ANTARCTICA—THE UNKNOWN CONTINENT*

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"President of the Indian Society of Agricultural Statistics, distinguished guests and members of the Society"

I feel greatly honoured to be invited to deliver this lecture before a distinguished audience at the 37th Annual Conference of the Indian Society of Agricultural Statistics. First of all I would like to pay my homage to Dr. Rajendra Prasad, whom I consider one of the very eminent leaders of our country. I have no doubt that the memory of Dr. Rajendra Prasad would continue to remain in the minds of the people of India. Dr. Rajendra Prasad was one of our great freedom fighters. Being a Gandhian, he devoted his life to the service of our people. Although he held the highest office of the President of India—and that too the First President of the Republic of India-simplicity, modesty and humility always marked his way of life. While holding that office, he never considered himself higher and far above than an ordinary citizen of India. It is for such a man that this lecture is dedicated and we have assembled here to commemorate his memory. I sincerely feel that the enthusiasm with which these memorial lectures have been arranged so far, the Indian Society of Agricultural Statistics would continue to perpetuate the memory of Dr. Rajendra Prasad.

A. What is Antarctica ?

The continent of Antarctica, which has hitherto ramained unknown, has been attracting the attention of scientists largely from the developed countries. Several expeditions had been undertaken in the past to know more and more about Antarctica which has often been referred to as the windiest, coldest and the stormiest of all continents in the world. Capt. Robert Falcon Scott, on reaching

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the South Pole on 17th January, 1912, said 'Great God ! This is an awful place.' The development of Antarctic science is linked with the earlier adventures and explorations.

Science in itself is a kind of exploration, whether it is done in the laboratory with atoms or electrons or with plants and animals or with satellites in space, it continues to remain a kind of exploration or adventure. It becomes even more exciting if it is used to study the unknown seas and unknown continents.

Antarctica is the 7th continent of the world. It is much larger than Australia, larger than United States and Europe combined and even larger than India and China put together. In the summer there is continuous sun-light for six months followed by continuous darkness during the winter.

B. Why Antarctica is called an "Unknown Continent" ?

Although man landed on Antarctica more than seven decades ago, his studies have largely been confined to the areas where he landed and where he built his bases of observation. This is because man in Antarctica is entirely dependent on the supplies he carries with him. As long as these supplies last, he is there, otherwise he either perishes or returns to the other continents. This is unlike the Arctic where man can live by obtaining food from the environment and there has been a native population of Eskimos in the Arctic for centuries. Thus, the sciences carried out on Antarctica are restricted to certain regions where intensive observations have been made, but the rest of the continent is still largely unknown. Published data on Antarctica are few and scattered and much of the data related to mineral resources of Antarctica are available only with a few nations.

The continent is almost lifeless. It has an area of 14 million square kilometres, most of which is covered with an ice sheet of 1.6 km of average thickness, varying from a maximum of 4.5 km to a minimum of 800 m. There is about 512,000 square kilometres of land mass which is free from ice. If the Antarctic ice were to melt, it would raise the world's ocean by about 60 metres.

C. The Indian Antarctic Programme :

The possibility of sending a scientific expedition which combines the deep sea exploration and the study of living and non-living resources in the Indian Ocean and the Antarctic region (an area

which is divided from our country only by a few islands and a continuous stretch of water of the Indian Ocean) has been under consideration for some time. After looking into the various implications of a such project, the Department of Ocean Development decided that it would be useful from a scientific point of view to send a scientific expedition as it would add to our knowledge of factors relating to the Indian Ocean and the monsoon phenomenon on which the economy of the country is critically dependent. In addition, there may also be several other advantages in the evaluation of several aspects of life in the ice-bound regions which are akin to areas on our northern frontiers. It would also help in taking concrete steps for environmental protection in our surrounding ocean areas as well as in other linked surroundings.

The ice sheet in Antarctica originated perhaps more than 50 million years ago and has continued since then, completely undisturbed by melt/freeze phenomena which occur, for example, in the Himalayan glaciers and lead to physical disruptions. This Antarctic ice, therefore, acts as an extremely well preserved repository of all things falling on it and buried in it such as fragments of cosmic bodies, nuclear products of cosmic rays, samples of entrapped air and minerals. Scientists from the world over have been experimenting to study and decipher these signals which undoubtedly provide records of global and cosmic changes over past millenia.

