2. DESCRIPTION AND NEED OF THE PROPOSED ACTIVITY

2.1 Need for the station

India through its sustained presence in Antarctica since 1981 has conducted scientific experiments, both at Dakshin Gangotri and Maitri in various disciplines. In view of the emerging trends in Antarctic research, India now intends to broaden the scope of its scientific research in Antarctica by complementing the existing studies from an additional location, so that the studies are regional and comprehensive rather than being site-specific.

Antarctica plays a significant role in global science by providing a platform for observing and measuring several natural parameters like global warming, nature of upper boundary layer, fluctuation in total magnetic field of earth, geological evolution of the crust and movement of crustal plates, fluctuation of continental ice margin etc. Understanding the monsoons and the effect of polar climatic regime in its generation, has been one of the most sought after objectives of climatic and meteorological research being undertaken in Antarctica by India, as it has direct implications on the predominantly agricultural based societal needs.

India has launched several programmes on microbiological diversity, physical oceanography and atmospheric research in the Indian Ocean sector, through regular cruises of its oceanographic research vessels (Vyas et al., 2003, 2004, Anil Kumar et al., 2005; Bhandari et al., 2005; D Souza et al, 2006; Luis et al., 2006; Mathur et al., 2006; Singh et al., 2006, etc.). Similar research in the Antarctic- Southern Ocean sectors of the Indian Ocean would be of interest to supplement and enrich the database.

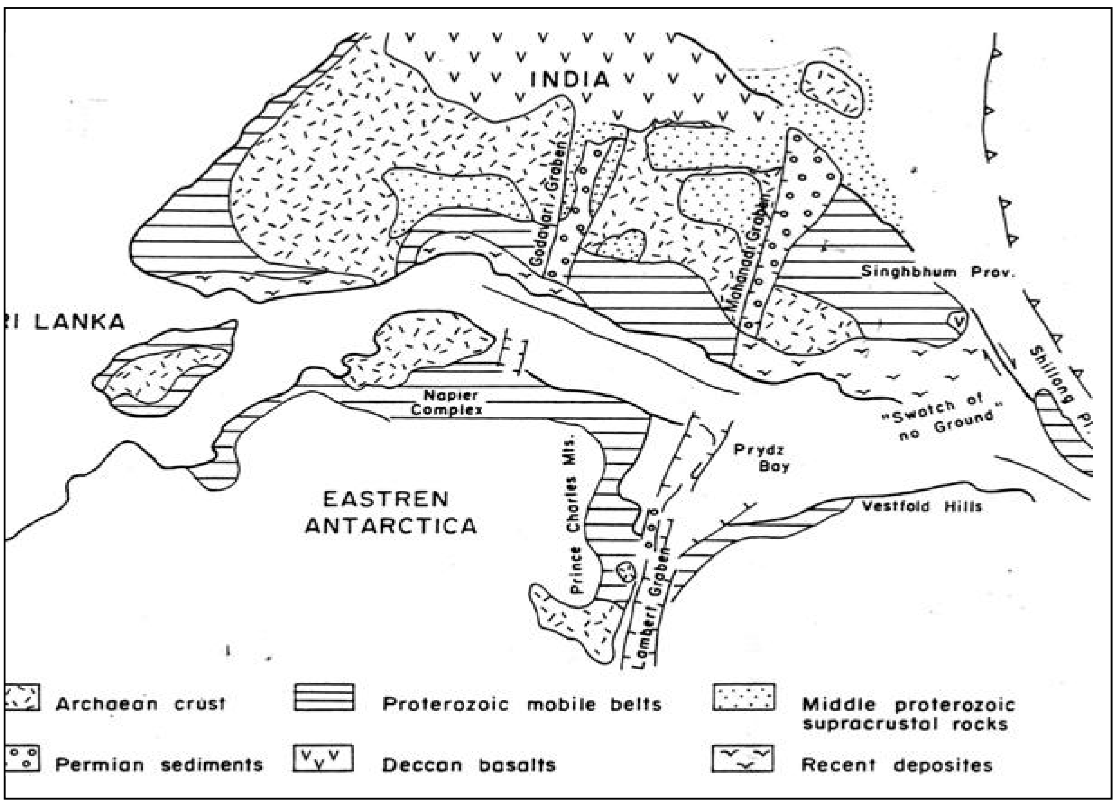
The need to have a location at the proposed site in Larsemann Hills is justified in view of the following scientific and logistic factors:

- The present Indian Antarctic station Maitri, is located in a sub auroral zone, while the proposed site at Larsemann Hills is located in auroral zone. The data set obtained from the two stations would be complementary to each other and would help in understanding the development and movement of longitudinal propagation of localized auroral current systems in a unique way.
- The magnetic field lines originating from Maitri pass over oceans and end up near Greenland in the ocean. There is no magnetic station under the footprint of this field line for conjugate area studies. On the other hand, the field lines originating from Larsemann Hills pass over Middle East and Europe (close to Hungary and Denmark). Both the countries have operational magnetic observatories and the combined data can be used for conjugate area studies.
- India is planning to launch its own polar synchronous satellite - OCEANSAT-2 with a payload of Ocean Color Monitor and Scatterometer followed by RISAT-1 in 2008 for monitoring global chlorophyll, winds and sea ice characteristics respectively. Earth station at Larsemann Hills (76^{o} E) will be extremely useful for having an extended coverage over the Indian Ocean sector of the Southern Oceans, as also the online transmission of data to archival centres in the mainland. The in-situ data collected over the oceans near Larsemann Hills will help in validating ocean circulation models being developed for Southern Ocean.

- The Mahanadi Graben located on the Eastern Ghat Mobile Belt of India exposes an entire sequence of rock types ranging in age from middle/late Proterozoic to Permian. A similar sequence is found to be present along the Lambert Graben. The correlation between the two distant locations with respect to lithology, structure, tectonics, P.T.t., and other geological constraints would help in fine-tuning the Gondwana fit (Figure 4). The significance of this region is best explained by Reading (2006) in the following lines;

"Although there is reasonable outcrop exposure around the Antarctic coastline, the mountain ranges surrounding the Lambert glacier are the only outcrop in the interior of East Antarctica and thus provide a window into understanding the assembly of Gondwana and earlier super continent".

