

Hydrographic Survey of Approaches to Indian Bay Antarctic Region

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Abstract

The objective of this paper is to present a summary of the work carried out by the first Indian Naval Hydrographic team during the XIV Indian Scientific Antarctic Expedition. The team was primarily deputed for carrying out a feasibility study of conducting hydrographic survey in Antarctic region. The team during the expedition deployed various types of hydrographic equipments under harsh field conditions for monitoring equipment parameters and for data collection. The team also carried one indigenously designed survey motor boat on experimental basis for carrying out bathymetric survey of India bay.

Introduction

The first ever hydrographic chart of Antarctica was prepared by Mr Murray in the year 1895. During recent past, only countries which undertook scientific work in Antarctic region carried out limited bathymetric surveys of areas adjoining their respective scientific stations. The first bathymetric chart of Antarctica was prepared by Murray in 1895.

International Hydrographic Bureau carried out a review of worldwide charting in 1992, and concluded that Antarctic continent was inadequately charted. A permanent working group for co-operation on Antarctica (PWGCA) under the aegis of International Hydrographic Organization was thus formed for planning a suitable charting scheme. In view of considerable efforts and resources required for complete charting of Antarctic waters, all members were requested to prevail upon National Governments for committing hydrographic resources in Antarctic region. As per the scheming of charts for the Antarctica region, duly approved by the PWGCA, a few charts have already

The work was assisted by Santosh Kumar, Chief Petty Officer, B T Joseph, Petty Officer and N Raveendran, Leading Seaman.

been published. Chart Nos. 9050 and 9051 pertain to the Indian Permanent Station Maitri (IPS). No country has so far taken up the responsibility of the survey of these two schemed charts. Only Indian and Russian permanent stations fall in the above area. India being a major hydrographic power, it is therefore but natural, the country would have to assume this international responsibility of undertaking the surveying work.

Although India has been regularly participating in scientific expeditions to Antarctica since 1981, however till 13th expedition (1993) no serious attempt was made to carry out hydrographic work.

The Naval Hydrographic Department has previously not conducted any hydrographic survey in Antarctic region and therefore, the suitability of the equipment, capabilities of the survey motor boats, ship, and stress caused to the personnel whilst operating, in extreme temperature condition, etc. were required to be studied prior to deployment of survey ships. Therefore it was decided by the Chief Hydrographer to the Government of India to depute a detached Hydrographic Survey Team, as a part of the XIV Antarctic Expedition in 1994.

The team consisting of one hydrographic officer and three surveying recorders embarked M.V. Polar Bird along with the indigenous survey motor boat and equipments on 17 Dec '94.

Objectives

The main objectives of the team were:

- (a) To carry out a feasibility study for conduct of hydrographic survey in Antarctica and gain experience.
- (b) To study the affect of environment on survey motor boat, equipment and personnel.
- (c) Establish sounding/chart datum.
- (d) Changes in ship design, if any, required for operating IN surveying ships in Antarctica waters in summer months.

Conduct of Survey

On arrival the team familiarised themselves with the operating environment and carried out reece for selecting position fixing sites for trisponder remotes as well as to mark ground control stations. The team carried out numerous trials of the field survey equipment and found the systems to be operating satisfactorily. The weather conditions were highly unpredictable and

frequent spells of depressions were observed which made field work extremely difficult. On a trial basis the team carried out the hydrographic survey of limited area of India Bay.

1. *Ground Control:* The inability to mark and build site on the icy continent necessitated fresh ground control to be carried out every time prior to undertaking sounding operations. Introduction of GPS 200 in Hydrographic Department and SKI post processing system available enabled ground control being completed in a short span of time. Survey of India (SOI) has established a permanent station at Maitri close to Priya Darshni lake, and the same was utilised for transfer of Geodetic control. During the expedition two geodetic stations were established on the Indian shelf which were utilised later for sounding and coastlining. These stations were established by simultaneous GPS observations at shelf and Indian permanent station Maitri.