The glacial history and the past climatic changes being studied at present from the Himalayan ice samples and glaciers, etc., are inextricably mixed with the effects of the spasmodic uplift (of thousands of metres) that these mountains had experienced. The Antarctica, which represents a stable situation affected only by global climate offers us a reference standard to separate the two sets of information and to refine the information about each set individually—a matter of great scientific importance to India.

Studies on the mass balance of annual glaciers are at present providing us data about the current short-term climatic fluctuations in the Himalayas. Linking this to the annual changes on the largest freeze-melt operation on earth i.e. in the sea regions of Antarctica is bound to yield important scientific insights into the global weather phenomenon, its changes and its effects on our environment. A study of the Antarctic waters, apart from the immense scientific interest it provides, would also be of much economic value. For example, it is known that the whalestocks have become seriously

depleted and many countries feel that further studies on the conservation of the Antarctic ecosystem are of great importance to the future of mankind. The meteorological conditions of the area and their influence on the physics, chemistry and biology of this area including the formation of the Antarctic bottom waters are of very much scientific and economic interest. Antarctica is crucial to global weather phenomena—the air circulation patterns, the cold phases (glacial and interglacial periods) and the sea currents. It, therefore, invites a study of its physical parameters like the radiation balance, water balance, temperature-induced phenomena, etc.

Many other countries have been exploring the Antarctic landmass and the surrounding seas for several decades. Many Indian scientists participated in the International Indian Ocean Expedition (IIOE 1959-65) ; 20 countries and many ships took part in IIOE which was initiated by the Scientific Committee on Oceanic Research (SCOR) and conducted by the Intergovernmental Oceanographic Commission of UNESCO. This expedition covered the Indian Ocean, Red Sea, Persian Gulf and the adjacent areas extending southward up to the Southern Ocean ; but did not go beyond 40 degree South.

Indian science has now developed enough expertise and experience in various branches of geology, geophysics, oceanography, meteorology, astrophysics, space science and communication science to take up a detailed scientific study on the landmass of Antarctica and oceanographic studies in the surrounding seas.

Keeping this in view, the Department of Ocean Development organised two scientific expeditions to the South Indian Ocean and Antarctica during 1981-82 and 1982-83.

The Antarctic continent is 990 km away from Cape Horn which is the southern most tip of Argentina. This is the nearest land area to Antarctica. Antarctica's average height is 1830 m and its highest point is Vinson Massif at 5140 m.

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

The scientific research in Antarctica can broadly be outlined as follows :

(*i*) Antarctica is an important location for observing the interaction of the earth's magnetic field in conjunction with charged particles from the sun.

(*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 the form of long-wave radiation.

(*iii*) The Indian, Atlantic and Pacific Oceans meet around Antarctica as a distinct body of water which girdles the earth and is uninterrupted by any land mass.

(*iv*) Antarctica is a stable platform 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 can be monitored.

(*v*) The glaciers of Antarctica comprise about 90 per cent of the earth's ice. Thus, this continent holds about 75 per cent of the freshwater reserve of the earth.

(*vi*) Antarctic ocean supports a biological community of a few species with large populations and short food chain magnifications. It is among the richest biological provinces on the earth. The important organisms regulating the simple food chain in the Antarctic waters is the red shrimp-like "krill".

(*vii*) In the mesozoic era, Gondwanaland had a common landmass of five continents, namely, Africa, Antarctica, Australia, India and South America. Later, the continents drifted apart and formed oceans in between them.

(*viii*) Geologists believe that rich deposits of minerals, oil, gas, polymetallic nodules, etc. could be found in the Antarctic landmass and under the surrounding sea bed.

The primary objective of the First Indian Expedition to Antarctica was to initiate some of our own research programmes in these fields. Only a few islands separate the sub-continent of India

from the continent of Antarctica. It is, therefore, very desirable that some of the points mentioned above should be probed from the Indian viewpoint.

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

FIRST INDIAN EXPEDITION TO ANTARCTICA 1981-82

A. Many oceanographic processes in the Indian Ocean are governed by the Antarctic ocean, which in turn, effect our coastal seas considerably. The two scientific expeditions to the Antarctic waters were organised entirely as a national effort. In the first expedition, the Council of Scientific and Industrial Research was selected as the lead organsation with the National Institute of Oceanography as the coordinating agency for the expedition. The second expedition was coordinated entirely by the Department of Ocean Development.

