Glacio-Geomorphic Study on Submarine Morphology East of Lützow-Holm Bay, East Antarctica

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Abstract

In the eastern part of the Lützow-Holm Bay, East Antarctica, there are several deep submarine valleys and/or drowned fjords on the continental shelf. The deepest submarine valley, sounded by the present author and named "Telen submarine valley", extends southward for 50 km to the ice front of Telen Glacier, and ice stream in the continental ice sheet. The valley is relatively narrow but deep, and it has the nature of fjord topography, such as flat valley bottom, undulating longitudinal profile, and steep side walls.

Telen submarine valley has a maximum depth of 1,140 m below mean sea level at the middle of its course. The submarine valley is concluded to have been formed by intense ice streams extending from Telen Glacier at the maximum glaciation of the area when ice sheet expanded seaward for 75 km, burying almost the Lützow-Holm Bay.

The ice thickness at the maximum glaciation is inferred from the depth of the submarine valley to be more than 1,300 m at the present coast line, assuming sea level was 100 m lower than at the present. The age of formation of the valley is not obvious yet, but the radiocarbon dates reported already in the neighbourhood suggest that ice sheet of the area had retreated before at least 35,000 yr. BP. But the value should be reduced, if we apply the modern carbon standard value determined by the modern samples in Lützow-Holm Bay.

After retreat of ice sheet, the valley which might be a glacial trough was drowned and formed deep fjord landform. The other fjords in the area have the same nature though their sizes are smaller than Telen Fjord.

1. Introduction

1.1. Previous works

Geomorphic studies on ice-free areas along the east coast of Lützow-Holm Bay have been carried out and reported by Yoshikawa and Toya (1957), Tatsumi and Kikuchi (1959), Koaze (1964), Meguro *et al.* (1964), Fujiwara (1973), Yoshida (1973),

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and Moriwaki (1974). While the submarine morphology off Prince Olav Coast and Prince Harald Coast have been reported by Kumagori *et al.* (1958), Niino (1958), Sato (1964), Shoji *et al.* (1964), and Yoshida *et al.* (1964).

But the submarine morphology of inner Lützow-Holm Bay has been remained insufficient to be clarified, because the bay is covered with flat ice and heavy pack ice nearly all the year round. Yoshida (1969) succeeded in sounding the bottom topography through polar sea ice. On the result, Fujiwara (1971) and Moriwaki (1975) could clarify the submarine topography of the glaciated continental shelf around the Ongul Islands.

In this paper, the present author intended to clarify the submarine morphology and glacio-geomorphic development of the east coast of the Lützow-Holm Bay, remaining unsolved.

1.2. Source of Data

Main data on which present paper is based are result of echo-sounding obtained mainly by the present author and the members of JARE-14, during their staying at Syowa Station, in 1973. Additional data are based on the former reports mentioned above, charts Nos. 3905, 3911, 3912, and 3941 published by Japanese Maritime Safety Board. The results of field observations which were carried out by the present author in 1969–1970 and 1973–1974, are also included in this paper. Bathymetric charts which accompany this paper were mapped from above mentioned materials.

1.3. Surveyed Area

The area to be described is that covered by 1:250,000 sheet of the Lützow-Holm Bay published by Geographical Survey Institute, Ministry of Construction. Sounded area is also covered by the charts Ongul Islands to Skarvsnes and Skarvsnes to Skallen, east of 38°50′E in longitude. The area forms a belt that extends 20 km to 50 km seaward from ice sheet, and extends 80 km from Syowa Station to Skallevikhalsen. The easternmost sounding route is nearly on the straight line connecting Benten Island and Einstödingen (Figs. 1 and 3).

1.4. Coastal Geomorphology

In the eastern part of the surveyed area, there is an ice sheet increasing altitude gradually to inland. Along the western margin of the ice sheet, there are distributed several ice-free areas and islands such as Langhovde, Breidvågnipa, Byvåg Åsane, Skarvsnes, Kjuka, Telen, Skallen and Skallevikhalsen. Coastal geomorphology of the area is characterized by conspicuous glaciated landform. It is divided into two majour topographical units according to its heights and erosional

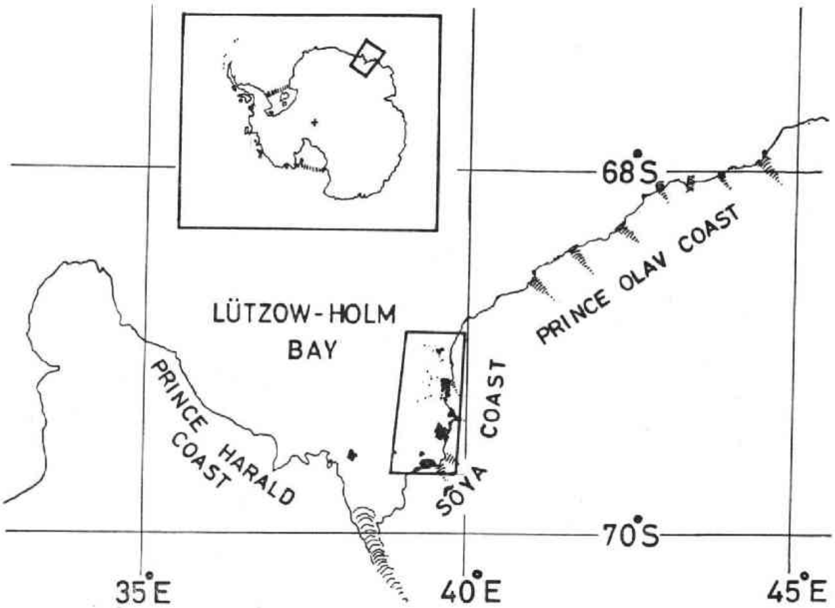

Fig. 1 Locality map of surveyed area (framed).

features. One is low undulated hills of *roches moutonées* with glacial striae and mammillated surfaces covered with thin morainic deposits, at 50 m to 150 m high above sea-level. The other is glaciated mountains, such as isolated dome-like peaks or highland surrounded by steep slopes higher than 200 m. The former landform is often observed at most of the islands, the western part of Langhovde, and Skallen. While the northern and eastern Langhovde, Breidvågnipa, Byvåg Åsane, Skarvsnes and Skallevikhalsen, bear the latter topographic features. These areas are mostly free from ice and snow in the present days, while erratic boulders bearing glaciated striae are scattered on these peaks higher than 480 m.

Giant *roches moutonées*, cirques, hanging valleys and glacial grooves prove that the area was glaciated, though the surface of bedrocks are mechanically weathered and striations are not so well preserved in the northern part of the area. Most of the striations and glaciated valleys are southeast to northwest or east to west in direction.

The coast line of the Lützow-Holm Bay is simple, except serrated coastlines and strandflats near glaciers and ice-free areas at Langhovde (Photo 12), Sakrvsnes, and around Ongul Islands, and at the west coast of Skjegget peak, Skarvsnes which are characterized as "skjeaergård". On the west coast of Langhovde, there are many inlets and islands rarely more than 60m a.s.l. along geologically weaker belt trending approximately NNE to SSW, which suggest differential glaciation. From above natures, these coasts are considered "fjärds" in genesis. Such a landform is also observed at the Åsen Bay, Skarvsnes.

Most of the coasts are rocky and strongly glaciated, but in some places such as in deep inlets, there are raised beaches, or coastal terraces. The distribution of terraces and the radiocarbon dates of their deposits were reported by Meguro *et al.* (1964), Yoshida (1973), Moriwaki (1974), Omoto *et al.* (1974) and Omoto (1976b). Their levels are below 20 m high on the east coast of the inner Lützow-Holm Bay. There are about 16 steps at Kizahashi-hama (Beach), Skarvsnes. At Ṣhinnaniwa, in the Prince Olav Coast, beach gravels are found at the levels of 30 m, 15 m and 10 m high a.s.l. (Yoshida, 1973). The present author could observe rounded beach gravels at levels of 20 m to 26 m, and 28 m to 32 m high on Ongulkalven Island.

Dried and shrunk lake and its former shore lines or terraces are well preserved at Hunazoko-ike, Skarvsnes, whose present lake level is about 23 m below mean sea-level (Photo 22). Many terraces are well preserved and cut by melt water streams at several places. A small deltaic terrace is on the coast downstream of Yukidorisawa, central Langhovde. In general, the terrace deposits are poor, but thin deposits derived from the morainic deposits and marine silt or clay including some fossil shells are seen.

1.5. Outline of Coastal Geology

Geological and petrological studies of the surveyed area were carried out and reported by Tatsumi *et al.* (1959 and 1961), Saito *et al.* (1961), Kizaki (1962), Tatsumi *et al.* (1964), Sato *et al.* (1965), Yoshida (1970), Yoshida *et al.* (1971), Yanai et al. (1974a and 1974b, 1975a and 1975b), Ishikawa (1974) and Ishikawa *et al.* (1976), and Yoshida *et al.* (1976) as follows (Fig. 2).

The geology is so monotonous that whole the area may belong to a single structural unit. Widely exposed gneisses are grouped here as "Lützow-Holmbukta system" (Tatsumi *et al.*, 1964) based on their mode of occurrence and their petrographic features. Foliations and boundaries between dark and light coloured bands generally strike north-south and dip 30° to 60° eastward, although local fluctuations and gentle folds are observed in some places. The petrological characteristics of gneiss affect also the glacial erosion and weathering. The dark coloured basic metamorphic rocks are more deeply eroded than the light coloured acidic rocks. Joints, foldings and fractured zones are also related closely to the landform of glaciated lowlands. As a good example of differential erosion the foliation strike of gneiss control serrated features of peninsulas and islands, points and inlets (Photos 2, 9 and 10).

Almost vertical cliffs 200 m to 300 m high a.s.l. observed at Langhovde, the

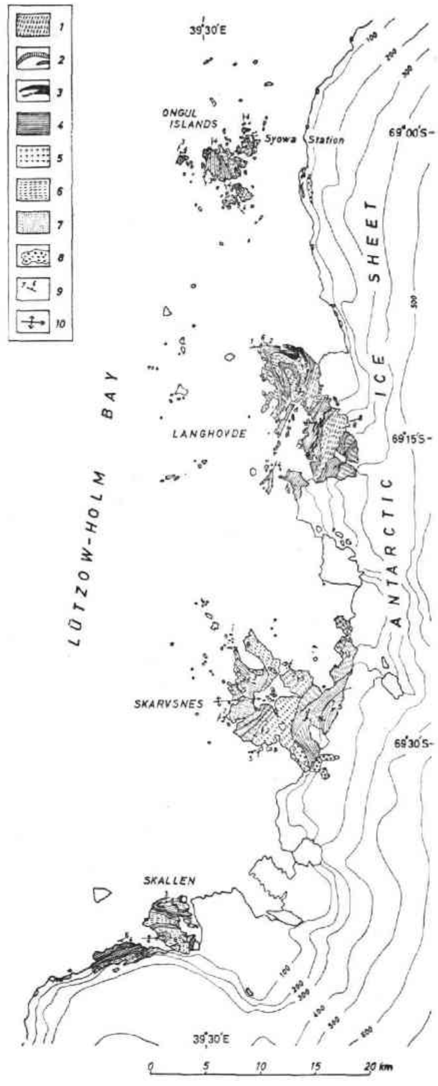

Fig. 2 Geological map of main barerock areas in the Lützow-Holm Bay (Modified from the map of Tatsumi *et al.*, 1964). **1**: Pyroxene-gneiss with intermediate composition, **2**: Marble and Quartzite, **3**: Metabasites with ultrabasic and basic composition, **4**: Garnet-gneiss with pelitic composition, **5**: Granites, **6**: Hornblende-gneiss, **7**: Fossil bearing sand and gravel deposits, **8**: Glacial morainic deposits and erratic boulders, **9**: Strike and dip at 10 degrees intervals, **10**: Anticlinal axis and plunge.

south cliff of Breidvågnipa, Skjegget peak, south of Mt. Tenpyo and Skallevikhalsen (Photos 15, 18, 19 and 21) are not fault origin. They are remained walls of U-shaped valleys and the opposite walls have been completely lost by glaciations.

