

4. ALTERNATIVES TO PROPOSED ACTIVITY

A review of the Indian Antarctic Programme was undertaken by an Expert Committee (Rao, 1996), which recommended broadening of India's scientific data base in Antarctica for having a regional spread of the data rather than a localized one. A Task Force was, therefore, constituted to go into the details and recommend a suitable site after considering all the pros and cons. This Task Force undertook reconnaissance traverses all along the eastern coast of Antarctica from India Bay at 11° E. longitude to 78°E longitude in Prydz Bay, to examine all possible alternatives suiting the scientific and logistic requirements set for the future station.

4.1 Alternative Locations at Regional Level

Three alternatives were suggested in the Review Report, mentioned above, based on the scrutiny of published literature and feedback from different Indian and international expeditions to Antarctica. These were:

- a) Antarctic Peninsula,
- b) Filchner Ice shelf
- c) Amery Ice shelf – Prydz Bay area

4.1.1 Antarctic Peninsula

Antarctic Peninsula is the most crowded place in Antarctica, so far as the stations of different nations and the visits of the tourists to the icy continent are concerned. The area is also very sensitive to the global warming as has been demonstrated by the international studies, which have shown that the Peninsula has warmed by 2° C since 1950 (Cook et al., 2005).

4.1.2 Filchner Ice Shelf

The Filchner Ice Shelf poses serious logistic constraints in maintaining a research station as the sea ice condition in this area are very tough. The Weddell Sea expedition by India in 1989-90 had brought to light the unpredictable ice conditions in this area.

4.1.3 Amery Ice shelf – Prydz Bay area

Against the above backdrop, the Task Force comprising experts in domains of science and logistics explored the Amery Ice shelf -Prydz Bay region of East Antarctica during February 2004 and examined the area between 66⁰ E and 78⁰ E Longitude in detail. After extensive traverses in the Vestfold Hills, Rauer Group of islands, Larsemann Hills and Bolingen islands, apart from the area along the Mawson Coast, the Task Force recommended a rocky promontory between Quilty Bay and Thala Fjord in the central part of the Larsemann Hills, bound by latitudes 69⁰24' S and 69⁰25' S and longitudes 76⁰10 E and 76⁰14' E, as the most suitable site for the new Indian base.

4.2 Alternate Sites examined within Prydz Bay

4.2.1 Vestfold Hills

Task Force took extensive traverses in Vestfold Hills, Rauer Group of islands, Larsemann Hills and Bolingen islands. While the Vestfold Hills, supporting the Australian Station Davis, was found to be an ideal location, it was observed that the approach to this low lying rocky terrain supported a number of rookeries and colonies of giant Antarctic and snow petrels, molting sites of seals etc. The depth to the bedrock in the open waters was generally shallow, as indicated by the grounded icebergs, north of the Long Peninsula. The area of ASPA 143

on the Marine Plains and ASPA 167 on Hawker Island on one side and the existing station Davis in the central parts does not leave much choice for any additional infrastructure.

