Department of Science and Technology, in which the research and development activities carried out in various fields of ocean science and technology by various institutions and organisations related to the deep sea fans of the Bay of Bengal was discussed. The seminar also focussed attention on the action programme for continuing the integrated studies on the deep sea fans in the Bay of Bengal.

A project on the various developments in the ocean sector is under preparation for exhibition at the Nehru Centre, Bombay, under the title "Discovery of India".

Department's tableau "India Explores Antarctica" at the Republic Day Parade 1985.

BUDGET AND ADMINISTRATIVE SET-UP

16.1 Budget

The budget estimates (BE) of the Department of Ocean Development for the year 1984-85 were Rs. 2446 lakhs while the figures for revised estimates (RE) 1984-85 are Rs. 1976 lakhs. Budget estimates of Rs. 2889.60 lakhs have been made for the year 1985-86. A summary of the financial requirement for Plan and Non-Plan budget is given below:-

Plan

(Rs. in lakhs)

	Item	*BE 1984-85*	*RE 1984-85*	*BE 1985-86*
	2	*3*	*4*	*5*
	A. Continuing Schemes			
1.	**Oceanographic Survey**			
(i)	Oceanographic Research Vessel (ORV) *'Sagar Kanya'*	300	370	
(ii)	Fishery and Oceanographic Research Vessel (FORV) *'Sagar Sampada'*	340	352	
(iii)	Other Research Vessels	100		50
2.	**Antarctic Research**			
(i)	Expeditions to Antarctica	625	625	350
(ii)	Chartering/running of Ice-Breakers			350
(iii)	Research stations in Antarctica			200
(iv)	Antarctic Study Centre			30
(v)	Acquisition of Ice-Breaker	32		20

* Provision appears under Non-Plan.

1	2	3	4	5
3.	**Polymetallic Nodules Programme**			
(i)	Surveys and exploration	625	273	
(ii)	Mining Research and Development			50
(iii)	Underwater Technology and Submersibles			
(iv)	Metallurgy			50
(v)	Contribution to International Sea-Bed Authority	25		30
4.	**Research**			
(a)	*Marine Research and Development*			
(i)	Assistance for Research Projects, Seminars, Symposia etc.	60	60	40*
(ii)	Remote Sensing for Oceano-graphic Data Collection (under All India Coordinated Projects)	30	30	50
(iii)	Marine Pollution			50
(iv)	Desalination and Marine Chemicals Schemes			25
(b)	*Ocean Engineering Programmes*			
(i)	Studies on Prevention of Coastal Erosion and Wave Energy	25	12	25
5.	**Training**			
(i)	Manpower Training for Ocean Research and Management	30	20	20*
(ii)	National Oceanographic Data and Information System	5		30

* Provision appears under Non-Plan.

	2	3	4	5
6.	**Other Expenditure**			
(i)	Administrative support and Infrastructure	14	12.02	10
(ii)	Exhibitions and Fairs	20	20	50
(iii)	Transit Hostel for Scientific Departments	8		
	A. Total	2244	1774.02	1875
	B. New Schemes			
	Marine Instrumentation			20
2.	Studies on Ocean Thermal Energy Conversion (OTEC)			75
3.	Short Term Training Programmes			30
4	Assistance for Establishment of Post-Graduate Centres			75
5.	International Cooperation			25
	B. Total			225
	Total (A+B)	2244	1774.02	2100

Non-Plan

(Rs. in lakhs)

Sl.No.	Item	BE 1984-85	RE 1984-85	BE 1985-86
	2	3	4	5
	Oceanographic Research Vessel			350
	Fishery and Oceanographic Research Vessel (FORV)	175	75	316
3.	Marine Research and Development– Assistance to Seminars, Symposia, Research Projects etc.			60
4.	Manpower Training for Ocean Research and Management			20
5.	Secretariat	27	27	28.90
6.	Administrative Support and Infrastructure			14.70
	C. Total	202	202	789.60
	Grand Total	2446	1976.2	2889.60

16.2 Administrative Set-up

16.2. Recruitment

The Department of Ocean Development which was created in July 1981 as a Department within the Cabinet Secretariat started functioning as an independent Department from March 1982. The total staff strength of the Department in all grades is 81.

During the year 1984-85 recruitment to the following posts were made:-

Group 'A'	2
Group 'B'	8
Group 'C' (Non-Gazetted)	—
Group 'C'	7
Group 'D'	6

Recruitment was also made to a Group 'B' (Gazetted) post of Hindi Officer. One person belonging to Ex-Servicemen category was appointed to Group 'C' post and two persons belonging to Scheduled Castes were recruited to Group 'D' posts.

16.2.2 Use of Hindi

Sustained efforts have been made during the year to encourage the employees and officers of the Department to use Hindi in their official work. A Hindi unit was also established. A joint Hindi Salahakar Samiti for the Departments of Ocean Development, Science and Technology and Environment was constituted in December 1983 under the chairmanship of the Minister of State.

In order to facilitate the employees and officers of the Department to do their official work in Hindi, various charts brought out by the Kendriya Sachivalaya Hindi Parishad were provided to them. "Karyalaya Sahayika" was also provided to each officer. All notifications and important documents were issued both in Hindi and English languages. The meetings of the Official Languages Implementation Committee (OLIC) were also held regularly.

16.2.3 Office Accommodation

During the year the Department acquired additional space covering an area of 3000 sq. ft in Block No. 9 of the CGO Complex for accommodating its staff and officers.