The absolute rock age from this region was determined about 4.7 m.y. (U-Pb method) by Saito *et al.* (1961), about 4.7m.y. (Rb-Sr method) by Nichlayson *et al.* (1961), 3.99–5.60 m.y. (K-Ar method) by Yanai *et al.* (1974). Therefore the last metamorphic event in the charnockitic gneiss of this region took place in Early

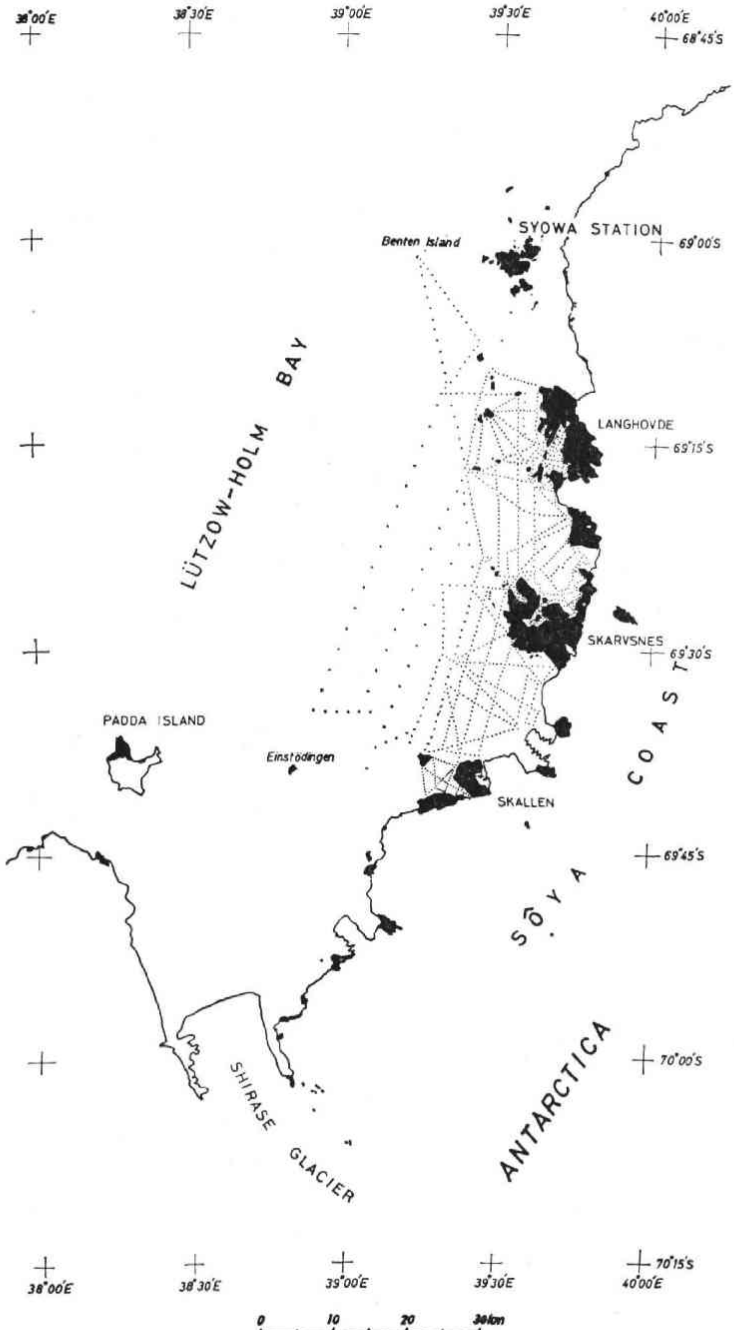

Fig. 3 Traverse route for echo-soundings in 1973. Main sounding stations are expressed by dots.

Palaeozoic time.

2. Echo-sounding and Result

2.1. Echo-sounding

Syowa Station of the Japanese Antarctic Research Expedition (JARE) is on East Ongul Island, located at the mouth of Lützow-Holm Bay and about 5 km apart from the continental ice sheet. In 1956–1957 the Ice-breaker "Soya" could invade Lützow-Holm Bay, but since 1957 she had no success to approach the Syowa Station. The Ice-breaker "Fuji" working since 1965 could approach the station three times along almost the same route, but since 1970 she has not closed to Ongul Island. Thus it was impossible to survey submarine landform of Lützow-Holm Bay on board.

Under these circumstances, it was planned to survey submarine geomorphology of Lützow-Holm Bay by echo-sounder installed on snowcar driving on sea-ice. Prior to the echo-sounding, the author could observe from air many openings, thawholes, and some leads of sea-ice near Langhovde at the end of February 1973. And in the whole area to be surveyed except south of Skarvsnes, there were many polynyas and thawholes. The route from Syowa Station to Skarvsnes and Skallen was sought carefully. The route for Skarvsnes was established at the beginning of May, when sea-ice was 50 to 75 cm thick. In this season, the author was troubled with changes of sea-ice conditions such as fracturing, ridging, and rafting in many places. But sea-ice grew up to 150 cm thick at the end of August, and the route for Skallen was established.

The echo-sounding party was organized by Dr. Hirasawa, the leader of the 14th wintering party, as shown in Table 1 and worked during the period from August 21 to November 8, 1973 on snow car driving over 1,600 km on sea-ice including the trips for person exchanges.

The traverse routes were set on straight lines connecting bare rocks or islands (Fig. 3). Sounding stations were spaced along the route closer near the coast and wider off-shore; they were set every 500 m to the east of the line from Sigaren Island (69°10.5′S, 39°28.0′E) to Hjartöy Island (69°38.0′S, 39°16.5′E) and 1 km or 3 km to the west, while 250 m in the inlets of Skallevika, Langpollen, Osöya and Hamna.

The position of each station was determined usually by magnet compass and distance meter of snow car near the coast, and by theodolite (Wild T2) off-shore, and plotted on a map of 1:100,000. There was a slight difference in longitude and azimuth between the map of Lützow-Holm Bay (1:250,000) published by Geographical Survey Institute, Ministry of Construction and the chart 3941 of Ongul to

Skarvsnes (1:100,000) published by Japan Maritime Safety Board. The author used the former except at inlets where he used topographic maps of 1:25,000 published by Geographical Survey Institute.

The echo-sounder NSL-1300 (M, N) made by Sanken Electronics Co. was mounted in the cabin of snow car with a gasoline generator (Photos 5 and 6). The echo-sounder has been improved for polar use whose details were reported by Yoshida (1969). The output power was 300 watts to 100 mm tranceducer (For under-ice sounding) and 1,200 watts to 264 mm tranceducer (For ice-surface sounding).

The eastern part of the surveyed area is on the leeward side of circumpolar easterly and katabatic wind, where a bare sea-ice belt about 10 km wide is developed off the continent. In this area, it was possible to obtain good echoes through thick polar sea-ice by using the tranceducer of surface-type (Photos 7 and 8). The author could obtain many clear echoes even when sea-ice was 235 cm thick, and where it is deeper than 900 m. No echo was obtained where sea-ice contained much brine, or melting layers in itself. The blue ice region was best conditioned for echo-sounding by the tranceducer of ice-surface type in the cold

Table 1 Activity of the echo-sounding parties in 1973.

Date	Area covered	Soundings	Members	Remarks
Apr. 29-May 12	Langhovde to Skarvsnes	52	OMOTO, K., SHIMANO, K., HIRABAYASHI, J. and TAKAHASHI, Y.	Support for Geochemical Research
Aug. 21-27	Breidvagnipa to Skarvsnes	190	OMOTO, K., JŌBASHI, H. and NEMOTO, N.	
Aug. 30- Sep. 6	West off Langhovde to Skarvsnes	313	OMOTO, K., ASHIDA, S., KAJIKAWA, M. and MATSUDA, S.	
Sep. 11-20	Skarvsenes to Skallen	249	OMOTO, K., IYAMA, N., TAKAHASHI, Y. and NAKAMURA, T.	Including Geographical Field Survey
Oct. 12-20	West off Skarvsnes to Skallen	144	OMOTO, K., KOZUMA, T., KAJIKAWA, M. and TSUBOI, S.	Including Geographical Field Survey
Oct. 24-31	Inlets of Skarvsnes and Skallen	228	OMOTO, K., HIRASAWA, T. and ISHII, I.	Including Geographical Field Survey
Nov. 2-8	Inlet of Hamna	110	OMOTO, K. and NAKAMURA, T.	Including Geographical Field Survey

season, and melting layers in sea-ice interrupted ultrasonic to penetrate into sea water in November. The author was also troubled sometimes with such uneven ice as slush and shuga, and had to plane ice surface with a pickel and a motor sander, and then apread grease over cut surface to fit the tranceducer on sea ice. This was very effective in uneven bare ice area.

The tranceducer of under-ice type was used where ice contained much brine, slush, or melting layers, and where ice was covered with snow completely. Under these conditions, an electric auger (an improved SIPRE core drill fit for an electric motor drill) was used for about 10 minutes to cut sea-ice 200 cm thick and to extend rods.

2.2. Accuracy and Result

It is needless to say that the velocity of ultrasonic in seawater is variable with water temperature and salinity. According to the oceanographic survey reports of Higano *et al.* (1970), Sato *et al.* (1971), and Nakabayashi *et al.* (1971), the mean values of salinity and water temperature in this area are 34‰ and –1°C respectively in summer season. Temperature of surface water down to 20 m deep on the echo-sounding traverse was between –1.9°C and –2.0°C.

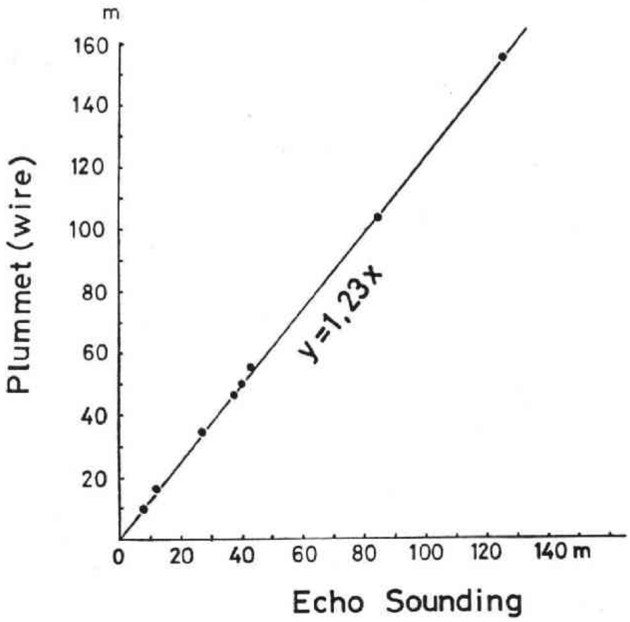

Fig. 4 Comparison of depths by echo-soundings and by plummets (wire soundings).