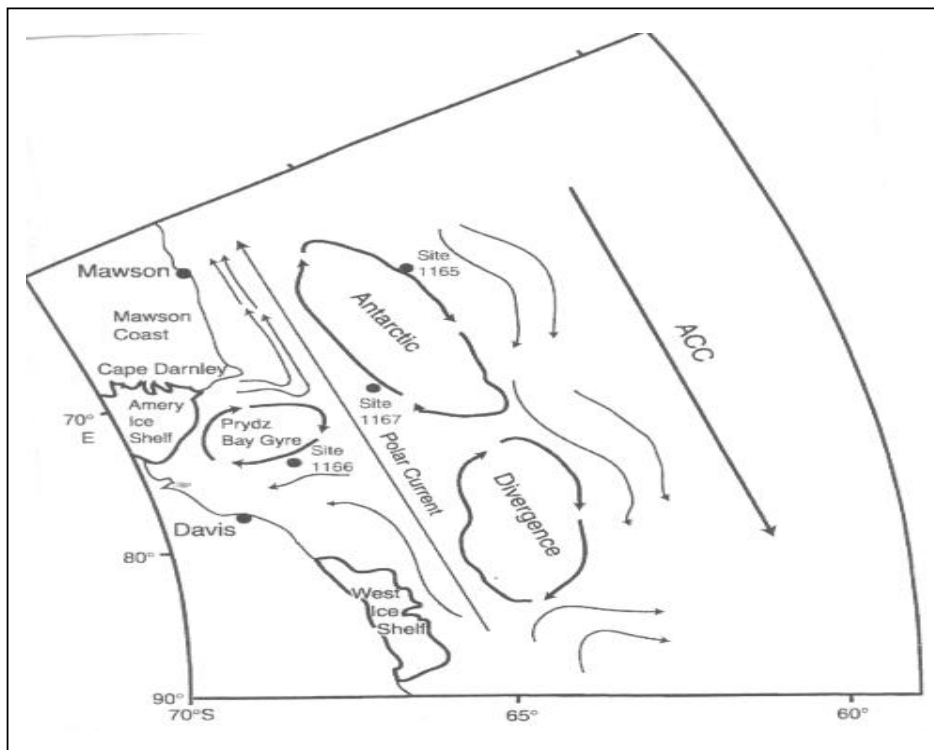
4.2.2 Rauer Group of islands

The Rauer Group of islands was found to comprise a number of closely spaced islands of limited aerial extent. The number of fresh water lakes as the source of potable water and flat land essential for construction purposes, was limited. The Task Force landed on five sites in the Rauer Group and measured depth, temperature and conductivity of lake water at two sites. The sites visited include:

- Filla Island (68048'20" S Lat & 77049'15" E Long)
- Hop Island (68049'20" S Lat & 77041'30" E Long)
- Varyag Island (68051'00" S Lat & 77047'30" E Long)
- Torckler Island (68053'30" S Lat & 770 50' 00 E Long) and
- Macey Peninsula (68055'12" S Lat & 77055' 30" E long)

The CTD measurements in one of the pro-glacial lake in Macey Peninsula indicated depth of the melt water lake to be 12 m. The water being fed by a glacier was of good potable quality. The two other lakes examined in the Filla Island were of shallow depth and contained brackish water. The Varyag, Hyslop, Lokot and Torckler Islands, located in the central and southern parts, have a difficult approach from the sea due to presence of a number of isolated islands blocking the passage as well as the cluster of icebergs brought together by westerly currents (Figure 15).

Figure 15 : Ocean currents in the Prydz Bay Area



Rauer Group is a rare area of wild life concentration. The islands support breeding grounds for Snow, Cape, Antarctic and Southern Giant petrels as well as Southern Fulmar. There are several rookeries of Adelie penguins and haul-out area of Weddell Seals spread over in the area. The northern islands (Lookout, Slon and Filla Islands) are known for the concentration of Weddell Seals. The central parts of Filla island shelter snow petrels. The western ends of this island, as also the Buchan Island north of it, are the sites of Adelie penguins' rookeries. The Hop Island, in the western end, is another area of concentration of wildlife. One of the biggest penguin rookeries of this region is located here (Figure 16). Restrictions on flying operations are in vogue in most of the area in Rauer Group of islands.

Figure 16 : Penguin Rookery at Rauer Group Island



There are no Antarctic stations located in this area. However, Australian Antarctic Division is managing two “Refuge Huts”, (an Igloo and a Googol) at Hop Island for monitoring the breeding and behavioral pattern of penguins. The Task Force did not recommend this site so as not to disturb the intrinsic wild life values of the area (Ravindra et al., 2004).

