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ABSTRACT

A survey of a part of the permanent ice shelf which surrounds the continent of Antarctica, was carried out between 15 L to 15 W longitude and around 70 S latitude to select a site for permanent Indian Station.

The survey has revealed that this part of the shelf has undergone no major topographical change during the last forty years or so except for the breaking of a large protruded portion along zero degree meridian. Stability of the shelf is due to its being in contact with the submarine continental shelf which has at places given rise to 'ice rises'.

INTRODUCTION

Ice shelf—an apron of permanent ice around the Antarctic landmass extends upto 100 km seaward and rises to a height of 100 m. In order to establish a manned station a part of the Antarctic ice shelf was surveyed around 70 S latitude especially between 10 -15 E longitudes, by the authors during the Second Indian Expedition.

During the period between 28th December, 1982 and 21st February, 1983, detailed investigations were carried out from the sea coast in the north to the landmass of Dakshin Gangotri (Schirmachei Hill) 60 km in the south, while reconnaissance survey of the polar ice sheet further 100 km southwards was also carried out. Traverses were taken over the shelf to study the aerial photography and interpretation of available satellite imageries for the last ten years were undertaken.

COASTAL FEATURES

The coastal part of the shelf has not shown any major topographical change in the form of calving or otherwise during the last forty years or so, except for the breaking of large protruded portion along the zero degree meridian as is evident from the comparison of the coastline relief map published in 1959 with satellite imageries of this shelf taken from 1973 onwards.

The latest map of the coastal area made through aerial survey and a large scale map of the Cape Ostray and two bays west of it, with the help of the ship's Radar, bring out the coastal relief, which is comparable with the map published by Swithinbank (1966), and further substantiates the rather stable nature of this shelf (Fig 1).

The shore ice on 28th December 1982, when the Second Indian Expedition landed on this shelf, extended northwards for about 23 km behind the ice shelf and showed presence of a large number of entrapped icebergs. Both Indian Bay and the Russian Bay (Fig 2) were completely filled with shore ice — fast ice — varying in thickness from 2 to 5 m. Towards the first week of February 1983, when the ship came to the mouth of the Indian Bay, the shore ice was still hard enough to

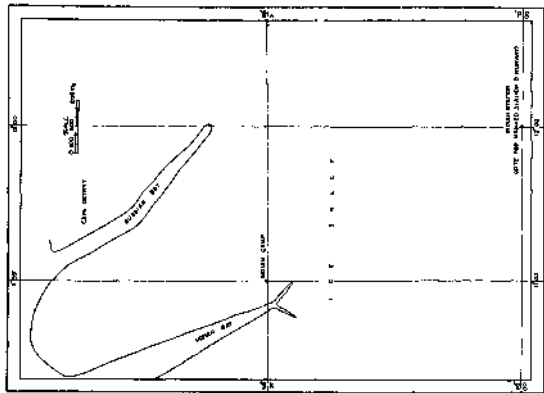


Fig 2 Outline of the shelf (as on 1921 '83) and location of Indian Station, Antarctica

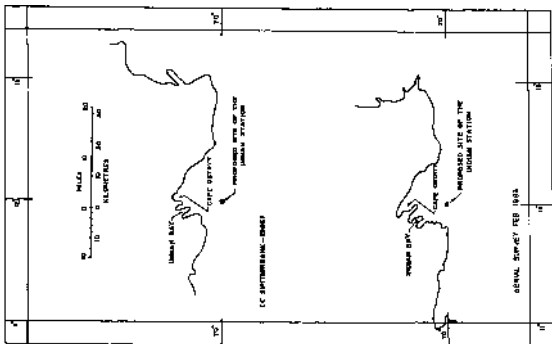


Fig 1 Nature of the ice shelf between 11 E to 13 E, Dronning Maud Land, Antarctica

enable the expedition to unload the fuel drums on it for transportation further interior. Towards the end of the month (February 1983) the entire Bay had become free of the shore ice, accelerated to a great extent by the ice breaking done by the American ice breaker, *Polar Star*.