The echo-sounder NSL–1300 is powered usually with alkali batteries of 24 volt and 60Hz 100 volt invertor, but the author used 50Hz generator (AC 100 volt) instead. Consequently, it is necessary to correct the readings. The difference was only caused by frequency differentiation of the driving motor in the echo-sounder. The frequency of the generator throughout the echo-sounding traverse was $47.2^{+4.2}_{-1.6}$ Hz. Therefore, the true depth should be; $Dt=Dr\times(60.0/47.2+Dw)=Dr\times1.23$, where Dt is the true depth, Dr the reading on the echo-gram, drived by a generator of 47.2 Hz, and Dw the correction term for water temperature and salinity; that is −0.04m/sec. The results of the actual calibration by wire through the tranverses are shown in Fig. 4 and well coincide with the above mentioned correction formula.

Then all the readings were corrected by multiplying 1.23, and the corrected figures are shown in Table 2 attached to this paper. The error of depth at each station did not exceed 8% and perhaps less than 5% even in maximum, judging from the drift of frequency of the generator, water temperature, and salinity. On the other hand, the error in location of each station was less than 20 m in usual, and did not exceed 100 m even on the outermost sounding route. Therefore the location on the Table 2 is enough to compare with the depth in accuracy.

3. Description of Submarine Geomorphology

3.1. Continental Shelf

Continental shelf is deeper around Antarctica than around other continents. It has been explained by isostatic subsidence due to ice sheet. According to Voronov (1958, 1961 and 1964) the latest tectonic movements in Antarctica were largely controlled by processes of isostatic levelling of large crustal blocks under the colossal load of the inland ice sheet. In East Antarctica, the depression along the outer margin of shelf are considered to have been formed by tectonic movements closely related with isostatic subsidence of the continent (Lisitzin, 1962). Adie (1964) reported on the latitudinal effect concerned with the isostatic subsidence in Graham Land and Antarctic Peninsula, where far greater extent of ice sheet during the Pleistocene than at present resulted in subsequent depression. With the deglaciation earlier than elsewhere because of geographical situation, isostatic adjustment has been more advanced correspondingly, and is undoubtedly reflected on the latitudinal variation in depth of continental shelf.

Continental shelf off Prince Olav Coast and Prince Harald Coast is about 60 km wide and 300 m to 400 m deep at its edge. The foot of the continental slope is about 4,000 m to 4,500 m deep, forming a flat ocean floor of Enderby Abyssal Plain (Fig. 5).

Continental slope off Prince Olav Coast about 400 m to 2,000 m in depth is steeper than off Prince Harald Coast. Zhivago (1964) considered that there might be a fault along the steep continental slope off Prince Olav Coast. Continental shelf along Prince Olav Coast has an irregular surface feature which often exceed 100 m in relative relief. Yoshida *et al.* (1964) considered the irregular surface to be covered with sandy sediments and sub-angular gravels as morainic accumulation. It would be expected that the morainic deposits were remained on the shelf surface accompanied by the advance and retreat of ice sheet or glaciers, or the calving of icebergs. But the morainic deposits are poor and thin in general on the bare rock areas along Prince Olav Coast.

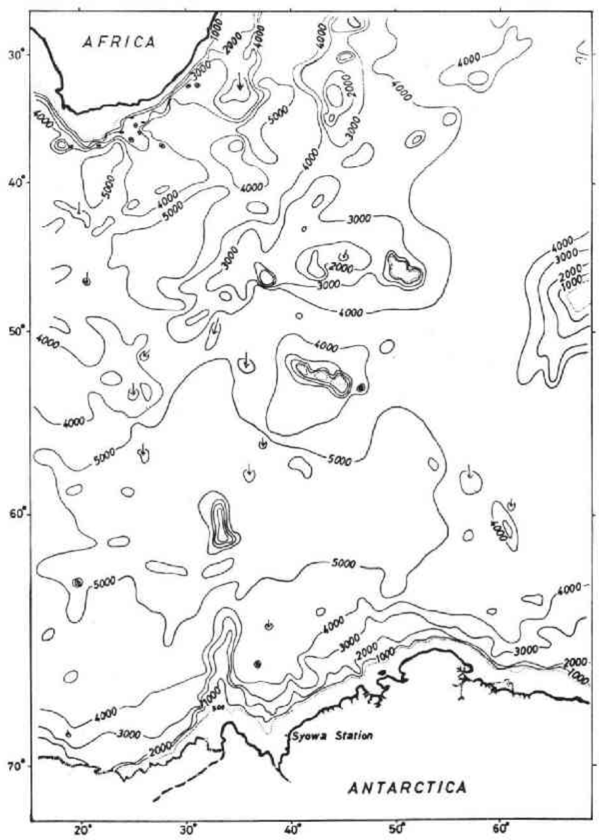

Fig. 5 Submarine landform between Anatrctica and Africa. Contour intervals are 1,000 m added with 500 m contour.

A deep channel on the continental shelf between Ongul Islands and Continent was noticed by Murauchi (1960). Fujiwara (1971) cleared out the topography of the channel, whose depth exceeded 600 m, and the northern extension was traced by Moriwaki (1975). Other deep troughs were also detected from poor sounding results, in front of Shirase Glacier (Murauchi, 1960 and Yoshida *et al.*, 1964), and Honnör Glacier (Fujiwara, 1971). But general features of submarine topography had remained unknown.

The echo-soundings carried out by the present author revealed the submarine geomorphology east of Lützow-Holm Bay (Fig. 6). Conspicuous findings are three deep submarine valleys; Telen, Skjegget and Honnör. Deep submarine valleys the author discovered deeply cut metamorphic rocks, and their longitudinal profiles are undulating. Their cross profiles show steep U-shaped valleywalls extending straightly, and the deepest points are at their middle course. They extend seaward from the floating ice tongues of glaciers at the margin of continental ice. Parallel to them steep cliffs are observed in ice-free areas. All these morphological features suggest that the deep submarine valleys on continental shelf are undoubtedly drowned fjords. The maximum depth of fjords of the world are listed in Table 3.

Subaerial riverine valleys have in general V-shaped cross profiles somewhat irregular and asymmetrical because of undercut and slip-off slopes, structual knobs, homoclinal shiftings, and climatic differences on the both sides (Thornbury, 1954), and their longitudinal profiles constantly descend downstream. Ordinary submarine canyons are shallow V-shaped valleys on the continental shelf and in most

Table 3 Maximum known depth of some fjords in the world (depth in meters below present sea-level). Modified after Embleton and King, (1968).

Fjord	Location	Depth (m)
Vanderford, Vincennes Bay	Antarctica	2,287
Skelton Inlet	Antarctica	1,933
Northwest Fjord, Scoresby Sound	Greenland	1,450
Sogne Fjord	Norway	1,308
Messier Channel	Chile	1,288
Baker Fjord	Chile	1,244
Telen Fjord*	Antarctica	1,148
Upernavik Ice-fjord	Greenland	1,055
Skjegget Fjord*	Antarctica	947
Chatham Strait	Alaska	883
Hardanger Fjord	Norway	870
Honnör Fjord*	Antarctica	807
Langhovde Fjord*	Antarctica	660

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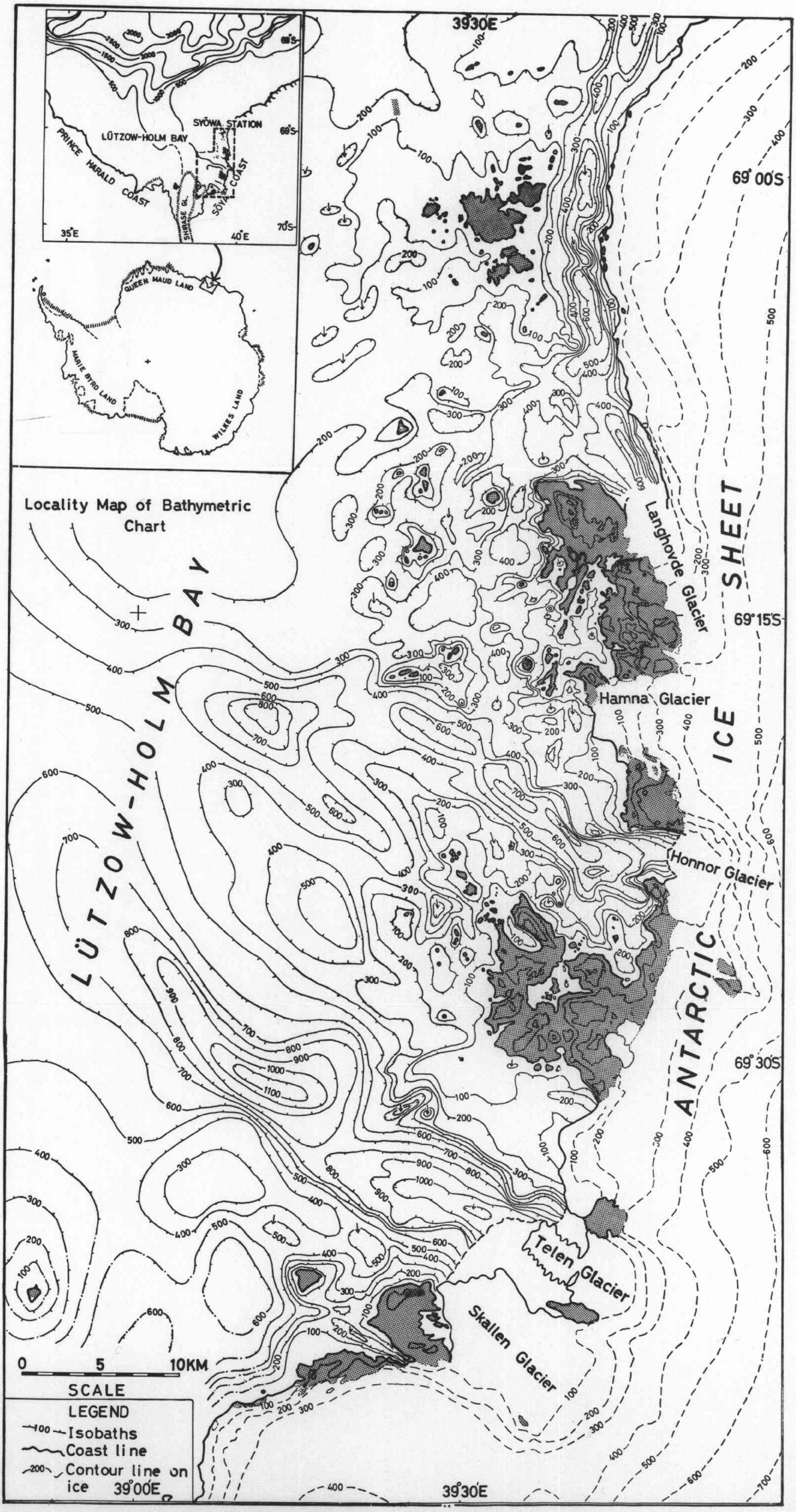

Fig. 6 Bathymetric chart of the east coast of Lützow-Holm Bay (Ice-free areas are inked.).

case cutting sedimentary rocks, and have longitudinal gradients 10 times greater than subaerial valleys. These morphological characteristics can not be recognized in those submarine valleys mentioned above.

3.2. Submarine Valley in Large Scale

(1) Telen Fjord

Telen Fjord is the deepest and widest glaciated valley in this region. The maximum depth measured was 1,148 m below mean sea level at its middle course. The deep glaciated valley rises immediately off floating ice tongues of the present Telen and Skallen Glaciers, stretching northwest more than 50 km, with an average width of 8 km (Photos 23 and 24). The end of the valley is not obvious yet, but judging from the former study of Yoshida *et al.* (1964), it seems to continue to an embayment of the continental shelf edge, decreasing its depth to 500 m at the mouth of the bay. The cross section is asymmetrical with steep slope on the north side which exceeds 45 degrees in some places. Since the cross sections in Figure 7 are not perpendicular to the valley axis and soundings are not so dense, each slope gradient does not show the maximum value. The longitudinal profile is generally smooth but somewhat undulating. The valley axis abruptly turns northward about 3 km to 5 km west of Hjartöy Island. From its features and continuity from the present ice tongues, this deep valley is inferred to have been scooped out by a vigorous glacier and remained as a deep fjord after retreat of the glacier from the trough.