2. *Tidal Data:* Rigging of tide pole for carrying out tidal observations was not feasible due to the unstable shelf edge. For the purpose of establishing a datum for sounding observation, GPS observations were carried out for obtaining mean sea level from the height of known station at Maitri.

3. *Calibration:* Various surveying equipment like, Trisponders, Remotes/Master units, Digital Measuring Units, Micro Distancers, GPS 200 units, etc. were tested and calibrated on the shelf/ship prior to their deployment on the field. Echo Sounders were calibrated by Bar Check method. The performance of boat echo sounder was regularly crosschecked with the ship's Simrad Echo Sounder.

4. *Coastlining of Indian Shelf:* For the purpose of obtaining a permanent record and for studying future changes, the team successfully delineated coastline of the Indian shelf by walking over the edges of the icy shelf. The team used DI 3000 alongwith T2 Theodolite for measuring the angles and distances.

5. *Bathymetric Survey:* With the help of indigenously designed survey motor boat it was decided to sound an area of 5 x 7 nautical miles of India Bay. Prior to running sounding lines the team ran few test lines in the bay. The sounding lines were run every 125 metres apart on a scale of 1:25,000. The lines were run east-west direction. The area of the bay was covered and the inlets were sounded evenly. For the ease of sounding operations it was decided to use GPS 200 in kinematic mode for position fixing. Echo sounder Atlas Deso 20 was used for obtaining depth. The sound velocity was calculated by the help of Smart Acoustic Current Meter observations (SACM), and sound velocity of 1460 was set on the echo sounders. The average gradient observed in the area was 240 metres and no undulation were observed on the sea floor. On completion of sounding the collected hydrographic data was compiled and scrutinised at Naval Hydrographic Office, Dehradun and Bathymetric Chart on the scale of 1 : 25,000 was prepared. A copy of the bathymetric chart is placed at annexure.

Future Survey Operations

For the first time in the Indian history an indigenous survey motor boat without any special modifications for operating in polar conditions was deployed for field work in Antarctica. Considerable difficulties were experienced during boat operations. The fuel oil mix (gas oil/diesel) was found to coagulate and choke the fuel filters. The boat had to perforce be operated by using AVCAT fuel. Due to freezing of residual waste oil in the bilges the bilge pumps could not be operated and therefore difficulties were faced in removal of bilges. In line with higher safety standards required for operation in Antarctica, the vessels/boats would have to undergo suitable modifications prior to operating in Antarctic waters. Due to onset of freezing of sea by end March, only a limited period is available for data collection, therefore a long term plan would be required to undertake surveying work.

Conclusion

The operating experience reveals that the extremely unfavourable weather conditions make data collection very difficult. Restrictions are further imposed by the environment and affects the endurance of personnel whilst working in the field. As the survey boat was not modified for operating in Antarctica, considerable amount of difficulties were experienced whilst carrying out boat operations. The data collection will have to be done on incremental basis. Only after sufficient experience of operating in Antarctic waters has been gained that a full fledged hydrographic survey of the area could be taken up. The ship/boat needs to be suitably modified for operating in Antarctic waters. The hydrographic data collected by the first hydrographic team could be of immense value and will be used for creating a databank and for future surveys. The operating experience gained by the team will go a long way while planning full fledged hydrographic task and for incorporating suitable modifications in the ships/equipment.

Acknowledgements

The authors are extremely thankful to the Department of Ocean Development for accommodating the team members in the XIV Scientific Expedition. Our thanks to Mr Tataghat Verma, Scientist of Defence Research and Development Organisation for helping out with hardware problems, whilst post processing field data. We express our deep debt and special gratitude to the members of the Indian Army team whose help was extremely valuable in conduct of boat operations in Antarctica.