For the first expedition, the programme was mooted in July/-August, 1981 and the Department initiated action to organise the expedition on a priority basis.

The main objectives of the first expedition were :

1. To initiate studies, build facilities and expertise in different oceanographic disciplines.
2. To continue and strengthen programme of routine data collection and studies.
3. To identify scientific programmes of significance to the Indian context in scientific and economic terms and pursue these as thrust areas to establish a position of Indian sciencc in this sector.
4. To set up a base of operation on Antarctica.

The major task before the Department was to acquire a suitable vessel (ice-breaker) and the necessary equipment for this expedition.

After careful consideration a Norwegian vessel, Polar Circle from Messrs G.E. Reiber and Co. Bergen was chartered. The excellent earlier record of the ship in Antarctica and facilities available on board, prompted the selection.

The Department lost no time in acquiring all the equipment to the vessel. These included snow scooters, position fixing equipment, bathythermograph, side scan sonar, seismic profiler, echosounders, etc.

All the equipment with the support and cooperation of various Ministries and Departments were purchased and procured in record time Logistic support was provided by the Indian Navy. At the same time, a team of dedicated scientists from the following organisations was selected :

1. Department of Environment (DOEn)
2. National Institute of Oceanography (NIO)
3. Indian Navy (IN)
4. Geological Survey of India (GSI)
5. Indian Meteorological Department (IMD)
6. Indian Institute of Geomagnetism (IIG)
7. National Physical Laboratory (NPL)

The participants were preacclimatised to cold in a vigorous training programme at Gulmarg and on board an oceanographic vessel for sea acclimatisation. The entire team was briefed by several top scientists of the country from different angles.

With the necessary preparation completed, the team assembled at Goa where the chartered ship MV Polar Circle arrived in late November of 1981. After the necessary formalities of loading the essential equipment, stores and accessories, the ship sailed on its voyage on 6th December, 1981 from Marmagao Harbour, Goa.

The team, after a very successful cruise, landed on Antarctica on 9th January 1982. A base camp was set up at Lat. 69°, 59′, 23.12″ S Long. 11°, 56′, 26.83″ E. It was considered an important landmark in Indian Science. The Prime Minister herself sent a message of greetings to the team while it was still in Antarctica. The expedition, after a stay of 10 days on the frozen continent, returned on 22nd February 1982,

The Indian Posts and Telegraphs Department issued a special stamp on 9 January 1983 to commemorate the landing of the First Indian Scientific Team on Antarctica. The stamp designed by the P & T Department was based on a photograph showing the Indian scientists in their camps in Antarctica. The first day cover design comprises a collection of photographs showing different activities of the expedition along with a map of Antarctica.

B. Summary of the Scientific work carried out during the First Expedition to Antarctica.

1. Meteorology

(*a*) On the way to Antarctica' the Indian team made a variety of observations and collected valuable data on atmospheric temperature, pressure, windspeed, humidity, surface ozone, cloud visibility and radiation. Many of these parameters was measured at 3 or 6 hourly intervals.

(*b*) Thirty three radio-sonde balloons equipped with radio transmitters and sensors to record the atmospheric pressure, temperature and humidity were released. These balloons covered the upper atmosphere upto 20-25 km height.

(*c*) Five radio-meter sonde balloons were also launched. In addition to measuring the atmospheric pressure, temperature and humidity, these balloons also measured radiation balance (*i.e.* how much radiation is reflected back into space and how much passes through the atmosphere).

(*d*) The team, during its stay in Antarctica, launched a total of 14 radio-sonde flights to measure precipitation albedo, (the amount of light reflected) of the snow cover, temperature and humidity.

(*e*) An unmanned weather station was set up in Antarctica to measure wind speed, wind direction, air temperature, humidity, and casing temperature. A snow-cum-rain gauge for measuring snowfall was also left behind. The weather station is solar powered and during the winter months, when there will be no sunlight, fully charged heavy-duty batteries are available to provide power to the computer which will record the data on a cassette to be recovered later. The station was named "Dakshin Gangotri", located at Lat. 70 45′ 12.9″ S Long. 11°, 38′, 13.6″ E.

2. *Radiowave propagation studies*

Four different areas of work in these studies were covered as follows :

(*a*) Very low frequency (VL) propagation studies : These consisted of a measuring phase of amplitude of wireless signals transmitted by two OMEGA navigation transmitters.