(2) Skjegget Fjord

Geographical name "Skjegget" is given to the highest peak at the northwest of Skarvsnes. The peak stands aburtply about 400 m above sea-level almost vertically in its south face (Photos 17, 18 and 19). To the south of the Skjegget peak, there is a small inlet named Langpollen whose submarine landform is shown in Fig. 9. The deepest point of Langpollen is 156 m in depth at the north-central of the inlet. At the western part of the inlet, many islands are scattered. After geological studies (Tatsumi *et al.*, 1959 and 1964), there is no fault along and across the vertical southern face of the Skjegget peak. To the east, the peak is faced to Åsen Bay whose deepest point is 108 m deep and a small inlet is surrounded by steep slopes of bedrock. The steep slopes extend south of the Skjegget peak. To the west of the Skjegget peak a narrow deep submarine trough extends northward as far as 30

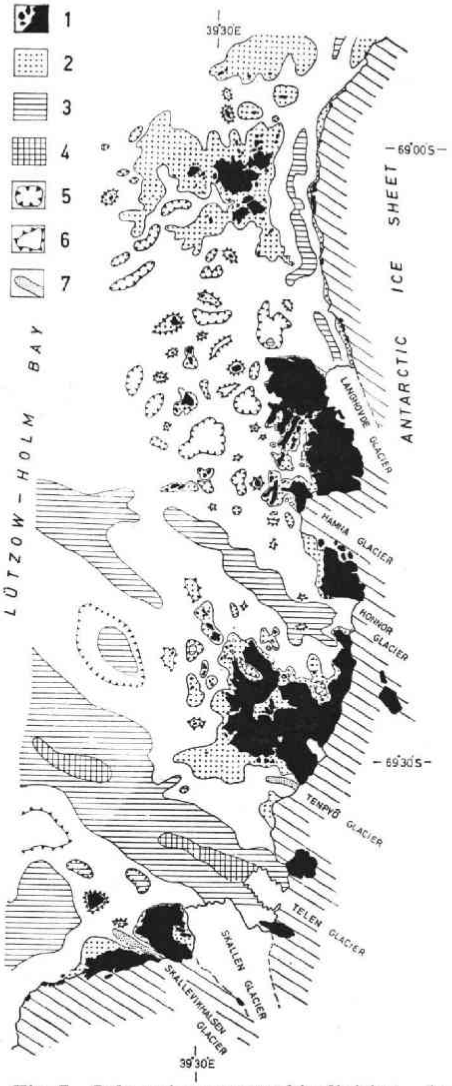

Fig. 7 Submarine geomorphic division. 1: Bedrock area, 2: Bank shallower than −100 m, 3: Fjord deeper than −500 m, 4: Fjord deeper than −1,000 m, 5: Submarine basin or depression, 6: Submarine rise or ridge, 7: Fjord in small scale.

km, of which the deepest point is sounded 809 m about 22 km northwest of the peak. It looks continuous to the deepest point (947 m) in the Lützow-Holm Bay reported by Yoshida *et al.* (1964).

The longitudinal profile is gently undulating (Fig. 8). The steep flank of the Skjegget peak and the deep trough more than 30 km long to the northwest might have been scooped by a strong glacier. The deep trough (the present Skjegget Fjord) was drowned after the retreat of glacier.

(3) Honnör Fjord

There is a floating ice tongue of Honnör Glacier between the bare rock areas of Breidvågnipa and Byvåg Åsane (Photos 14, 15 and 16). To the northwest of the Honnör Glacier a deep narrow submarine trough 3 km wide extends more than 20 km long. Its walls are steep and its longitudinal profile is gently undulating (Fig. 8). The cross sections are "U-shaped", and the deepest point is located as far as 7 km west of Breidvågnipa from the floating ice tongue of Honnör Glacier. The 500 m isobath closely runs to the Systerflesene Island, while as shown by 400 m isobath Honnör Fjord joins to Skjegget Fjord in the west. The deep narrow submarine trough might have been scooped by the advancing Honnör Glacier, and was drowned after the retreat of glacier.

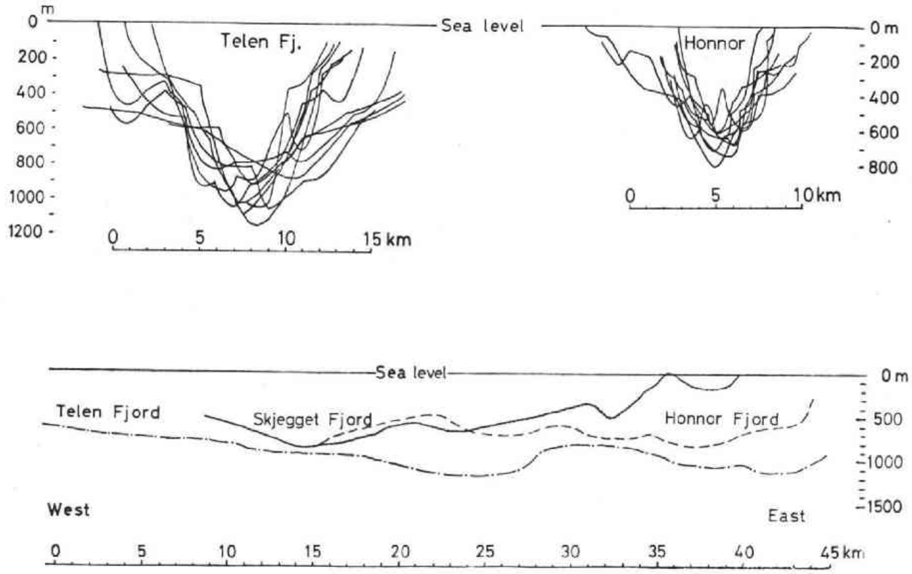

Fig. 8 Cross (upper) and longitudinal (lower) profiles of Telen, Skjegget, and Honnör Fjords.

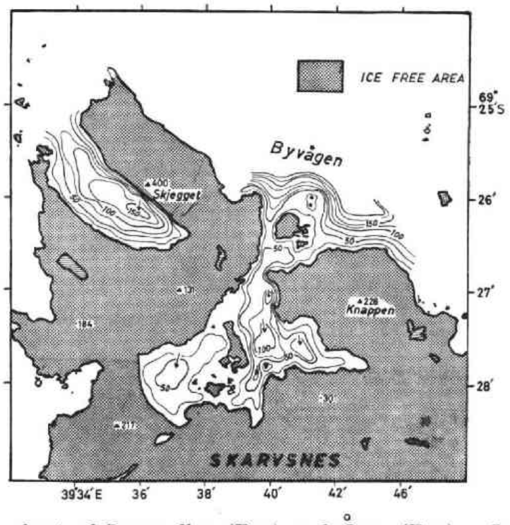

Fig. 9 Bathymetric chart of Langpollen (Bay) and Ösen (Bay). Contour intervals are 50 m each.

(4) Langhovde Fjord

Another deep narrow submarine trough extends about 5 km parallel to the ice sheet in front of Langhovde Glacier (Photos 1 and 9), whose maximum depth was sounded 635 m by Fujiwara (1971). The northern extension of the trough is continuous to the deep channel between Ongul Islands and the continent. According to Fujiwara (1971), "the cross sections of the channel are U-shaped in some places and V-shaped in other places. Lateral slopes of the channel are steeper on the continental side than on the Ongul Islands side. Comparatively wide shelf 200 m to 300 m in depth extends along the channel which forms wide U-shaped valley and is cut by another U-shaped valley". It is clear that the deep submarine valley in front of Langhovde Glacier was formed by a former advancing glacier and drowned after its retreat. It's northern extension was traced and reported by Moriwaki (1975).

3.3. Submarine Valley in small Scale

(1) Hamna Fjord

To the east and the south of Hamnenabben, two narrow and deep submarine valleys extend northward and westward respectively (Fig. 10). The former is continuous to the present Hamna Glacier (Photo 13). The latter is clearly distinguished from the former on bathymetric map (Fig. 10). Both are about 4 km long and 500 m to 1,000 m wide, and their deepest points are 208 m and 322 m respectively.

(2) Skallen Fjord

There is a small but conspicuous ice fall at the southeast end of Skallevika Inlet (Photos 24 and 25). In front of the ice fall, a narrow and deep submarine valley extends northward for 5 km (Fig. 11). The deepest point is 296 m deep at the innermost of the inlet. It is continuous to a deep submarine basin to the west of Hjartöy Island. The valley must have been formed also by a trespassing glacier over Skallen and Skallevikhalsen and drowned after the glacier retreat.

(3) Tenpyo Fjord

To the south of Mt. Tenpyo (260 m a.s.l.), southeast of Skarvsnes, a narrow submarine valley more than 3 km long and 500 m wide extends in front of Tenpyo Glacier and ice sheet. The southern flank of Mt. Tenpyo rises abruptly more than 200 m above sea-level (Photos 20 and 21), and the depth of the drowned valley at the foot of the peak exceeds 200 m. Though the submarine valley is narrow, short and comparatively shallow, it must have been scooped by the Tenpyo Glacier, and drowned after its retreat.

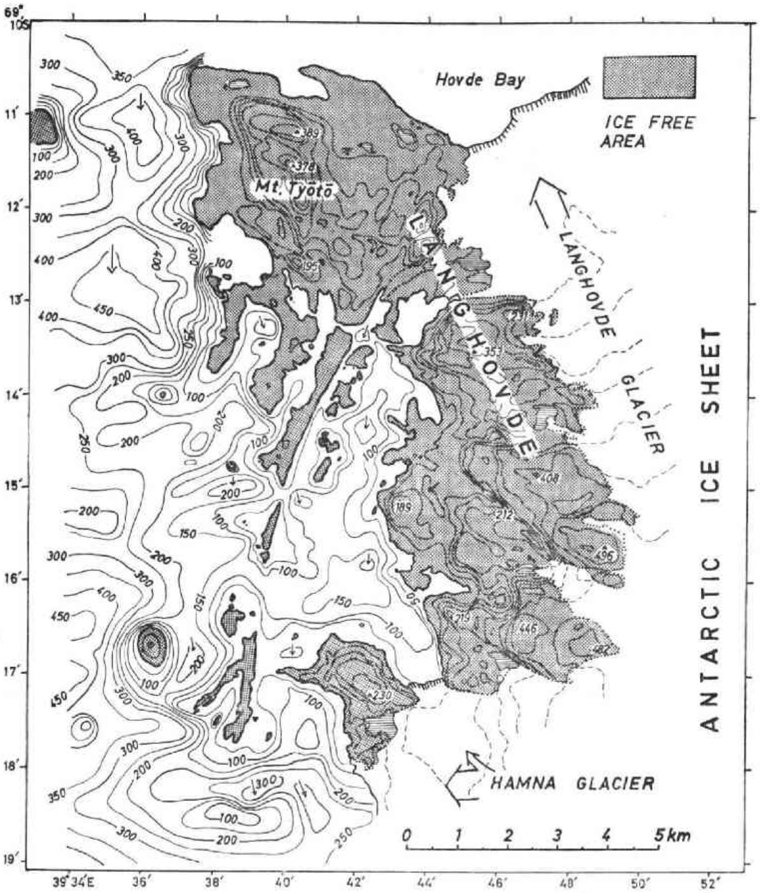

Fig. 10 Bathymetric chart of the west coast of Langhovde.