(1) Survey motor boat onboard, M. V. Polarbird



(2) Field work afloat collection of data onboard survey motor boat



(3) Field work ashore coastlining of India Bay

ENCLOSURE-1

**Deputation of Naval Hydrographic Department
XIV Scientific Indian Expedition**

1. The naval hydrographic team was deputed for the first time during the XIV scientific expedition, for carrying out a feasibility study of undertaking hydrographic survey in Antarctica. The hydrographic team was deputed in the background of Chief Hydrographer's international responsibilities, as a member of the permanent working group for cooperation on Antarctica. International Hydrographic Organisation (IHO) carried out a review of world wide nautical charting in 1992 and concluded that Antarctica was inadequately charted. A permanent group for cooperation on Antarctica (PWGCA) was formed under the aegis of IHO, with the express purpose of coordinating global hydrographic resources and for finalising suitable charting scheme for Antarctic region. All member countries including India were invited to take part in deliberations of PWGCA. In view of large resources and efforts required to undertake charting action in Antarctica, it was decided that all member countries on a voluntary basis would assume producer status in respect of certain nautical charts. A number of countries such as U.S.A., U.K, Australia, Russia, France, Italy, Japan, Brazil, Chile, Spain etc., are undertaking hydrographic work in proximity of their bases in Antarctica. Chart Nos. 9050 and 9051 form the approaches to Indian permanent station Maitri and till to-date no member country has volunteered to undertake charting action in this area. Naval Hydrographic Department did not possess the requisite expertise for operating in Polar region, and thus India could not assume its share of responsibilities commensurate with its maritime status. Accordingly the Chief Hydrographer to the Government of India decided to depute a hydrographic team for carrying out a feasibility study of undertaking a hydrographic survey of an area encompassing approaches to Indian Permanent Station Maitri.

- (a) Role and function of Naval Hydrographic Department
- (b) Deputation of first hydrographic team to Antarctica
- (c) Cooperation extended by the team to other departments
- (d) Envisaged benefits of data collection to other agencies

2. **Role and Functions:** The Naval Hydrographic Department is the only authorised National Authority for production of legally valid Navigational Charts and Publications. These nautical charts and publications are made available to the mariners through the various agencies. The work carried out by the department has been singularly responsible for ensuring the safety of mariners at sea. For the purpose of data collection, the department has a fleet

of six specialized survey ships. Depending on the national priorities and defence requirements these ships are deployed along the Indian coast for collection of hydrographic and oceanographic data. The data is thereafter processed at Naval Hydrographic Office, Dehradun and finally Nautical Charts and Publications are printed. In addition to the national commitments the chief hydrographer has also the global responsibilities. As Navarea VIII coordinator, the chief hydrographer is responsible for promulgation of all navigational warnings for the region comprising Persian Gulf, north Indian Ocean, Arabian Sea and Bay of Bengal. The chief hydrographer is also the coordinator for international chart scheme for area 'J'. As the national representative in PWGCA, the chief hydrographer is the only authority in the country, who has the where with all and the expertise for conduct of hydrographic survey in Antarctica.

3. **First Team:** A hydrographic team comprising one hydrographic officer and three sailors was deputed for the first time as part of XIV Indian Scientific Expedition.

Pre-Expedition Phase

(a) *Preparations:* As the team was cleared as late as November for participation in XIV Scientific Expedition, only a limited period of time was available for carrying out predeployment checks on various surveying equipments prior to embarkation on board MV Polar Bird.

(b) *Logistic support:* Only limited logistic support could be provided to hydrographic team. The normal procedure for undertaking hydrographic survey in Indian waters is through the specialised survey vessels who have large resources at their disposal. Due inherent restrictions of deputing a small team with limited equipments, the scope of work was perforce reduced.

(c) *Acclimatisation:* Team members could not take part in the acclimatization training carried out at Auli This being the first ever exposure to the harsh operating environment in an unfamiliar terrain, considerable time was expended towards acclimatizing to field conditions.

Work Undertaken

(a) *Ground control:* It was carried out for marking suitable sites for placing the position fixing aids. This was required for working out the position, of the vessel/boat from the known station ashore. As the only permanent mark was available in Maitri, established earlier by the Survey of India, the same was transferred to shelf by help of observations carried out by the hydrographic team using Global Positioning System (GPS 200). The inability to mark and build

permanent sites on the icy shelf led to considerable delay in establishing ground control.