(*b*) High frequency (HF) propagation time delay : HF standard time signals were measured during the cruise. For this, a synchronised atomic clock, was kept running on board the ship.

(*c*) Measurement of high frequency (HF) radio noise level : This experiment was conducted for measuring the ambient radio noise level over the frequency range 10 KHz to 30,000 KHz using a calibrated field intensity meter.

(*d*) Communication experiments : the result of these experiments indicate that radio communication in Antarctica suffers from several problems. There are radio black-outs caused by the polar cap which last from a few hours to a few days. The non-conducting ice cover makes the operation of antenna difficult. Non-directional beacon transmitters from the helicopter operations were also found difficult to set up.

3. *Glaciology*

Ice samples, ice cores and ice crystals were collected from the ice-shelf studies were conducted on the melting rate of ice as well as on the radiation falling over the ice for 24-hour periods.

4 *Magneticm easurements*

The studies during the expedition can be sub-divided into two parts :

(*i*) Magnetic studies in ocean, and

(*ii*) Magnetic studies on the Antarctic continent,

Magnetic studies in the ocean were carried out using a marine proton magnetometer with a towed sensor. On the whole, 70,000 line kilometres of magnetic data were collected from the sea. In magnetic studies on land, a proton magnetometer was used for

recording the total field continuously. A fluxgate magnetometer to record the field components continuously was used and a digital component fluxgate was used to make on the spot observations, so that the sensitivity of the fluxgate could be derived and verified.

5. *Aerosol measurements*

Forty samples of Aerosol were collected during the cruise by running an indigenously fabricated sampler. These measurements will give an insight into the pollution levels in the oceanic areas between Goa and Antarctica.

6. *Geology*

Rock samples were collected in Antarctica from the out-crops. Dust and debris from within the ice-layers were also collected for petrological and geochemical studies. Some significant observations were made on pack-ice, bay-ice and ice-shelf.

7. *Oceanic Studies*

(*a*) A continuous temperature profile up to 70 meter depth was taken between Goa and Antarctica, which enables to understand the energy tranfer mechanism.

(*b*) Seismic profiling of the ocean-bed was carried out.

(*c*) A productivity survey of the Indian ocean and the Antarctic waters was accomplished.

(*d*) Distribution of chlorophyll-bearing plankton was studied to assess the primary productivity of Antarctic waters.

(*e*) Benthic studies were carried out on the bottom sadiments (sea-floor) to evaluate the qualitative and quantitative aspects of life.

(*f*) Several hundred water samples were collected for chemical analysis of dissolved oxygen, phosphorus, nitrogen and silicatesilicon. Nearly 500 samples of sea water were collected for the analysis of calcium, magnesium, sulphate, fluoride, bromide and iodine.

(*g*) Samples for the study of physical aspects of the Southern Ocean were collected from many stations. Salinity and temperatures at different depths were recorded. The data when processed, will help in the determination of Antarctic convergence and divergence,

8. *Chemistry and biology of shelf-ice*

Experiments were conducted for assessing the magnitude and rate of production of organic matter in the shelf-ice. Ice samples were also collected up to a distance of approximately 20 km from the ice front for the analysis of the nutrient content of ice.

9. *Collection of living organisms from Antarctica work*

Several samples of primitive vegetation such as mosses and lichens from the rock crevices were collected for further investigations.

SECOND INDIAN EXPEDITION TO ANTARCTICA 1982-83

During the year, after the successful completion of the first expedition, the Department organised a second expedition to Antarctica which successfully landed on the frozen continent on 28 December 1982. The following work was carried out by the team:

I. Logistics

(*a*) The stay on Antarctica during the first expedition was for a total duration of 10 days. This was too short a duration for carrying out extensive scientific research on land. The second expedition stayed on the landmass of Antarctica for a period of 57 days.

(*b*) It surveyed the area and selected a site for setting up a permanently—manned station on Antarctica. It established a base camp on the landmass. It recovered the cassette from the automatic weather—recording equipment left behind during the first expedition.

(*c*) It worked out the logistic sfor setting up and servicing a permanently—manned research station on Antarctica. For this purpose, it carried out a detailed assessment of the annual requirements of manpower, stores, equipment and services for the permanently—manned station to be operative during 1983-84 season.