(4) Tankobu Fjord

An embayment is scooped more than 500 m deep between Mt. Tankobu (155 m a.s.l.) and Mt. Bōzu (235 m a.s.l.). It extends northward and joins Honnör Fjord (Photo 14). The southern flank of Mt. Tankobu is strongly eroded by glacier and a small glacial lake is seen at the col between Mt. Tankobu and Bozu. Erratic boulders and morainic deposits covering both peaks evidence the region once underlain by ice sheet.

(5) Bōzu Fjord

Another U-shaped submarine valley is continuous to the U-shaped valley between Mt. Tankobu and Mt. Knappen (210 m a.s.l.). The submarine valley joins

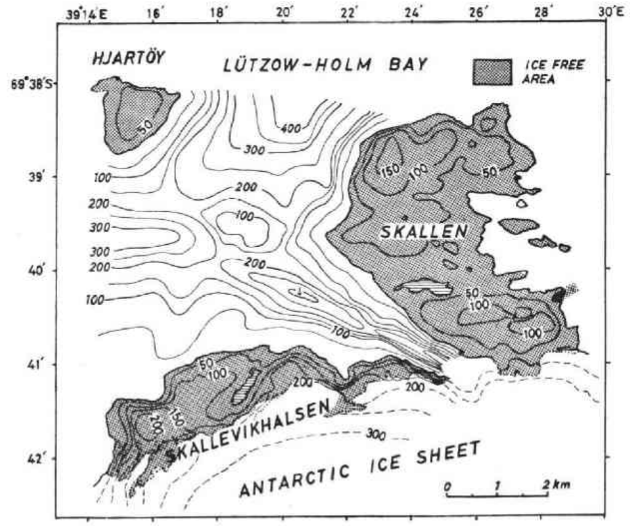

Fig. 11 Bathymetric chart of Skallevika (Inlet).

discordantly Tankobu Fjord. Its floor is relatively wide to its length.

(6) Knappen Fjord

Between ice-free areas of Byvåg Åsane and Skarvsnes, a broad U-shaped submarine valley extends northward, which is bifurcated into two submarine troughs at Kamejima (Island) 2 km northeast of Skjegget peak, joining the Honnör Fjord discordantly (Photo 16).

(7) West Skarvsnes Fjord

To the west of Skarvsnes, three submarine troughs are found. One is directed southward with the depth of 700 m, and another extends 5 km long westward. These troughs join the Telen Fjord to the southwest of Skarvsnes. The other one extends 10 km long northwestward and reaches a flat basin floor 500 m deep.

(8) North Langhovde Fjord

Langhovde Glacier seems to branch into three directions, NNW, NW, and WNW, controlled by local geological structures. The submarine ridges through East Ongul, Teöya and Ongulgalten Islands, and another ridge from Ongulkalven Island to Mejirushijima (Island) are composed of resistant rocks and survived against glacial erosion. The Langhovde Glacier eroded deeply into comparatively soft rocks of garnet gneiss and metabasite, and formed deep glacial troughs running toward three directions.

The closed isobath of 500 m expresses well the deep Langhovde Fjord in Hovde Bay. The 400 m isobath shows other two deep valleys in direction of NW and WNW extending from the Langhovde Fjord. The NW one, which is 2–3 km wide and loses the depth soon, runs between Mejirushijima (Island) and Ongulgalten Island, and reaches off West Ongul Island. It has a wide flat valley floor 15 km long at the west of Teöya Island. The WNW one with the depth of 500 m is continuous to a small submarine basin 1 km east of Rumpa Island. Its floor is about 2 km wide near Rumpa and disappears at the north of Rumpa.

Small submarine rises or highs at the end of the deep fjords, basins and submarine valleys, may be "threshould" or morainic deposits. Not only small fjords, but also Telen, Honnör, Skjegget and Langhovde Fjords have commonly such rises among two or three rock basins.

3.4. Glaciated Submarine Basin

Glaciated submarine basin is fundamentally different from submarine canyons or valleys. The author grouped them into three by region (Table 4).

Table 4 Glaciated submarine basins

Langhovde Group	Skarvsnes Group	Skallen Group
North Langhovde Rumpa West Langhovde Ungane Nabböya	West Skarvsness Nökkel	North Skallen North Hjartöy West Hjartöy

(1) Langhovde Group

North Langhovde Submarine Basin located 1 km north of Langhovde has flat basin floor 400 m deep and its maximum depth exceeds 500 m to the north of Mt. Tyōto. It is in a transverse valley connecting Langhovde Fjord to Rumpa Submarine Basin.

Rumpa Submarine Basin located 2 km east of Rumpa Island is elongated east to west and 300 m deep.

West Langhovde Submarine Basin adjoins to Fuji Bay, at the west of Langhovde. It is 400 m in depth and 3 km in width.

Ungane Submarine Basin located 3 km north of the Ungane Island is 400 m in depth. It is the largest among this group.

Nabböya Submarine Basin located at the west of Nabböya Island, is 400 m in depth.

Nabböya and Ungane Submarine Basins are on the straight line extending from Hamna Glacier. The depth of basin floors is mostly 300 m except Rumpa Submarine Basin. Langhovde and Nabböya Submarine Basins are in the direction of NNE to SSW.

(2) Skarvsnes Group

Nökkel Submarine Basin located about 5 km west of Skjegget peak is surrounded by triangular 200 m isobath. Its depth increases gradually toward the center and reaches more than 500 m. The submarine basin was perhaps eroded by Skjegget Glacier from its continuity.

West Skarvsnes Submarine Basin located 13 km west of Skjegget peak is on a submarine rise which extends northward from Skarvsnes. It is surrounded by 500 m isobath in oval form. The basin floor is 5 km wide from northwest to southeast and 3 km wide from northwest to southeast and 3 km wide from northeast to southwest. The principal axis of the basin is continuous to Trilling Fjord. Therefore the main ice flow which formed the basin seems to be the extension of Tenpyo Glacier.

(3) Skallen Group

North Skallen and North Hjartöy Submarine Basins are about 3 km northwest of Skallen and Hjartöy Island respectively. They are oval in shape, and extend 2 km and 3 km northwest to southeast, respectively. Their basin floors are about 500 m deep.

Another submarine basin is located 3 km to the west of Hjartöy Island. Its basin floor reaches 600 m in depth. The basin feature is not obvious because of the paucity of soundings especially in the northern part.

3.5. Submarine Depression

Submarine depression is smaller than submarine basin. The major examples are observed at Kitamisaki Strait, west of Ungane Submarine Basin, and to the south of Nabböya Submarine Basin in the vicinity of Langhovde, both 400 m deep. Other depressions are Nökkel Depression 6 km west of Skjegget peak and another small one 8 km southwest of the peak. These two depressions exceed 500 m in depth. Some depressions shallower than 300 m are at the west of Ongul Islands and Langhovde. The depressions west of the Ongul Islands are about 200 m deep and are elongated in the northeast to southwest trend, while those west of Langhovde expressed with 300 m isobath extend from northeast to southwest. A small scale depression 200 m in depth is also found 500 m south of Ungane

Island.

3.6. Bank

Most of the surveyed area is full of relief and bank is scarcely found. But around islands or around ice-free areas are seen some submarine banks. For example, around the Ongul Islands, there is a wide bank 100 m deep. Its top surface has rugged relief and shallow submarine valleys which suggest the geological control.

Another wide bank clearly delimited by 100 m isobath is to the southwest of Skarvsnes. Small and shallow banks less than 100 m deep are off Hamna Glacier and to the northwest of Skarvsnes. Submarine banks with some depression 100 m to 200 m deep are also found to the west of the Ongul Islands. Banks 300 m deep are between Honnör and Telen Fjords, and between Telen Fjord and West Hjartöy Sumbarine Basin. The latter is a typical bank, with a flat surface of 300 m rising above the surrounding area.

4. Fjord Development in Lützow-Holm Bay

4.1. Expansion and Retreat of Ice Sheet

(1) Maximum Ice Thickness and Isostatic Subsidence

Before the formation of deep fjords, Antarctic glaciers extended to fill some deep glacial troughs. The thickness of the glacier ice is calculated at submarine Telen Fjord at least 1,050 m based on its depth, assuming the sea-level dropping of 100 m. Morainic deposits or erratic boulders and striated surfaces are found in coastal bedrock areas 180 m a.s.l. or higher in Skallen, 350 m or higher in Skarvsnes, and nearly 500 m in southern Langhovde. Then the thickness of ice sheet in the deep fjord exceeds at least 1,250 m including the part above sea-level. If the bare rock areas in the margin of the present ice sheet was overlain by ice 1250 m thick at that time, isostatic subsidence of about 250 m (calculated based on the value of Fairbridge, 1961) was possible and most of the present ice-free areas were subsided below the present sea-level.

(2) Ice Sheet Expansion

At first, the author would like to introduce former two studies by Cameron (1965) and Hollin (1962), concerning ice expansion of Antarctica. According to Cameron (1965), Vanderford Fjord in Vincennes Bay, East Antarctica is the deepest fjord in the world, whose depth is 2,287 m below present sea-level. He concluded that the edges of the valley were covered by ice 1,533 m and 1,492 m in thickness, and the ice over the valley was 3,194 m thick. He estimated that the ice terminus was about 85 km north of the present terminus of the Vanderford Glacier during maximum glaciation of the Antarctic continent (Cameron, 1964).

Hollin considered that the "grounding line (a line where ice-shelves begin to float)" shifted 90 km seaward on sea floor of about 0.1 degrees in declivity as a result of sea-level lowering of 150 m at the last glaciation in the northern Hemisphere, and consequently the ice thickness considerably increased amounting to 1,230 m at the original grounding line.

In the Lützow-Holm Bay the maximum extension of ice sheet was estimated by the author as follows. The maximum extension of ice sheet was calculated based on its maximum thickness, assumed to be as thick as of the deepest fjord, and the longitudinal profile of ice sheet at that time, assumed to be similar to the present one. The latter assumption is due to the fact that the longitudinal profiles of the present ice sheet resemble each other in different regions. Thus the actual and extended longitudinal profiles of ice sheet near Syowa Station were drawn as in Figures 12 and 13. A stage of ice sheet advance is shown in Figure 13, assuming the ice thickness 1,250 m at the present coastline, and the lowered sea-level. Then the ice sheet extended about 75 km to the west, filling whole the Lützow-Holm Bay. This extension range is somewhat smaller compared with the former two studies (Cameron, 1964 and Hollin, 1962).

(3) Isostatic Uplift

The estimated maximum ice thickness 1,250 m at the present coastline will bring an isostatic subsidence of ca. 250 m to 320 m. The isostatic subsidence of

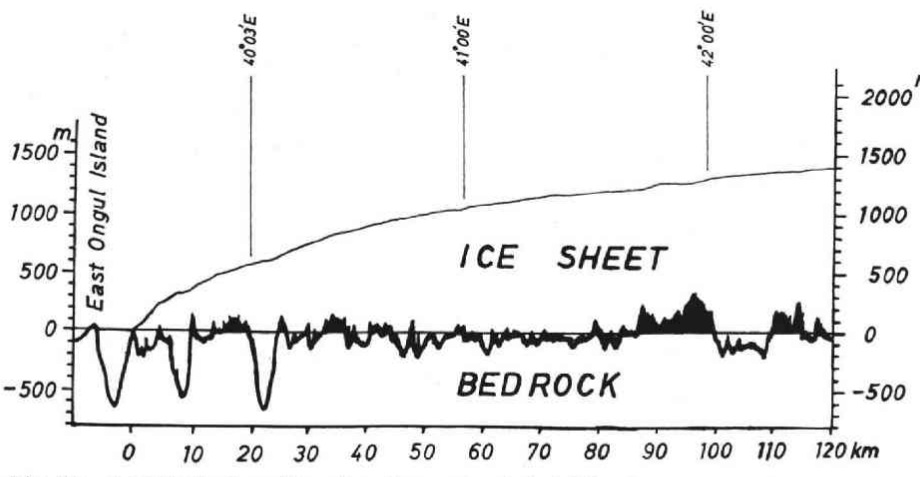

Fig. 12. Longitudinal profiles of surface and subglacial landform of ice sheet, along the 10th inland traverse route 1969–1970 (Omoto, 1976a).