(b) *Field checks:* Various survey equipments were tried and tested under the field conditions. The performance was monitored and all the equipments were found to be functioning satisfactorily. However it was experienced that the lead acid batteries tended to lose charge rapidly. The Digital Distance Measuring Unit of Trisponders were calibrated by help of electronic distance measuring units.

(c) *Coastlining:* During the field recce it was observed that changes did occur to the Continental Shelf by action of wind and sea. A request was received from the DOD Rep. for delineating the coastline of India Bay, with the aim of maintaining a permanent record for studying future changes. The hydrographic team successfully delineated the coastline by walking on the precarious shelf edges using Distomat. The task was accomplished under trying circumstances wherein there was always a danger of encountering hidden crevasses.

(d) *Bathymetric survey:* The bathymetric survey of an area approximately six square miles was undertaken during the expedition. The results have since been scrutinised at Naval Hydrographic Office for quality control. Prior to commencement of sounding, test lines were run in the area to see the prevalent slope of the seabed. The sound velocity is determined accurately and is used for obtaining precision depths. An indigenised survey motor boat was also embarked on trial basis for undertaking boat work. Since the boat was not modified for operation in Antarctica, considerable difficulties were encountered during boat operations. The operating environment and lack of sufficient experience extracted a heavy price. The survey motor boat during the course of survey sustained damages, in which the oil/fresh water plates of coolant chambers were badly damaged. Despite best efforts of the ship's chief engineer the boat could not be made operational. We would like to mention our appreciation for members of army team, without whose help we could not have made the boat operational. Notwithstanding the constraints of operating in the harsh operating environment and considering the that team members were greenhorn, the bathymetric survey of allotted area was successfully completed.

4. *Benefits to Other Departments:* In keeping with the spirit encore of scientific expedition, the team cooperated with scientists of other departments for providing a mutually beneficial assistance. Some of these tasks were concurrently undertaken whilst carrying out Sounding operations.

(a) A request was received from the Zoological Survey of India for collection of sea water samples for studying of marine organisms such as plankton. On

completion of hydrographic work dedicated boat sorties were provided to scientist of ZSI.

(b) Presently the study carried out by the scientist of Wildlife Institute is chiefly depended on the drop/pick up provided by the helicopters. Due to the technical constraint only limited sorties could be provided. Boat sorties were provided on as required basis to Wildlife Institute for studying marine life.