(*d*) It surveyed and identified a suitable airstrip and prepared it for landing of an aircraft.

(*e*) It established a direct communication link between the base camp on Antarctica and India as also between the base camp and the mobile parties on the land-mass and the ship.

II. Scientific

1. *Geological Studies :*

Geological mapping of an area of 4.5 square kilometers on 1:10,000 scale, within the Dakshin Gangotri range, Lat. 70°, 45′, 12.9″S, Long. 11°38′, 13.6″E was completed wherein the nature of the various rock outcrops and structural disposition were plotted.

A geological reconnaissance of the Wohlthat mountains around Lat. 71°, 18'S and Long. 13°, 31'E was also carried out. The Wohl that mountain range can be divided into massifs with south to north trending glaciers emerging from the inland polar ice and the range of exposed rocks of metamorphic and volcanic origin.

2. *Snow and Jce Studies* :

Studies were carried out near the base camp and far inland upto Dakshin Gangotri Hills. These studies covered the recording of (a) snow accumulation and ablation at the shelf (b) changes in the surface microrelief of the shelf ice (c) nature of movement along the crevasses within the shelfice (d) experiment on artificial augmentation of ablation of the shelf-ice (e) thermal profile of the shelf ice (f) crystal studies on ice (g) snow stratigraphy and density profiling of polar and shelf ice (h) studies on ice berg flow drift and stratigraphy.

In addition, a map of the Drkshin Gangotri glacier was made marking the terminal of the ice front. Ice core samples have been collected for dating purposes.

3. *Meteorological Studies* :

In all, 55 balloons were launched from Antarctica which included 8 low level sondes, 6 ozone sondes, 10 omega sondes and the rest radio-sondes (50 of these soundings were successful and yielded valuable data). Lowest temperature recorded was—15°C and the highest was+8°C. However, the average temperature was well below zero most of the time ranging between —5° to —10°C. Winds had a particular pattern of fluctuations with spells of calm interspersed between spells of high winds. The intensity of high winds was increasing towards the end of our stay. There were many clear days in January but cloudy spells increased during February—both low and medium clouds were present. Excellent visibility prevailed most of the time (upto 10 km) but during the storms it was reduced to 50 metres. Strong reflection of solar radiation from the snow

was the most interesting feature of the radiation measurements. Spectral measurements in the UV band showed no significant attenuasation of UV in the reflected solar radiation. Temperature under snow showed a steep gradient going down to—13.5 at 20 feet sharpest gradient existed between the first 10 feet under snow. Diurnal variations were negligible.

4. *Radio wave propagation studies :*

VLF propagation experiment consisted to recording the VLF/ OMEGA signal phase and the amplitude. The phase measurements were carried out with respect to an atomic frequency source. The VLF experiment had also been carried out during the previous expedition and some conclusions were made regarding the quiet time Solar Zenith angle dependence of the D-region electron density. With the more extensive data, these conclusions were reassessed.

Riometer experiment consisted of continuous recording of the extra terrestrial cosmic noise along the local zenith on two frequencies—20 and 30 MHz. The analysis of cosmic noise variations will yield quantitatively the nature of the lower ionospheric variations during quiet time as well as during the geomagnetically disturbed conditions. Several cosmic noise absorption events have indeed been recorded. These events correlated very well with the poor long distance HF reception (from COMCEN Bombay).

5. *Air-Sea Interaction studies :*

A continuous set of observations was made on the temperature at the sea surface and at a level of 40 feet of humidity at the 40 feet level, and of the wind speed and direction at the 40 feet level. A computer programme has been developed to compute the various heat flux terms. It is proposed to compare the heat flux computations as outlined above with the semi-theoretical model calculations worked out earlier.

6. *Microbiological and biological studies* :

Bacterial counts were taken from the shlf ice (at 5 stations) melt water (at 3 stations) and from the ice core (0m, 0.5 m, 1m, 1.5m, ken from the ice shelf near the Indian base camp. Ice incubare done to measure the productivity potential from the 13 llected from the shelf ice. Bacterial counts were taken mples and one core (0m, 1m, 2m, 3m) was taken from

the iceberg. These samples were incubated at 14°C to study the productivity potential of the samples collected from the iceberg.