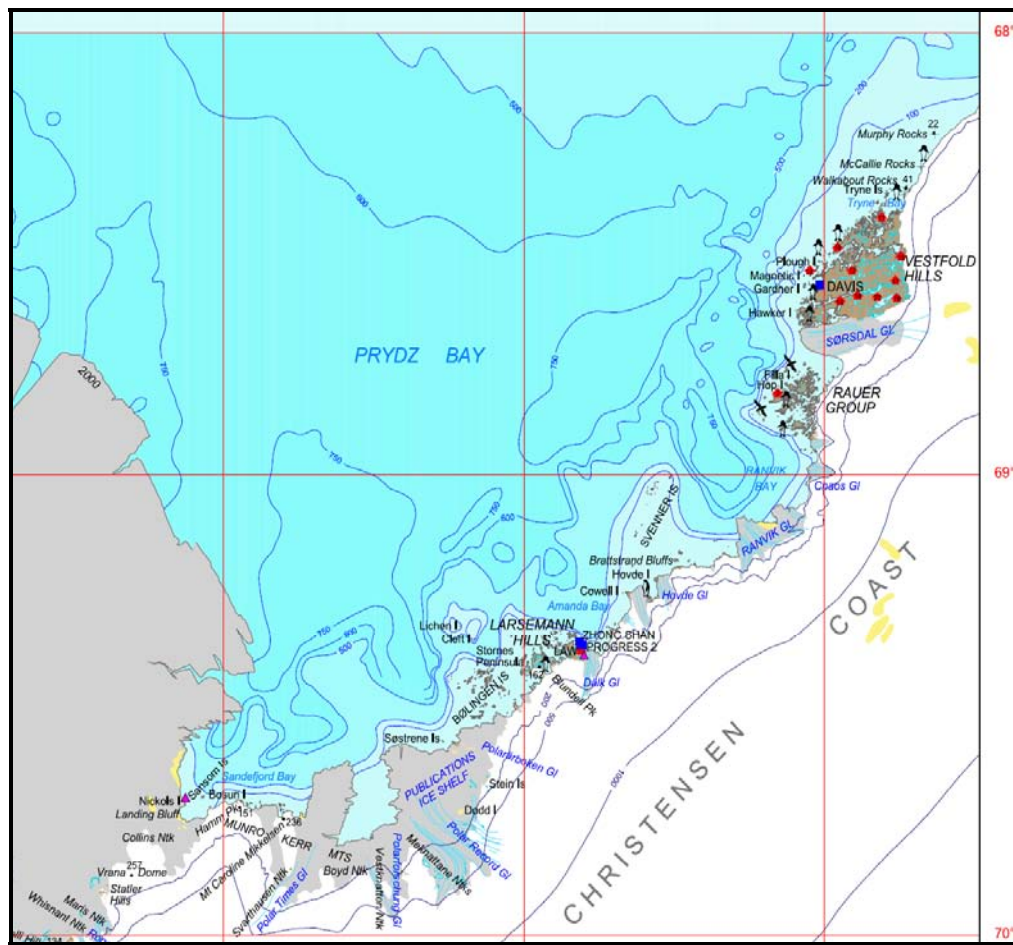
4.2.3 Area between the Bolingen and Svenner Islands (Larsemann Hills):

The area between Bolingen and the Svenner islands (Figure 17) bounded by the Polar Record Glacier, off the Publication Ice shelf on one side and the Brattstrand Bluffs on the other side, was found to encompass many ice free peninsulas and Islands. Within the limits of this region, the Task Force focused its attention on Larsemann Hills.

The Larsemann Hills (69°20'S to 69°30'S Lat ; 75°55'E to 76°30'E Long) at Prydz Bay is an ice-free oasis on the Ingrid Christensen Coast, Princess Elizabeth Land, located approximately midway between the eastern extremity of the Amery Ice Shelf and the southern boundary of the Vestfold Hills. At 50km², it is the second largest of four major ice-free oases found along East Antarctica's 5000 km coastline (Hodgson, et al. 2006). The region includes two main peninsulas, the western, named Stornes and the eastern named Broknnes. In between these two peninsulas, there are number of islands of varying

dimensions. Four Antarctic stations viz. the Progress I & Progress II (Russia), Law- Racovita (Romania) and Zhongshan (China) are located along the edge of the Broknes peninsula. A cluster of icebergs and some islands such as Striped, Lovering and Manning Islands mark the northern boundary of the Broknes Peninsula. The westerly currents break the fast ice during early summer facilitating the entry of the vessels quite close to the stations. 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, Easter, Breadloaf, Butler, Betts, McLeod, Jeason, Solomon and Sandercock Island.

