

Tenth Indian Antarctic Expedition — A Review

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The tenth Antarctic Expedition sailed off the Indian coast on 27th November 1990. The 100-member team had representatives from 13 research organisations and three defence services. Survey of India, All India Institute of Medical Sciences, Defence Institute of Fire Research and Indo-Tibetan Border Police participated in the Antarctic Program for the first time. Scientists from National Physical Laboratory and Defence Agricultural Research Laboratory and a doctor from Indo-Tibetan Border Police wintered in the icy continent for the first time.

The members successfully completed all the assigned scientific and logistic tasks. The highlights of the summer period were the establishment of an advanced summer camp in the southernmost part of Humboldt mountains as well as in Petermann I range, erection of generator accommodation and installation and operation of Acoustic sounder. During winter, the going was not very smooth as far as the vehicles were concerned because the team was handicapped due to their unprecedented break-down. In spite of that, the entire fuel and all the Hydrogen cylinders lying at Dakshin Gangotri were transported to Maitri.

The scientific objectives for the tenth expedition are listed below:

1. *Atmospheric Sciences:* This program included recording of usual meteorological parameters at ground level during the voyage as well as at Antarctica, launching of Radiosonde and Ozonesonde Ascents, installation and operation of SODAR at Maitri, measurement of ground level UV-B for columnar ozone calculations, turbidity measurements and aerosol and air sampling for analysis of trace gases.

2. *Earth Sciences:* This program included mapping of southern Humboldt mountains of Wohlthat range, rock sample collections in Petermann I,II,III, Gruber and Schirmacher for petrochemical and geochronological studies, gravity measurements at select locations, soil and rock sample collection for measurement of natural radioactivity. Position fixing of several points in and around Schirmacher was done using GPS.

3. *Biological Sciences*: The bio-sciences program for the expedition included growth and collection of cyanobacteria for physiological, biochemical and genetical studies, optimising Antarctic greenhouse environment and growing plants in hydroponics, phytoplankton count in Antarctic waters and trace element and organic carbon distribution in Antarctic lake waters.

4. *Physiological Studies*: The tasks were mainly the studies on behavioural adaptation to Antarctic conditions. The winter part of the program was to collect medical data and blood/urine samples of all members every month for analysis back home.

5. *Logistic Tasks*: The tasks included identification and loading of cargo at Goa and their packing as per pre-drawn plan, communication links between ship and India, ship and Maitri, Maitri and India and communication support to various field camps and convoys, erection of emergency shelters in field camps, erection of generator accommodation at Maitri, transportation of men and material by helicopters in summer and by convoys in winter, maintenance and operation of gensets, water supply and other life support systems at Maitri and the station maintenance besides providing a medical cover to the members.

The Voyage

On 27th November, 1990, the hundred-member team of the Tenth Indian Scientific Expedition to Antarctica sailed off Mormugao harbour. The members were briefed about the life on the ship and the tasks assigned to them. Members were curious about the unknown - this being a maiden voyage for most of them and that too to a place like Antarctica. They felt elated for being on such a purposeful and challenging trip. Various committees were formed for smooth execution of the tasks. We crossed the equator on 1st December and entered the roaring 40°S (which in our case was relatively calm) on 11th December. Meetings were held with the scientists and logistic personnel discussing the finer details regarding the execution of tasks at Antarctica. Icebergs were sighted from 61° S onwards and without encountering much of the pack ice, the ship reached India Bay in Antarctica on 20th December, the earliest that any Indian Expedition had ever reached.

At Antarctica

The summer camp was established at Maitri the very next day of our touching Antarctica and most of the scientists inducted to start their program. As is desired, each moment of fair weather was fruitfully utilized. Sixth January 1991 saw the establishment of the GSI field camp in the southern most part of Wohlthat mountains. On 7th January, the summer camp at DG was established and fuel transportation from ship to DG started. In the meanwhile, the panels and other

construction material for the generator accommodation was being flown to Maitri and the construction party was on its job. On 8th January, NGRI camp was established at Petermann. Both the field camps were provided, apart from other facilities, a hut, medical and communication support. The huts proved to be life saving as towards the closing stages of the GSI camp, a blizzard blew off all their tents and their survival was possible only due to these huts.