Five lakes were studied for primary productivity and bacterial counts in the water along with their total suspended matter (particulate), organic carbon and ATP content of the water mass. Fifty soil samples were collected from the field sites close to the five lakes and these were immediately plated for the study of bacteria, fungi, and yeast population respectively. Bacterial counts varied from 1.2×10^4 to 1.8×10^5 fungi counts were found in the range of 10.0 to 2×10^2 whereas yeast counts were also equally high (500 to 9.4×10^3 counts per gm of soil).

Dense patches consisting of mosses, lichens and algae were observed on rocks and on the soil. 40 sample were taken for the study of diversity, biomass, physico-chemical environment of soil supporting the life at Dakshin Gangotri.

Krill biomass was measured from 16 stations. Krills were found both North and South of 68°S. Several shoals of krill were located ranging from few mm to mature 5 cm in length, in the cold, nutrient-rich waters of the Antarctic summer. Detailed laboratory analysis of the samples will provide data about krill biomass in the region of 67°S to 55°S of the Antarctic Ocean.

7. *Geophysical Studies* :

Magnetic survey (measurement of the total intensity of the earth's magnetic field) was conducted over a small part of Antarctica using proton precession magnetometer. The details of the survey are :

Total data collected	:	60 line km
Number of profiles	:	7
Profile interval	:	500 metres
Observation spacing	:	200 metres
Profile direction	:	North—South (App.)
Magnetometer senstivity	:	± 1 gamma

Measurement of diurnal variation of the earth's magnet
was also made at the base station during the survey perio
to remove the diurnal effects.

8. *Paleomagnetism and magnetic properties :*

Fifty rock samples were collected from ten different sites at Dakshin Gangotri for the determination of paleomagnetism and magnetic properties.

9. *Acoustic and hydroacoustic studies :*

Noises produced by the ice cracks in pack ice and those between the ice shelf and pack ice were recorded both through ice and air. The effect of the sun's radiation on the cracking sound was also studied by recording diurnal variation of these noises at intervals of every four hours.

10. *Physical oceanographic studies* :

Ocean thermal structure was studied by recording temperature profile of the oceans continuously upto 450 meters.

11. *Hydroacoustic studies relevent to sonar* :

Existence of well-formed sound channels at shallow depth (10-100 metres) in the Antarctic Ocean was established and the variation of depth of these sound channels with latitude was studied.

12. *Geomagnetic studies* :

The strength of the total geomagnetic field 'F' at the Base Camp (Lat. 69°, 59' Long. 11°, 55') was recorded continuously using a proton magnetometer. The data were recorded every 10 seconds with a sensitivity of ± 1 gamma. The three vector components of the geomagnetic field viz. northward, eastward and vertical (X, Y, Z) where individually recorded. The vertical component 'Z' of the geomagnetic field was measured regularly using a direct reading digital Fluxgate Magnetometer. Spot observations of the strength of total geomagenetic field 'F' were made at the Dakshin Gangotri Camp (Lat. 70°, 45' Long. 11°, 38') as well as around the ice shelf at the base camp. VHF signals at 244 MHz from the Geostationary Satellite Flectsat were also recorded.

It is proposed to set up a manned station at Antarctica by the year 1983-84 to have a continuous scientific observation all the year round.

III. Participating institutions

The members of the team for the second expedition were selected from the following organisations :

1. Geological Survey of India
2. National Physical Laboratory
3. India Materological Department
4. Indian Institute of Geomagnetism
5. National Geophysical Research Institute
6. Naval Physical and Oceanographic Laboratory
7. Ministry of Information and Broadcasting
8. National Institute of Oceanography
9. Bharat Electronics Limited
10. Indian Air Force
11. Indian Army
12. Indian Navy

Mineral Resources of Antarctica :

Antarctica still remains largely unknown geologically. So far there has been no mineral exploitation although exploration of miniral resources is going on both on the landmass and in the adjoining sea.

A British expedition to Antarctica during the early part of this century discovered coal, and burnt it as fuel. This discovery and several others of a similar nature paved the way for finding mineral deposits in these areas. However, most of the rocks of Antarctica are inaccessible and remain buried thousands of metres below the moving ice.

The prospects of exploitating mineral resources of these region was not looked into for a long period of time because of the following reasons :

1. It was not known that there existed large deposit of minerals.

2. The technology to find the exact the location of the minerals and to extract them from the deep ice layers was not known.