Figure 4 : India-Gondwana Fit

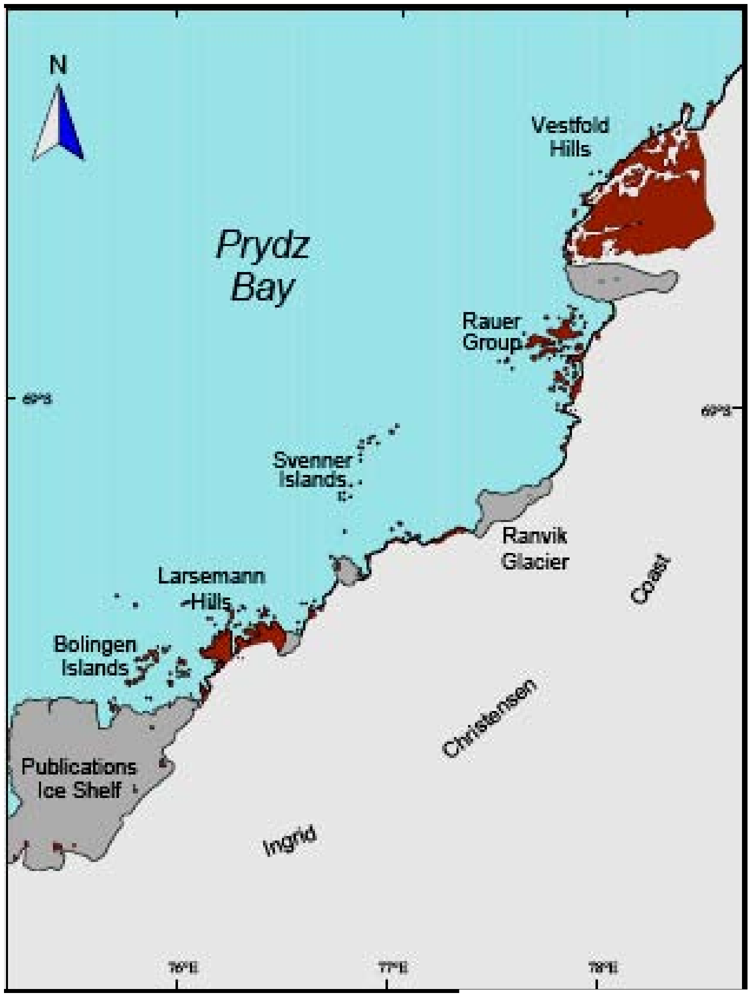


- There are very few locations available along the east Antarctic margin like Larsemann Hills that are free of ice shelf and easily accessible.

2.2 Location of site

The proposed location for new research base is at Larsemann Hills of Prydz Bay area. The Prydz Bay represents an embayment along the Eastern Antarctic margin, lying between the East Longitudes 66^0 and $79^{0.}$ The Amery Ice Shelf on the southwestern side and Ingrid Christensen Coast on the southeastern end define its limits. Isolated islands, promontories, peninsulas and nunataks occurring along the continental ice, describe the rocky terrain exposed in the area, which, from North-East to South-West, fall under Vestfold Hills, Rauer Group, Svenner Island, Larsemann Hills and Bolingen Islands respectively (Figure 5).

Figure 5 : Prydz Bay Area



Source AAD

The Larsemann Hills (69^{o}20'S to 69^{o}30'S Lat : 75^{o}55'E to76^{o}30'E Long), named after Mr. Larsemann Christensen, is an ice-free coastal oasis fringing the Prydz Bay and is located approximately midway between the eastern extremity of the Amery Ice Shelf and the southern boundary of the Vestfold Hills .

There are two main peninsulas on the two extremities of the Larsemann Hills, namely the Broknes and the Stornes Peninsulas (Figure 18). In between these two, there are number of islands of varying dimensions and some unnamed promontories. Westwards, the Clemence Fjord separates Broknes Peninsula from Stinear Peninsula and Fisher Island. The area north and westwards is marked by a number of islands, namely Harley, Easther, Breadloaf, Butler, Betts, McLeod, Jeason, Solomon and Sandercock Island. Geomorphology of the area has been described in detail by Gillieson et al.,(1990), Burges et al., (1994), Hodgeson et al., (2001, 06), Ravindra et al., (2004) and several others.

The area exposes Late Proterozoic rocks comprising gneisses with intrusive granite bodies (Stuwe et al, 1989; Beg, 2005). The physiographic disposition of rocks exhibits low rising strike ridges, lying between the heights of 65 m to 85 m above msl in general. However, the hills close to the continental ice rise to more than 105m. The highest elevation in Larsemann Hills is observed to be 153 m above msl in the Broknes peninsula. The hills are dissected by steep valleys. One such feature represented by the western margin of Thala Fjord, is a N-S running lineament (fault) that runs for a distance of about 5 km. The landscape is controlled by the lithology and geological structures, particularly joints and lineaments. Wind, snow/ice and chemical processes have been the main agencies responsible for the weathering and erosion.

The selected site (69°24'28.8"S: 76°11'14.7"E) is an unnamed pear shaped promontory, trending NE-SW that has its broader end towards sea (Figure 6). The northern and western slopes have a high gradient with the edge being exposed in the form of a steep cliff. The southern margin merges with Polar ice. The western part has ice upto 50 m thick at places and hence hills are inaccessible from this end. The area is fairly undulated, and encased by Thala fjord and Quilty bay, and remains ice-free during most of the months in year. Water is available in a big lake and five small lakes. The big lake (numbered as 37 by Gillieson et.al, 1990) holds water that is saline in characteristics. Smaller lakes, however, have been found suitable for drinking purpose. The site is accessible from open sea through a passage between McLeod and Sandercock Island. A suitable landing site at the northeastern corner of the promontory is an area of low gradient, where landing can be made by barges. With some effort, a flat surface can be carved out of the sloping rocky ground for off -loading cargo on to the land. The area being rocky, an approach road will be made from the landing site up to the proposed site of the station. The flat ground available at location is suitable for the construction of the base.