The various scientific and logistic tasks that we could accomplish during the summer period of the expedition are described below :

1. Atmospheric Sciences

Members from India Meteorological Department recorded 3 hourly synoptic observations during the cruise. Sea surface temperature was also measured every 3 hours. During the southward voyage, 14 radiosonde ascents were taken. Five Ozone ascents were taken at Maitri during the summer period.

National Physical Laboratory installed a Sodar at Maitri for the boundary layer studies at Antarctica. Direct UV-B at ground level was measured in the range 280-320 nm to calculate columnar ozone. Turbidity measurements using sun-photometer were made for estimation of aerosol size distribution. During the cruise as well as at Maitri, high volume sampler was operated to collect samples of particulate aerosol and concentrations of oxides of sulphur and nitrogen in air. Antarctic air samples were also collected for analysis of trace gases. The data from the automatic weather station was also taken for use with Sodar data.

The participant from Calcutta University measured various meteorological parameters for planetary boundary layer studies.

Participants from Bhabha Atomic Research Centre conducted measurements of natural radioactivity enroute and around Maitri for estimation of trace element concentrations in atmosphere, sea and fresh water lakes. Number of soil and rock samples around Schirmacher have been collected to estimate the level of natural radioactivity. Sea organism sampling was done during return voyage for natural radioactivity studies.

The geophysicist from National Geophysical Research Institute obtained gravity values at 20 different stations, the locations of which were fixed by Survey of India through GPS system. The data obtained is to be connected with the absolute gravity values of selected points in India.

2. Earth Sciences

Geologists from Geological Survey of India undertook systematic geological mapping in southern Humboldt mountains of the Wohlthat range covering approximately 1000 sq km area. Detailed sampling for petrochemical and geochronological studies was undertaken. Observations regarding various geomorphological and

glaciological parameters were made both in Humboldt Mountains and Schirmacher Oasis. The on-going program, like iceberg monitoring and glacier movement studies, was also carried out. The search for meteorites was conducted over the polar plateau region upto 72° 25'S latitude.

Scientists from National Geophysical Research Institute conducted sampling in Petermann I, II, III, Gruber Mountains and Schirmacher Oasis for studying secular compositional variations in the Precambrian lithologies of Antarctica, with a view to model break up of Gondwanaland.

The participant from Indian Institute of Geomagnetism installed a fluxgate magnetometer at Maitri with a view to measure all the three components of the earth's magnetic field. A 30 MHz riotmeter was also brought for installation but developed some snag.

The group from Survey of India established 16 ground control points using Global Positioning System, Observations were carried out at two ends of each vector. One of the control-points at Maitri was connected with sea level for height calculation above mean sea level.

3. *Biological Sciences*

Participant from Banaras Hindu University established mass cultivation of Antarctic cyanobacteria in collaboration with DARL scientists. Cyanobacteria were found to grow in abundance near the lake feed points. In spite of cyanobacteria, species of green filamentous algae were also observed in the slow flowing streams. Samples were collected for physiological, biochemical and genetical studies.

Scientists from Defence Agriculture Research Laboratory conducted Greenhouse experiments for optimum plant growth under controlled environmental system by continuous monitoring of temperature, humidity, carbon di-oxide concentration and light conditions. A hydroponic unit for growing plants has also been installed wherein the nutrient solution having essential micro and macro nutrients is circulated in a closed NFT system.

Scientists from National Institute of Oceanography collected water samples onboard from equator to 60°S and in Polynya for phytoplankton counts, chlorophyll pigments, bacterial counts and trace element analysis. Sampling in 1.5 fresh water lakes of Schirmacher hills was done with a view to study the trace elements and organic carbon distribution in water.

4. *Physiological Studies*

The physiologist from All India Institute of Medical Sciences studied the behavioural adaptation of the expedition members to Antarctic conditions. A continuous monitoring of physical and physiological parameters was undertaken. These included heart rate, arterial blood pressure, peripheral blood flow, cold pressure test,

sleep test, physical efficiency test, diurnal changes in DLC and sleep-awake studies. Apart from these, psychological response questionnaires were also completed for 50 subjects.