Figure 17 : Location of Bolingen and Svenner Islands, Rauer Group and Vestfold Hills



Source: AAD

In the Larsemann Hills, a promontory located between Quilty Bay and Thala Fjord, was found to be the most suitable site for the Indian base. The promontory has a number of fresh water lakes with sufficient depth that can serve as the source for drinking water. The approach from the sea in February opens and ships could come quite close to the landing site, where after the barges could be put into operation. The area is located in the central part of Larsemann Hills and is about 10-km crow fly distance from existing Antarctic stations of Australia-Romania, China and Russia.

The pear shaped promontory where the station is to be built has its broader end towards sea, trending NE-SW. The northern and western slopes have a high gradient with the edge being exposed in the form of a steep cliff. The southern margin separates Polar ice margin and the

hills thereupon by a narrow bay. This part has ice up to 50 m thick at places and hence not suitable for approaching the hills. This area is fairly undulated and encased within Thala Fjord and Quilty bay which remains ice-free in most of the months in a year. Water is available in form of a big lake and five small lakes. The big lake holds water with saline characteristics, however small lakes were found suitable for drinking purpose. It is found possible to access this place through sea from NNE part of the Promontory. The advantages of the site have been mentioned in Chapter 2.

4.3 Alternative Locations in Larsemann Hills

- The alternate sites examined in the Larsemann Hills include:
- Tonagh Promontory at the western edge of Larsemann Hills
- Area adjoining Lake Ferris and northern margins of Stornes Peninsula
- Area west of Johnston Fjord
- Donovan Promontory
- Fisher Island
- Area north of Murkwater Lake, on the Promontory between Quilty Bay and Thala Fjord

Tonagh Promontory: A promontory located on the western edge of Larsemann Hill exposes a flat terrain rising approximately 40m above sea level. A landing was made at 69°26'00.6" S. Latitude and 75°59'37.8" E. Longitude. A chain of small islands northwards was found to block the entry to this promontory. A number of grounded icebergs were found within the fast ice, west of the hills, indicating shallow depth to bedrock. The area is devoid of a source of fresh water and hence was not considered suitable for habitation.

Lake Ferris and northern margin of Stornes Peninsula: Lake Ferris and the area adjoining to it is located at the northern most margin of Stornes Peninsula (69°24'S Latitude and 76°08.5'E Longitude) and can be approached from the sea. Low lying, beach landing is available. There are two interconnected lakes fed by snowmelt but no permanent source of recharge like a feeder channel from a glacier. Most of the lakes are of shallow depths and were found in the frozen condition. The area is extremely undulating.

Profuse growth of algae and moss was observed on the exposed rock surface. Fast ice could still be seen in the adjoining area in sea at the time of visit i.e. middle of February. Lots of seals were found molting on this ice. The occurrence of fossiliferous marine Pliocene sediments about 4 Ma old in this peninsula, makes this area of geological significance that requires preservation (Quilty et al., 1990a,b, 1993). Rare aluminum borosilicate- boralsilite described in 1998 from this area is known from only one other locality world wide (WP8, 2006). It was thought best to leave the area undisturbed for the reasons mentioned above.

Johnston Fjord: The location at 69°24'47.1" S. Latitude & 76°03'48.4" E Longitude at the hills east of Johnston Fjord is marked by the presence of a very prominent lineament running N-S. The lineament can be traced from west of Malachite Lake to west of Tumbledown Hill and further in the northerly direction up to Hill Island. There are two lakes in the immediate vicinity of the site but both are shallow with moderate to high salinity. The approach from the north and east is blocked by a number of islands. This area was not found suitable for the purpose of supporting a station.