3. The prices of minerals and oil were very low to make exploitation economical, particularly in difficult conditions.

4. The region of Antarctica was considered to be outside the area of commercial exploitation.

However, these constraints do not exist today because geologists are of the opinion that exploitable deposits of several minerals including oil do exist in Antarctica and its surrounding Southern Ocean. Technologies are now available to extract minirals and oil from such regions. The prices of minerals and oil are rising sharply and hence man is forced to search for the other avenues to get these minerals. Vinson Massif is an area in Pensacola Mountains. These mountains have geological similarities to some of the most minerally productive areas of the world.

A comparison of the Antarctic minerals, as far as these are known, with other countries of the world has indicated that almost all major mineral deposits are present in Antarctica. Almost 20 mineral deposits are likely to be located in the ice-free regions of Antarctica. Two large mineral deposits have been located in this gigantic continent. These include, iron in Prince Charles Mountains and coal in Transantarctic Mountains.

The Antarctic peninsula had mountain ranges which were once connected with Andes. This would mean that this region of Antarctica may have lead and copper deposits similar to those of Peru and Chile. The Eastern Antarctica has a strucural similarty with several parts of Australia and South Africa, indicating that these areas may have possible deposits of uranium.

Antarctica and its Oil Resources :

There is a strong indication that oil and gas may exist at a number of places in Antarctica and in its surrounding seas. Geologists believe that the most likely places for oil and gas are :

1. The Ross Sea Basin.
2. The Weddell Sea Basin.

The continental shelf of the Ross Sea was once close to the Bass Strait between Tasmania and the rest of Australia where oilfields have already been discovered. Oilfields have also been found off the coast of New Zealand and Argentina. These areas were once close to Antarctica during the Gondwanaland period.

Enough evidence has also been obtained to show tha toil may exist in large quantities in the Bellingshausen area. Thick layers of unmetamorphosed tertiary sediments have been found by the United States research ship, Glomar Challenger. The Indian expedition to Antarctica has also found very thick sediments in the sea close to Antarctica. These types of sediments are normally associated with oil. The scientists from the United States have carried out several investigations in the Ross Sea region. The research ship Glomar Challenger drilled four holes in the shallow waters around 470 metres in the Ross Sea. The three holes were found to contain ethane, ethylene and methane. These holes were drilled away from the oil-bearing areas because Glomar Challenger did not have provisions to prevent blowouts. The existence of these hydrocarbons indicates the possibility of the occurence of petroleum hydrocorbon. The presence of methane is observed in almost all deep sea cores.

Living Resources of Antarctica

The landmass of Antarctica is almost without life but the seas around Antarctica are among the most productive biological provinces on the earth. More than 40 species of sea birds breed on Antarctica near the sea coasts. The Emperor Penguin breeds in winter. Springtails, ticks, mites and midges from the founa of Antarctica.

Krill : Krill is usually found in the areas north and south of 60°S. Many experts on fisheries feel that krill is the world's largest untapped source of natural protein. The total stocks of krill present in Antarctica amount to about 100 million tonnes. Of this, nearly 40 million tonnes are expected to be harvested every year without endangering the stocks. It is the main source of food to all species of whales, fish, seals, birds and squids.

Fish : Several species of fish have been recorded from Antarctica including shell fish and squids. Of the 20,000 species occuring in different parts of the world oceans, about 100 have been recorded from Antarctica.

USSR had carried out commercial fishing in the Southern Ocean since 1967. They used trollers and have obtained upto 300,000 tonnes of fish, largely the Antarctica cod, from the Southern Ocean.

Whaling : Antarctica waters have been found to be very important whaling grounds for the last 50 years. Till today more than one million whales have been killed by the Japaneses and USSR boats. Norway at one time had anchored a floating factory in South Shetlands. There is a strong movement throughout the world that whaling should be stopped immediately and all the whales should be declared as endangered species.

Sealing : Sealing was first a commercial enterprise in the region of Antarctica. The USSR could harvest a large number of crab-eater seals in early 1970s. Harvesting of southern fur and elephant-eater became a known feature in the late 1970s.

Protection of the Environment of Antarctica

The most beautiful scenic landscape in the world is found in the continent of Antarctica. So far, human activities have not spoiled Antarctica. There are no trees in the Antarctic but plant species are quite abundant there. The quality of air and water is not degraded in Antarctica. The scientific research stations in Antarctica have not added any further degradation and the minor changes which may be found in these areas are in the vicinity of the various stations.