5. Logistic Tasks

The logistics commenced from Goa harbour onwards when the Indian Army contingent took over the responsibility of placement and identification of different cargo. The items were stored in containers as per the priority of requirements. Thus the clothing (to be issued before reaching Antarctica), summer ration and the scientific equipment needed during cruise were kept on the deck. The construction material which was accorded top priority, was stacked in the order of its requirement at Maitri. This helped greatly in starting the construction immediately after reaching Antarctica. The scientific equipment and the personnel were shifted to their site of work soon after reaching the continent and by first week of January, all the working sites, viz., Maitri summer camp, Dakshin Gangotri, Humboldt and Petermann were fully operational. The Army contingent erected the emergency shelters at Petermann and Humboldt which came handy for the camp inmates during the severe blizzard. The camps were provided with communication equipment, generators and the snow scooters to increase their mobility for sample collection. A medical officer was stationed in Petermann camp to provide medical cover to the camp inmates.

Air Force helicopters played a crucial and important role in transporting enormous quantity of building material to Maitri besides commissioning and de-commissioning the advance camps. The Naval team had some rough time initially when their helicopters developed some snag. However, they soon repaired them and the team completed all the tasks assigned to them including the drops given to members of Survey of India at the top of various nunataks.

The main construction tasks completed during the summer period of the expedition were:

- a) erection of a generator accommodation to house nearly 10 generators.
- b) erection of laser heterodyne hut for NPL.
- c) erection of Sodar antenna shield.
- d) erection of huts in field camps at Wohlthat and Petermann.

Other tasks completed were:

- a) transporting entire fuel to DG.
- b) anchoring of water pumping house at Maitri.
- c) on-the-spot training in vehicles and other sub-systems.

The summer component of the tenth expedition started their return voyage after successfully completing their tasks. A group of 25 wintering members including 5 scientists was left behind.

The tasks performed during the wintering period were both of scientific and logistic nature and are briefed here.

Scientific Tasks

1. *Atmospheric Studies (by NPL)*

a) *Ground level UV-B*: The ground level direct UV-B was measured for the months of March, April 1991 and from mid-October '91 to February 1992. This data was used to calculate total ozone on a daily basis. These values were cross-checked with those obtained from ozone ascents both from Maitri as well as from the German Station Georg Forster.

b) *Atmospheric Turbidity*: The aerosol optical depth was measured at 4 different wave lengths spread over the UV and the visible range. Apart from giving aerosol particle size distribution, the data is used as an input in calculating ozone from UV-B data.

c) *Aerosol Sampling*: A high volume sampler was used to collect aerosol samples at regular intervals as per the NPL program. Other constituents sampled were SO_x and NO_x .

d) *Air Sampling*: Air was compressed in stainless steel containers for analysis at NPL for greenhouse gases and other minor constituents.

e) *Automatic Weather Station*: An automatic weather station with a data acquisition system was set up to measure ground level meteorological parameters.

f) *Acoustic Sounder*: A Sodar was installed and data collected for the winter period. This remote probing technique was successfully used to study first few hundred metres of atmosphere for inhomogeneities. The continuous data obtained was used for Planetary Boundary Layer studies.

g) *Infrasonic Pressure Fluctuations*: A microbarograph was used to record the infrasonic pressure fluctuations.

2. *Meteorological Studies (by IMD)*

a) Regular synoptic observations were taken every 3 hr and the data telexed to IMD, New Delhi.

b) Ozonesonde ascents and Radiometric ascents were taken as per schedule. The ozone campaign was intensified in September-October 1991 when ozone is minimum. Regular exchange of ozone data was made with the German station Georg Forster and the Japanese station Syowa.

c) All ground level meteorological parameters were continuously monitored and registered. These included radiation measurement and surface ozone measurement.

3. Geomagnetic Studies (by IIG)

A 3 component magnetometer was installed to measure the components of earth's magnetic field. Analog recording was done on strip chart recorder whereas the digitized values were logged by a data logger. The data was comparable to that recorded at Georg Forster station as was evident from the comparison of various events. Being a year of high solar activity, magnetic storms were very frequent. Polar lights were a regular feature and were photographed.

4. Greenhouse Activities (by DARL)

Present greenhouse has the obvious limitation of facing the east and thereby

- a) not getting adequate sunlight even in the summer months and
- b) prevailing wind being east to west cools the greenhouse extremely during winter and blows snow into it inspite of regular sealing of the slits.