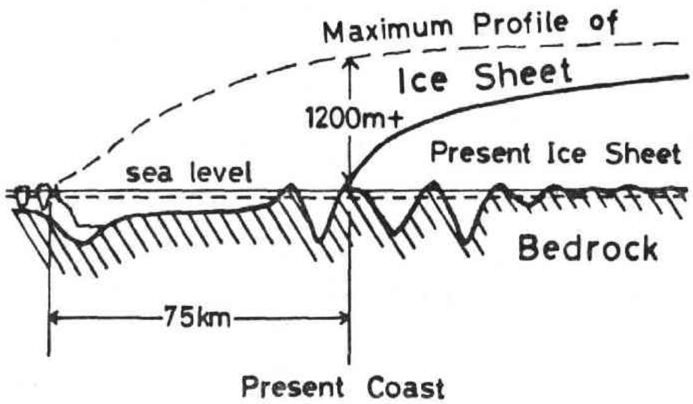

Fig. 13 Schematic cross section of ice sheet at the maximum extension.

Ongul Islands at that time can be estimated to have been ca. 200 m. There are many raised beaches at several levels on the Ongul Islands from where fossil shells and Foraminifera were collected and dated by radiocarbon method between 3,840 yr. BP. to 34,000 yr. BP. (Meguro *et al.*, 1964, and Fujiwara, 1973). Yoshida (1971 and 1973) concluded that the area uplifted about 15 to 20 m after the retreat of inland ice, based on his field surveys of terrace like landform, fossil shells (*Adamussium colbecki* and *Laternula elliptica*) and the above radiocarbon dates. While Meguro *et al.* (*ibid.*) and Uchio (1966) concluded based on their Foraminifera study that Foraminiferas collected at levels 3 m to 12 m a.s.l. on East Ongul Island were deposited at a level deeper than 100 m and thereafter uplifted isostatically in shallow water area. The isostatic subsidence estimation by the author seems to support the result of Foraminifera study. Difference between both depths will be attributed to the duration of Foraminifera habitation. Isostatic uplift seems to have taken place immeadiately after the retreat of ice sheet from Ongul Islands. In conclusion, the isostatic uplift undoubtedly exceeded 20 m at the Ongul Islands and it may reach 200 m at maximum.

(4) A Comment on Radiocarbon Age

Above mentioned discussion is based on the radiocarbon ages measured. But they should be carefully treated as suggested by the author (Omoto, 1972), and the errors could not be negligible. The radiocarbon age theoretically indicates the age of death of living organism. The age of landform is always later than the age of fossil oraganism deposited in. For example, the shore terrace is formed later than the radiocarbon age measured by the fossil organisms deposited in. Moreover the radiocarbon age is not always correct at Antarctica as the author reported

(Omoto, 1972 and 1976b). Antarctic surface water and seal died in 1974 were sampled and dated "not recent (modern value)". The author calculated corrected ^{14}C dates based on some modern samples taken at Lützow-Holm Bay. All the ages measured before need to be reduced based on the value of modern standard in Antarctica. The result of some measurements on modern samples in Lützow-Holm Bay is shown in Table 5.

Table 5. Ages of Some Modern Samples in Lützow-Holm Bay.

Code	Sample	^{14}C Age (yr. BP.)	Reference
N–858	Sea water	2860±125	Omoto, 1972
N–860	Sea water	880±115	Omoto, 1972
Gak–3666	Echinoidea	150± 80	Yoshida, 1973
TH–052	Crab-eater Seal	1455±110	Omoto, 1976

Simple way to correct the former radiocarbon age is only to reduce the value of radiocarbon age decided by the present modern standard of the area. The deviation from the former radiocarbon age is small in old samples, but can not be negligible in young samples. In former case, it should be noteworthy that some old samples have possibility that they might show overscale by re-calculation based on new modern standard value.

Another way is to add the difference of counting rate between modern standard (95% of NBS) and the modern sample of the area to the counting rate of the sample before age calculation. This is a way to reduce difference by perforce between the counting rate of 95% of NBS and the counting rate of modern sample of Antarctic region. In this case, radiocarbon age of 10,250 yr. BP. (Moriwaki, 1974) is reduced to 7,710 yr. BP., which may be correlated to the high sea-level in Jomon Period as discussed in Japan. The radiocarbon age of 34,000 yr. BP. of the Foraminifera is reduced to ca. 17,155 yr. BP., when the sea-level was at least 100 m lower than the present sea-level. This supports the Foraminifera study (Meugro *et al.*, 1964) and the isostatic uplift nearly 200 m.

But the latter correction is questionable and may be uncorrect, though the radiocarbon ages seem to be favourable to explain geomorphic development of the surveyed area. Because there is no reason nor guarantee to add the difference of counting rate between modern standard of NBS and the modern standard sample in any time to all the counting rate of the samples unknown.

4.2. Fjord Development in Lützow-Holm Bay

(1) Glaciation

By advancing ice sheet, weak zones such as fracture, joint, and soft rocks were eroded deeply, and resulted in Langhovde Fjord, Honnör Fjord, Skjegget Fjord and many basins, and resistant areas remained as ridges, e.g. a ridge extending NNW-SSE from West Ongul Island to northern Langhovde. Pre-glacial fluvial valleys or depressions perhaps facilitated the advance of ice sheet at first.

Glaciated valleys, grooves, and striae remaining on bare rock area indicate that the main direction of the past glaciers was SE to NW. From the arrangement of submarine landforms such as fjord, trough, basin, and ridge the past glaciers flowed mainly SE to NE, SSE to NNW or E to W in direction (Fig. 14). The arrangement of submarine valleys and basins in NE-SW direction is perhaps due to differential glaciation at the retreat of ice, i.e. due to individual movement of separated ice mass. In many cases, subaerial glacial valleys are continuous to submarine

Fig. 14 Ice motions in past and present at the east of Lützow-Holm Bay (Modified from the map of Yoshida, 1973). 1: Past glacier flow direction remained on bedrocks as glaciated valleys, striations and glaciated grooves, 2: Present glacier flow direction measured by triangulations and photo interpretations.

glacial valleys, and this means that both were scooped by the same glacier almost at the same time.

Though other deep fjords, Honnör, Skjegget and Telen are oblique to the margin of ice sheet, Langhovde Fjord runs nearly parallel to the margin of ice sheet and it changes direction from NNW to north and to NNE. The Langhovde Glacier has branches in three directions NNW, NW and WNW as described already. Glaciated valleys and striae prove that the main direction of the Langhovde Glacier was from SE to NW. The northern extension of the deepest submarine valley in the Ongul Strait is NNW or N in direction. This difference in direction between the past Langhovde Glacier flows and the present deep submarine valley stretching northward from the present Langhovde Glacier terminal is interpreted as follows: The Langhovde Glacier flowed from SE to NW and changed its direction northward at the Langhovde bedrock area as a barrier. Then a submarine ridge from the Ongul Islands to the northeast Langhovde determined the glacier channel northward.

Another submarine valley extending northward sounded by Moriwaki (1975) near Tottuki Point. It may continue to the subglacial valley sounded by the author (Omoto, 1976a). Other deep fjords seem to rise inland, but their continuity with the inland subglacial valleys sounded by Oura (1965), Ishida (1970) and the author (1976a) is uncertain. The subglacial landform at the east coast of the Lützow-Holm Bay has not been clarified in details.

(2) Formative Period of Fjord

The present author has not data enough to determine directly the formative period of deep fjords. The period of the last retreat of ice sheet from Ongul Islands is indicated by Meguro et al. (1964) at latest 23,000 yr. BP. and at earliest 40,000 yr. BP., and by Yoshida (1970) at latest 30,000 yr. BP. The radiocarbon ages should be reduced much as discussed in the former section. Although the formative period of fjords is not exactly determined, they had already been at the lowest sea-level i.e. Early Wisconsin. Seaward extension of ice sheet, lowering of sea-level and seaward advance of grounding line (Hollin, 1962) were combined in operation to erode continental shelf deeply, and resulted in deep fjords.

(3) Geomorphic Development

Submarine morphology of the Lützow-Holm Bay has been formed with the oscillation of ice sheet or glaciers which scooped deeply at some places. Longitudinal profiles of fjords in the Lützow-Holm Bay (Fig. 8) have gentle relief, and their cross sections have some shelves just like river terraces. The submarine fjords

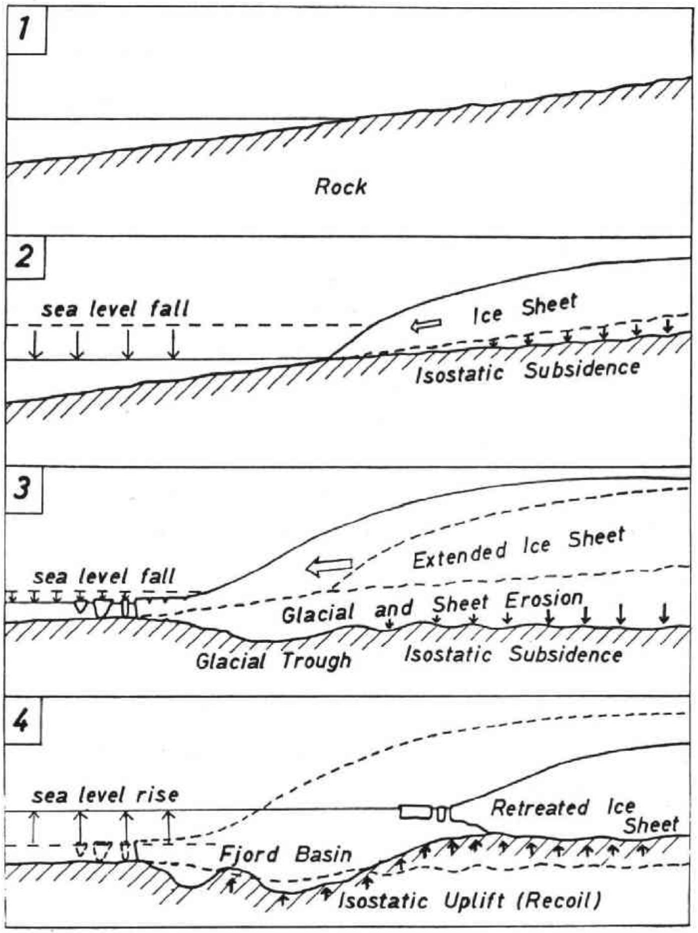

Fig. 15 Schematic development of Antarctic fjord.

is often connected with small-scale basin. Such characteristics indicate advancing and retreating of ice sheet several times, and alternation of widening and deepenning of trough bottoms.

The bare rock area should be higher before glaciation, by which it was eroded more than 500 m at Skarvsnes, judging from the remaining landform of Skjegget peak or Langpollen (Inlet). The original landform of the surveyed area was considered by Koaze (1964) to be peneplain. But it was too much completely eroded by advancing ice sheet several times to restore the original landscape.

Development of an Antarctic fjords is shown in Figure 15 from the original to the present landform.

