

# BATHYMETRIC OBSERVATIONS FROM 60° SOUTH TO PRINCESS ASTRID KYST IN QUEENS MAUD LAND, ANTARCTICA

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## Abstract

The objective of this work is to present a summary of the bathymetric data collected during the First Indian Antarctic Expedition. The bathymetric data collected during the expedition is useful for updating the existing charts which are available on a small scale map. This provides knowledge of the Antarctic region and of the seaward approaches to its ice shelf. The bathymetric track shows that the southern ocean has truncated ends of incomplete mountain ranges. A considerable elevation is matched by an equally large parallel depression, these being found on the continental side of the ridge. The west Indian Antarctic basin has a greater depth of 5320 metres at Lat. 62° S : Long. 42.5° E.

The bathymetric description has been limited so far to the limited number of tracks to substantiate the extension of submarine features. This study will enhance the knowledge of bathymetry in Antarctic region.

## INTRODUCTION

The first bathymetric chart of Antarctica was prepared by Murray (1895). A gradual improvement in the delineation of bathymetric features took place as and when the results were available. The *Meteor* expedition, equipped with a deep water echosounder, made a detailed survey of Atlantic sector of Antarctica. Despite the large number of studies conducted as a result of increased research activities during various expeditions, very little bathymetry of the Antarctic region has been studied. There are large areas which have not been bathymetrically described at all. Hence there is a scope to fill these gaps and for updating of the data.

The First Indian Antarctic Expedition carried out the bathymetric surveys onboard M.V. Polar Circle. During the entire expedition, regular soundings were taken and the route thus constitutes more or less complete line of soundings. The bathymetry and geomorphology of the approaches to Princess Astrid Kyst, Queen Maud Land Antarctica

have been described by Siddiquie and Pathak (1983) along with a new sea mount named after Shrimati Indira Gandhi, the then Prime Minister of India (Siddiquie *et al.*, 1983). Since the area was poorly surveyed earlier and very few depths are shown on the navigational charts, some detailed information is presented here.

## METHODS

**Position fixing :** Positions during the surveys were obtained by Magnovox MX 112 (single channel) satellite navigation system interfaced with a Gyro and speed log. This provided an accuracy of about  $\pm 150$  to 300 metres which is considered sufficient for a reconnaissance survey.

**Echosounding :** Echosounding was carried out using Simrad EKS -12 echosounder having maximum depth range of 10,000 metres with a Simrad 1100 recorder.

## RESULTS AND DISCUSSION

During the expedition, echosounding was carried out along two tracks 850 km apart extending in the area between  $10^{\circ}$  to  $40^{\circ}$  E meridian along with one interconnecting track in meridional direction (Fig. 1). The interconnecting track is particularly valuable in determining the shelf relief of the Antarctic region. The results of these lines are used in interpolating the regional geomorphology of the area. Large near-flat areas of deep-sea floor were found along almost the entire range of tracks from  $62^{\circ}$  to  $66^{\circ}$  S except in eastern track at a point  $64.5^{\circ}$  S :  $41.5^{\circ}$  E, where the depth reduces to nearly 400 metres (Fig. 2a) In the western track, a peak of about 350 metres was observed at a point  $62.3^{\circ}$  S :  $24^{\circ}$  E (Fig 2 b). The maximum depth observed in this area was 5350 metres at  $60.25^{\circ}$  S :  $44.3^{\circ}$  E. The plains occupy the southern parts of the great basins. The continental shelf changes sharply south of  $66.6^{\circ}$  S. During investigations, a bottom relief was observed as a shallow water area in the longitudinal track between meridians  $40^{\circ}$  E and  $30^{\circ}$  E. It seems to be a continental rise. A shallow depth of 989 fathoms (1780 metres) shown in British Admiralty Chart No. 3171 at  $66.45^{\circ}$  S :  $36.6^{\circ}$  E location could not be traced. An effort was made to shoot over the location, diverting the track north to south direction but its presence could not be confirmed. The shallowest depth of 4350 metres was recorded in this area.