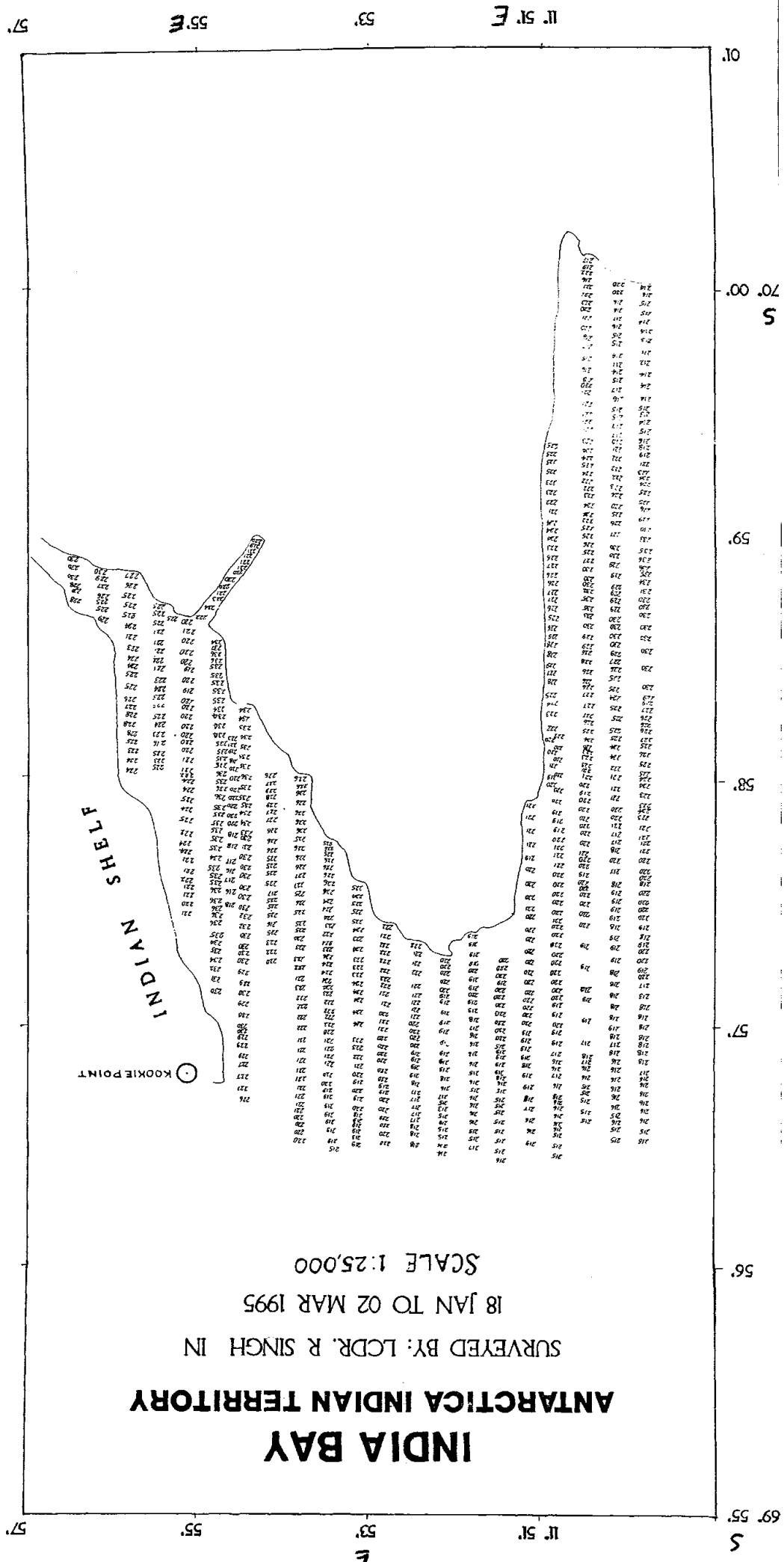
(c) During the XIV Indian Scientific Expedition, the hydrographic team took part in the land convoy and carried out a study regarding navigational aspects of route marking. The existing system of navigation by land convoys is based on visual sighting of numbered barrels. In adverse weather conditions all references are lost which could lead to accidents. For safe navigation it is proposed to prepare a land map with the help of GPS observations for use of convoy commander.

During the conduct of hydrographic survey various type of data is collected. As a spin-off some of this data can be utilized by other agencies.

(i) *Mean Sea Level Observations:* the mean sea level is monitored during the course of hydrographic survey to establish vertical datum. Observations are carried out using conventional tide pole or automatic tide gauge. Survey of India carried out observations in 1991 for connecting the mean sea level with Geodetic station Maitri. Due inherent problems associated with carrying out prolonged observations in determination of mean sea level the same were carried out by using GPS. During the XIV Scientific Expedition, the hydrographic team carried out observations in Feb 95 for checking the validity of the previously carried out observations by Survey of India. The same were found to be in close agreement. This is especially relevant in case of Antarctica where the sea level needs to be continuously monitored for determining any rise in the level of sea, caused due to the global warming.

(ii) *Nature of Seabed:* Sea bottom samples are collected by help of corers and grabs, in addition to determining the good anchorage position. The samples thus obtained can also be utilised in the field of geology.

(iii) *Physical Oceanographic Data:* Physical oceanographic data such as temperature, conductivity and salinity are collected at various positions/depths. For hydrographic work these parameters are required to calculate sound velocity and for studying propagation of sound waves at various depths. In addition these data can also be exchanged with Naval Physical Oceanographical Laboratory and National Institute of Oceanography.



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5. The field tracing of the bathymetric survey carried out by the team is placed at Annexure 1. The depths are indicated in metres and the survey has been carried out on a scale of 1:25,000.

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