Donovan Promontory: This promontory at the eastern extremity of Stornes Peninsula also exhibits a prominent N-S trending lineament, parallel to the one described above (Johnston Fjord). The area exposes number of glacial lakes, viz. Lake Gillieson, Lake Burgess and channels like Stuwe Gully etc. A landing was made at 69°24.7' S. Latitude & 76°08.5'E

Longitude. The area was found to be rugged and lacking suitable topographic flat for construction activity. Though there are a number of lakes in the area, they are very small and shallow in depth. The sheltered Bay (Blair) is too narrow with steep cliffs on the hill side. The topography and general lay out of the area do not justify locating a station on this site.

Fisher Island: Separated from the Broknes and Stornes Peninsulas by Clemence and Thala Fjords respectively, the Fisher Island is a bow shaped island situated very close to the continental ice. It is one of the biggest islands in terms of geographical area. It's approach from the north is blocked by a group of small islands but the western margin can be approached from McLeod Island. Physiographically, the western part has high relief with highest peak at 117m. In comparison, the eastern part exhibits moderate relief and open stretches. The location at 69⁰23'32''S Latitude & 76⁰13'23.4'' E Longitude offers a near flat ground very close to fast ice for landing purposes. Australia maintains an astronomical station at this site. There are six lakes in the eastern parts but none has substantial depth or area. Fresh water bodies of limited depth and extent are present.

The Island is not connected to the continental ice of the Antarctica as a narrow stretch of open sea separates it from Stinear Peninsula.

4.3.1 Broknes Peninsula

This area is ice free and undulatory in general, except the north eastern part where three stations are already existing namely Law- Racovita, Progress II and Zhongshan. Few lakes are available to cater to the routine water demands of the existing stations. There is a general scarcity of the potable water. Water in most of the lakes has high salinity. Ships providing supply to stations are usually anchored 5 nm. away, from the coast because access to the eastern shore of Broknes by small boat or barge is difficult (and sometimes impossible) due to ice debris that cover hundreds of metres off shore, blown by the prevailing north-easterly winds. Sea ice conditions are highly variable. Helicopters are therefore the only reliable means by which persons and supplies can be transported ashore quickly.

The positioning of the new Indian station in this area was not found sustainable on following grounds:

1. There are already three stations existing within close distance to one another,
2. Resources in respect of drinking water are scarce,
3. Regular scientific observations on meteorology, magnetism, atmospheric conditions are being carried out by the three stations. Setting up any additional Observatory in the area will result in interference of the output.
4. The area south of Seal Cove in the Broknes Peninsula is rugged and does not provide an easy access to the ship for off loading the cargo.

4.4 Alternative transport to the Station

The essential men and materials, as far as possible shall be transferred through helicopters from the ship. This may produce some noise pollution due to frequent flying of helicopters to the site but as there are no penguin rookeries or Antarctic bird colonies along the proposed corridor of flight operation, the impact on the wild life is expected to be negligible. The barges may be put in operation once a facility to offload the cargo on to a platform near the landing site is finalized.

A few other alternatives to access the station site were also assessed. These are:

- Transporting of all the men and material from Hobart/ Cape Town to the air strip located near the site by using air operators network of either Australian or DROMLAN. From here the material may be towed by Piston

Bully over the ice and then by ATV/Dozer to the site. Difficulty in this option will arise due to the undulated nature of terrain and the movement of the material over it. Other disadvantages of this option are that all the heavy materials will have to be airlifted and the uncertainty about the flight schedules due to weather uncertainties would continue to haunt. High cost of operation is also one of the negative points in this option.

- Sharing the ship with other stations located in this region for logistic purposes, to encourage minimum environmental impact. This option will be explored once the major shipment of construction material is over.

4.5 Alternative of not proceeding with the activity

The alternative of not proceeding with the activity has been given due thought during the planning phase. It was considered whether the proposed research could be carried out from existing stations in the Larsemann Hills or any other station in the region. However, the option did not find favor because of not meeting the national aspirations of having a station located favorably to supplement the data collection in entire Indian Ocean sector between India and Antarctica. While the area between the equatorial waters of the Indian Ocean is adequately covered by data buoys and satellites, the new site would cover the area of southern Indian Ocean and the gap area located in the Southern Ocean and Antarctic sector of the Indian Ocean by having an earth Station in line with the OCEANSAT II satellite of India for efficient data transfer.

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