2.3 Scope of CEE

All the principal activities pertaining to the proposed base inclusive of design, transportation of men, material and machine during construction and operation have been considered in development of this report. The proposed scientific studies have also been taken into consideration, while formulating the CEE.

The CEE has been prepared in accordance with Annex I of the Protocol on Environmental Protection to the Antarctic Treaty (The Madrid Protocol 1991) and the Guidelines for Environmental Impact Assessment in Antarctica (Resolution 4, XXVIII ATCM, 2005). Environmental monitoring during construction and operational phases will adhere to the Practical Guidelines for Developing and Designing Environmental Monitoring programmes in Antarctica (COMNAP, 2005), with regard to various aspects of pollution indicators.

2.4 Proposed facilities at the Station

The Station is being designed as an ergonomic entity in harmony with the local environment. It is proposed to build a self-contained thermally insulated double-storey structure on stilts. While the ground floor will house the general facilities like, storage, laboratories, general facilities etc., upper floor will be used for living accommodation, kitchen, lounge, offices, recreation facilities, medical room, etc. State-of-the-art communication facilities as well as laboratories will be established at the station. As the building is proposed to be constructed at around 50 m above msl, the structure will be visible while approaching the area from north. The designed life span of the station has been envisaged as 25 years. Footprints and different views of site location are shown in Figure 6 a to 6 e.

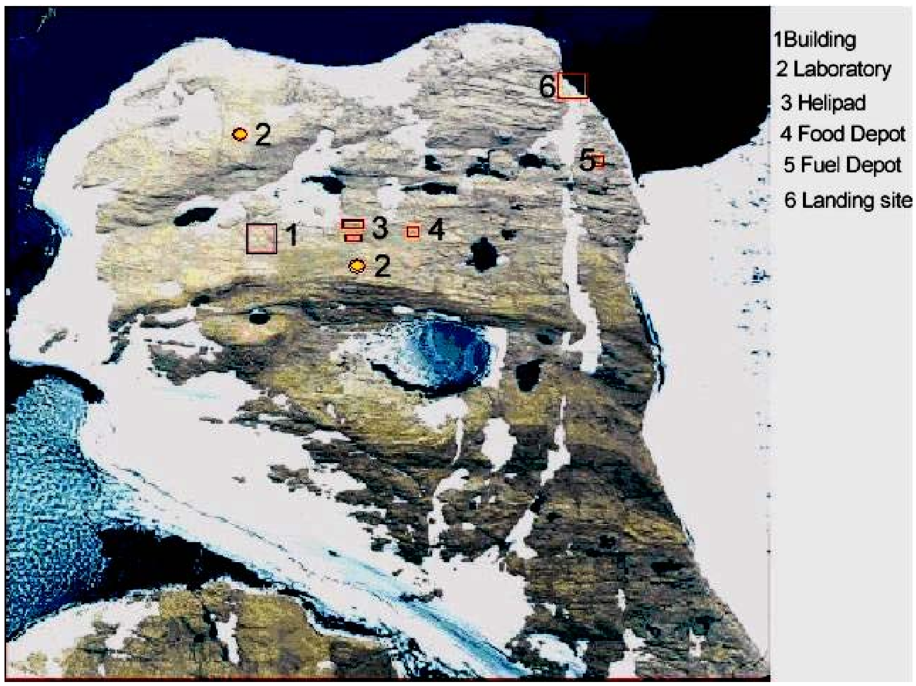
2.4.1 Living accommodation

The Station is being designed to accommodate 25 people during summer and 15 people during winter period *(Appendix 1)* with all the facilities to carry out routine as well as scientific work.