We had to resort mostly, to artificial lights and heating. Hydroponic unit was established for tomato, cucumber, chilli, capsicum etc. in rockwool slabs. Their growth, yield and other aspects were studied. The general growth was good even in polar night. Lake water used for irrigation is slightly acidic and had to be accordingly treated for a favourable pH value. The effect of different light sources on the growth of plants could not be studied due to limited size of the greenhouse. Various seeds have been produced and shall be tried back home. The new green house dome assembled in the summer could not be used because of some limitations which were subsequently removed in the next summer.

Logistic Tasks

Apart from the normal maintenance of the station, the generators, the vehicles, the water supply and other support systems, the following tasks were undertaken.

- a) A new klargester (bio-digester of B3 size) was received through German research vessel *Polarstern*. The same was brought to Maitri by surface transport. A housing was erected for the same and it was installed to treat the station effluent before discharging it in the pit.
- b) A 125 KVA generator was transported to Maitri and installed in one of the bays of generator accommodation. It was used for the best part of the Antarctic winter till it developed a snag in October and had to be discontinued for want of spares.

c) Station and support system maintenance including sorting of stores, indexing of library material, maintenance of radiators and pipes, installation of new urinals and a washing machine was performed.

d) All fuel barrels and part of the bulk fuel was transported by the snow vehicles. The neighbouring Russian station Novolazarevskaya helped us in transporting part of the bulk fuel.

e) A shed with a ramp for vehicle maintenance in absence of a garage facility was constructed from the available material.

f) Three 62.5 KVA generators were retrieved from Dakshin Gangotri station and transported to Maitri. Two of them were installed in the genset accommodation and were used throughout the winter.

g) HF link with India was active and effective throughout the expedition. Daily HF/VHF contacts were made with neighbouring stations Novolazarevskaya and Georg Forster. Occasional contacts were also made with other Antarctic stations like Georg Von Neumayer, Halley-4 etc. An effective VHF link was established with the convoys to DG.

h) For monitoring and keeping a continuous track of the health status of the members, monthly medical check-ups were undertaken. Electrocardiograph recordings of all members were taken at regular intervals. Blood samples of all the members were taken once every three months and stored for transportation back home to be studied at AIIMS. Monthly urine samples were collected for studies at AIIMS. Analysis of all these samples for protein and sugar content was carried out at the station itself. Psychological assessment forms and proforma were duly filled up every three months by all members for analysis at New Delhi.

The team after completing their wintering successfully, were joined by the XI expedition members towards the closing stages of 1991. Alongwith the summer component of the XI expedition, we started our return journey in the last week of February 1992 - a little earlier than usual - to accommodate for the oceanographic work, scheduled during the voyage. Right from Polynya, oceanographic sampling started and continued at intervals of 1 to 2 degree latitudes right upto 40° South. Scientists also utilised this time in preparing their interim reports. The team landed at Goa on 24th March 1992 to mark the end of the expedition.

References

- Hanjura, A. K., Interim report of the Summer period of Tenth Antarctic Expedition, Department of Ocean Development, New Delhi, 1991.
- Hanjura, A. K., Interim report of the Winter period of Tenth Antarctic Expedition, Department of Ocean Development, New Delhi, 1992.



Fig. 1. Wintering team of the Tenth Antarctic Expedition.



Fig.2. Penguins welcoming the expedition.



Fig.3. The expedition vessel M.V. Thuleland,



Fig.4. Front view of Indian Antarctic Station, Maitri.



Fig.5. The generator accommodation, greenhouse dome and bio- digester at Maitri.



Fig.6. Installing the B3 Klargester (bio-digester).



Fig.7. Strengthening the pump house foundation.



Fig.8. Drinking water pipeline at Maitri.



Fig.9. Placing a container at Maitri.



Fig. 10. Generator accommodation under construction.



Fig. 11. Dakshin Gangotri during a winter convoy.



Fig. 12. Fuel dumps at Dakshin Gangotri.



Fig. 13. A field hut in the interior of Wohlthat mountains.



Fig. 14. Aurora Australia viewed in polar winter.



Fig. 15. Plants grown in Maitri greenhouse alongwith environment control systems.



Fig. 16. Acoustic sounder operating at Maitri.