TIDAL WAVE ICE CRACKS

During the month of January 1983, the fast ice was still preserved around the shelf of the base research station of the expedition. The junction between the fast ice and the shelf ice was very conspicuous where the shelf ice is thick and is with a steep fall; whereas in low-lying peripheries, shelf ice was observed to merge inconspicuously with the fast ice. The transition zone was found to be riddled with cracks and crevasses and these cracks could, at certain times during the day, be seen developing and widening and giving rise to off-shoots. The trend of these ice cracks was noticed to be parallel to the shelf outline and would swerve with any inundation in it. A developing crack was earmarked for monitoring which had a width of 9 cm on 6th January and trending N50°W-S50°E. Subsequent observation on 11th January revealed that the crack was widened to 18 cm. The aluminium strip placed across the crack for measuring the widening process, had cut a plane dipping 67° towards NW with a clockwise rotation of 10° (Figs. 3 and 4).

The inference drawn from these observations are that the shelf ice-fast ice contact zone was in a dynamic state. The combined effect of vertical, rotational and forward movement produced the dipping cracks and possibly due to the force generated by tidal waves.

SHELF ICE - SURFACE FEATURES

In this area the ice shelf abruptly rises southwards to a height of 50 to 60 m for first 10 km or so (Fig. 5), after that gradually slopes downward till near the northern face of the *Dakshin Gangotri* (Schirmacher Hill) at the sea level. At this site two lagoon-like features are formed, surrounded on three sides by the highly contorted shelf ice and on the fourth side by the landmass. These lagoons mark the exposed parts of the sea surface. Thinning down of the shelf ice at this locality is apparently due to high radiation caused by the reflection of the sunlight from the rock cliffs.

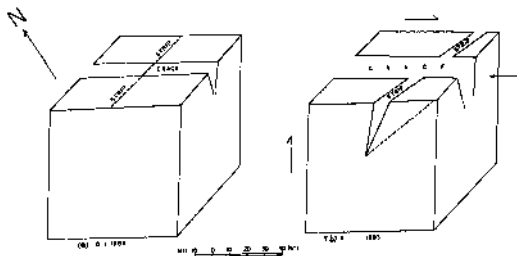


Fig 3 Block diagram showing the relative position of the ice crack and aluminium strip on 6-1-83 and 11-1-81

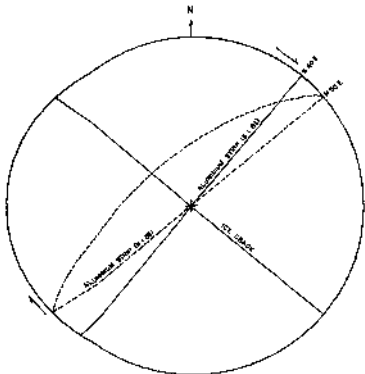


Fig 4 Stereographic projection of the ice-crack and the aluminium strip (solid lines) and the resultant development of the imposed plane due to coupling (dashed lines)

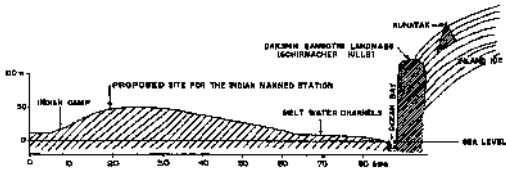


Fig 5. Section of the ice shelf at Dakshin Gangotri

The surface of the ice shelf upto 40 km from the coast, exhibits an undulatory appearance with sastrugis mostly oriented in the $N80^{\circ}E-S80^{\circ}W$ direction. Beyond this point, a dendritic network of melt-water channels covers the shelf ice, and still further south, number and size of the channels increased and end up on a vast greenish blue lake. The melt-water everywhere, flowed from east to west.

Density profiling of the shelfice shows the density is of the order of 0.5 gm/cm^3 , the hardness varying from 5 to 10 kg/cm^2 .

The inland ice sheet, which has given rise to vertical cliffs of predmont glaciers on the southern side of the *Dakshin Gangotri* landmass, and which flanks this landmass on the eastern and western side, slopes down steeply on to the shelf ice along this latitude. The contact of two ice bodies here is marked by highly corrugated ice ridges, with well developed, deep, serpentine meltwater channels. Small terminal moraine ridges, of about 2 m height, are very prominent. The inland ice sheet shows a gradual rise southward upto the Wholthat mountains. The surface of the ice sheet which was observed to be hard and devoid of any sastrugi is barren except for a few solitary nunatak protruding out of the ice mass, here and there. Closer to the Wholthat mountain, the ice sheet reveals dark curvilinear features apparently remnants of old snow filled crevasses.