Surveys made in the longitudinal track from  $66^{\circ}$  S :  $30^{\circ}$  E to  $68.5^{\circ}$  S :  $13^{\circ}$  E showed that the bottom topography in this area is uneven and has sharp peaks whose slopes are frequently vertical with a height variation of 400 metres to 2480 metres (Fig. 2 c). These tracks revealed that a deeper water trench extends east to west. The observations obtained in the segment Long.  $12^{\circ}$  E reveals a predicted topographic gradient sloping up from the position of Lat.  $68^{\circ}$  S : Long.  $13^{\circ}$  E beginning up in the north. The minimum depth slowly decreases from 3600 to 612 metres.

The depth measurement made from ocean basin to the foot of the ice shelf showed that the sea is deeper north of the shelf, in the area off Princess Rangild Kyst than the

area of Princess Astrid Kyst. At the upper end of the ice shelf, there is an abrupt transition from the continental shelf to the slope. Sounding shows that the continental shelf borders the ice shelf on the western side and extends eastwards under it. Ocean depth at the approaches to the First Indian Antarctic Expedition base station ranges from 120 to 700 metres north of it. The large variation in depth may be due to the existence of underwater channel that bisects the continental shelf. The ice barrier is bisected by wedge-shaped bights several kilometres long. The thickness of ice in the nearest approaches to the station was about 1.5 metres in 1981. At the coast of Antarctica, the expedition encountered a Polynya area about 50 miles wide and a few hundred miles long. In spite of the snow covered shore ice and drifting sea ice, the temperature of Polynya water cannot fall below the freezing point. To study the bathymetry of the polynya, the expedition made an extensive survey between  $11.5^{\circ}$  to  $11.95^{\circ}$  E and  $69.8^{\circ}$  to  $70^{\circ}$  S. In the base camp area of the expedition, the bathymetry of the polynya is regular and smooth (Siddiquie and Pathak, 1983 ; Fig. 2 d), and the maximum water depth recorded at the foot of the ice shelf was 224 metres. The great depth at the foot of ice shelf and disintegration of ice shelf, north and south of base camp indicates that deep water area continues eastward under the ice shelf.

### CONCLUSION

The data collected during the expedition is useful for updating the existing charts, but the underwater information remains insufficient in the form of single line data. However, with the limited bathymetric information in the region, this will add some more bathymetric information to the present knowledge. The bathymetric tracks discussed in this paper show that the southern ocean has truncated ends of incomplete mountain ranges and a considerable elevation is matched by an equally large parallel depression encountered being found on the continental side of the ridges. To have more details of these unknown submarine features a survey has to be conducted in a suitable scale with a multibeam echosounder.

### ACKNOWLEDGEMENTS

The authors are extremely thankful to Dr. B.N. Desai, Director and Mr. P.S.N. Murthy, Head Geological Oceanography Division for permission to publish this paper. They are also grateful to Mr. N.H. Hashimi, Dr. R. Nigam and Dr. Pratima Jauhari for critically going through the manuscript. One of us (M.C.P) who was one of the member of the team is thankful to Dr. S.Z. Qasim Leader and Late Dr. H.N. Siddiquie, Deputy Leader of the expedition for their constant encouragement and guidance during data collection and processing on board the ship.