5. Conclusion

The findings on the submarine geomorphology at the eastern Lützow-Holm Bay by the author's soundings and field observation are summarized as follows.

(1) Drowned glacial troughs such as Telen, Skjegget, Honnör and other fjords were discovered in the Lützow-Holm Bay. Telen Fjord, the deepest one showing typical fjord landform extends northwestward from floating ice tongues of Telen and Skallen Glaciers. It reaches 1,148 m below mean sea-level at the deepest sounding point.

(2) Telen Glacial Trough (before drowning) has been completely filled with ice, 1,050 m thick at the deepest point, assuming sealevel lowering 100 m. The ice terminus advanced about 75 km westward during the maximum glaciation, when the whole Lützow-Holm Bay was buried with ice.

(3) The formative period of deep fjords has not been determined. According to Meguro *et al.* (1964) and Yoshida (1970) the retreat of continental ice from Ongul Islands took place 34,000 yr. BP. Situation of the deep fjords found by the author is close to Ongul Islands. Therefore they have been formed before the retreat. The radiocarbon age should be reduced based on modern sample by future study.

(4) Isostatic uplift occurred after retreat of ice sheet at Ongul Islands. It exceeded 20 m and it might reach about 200 m at maximum. The latter value seem to support the studies of Foraminifera (Meguro *et al.*, 1964 and Uchio, 1966) on the East Ongul Island.

(5) Glaciated valleys, grooves and striae on bare rock area, and submarine fjords, troughs, basins and ridges indicate the main direction of ice movements from southeast to northwest. Other directions were determined by local geological structures and preglacial landforms.

(6) The bare rock areas are low undulating and characterized by *roches moutonnées*, cirques, glacial troughs and grooves. The coastal geomorphology is controlled by local geological structures such as joints and foldings of petrological natures. Mechanical weathering dominates at ice-free areas of the northern part of the surveyed area, while fresh striations are well preserved at the southern part. "Fjärd landform" with many narrow inlets and islands is seen at the west coast of Langhovde and Ösen (Bay) in Skarvsnes. "Skjaergård landform" is seen at the west coast of Skjegget peak, Skarvsnes and arround Ongul Islands.

(7) The development of fjords in Antarctica is schematized as shown in Fig. 15.

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This paper is dedicated to the late mother, with heartfelt gratitude and good remembrance.

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Table 2 The result of the echo-soundings (*Echo obtained by under-ice transducer).