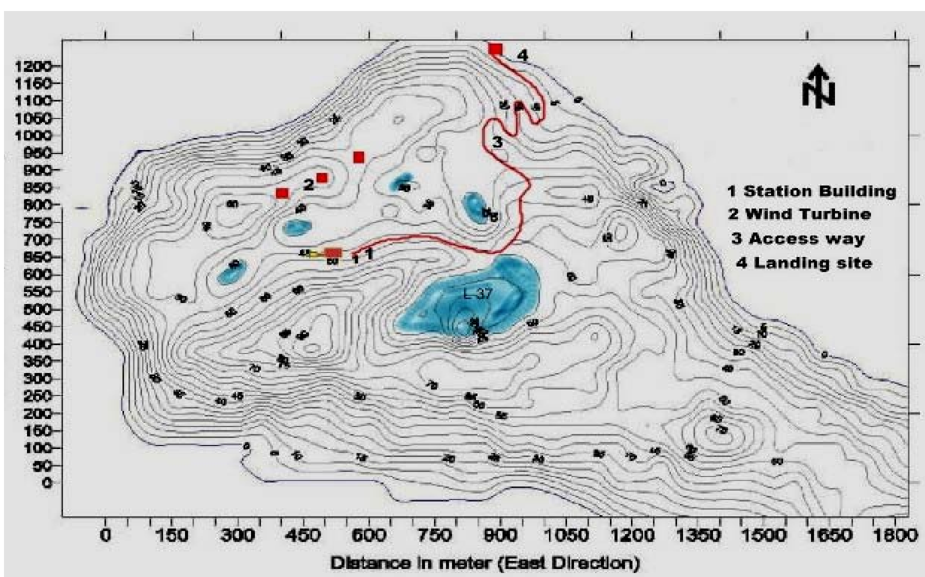
2.4.2 Laboratories

The base will have well-equipped laboratories on the ground floor which would cater to earth and biological sciences as well as environmental studies. Some laboratories such as meteorology, astronomy, geomagnetism and seismology would be located outside of the main station to avoid radio interference, manmade noise and other disturbances (Figure 6). An environmental monitoring laboratory would be among the first facilities to be established to monitor the environmental parameters.

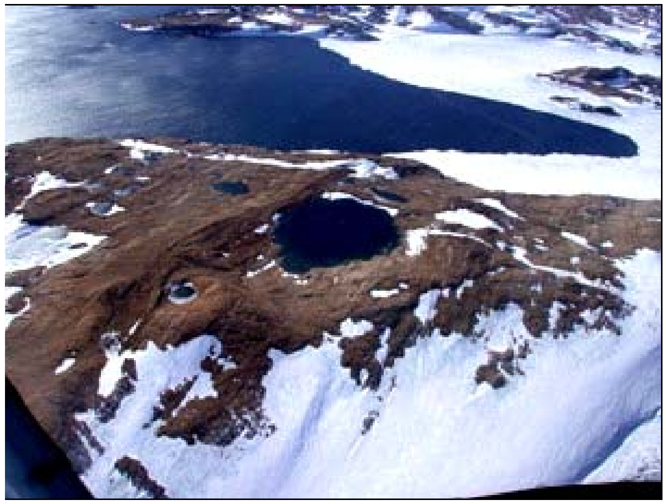
Figure 6: Layout plan of the station building and other infrastructure



(a)



(b)



(c)

(d)

(e)

2.4.3 The Medical facilities

The sick bay and medical room will be housed on the first floor and will have all the modern facilities including an Operation room. The facility will be designed as per the best practice guidelines for sterility and efficiency. Proper health care and safety measures will be enforced to minimize any risk.