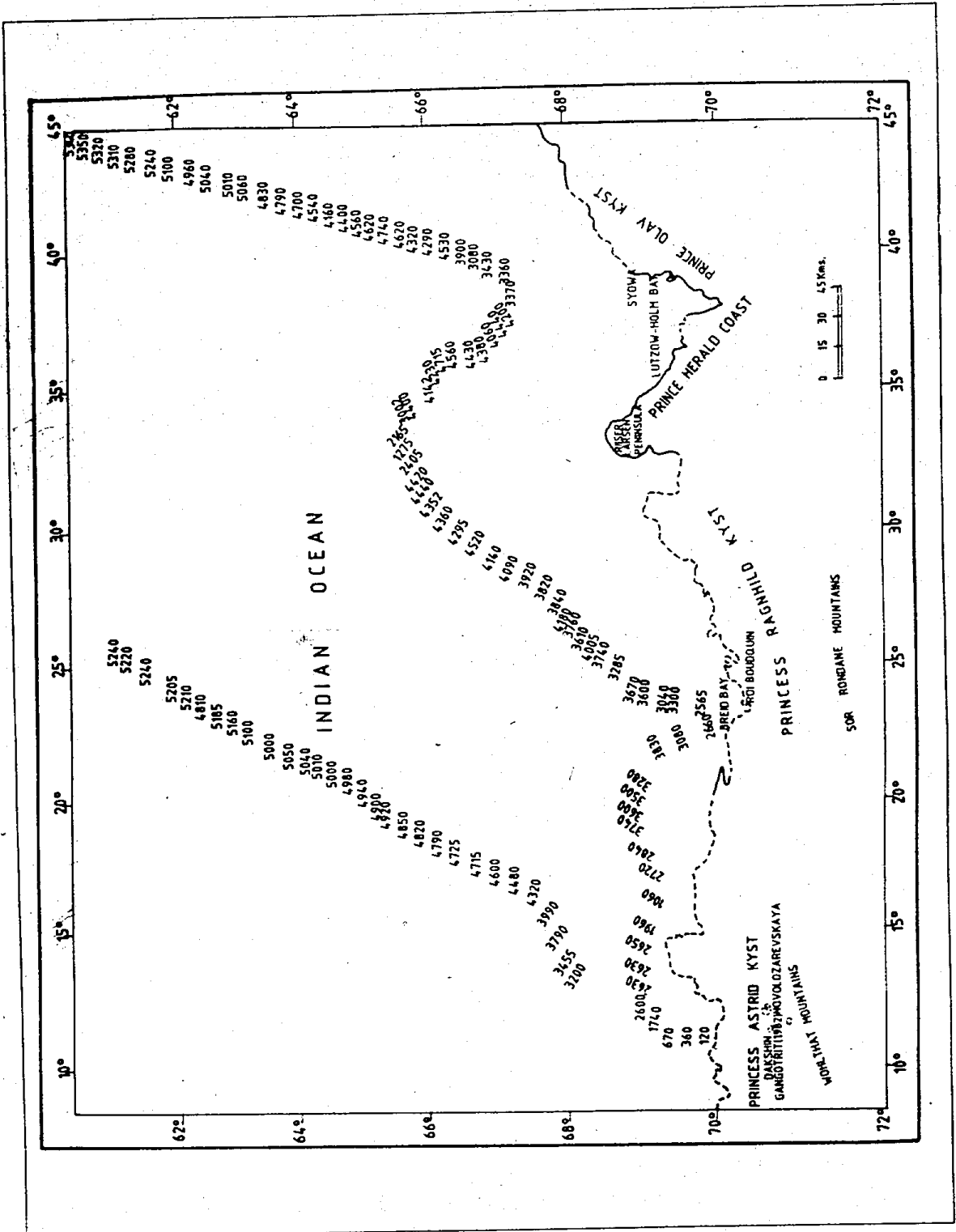


Fig. 1. Bathymetry of the south Indian Ocean.