ICE RISES

The shelf area between 15° and 13°W longitude and within 70° to 71°S latitude shows the presence of as many as 19 ice rises, which could be easily identified on the 1981 satellite imagery. Not many of these ice rises are identifiable in the field. The nature and the respective position of these ice rises is given in Table I. The coordinates given coincide with the central point of the ice rises. The

TABLE I

Ice rise recognised from Landsat imagery (1973 & 1981)

| No | Ice Rise Position | Length (km) | Width (km) | Ratio width/ length | Trend |
|----|---------------------|-------------|------------|------------------------|-------|
| 1 | 72° 41' S 14° 30' W | 30 | 20 | 0.66 | |
| 2 | 72° 50' S 13° 45' W | 30 | 12 | 0.40 | N50°E |
| 3 | 72° 28' S 13° 45' W | 24 | 12 | 0.50 | N-S |
| 4 | 71° 41' S 12° 10' W | 24 | 12 | 0.50 | N-S |
| 5 | 71° 14' S 09° 00' W | 90 | 42 | 0.47 | N-S |
| 6 | 71° 00' S 06° 00' W | 102 | 48 | 0.48 | N-S |
| 7 | 70° 18' S 05° 30' W | 18 | 13 | 0.70 | N-S |
| 8 | 70° 19' S 02° 30' W | 30 | 21(2) | 0.70 | N-S |
| 9 | 70° 46' S 02° 00' W | 42 | 24 | 0.57 | N-S |
| 10 | 70° 23' S 02° 45' E | 30 | 12(2) | 0.40 | N40°E |
| 11 | 70° 09' S 00° 30' E | 30 | 18 | 0.60 | N-S |
| 12 | 70° 05' S 05° 45' E | 12 | 9 | 0.75 | N-S |
| 13 | 70° 00' S 06° 30' E | 9 | 6 | 0.66 | N-S |
| 14 | 70° 12' S 07° 40' E | 24 | 18 | 0.75 | N-S |
| 15 | 70° 00' S 09° 00' E | 60 | 20 | 0.33 | N-S |
| 16 | 70° 00' S 10° 30' E | 16 | 6 | 0.23 | L-W |
| 17 | 70° 00' S 11° 30' E | 10 | 4 | 0.40 | F-W |
| 18 | 70° 00' S 12° 10' E | 4 | 4 | 1.00 | L-W |
| 19 | 70° 00' S 13° 00' E | 30 | 10 | 0.33 | E-W |

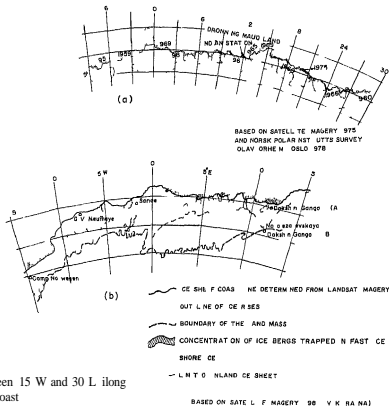


Fig. 6 (a) & (b)

Antarctic ice shelf between 15°W and 30°W along Dronning Maud Land Coast

identification of some of these ice rises is doubtful (Nos 5 & 15) as these appear to be joined to the inland ice sheet along their southern margins and may in fact represent the grounded inland ice sheet. They do show a characteristic isolated elevated nature and are bound on three sides by the shelf ice.

A correlation of the ice rises as identified from the imagery of 1981 with the ones described by Olav (1978) shows a considerable similarity and confirms the fact that there has been practically no major change in the coastal features of this area between 1975 and 1981 there being no significant ice movement in this part of the shelf. In fact the pictorial representation of the shelf between the longitude 3° to 7°W as seen in the 1981 imagery (Fig. 6a and 6b) is practically the duplication of the imagery picture published by Olav (*ibid.*, p. 75).

These ice rises apparently represent continental shelf rises which have been overridden by the shelf ice and the former now hold the shelf in more or less a stable position.

ACKNOWLEDGEMENTS

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