Scientists, however, are keen to obtain quantitative measurements of various pollutants on earth so that it is possible to use Antarctica as a datum point for the studies of the pollution of the Environment.

India and the Antarctic Treaty

The Antartic Treaty was signed in Washington in 1959 and came into effect in June 1961. The Treaty is in force for 30 years *i.e.* till June 1990. Originally, 12 countries viz., Argentina, Chile, New Zealand, Australia, Norway, France, UK, USA, USSR, Japan, South Africa and Belgium signed the Treaty. The Antarctic Treaty was kept open to all countries who were members of the UN. Since 1961, some other countries viz., Brazil, Bulgaria, Czechoslovakia, Denmark, Federal Republic of Germany, Italy, Netherlands, Papua New Guinea, Peru, Poland, GDR, Romania and Uruguay have signed the Treaty. Of them, Poland and Federal Republic of German have joined the Consultative Committee. China has also recently acceded to the Treaty. All decisions of the Consultative Committee are through consensus. To participate in the Consultative Committee, a nation has to show evidence of substantial scientific

research in Antarctica. Of the members of the Consultative Committee, 7 viz., Argentina, Chile, New Zealand, Australia, Norway, France and the UK claim territory in Antarctica. The salient features of the Treaty are :

(*i*) Antarctica should be used for peaceful purposes only and that all military activities should be banned ;

(*ii*) Cooperation and exchange for information in scientific research should be established ;

(*iii*) Protection should be given to the vulnerable natural environment ;

(*iv*) All earlier territorial claims should be frozen and non-exploitation of resources should be encouraged.

Recently, the Treaty members have expressed interest in the resources of Antarctica. Although the Treaty does not have provisions relating to the exploitation of resources, in 1981, after consultations amongst the Treaty members, a Convention on the Conservation of Antarctic Marine Living Resources was drawn up. Under this Convention, any country having interest in exploiting the living creatures in the area would be free to join this Convention, which will not be restricted to the Treaty members alone.

The first session of the Special Consultative Meeting on Antarctic mineral resources was held in Wellington, New Zealand from 14th to 25th June 1982. The Indian High Commissioner in New Zealand has reported that a regime for the exploitation of mineral resources is expected to be established in about 2 years. It is obvious that the Treaty nations have started thinking ahead and particularly to the time when the existing mandate of the Antarctic Treaty comes to an end in 1990-91. The intention seems to be to freeze the present situation thereby avoiding a scramble for resources while simultaneously confining them to a closed club. Other countries are also evincing interest in Antarctica, and perhaps in its resources. Brazil has already sent an expedition to Antarctica in 1982-83. According to reports, China and Peru may be sending expeditions to Antarctica soon. Reportedly China and Brazil sent their observers to the last Scientific Group Meeting of the Treaty. There are reports that China has been sending its scientists to the Stations of Australia, New Zealand and Chile in Antarctica. It is reliably learnt that China is preparing to send an expedition to Antarctica in the near future and is expected to set up a research base there.

Although the Antarctic Treaty was originally signed in 1959, India did not join it at that time because India's scientific interest in Antarctica has developed only in recent years. After a careful consideration, India acceded to the Antarctic Treaty on 19 August 1983 and the Instrument of Accession was handed over to the Depositary Government in Washington D.C. On 12 September 1983 at a Special Consultative Committee Meeting held in Canberra (Australia), India's nomination for a Consultative Status was considered and India was give a full Consultative Status as a 15th Member State. India's Antarctic Programme was received with appreciation and in the 12th Antarctic Treaty Consultative Meeting (ACTM) held in Canberra from 13 to 27 September, India participated as a full Consultative Member. In the same meeting, Brazil was also given a Consultative Status as 16th Member State.

The reasons for India's joining the Antarctic Treaty are as follows :

(*i*) By achieving the Consultative Status, India has a right to express her opinion on all matters related to Antarctica.

(*ii*) India would be able to exchange scientific information with other members of the Treaty and thereby enhance its analytical capabilities.

(*iii*) India would be able to participate in the meetings of the Consultative Committee and in doing so, will effectively project her own views as well as those of the non-aligned countries of which India is presently the Chair-person.

(*iv*) India will be able to participate in the ongoing discussions on the Antarctic resources and ensure that any regime set up is in harmony with India's overall policies and objectives.