2.4.4 The Kitchen and dining

The kitchen and the dining, both adjacent to each other and on the first floor, will be designed to foster the concept of group living in the harsh conditions of Antarctica. The lounge and auditorium will be multifunctional in scope providing facilities for group meetings, discussions and indoor recreation.

2.4.5 The Garage, workshop and Stores

It is proposed to provide these facilities on the ground floor, which would be easily accessible. This structure will comprise pre-fabricated modules with a stress on keeping the noise levels to the minimum.

2.4.6 Waste Management

A well designed wastewater treatment system and a comprehensive solid and liquid waste management system would be implemented with minimum waste generation at source. There will be an overall attempt to keep the environmental impact due to waste generation at minimum.

2.4.7 Water Management

Drinking water demands shall be fulfilled mainly by the small fresh water lakes, which get their recharge through snow accumulation. Recycled grey water will be used for supplementing the water requirements in toilets etc.

2.4.8 Energy Management

While the fuel based power generation system will remain the main source of energy the attempts will be made to supplement the power demand with alternate source like wind and solar energy. The heat generated from the generators will be utilized in heating the station using Combined Heat and Power concept. These provisions will reduce the environmental impact of the fossil fuel.

2.5 Shipping and logistics

2.5.1 Accessibility from the open ocean

The promontory is accessed through the gap between the McLeod and Sandercock Islands Figure 7). This area of the sea has been found to be open during early February 2004, 05 and 06 with presence of some isolated icebergs on the outer periphery. An isolated iceberg was found berthed between the McLeod and the Sandercock islands but comparison of imageries of past few years have shown that the said iceberg is firmly grounded and is getting destroyed (Inset Figure 7).

Figure 7 : Larsemann Hills and Surroundings

(Source AAD)

In Prydz Bay area, bathymetry data was available only upto McLeod Island in navigational charts. During late February 2006, preliminary multibeam swath bathymetric surveys *(Appendix 2 and 3*) were undertaken along a corridor from the grounded iceberg to the western face of the Larsemann promontory to define an approach channel for the ship. The NW-SE trending corridor from the grounded iceberg to the promontory measured about 6 km and had a width of about 2.5 km. Bathymetric data totaling 122 line km was collected along 22 survey lines within the corridor. The minimum depth recorded in the channel was 10 m and the maximum, 460 m.

2.5.2 Transportation and Movement

The men and material would be transported through an ice class ship. Two heavy–lift helicopters will also be used. The weight of the various components of the station will be modulated to conform with the lifting capacity so that transportation of container/modules will be possible by helicopter from ship to site. In addition, barge may also be used for movement of odd-size and heavy equipment/machinery. A Russian airstrip exists about 6 km away from the proposed site and this may also be used as an option to send men and material. The fuel will be transported using flexible pipes by pumping directly from the ship to the shore.

2.6 Construction of Station

The construction is proposed to be initiated in the austral summer of 2008 after getting the necessary approval of the CEP. It is planned to complete the construction activity during two austral summers, by using pre-fabricated structures/modules. A dedicated work force of 25-30 will operate from the ship. One Igloo hut, already placed at the site during 2004-05 will be supplemented by another hut this summer to act as emergency shelters.

Different stages of design development are scheduled as follows:

Basic requirement framework	*April-June 2006*
Expression of Interest	*August-September-2006*
Concept Proposal	*November 2006*
Selection of Architect	*Early December 2006*
Design Development	*May- 2007*
Construction	*Austral Summers of 2008 and 2009*

2.7 Installation of Wind Turbines and Solar Panels

It is proposed to supplement the energy demands through wind and solar energy. The wind turbines shall be installed near the station on the hills, while the solar panels will be placed over the walls and the roofs of the station.

2.8 Decommissioning of Station

The station is designed for total life span of 25 years. Every five years, strength of the station shall be assessed through inspection and material testing. Any strengthening or replacement of a particular block or a portion would be carried out without disturbing adjacent structure. The decommissioning of the station will depend upon the health of the structure and/or the completion of the objectives of the planned scientific activities after its envisaged life.

Intentionally Left Blank