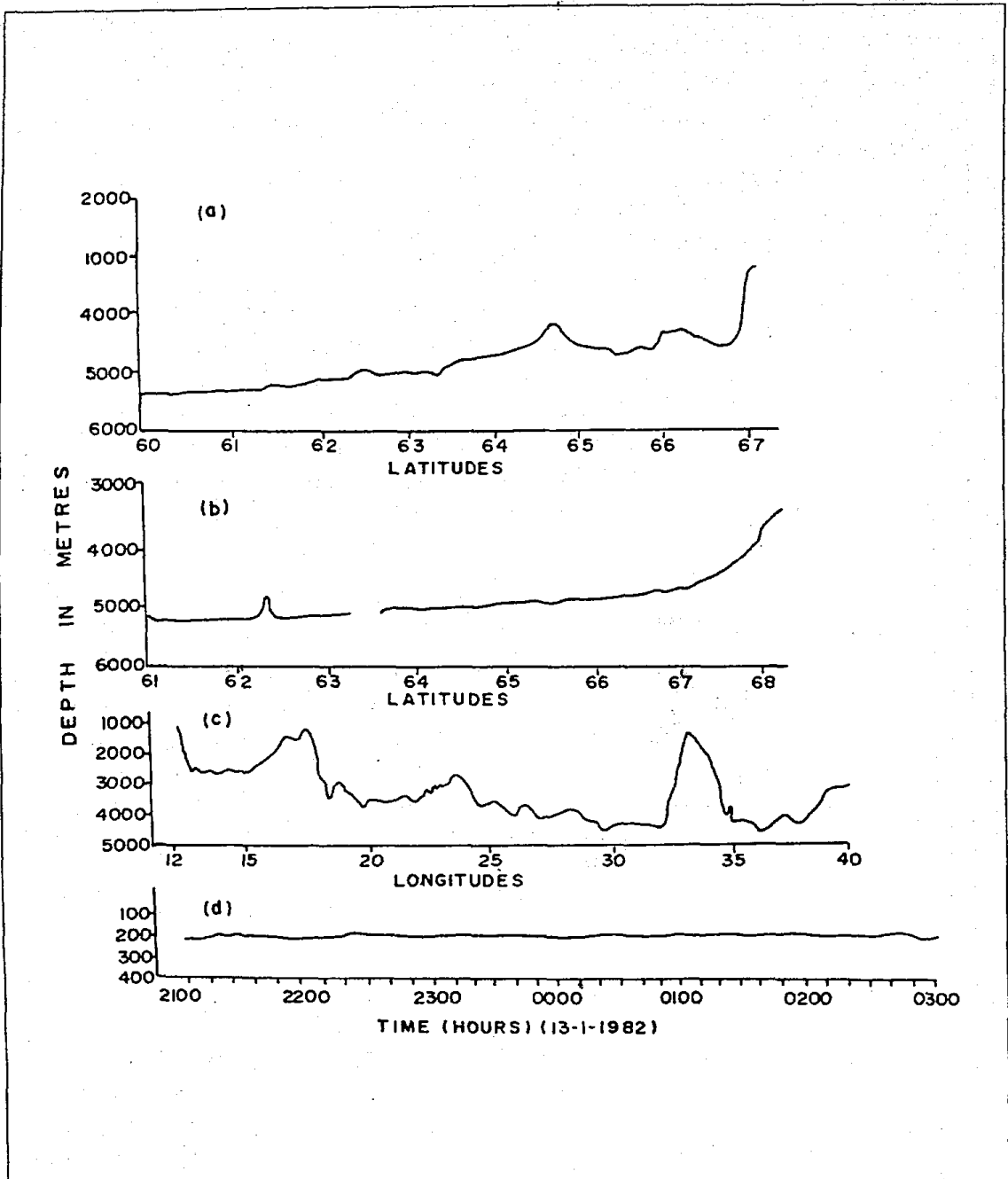


Fig. 2. Selected profiles from 60° S to Princess Astrid Kyst.

(a) Profile from 60° S to Prince Olav Kyst.

(b) Profile along latitudinal direction from Prince Olav Kyst to Princess Astrid Kyst.

(c) Profile from the Princess Astrid Kyst to 60° S.

(d) A selected bathymetry profile of Polynya area.

## REFERENCES

- Bakaev, V.G., Editor, Atlas of Antarctica, Chief Organisation for Geodesy and Cartography of the USSR (In Russian), 1966, 225.
- Buinitskii, V. Kh., Lazarev ice shelf, its morphology and origin. In : Soviet Antarctic Expedition, Information Bulletin, Vol. II. Elsevier Publishing Co., Amsterdam, 1964, 215.
- Johnson, L.G., Jean-Reane Varney, Anders Elverhoi and John, L. La Brecque., Morphology of the Weddel sea and south west Indian Ocean : Deutsche Hydrographische Zeitschrift, Jahrgang, 34, 1981, 263.
- Siddiquie, H.N., Bhattacharya, G.C., Pathak, M.C. and Qasim, S.Z., Indira Mount—An under water mountain in the Antarctic Ocean : Scientific Report of First Indian Expedition to Antarctica, Technical Report 1, 1983, 161.
- Siddiquie, H.N and Pathak, M.C., Bathymetry and Geomorphology of the approaches to Dakshin Gangotri, Princess Astrid Coast, Queen Maud Land, Antarctica : Scientific Report of First Indian Expedition to Antarctica, Technical Report 1, 1983, 149.
- Voronov, P.S. and Kruchinin, Yu. A., Brief Physiographic description of the Lazarev station Region : Soviet Antarctica expedition, Information Bulletin, Vol. 2, 1959, 34.
- Voronov, P.S. and Koblents, Ya. P., Iceberg drift as an aid in the study of the relief of the Antarctic continental shelf. In : Soviet Antarctic Expedition, Information Bulletin, Vol III. Elsevier Publishing Co., Amsterdam, 1965, 248.