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
M-001	69°27.8′	39°40.0′	38	*730505	A-002	69°25.5′	39°41.8′	123	
002	27.6′	40.1′	70	*	003	25.4′	42.1′	316	
003	27.3′	40.2′	97	*	004	25.1′	42.4′	319	
004	27.0′	40.3′	116	*	005	24.8′	42.6′	353	
005	26.2′	33.5′	63	*730508	006	24.6′	43.0′	492	
006	26.2′	32.9′	139	*	007	24.3′	43.3′	412	
007	25.8′	33.2′	21	*	008	24.2′	42.6′	625	
008	25.4′	33.8′	10	*	009	24.1′	42.0′	668	
009	25.2′	34.0′	43	*	010	24.0′	41.2′	630	
010	25.0′	34.4′	33	*	011	23.9′	40.4′	445	
011	24.8′	34.8′	42	*	012	23.8′	39.7′	183	
012	24.3′	35.7′	164	*	013	23.7′	39.1′	66	
013	24.4′	37.0′	127	*	014	23.6′	38.6′	191	
014	24.4′	37.7′	82	*	015	24.7′	39.0′	338	
015	24.4′	38.9′	15	*	016	25.0′	39.0′	255	
016	24.1′	38.8′	109	*730510	017	25.2′	39.2′	86	
017	23.8′	38.6′	157	*	018	25.5′	39.2′	63	
018	23.5′	38.5′	194	*	019	25.8′	39.4′	149	
019	23.2′	38.4′	363	*	020	25.7′	40.7′	140	
020	22.9′	38.3′	460	*	021	26.1′	40.5′	70	
021	22.4′	38.1′	578	*	022	26.5′	40.3′	54	730824
022	22.1′	38.0′	630	*	023	26.8′	40.2′	81	
023	21.9′	38.0′	627	*	024	26.6′	44.8′	52	
024	21.5′	37.9′	667	*	025	26.4′	45.0′	101	
025	21.3′	37.9′	673	*	026	26.3′	45.0′	92	
026	21.0′	37.8′	451	*	027	25.9′	44.8′	30	
027	20.7′	37.7′	264	*	028	25.5′	44.6′	23	
028	20.3′	37.5′	244	*	029	25.3′	44.5′	9	
029	20.0′	37.4′	223	*	030	25.0′	44.2′	103	
030	19.7′	37.3′	262	*	031	24.9′	44.8′	266	
031	19.4′	37.2′	266	*	032	24.7′	44.9′	277	
032	18.94′	37.16′	300	*	033	24.4′	45.0′	438	
033	18.67′	37.16′	169	*	034	24.1′	45.2′	562	
034	18.40′	37.16′	176	*	035	23.9′	46.0′	344	
035	18.13′	37.16′	234	*	036	23.7′	46.3′	508	
036	17.88′	37.16′	172	*	037	23.4′	47.2′	584	
037	17.59′	37.16′	310	*	038	23.3′	47.7′	437	
038	17.33′	37.16′	36	*	039	23.5′	48.0′	271	
039	17.05′	37.16′	205	*	040	23.7′	48.5′	18	
040	16.78′	37.16′	180	*	041	23.7′	48.0′	66	
041	16.48′	39.94′	150	*	042	23.8′	47.3′	58	
042	16.20′	35.50′	272	*	043	24.0′	47.0′	359	
043	14.49′	38.95′	123	*	044	24.3′	46.7′	558	
044	14.35′	38.34′	212	*	045	24.4′	47.4′	579	
045	14.16′	37.00′	111	*730512	046	24.5′	48.1′	289	
046	13.99′	35.71′	154	*	047	24.6′	48.9′	160	
047	13.45′	35.56′	321	*	048	24.8′	48.4′	187	
048	12.92′	35.25′	472	*	049	24.9′	47.8′	285	
049	12.35′	35.16′	448	*	050	25.2′	47.1′	242	
050	11.82′	35.02′	301	*	051	25.3′	46.6′	261	
051	11.26′	34.95′	327	*	052	25.6′	47.4′	112	
A-001	25.9′	41.4′	46	730823	053	25.6′	47.7′	95	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
A-054	69°25. 8′	39°48. 4′	79		A-106	69°25. 2′	39°40. 8′	268	
055	25. 9′	47. 6′	108		107	24. 9′	41. 1′	364	
056	26. 1′	46. 8′	149		108	24. 8′	40. 6′	359	
057	26. 4′	46. 7′	89		109	24. 6′	39. 2′	17	
058	26. 6′	46. 6′	111		110	24. 5′	36. 7′	164	
059	26. 9′	46. 7′	161		111	24. 1′	36. 0′	162	
060	27. 2′	46. 6′	17		112	23. 9′	36. 6′	199	
061	27. 4′	46. 3′	34	730825	113	23. 8′	37. 1′	194	
062	26. 9′	45. 8′	180		114	23. 6′	37. 7′	109	
063	26. 6′	45. 3′	137		115	23. 4′	38. 3′	235	
064	26. 2′	44. 4′	122		116	23. 2′	39. 0′	458	
065	26. 0′	43. 9′	212		117	23. 1′	39. 5′	597	
066	25. 7′	43. 4′	310		118	22. 8′	39. 2′	541	
067	25. 5′	42. 8′	376		119	22. 6′	39. 7′	615	
068	25. 3′	42. 4′	337		120	22. 4′	40. 2′	830	
069	25. 1′	42. 0′	370		121	22. 1′	40. 8′	431	
070	24. 9′	41. 5′	381		122	22. 0′	41. 4′	347	
071	24. 7′	41. 0′	381		123	21. 8′	41. 8′	338	
072	24. 5′	40. 7′	326		124	21. 6′	42. 4′	304	
073	24. 3′	40. 1′	219		125	21. 4′	42. 9′	271	
074	24. 1′	39. 5′	23		126	21. 2′	43. 3′	283	
075	23. 9′	40. 4′	320		127	21. 0′	43. 9′	220	
076	23. 6′	40. 8′	517		128	20. 9′	44. 5′	223	
077	23. 3′	41. 5′	683		129	20. 7′	45. 0′	106	
078	23. 1′	41. 9′	727		130	20. 5′	45. 4′	49	
079	22. 9′	42. 4′	738		131	20. 3′	45. 0′	60	
080	22. 7′	43. 0′	745		132	20. 2′	44. 4′	49	
081	22. 5′	43. 4′	480		133	20. 2′	44. 0′	39	
082	22. 4′	43. 8′	443		134	20. 4′	43. 0′	159	
083	22. 2′	44. 3′	236		135	20. 6′	42. 2′	204	
084	22. 0′	44. 8′	180		136	20. 8′	41. 6′	283	
085	21. 7′	45. 1′	25		137	20. 9′	40. 9′	339	
086	22. 0′	45. 5′	16		138	21. 1′	40. 3′	381	
087	22. 3′	46. 0′	103		139	21. 3′	39. 6′	566	
088	22. 5′	46. 4′	498		140	21. 5′	39. 0′	567	
089	22. 4′	47. 2′	300		141	21. 7′	38. 3′	742	
090	22. 7′	47. 0′	443		142	21. 9′	37. 7′	670	
091	22. 6′	46. 0′	530		143	22. 0′	36. 9′	646	
092	22. 9′	45. 2′	547		144	22. 2′	36. 3′	554	
093	23. 1′	44. 7′	689		145	22. 4′	35. 7′	486	
094	23. 2′	44. 1′	640		146	22. 5′	35. 3′	354	
095	23. 4′	43. 6′	627		147	22. 7′	34. 7′	250	
096	23. 6′	43. 1′	467		148	22. 8′	34. 2′	225	
097	23. 7′	42. 9′	467		149	22. 9′	33. 6′	310	
098	23. 9′	41. 5′	624		150	23. 2′	33. 8′	308	
099	24. 4′	41. 7′	544		151	23. 4′	33. 8′	287	
100	24. 1′	40. 7′	344		152	23. 7′	33. 8′	269	
101	24. 2′	39. 9′	85		153	23. 9′	33. 9′	165	
102	24. 4′	39. 7′	100		154	24. 2′	33. 9′	106	
103	24. 6′	39. 4′	49		155	24. 4′	33. 9′	36	
104	24. 9′	39. 5′	268		156	24. 4′	35. 1′	113	730826
105	25. 4′	40. 3′	245		157	24. 2′	35. 0′	278	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
A-158	69°23. 9′	39°35. 0′	220		A-210	69°12. 8′	39°28. 4′	231	
159	23. 6′	35. 0′	256		211	12. 9′	29. 0′	303	
160	23. 3′	34. 9′	276		212	13. 0′	29. 8′	309	
161	23. 1′	34. 9′	293		213	13. 2′	30. 4′	289	
162	22. 8′	34. 9′	188		214	13. 3′	31. 0′	279	
163	22. 5′	34. 9′	285		215	13. 4′	31. 6′	338	
164	22. 2′	34. 9′	357		216	13. 6′	32. 4′	305	
165	21. 9′	34. 9′	480		217	13. 7′	33. 1′	331	
166	21. 7′	34. 8′	535		218	13. 9′	33. 8′	192	
167	21. 4′	34. 8′	659		219	14. 0′	34. 5′	225	
168	21. 1′	34. 8′	726		220	14. 1′	35. 3′	189	
169	20. 1′	34. 8′	625		221	14. 3′	36. 0′	216	
170	19. 8′	34. 8′	592		222	14. 5′	36. 8′	108	
171	19. 5′	34. 8′	603		223	14. 7′	37. 6′	218	
172	19. 2′	34. 8′	396		224	14. 5′	37. 9′	245	
173	18. 90′	34. 78′	383		225	14. 2′	37. 6′	194	
174	18. 63′	34. 72′	333		226	13. 9′	37. 4′	60	
175	18. 35′	34. 65′	274		227	13. 6′	37. 1′	223	
176	18. 09′	34. 57′	385		228	13. 3′	36. 9′	263	
177	17. 81′	34. 45′	389		229	13. 1′	36. 9′	344	
178	17. 55′	34. 45′	300		230	12. 8′	36. 9′	333	
179	17. 28′	34. 42′	384		231	12. 5′	36. 9′	319	
180	17. 01′	34. 33′	467		232	12. 3′	36. 9′	331	
181	16. 73′	34. 27′	418		233	12. 1′	36. 8′	167	
182	16. 46′	34. 19′	493		234	12. 3′	36. 6′	64	730831
183	16. 18′	34. 13′	417		235	12. 3′	30. 9′	319	
184	15. 94′	34. 07′	362		236	12. 4′	35. 4′	374	
185	15. 65′	34. 05′	287		237	12. 4′	34. 7′	443	
186	15. 39′	34. 00′	197		238	12. 5′	33. 6′	444	
187	15. 12′	33. 45′	226		239	12. 5′	32. 8′	421	
188	14. 85′	33. 85′	268		240	12. 5′	32. 1′	364	
189	14. 58′	33. 80′	276		241	12. 5′	31. 3′	192	
190	14. 30′	33. 75′	274	730830	242	12. 5′	30. 6′	272	
191	14. 03′	33. 68′	255		243	12. 6′	29. 7′	287	
192	13. 68′	33. 65′	352		244	12. 6′	29. 1′	335	
193	13. 38′	33. 60′	338		245	12. 6′	28. 3′	268	
194	13. 08′	33. 51′	426		246	13. 0′	27. 1′	86	
195	12. 75′	33. 46′	427		247	13. 2′	27. 7′	258	
196	12. 44′	33. 40′	394		248	13. 4′	28. 3′	357	
197	12. 15′	33. 32′	337		249	13. 6′	28. 9′	406	
198	11. 88′	33. 20′	205		250	13. 9′	29. 4′	431	
199	11. 60′	33. 16′	204		251	14. 1′	29. 9′	408	
200	11. 38′	33. 12′	86		252	14. 3′	30. 5′	455	
201	11. 5′	32. 3′	208		253	14. 6′	31. 1′	416	
202	11. 6′	31. 6′	240		254	14. 8′	31. 6′	381	
203	11. 7′	30. 8′	207		255	15. 1′	32. 2′	384	
204	11. 9′	30. 0′	239		256	15. 3′	32. 7′	332	
205	12. 0′	29. 4′	253		257	15. 5′	33. 3′	170	
206	12. 2′	28. 4′	301		258	15. 6′	33. 6′	255	
207	12. 3′	27. 6′	253		259	15. 8′	34. 0′	312	
208	12. 4′	26. 8′	114		260	16. 0′	34. 5′	357	
209	12. 6′	27. 6′	194		261	16. 2′	35. 1′	394	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
A-262	69°16. 4′	39°35. 7′	295		S-036	69°25. 5′	39°31. 4′	210	
263	16. 5′	36. 2′	185		037	25. 5′	32. 2′	80	
264	16. 7′	35. 9′	64		038	25. 5′	32. 9′	65	
265	17. 0′	36. 2′	138		039	25. 5′	33. 5′	28	
266	17. 4′	36. 1′	355		040	25. 2′	34. 5′	59	
267	17. 4′	35. 2′	349		041	25. 4′	35. 1′	108	
268	17. 3′	34. 3′	384		042	25. 5′	35. 5′	133	
269	17. 3′	33. 6′	397		043	25. 7′	36. 4′	141	
270	17. 3′	32. 9′	380		044	25. 9′	37. 0′	145	
271	17. 2′	32. 0′	258		045	26. 2′	38. 0′	32	
272	17. 2′	31. 2′	209		046	26. 3′	37. 4′	66	
273	17. 2′	30. 4′	182		047	26. 1′	37. 1′	144	
274	17. 1′	29. 6′	224		048	25. 9′	36. 3′	144	
275	17. 1′	28. 8′	182		049	25. 6′	35. 2′	127	
276	17. 1′	27. 9′	97		050	25. 3′	34. 2′	26	
277	17. 1′	27. 1′	49	*	051	24. 3′	31. 8′	70	730902
278	17. 1′	26. 3′	47	*	052	23. 9′	31. 7′	183	
S-001	17. 2′	24. 4′	42	730901	053	23. 6′	31. 5′	178	
002	17. 5′	24. 5′	228		054	23. 2′	31. 4′	137	
003	17. 7′	24. 7′	437		055	22. 9′	31. 3′	130	
004	18. 0′	24. 8′	492		056	22. 8′	31. 1′	148	
005	18. 3′	25. 1′	651		057	22. 5′	31. 2′	231	
006	18. 5′	25. 3′	603		058	22. 2′	31. 1′	155	
007	18. 8′	25. 5′	536		059	21. 9′	31. 0′	148	
008	19. 1′	25. 7′	523		060	21. 5′	30. 9′	189	
009	19. 4′	25. 9′	432		061	21. 3′	30. 8′	306	
010	19. 7′	26. 1′	396		062	21. 1′	30. 7′	412	
011	20. 0′	26. 3′	389		063	20. 8′	30. 6′	470	
012	20. 3′	26. 5′	371		064	20. 6′	30. 5′	445	
013	20. 6′	26. 7′	368		065	20. 3′	30. 5′	400	
014	20. 9′	26. 9′	314		066	20. 1′	30. 4′	461	
015	21. 2′	27. 1′	251		067	19. 8′	30. 3′	510	
016	21. 4′	27. 3′	133		068	19. 6′	30. 2′	615	
017	21. 7′	27. 5′	63		069	19. 3′	30. 1′	600	
018	22. 0′	27. 7′	59		070	18. 9′	30. 0′	567	
019	22. 4′	28. 0′	17	*	071	18. 7′	29. 8′	535	
020	22. 7′	28. 1′	123		072	18. 5′	29. 8′	493	
021	22. 9′	28. 4′	124		073	18. 4′	29. 8′	412	
022	23. 1′	28. 6′	11		074	18. 0′	29. 7′	255	
023	23. 5′	28. 2′	248		075	17. 7′	29. 6′	161	
024	23. 8′	27. 8′	186		076	17. 4′	29. 5′	170	
025	24. 0′	27. 4′	199		077	17. 1′	29. 4′	220	
026	24. 3′	27. 1′	338		078	16. 8′	29. 3′	255	
027	24. 6′	26. 7′	277		079	16. 6′	29. 2′	80	
028	24. 8′	26. 3′	212		080	16. 6′	28. 5′	81	
029	25. 1′	25. 9′	98		081	16. 7′	28. 0′	200	
030	25. 2′	26. 8′	279		082	16. 8′	27. 2′	188	
031	25. 3′	27. 8′	506		083	16. 8′	26. 7′	113	
032	25. 3′	28. 4′	433		084	16. 9′	26. 1′	109	
033	25. 4′	29. 1′	296		085	17. 0′	23. 1′	66	
034	25. 4′	29. 9′	106		086	16. 7′	23. 2′	251	
035	25. 5′	30. 6′	229		087	16. 4′	23. 2′	301	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
S-088	69°16. 1′	39°23. 3′	264		S-140	39°18. 3′	39°37. 3′	248	
089	15. 8′	23. 4′	320		141	18. 5′	37. 9′	97	
090	15. 5′	23. 5′	316		142	18. 6′	38. 6′	92	
091	15. 3′	23. 6′	389		143	18. 8′	39. 2′	117	
092	15. 0′	23. 7′	370		144	18. 9′	39. 8′	208	
093	14. 6′	23. 8′	315		145	19. 1′	40. 4′	285	
094	14. 4′	24. 0′	262		146	19. 3′	41. 0′	280	
095	14. 2′	24. 2′	277		147	19. 5′	41. 8′	234	
096	13. 8′	24. 3′	244		148	19. 6′	42. 2′	193	
097	13. 6′	24. 4′	235		149	19. 8′	42. 8′	93	
098	13. 2′	24. 4′	117		150	19. 9′	43. 5′	69	
099	13. 3′	25. 3′	127		151	20. 0′	42. 7′	106	
100	13. 2′	26. 1′	41		152	20. 0′	41. 9′	164	
101	13. 5′	26. 4′	311		153	20. 0′	41. 2′	141	
102	13. 8′	26. 7′	346		154	20. 0′	40. 5′	137	
103	14. 0′	27. 0′	416		155	20. 1′	39. 7′	239	
104	14. 3′	27. 2′	453		156	20. 1′	38. 0′	263	
105	14. 5′	27. 6′	445		157	20. 2′	37. 0′	415	
106	14. 8′	27. 9′	426		158	20. 2′	35. 9′	506	
107	15. 1′	28. 3′	418		159	20. 0′	35. 1′	421	
108	15. 3′	28. 7′	354		160	19. 8′	33. 9′	333	
109	15. 6′	29. 0′	355		161	19. 5′	33. 2′	400	
110	15. 9′	29. 3′	315		162	19. 2′	32. 3′	492	
111	16. 1′	29. 6′	14	730904	163	19. 0′	31. 4′	492	
112	16. 6′	30. 0′	149		164	18. 8′	30. 5′	470	
113	16. 6′	30. 7′	277		165	18. 6′	29. 7′	490	
114	16. 6′	31. 5′	258		166	18. 4′	28. 7′	408	
115	16. 6′	32. 2′	371		167	16. 5′	26. 8′	182	730905
116	16. 6′	32. 9′	418		168	16. 3′	26. 6′	338	
117	16. 6′	33. 7′	426		169	16. 0′	26. 5′	304	
118	16. 6′	34. 5′	306		170	15. 8′	26. 5′	387	
119	16. 6′	35. 4′	47		171	15. 4′	26. 3′	406	
120	16. 2′	36. 6′	235		172	15. 2′	26. 2′	418	
121	16. 0′	36. 9′	199		173	14. 9′	26. 1′	410	
122	15. 7′	37. 2′	189		174	14. 6′	25. 9′	339	
123	15. 4′	37. 5′	155		175	14. 3′	25. 7′	374	
124	15. 2′	37. 7′	102		176	14. 1′	25. 7′	335	
125	15. 0′	38. 0′	216		177	13. 8′	25. 5′	197	
126	14. 8′	38. 0′	143		178	13. 5′	24. 6′	129	
127	15. 0′	37. 1′	143		179	13. 4′	23. 7′	218	
128	15. 1′	35. 6′	138		180	13. 1′	24. 1′	188	
129	15. 2′	36. 4′	244		181	12. 9′	24. 3′	237	
130	15. 3′	35. 0′	250		182	12. 6′	24. 4′	299	
131	15. 5′	34. 3′	196		183	12. 3′	24. 7′	197	
132	15. 6′	33. 4′	204		184	12. 1′	24. 9′	86	
133	15. 7′	32. 9′	214		185	11. 9′	25. 1′	207	
134	15. 8′	32. 2′	264		186	11. 6′	25. 4′	295	
135	16. 0′	31. 5′	371		187	11. 4′	25. 5′	285	
136	16. 1′	30. 9′	342		188	11. 0′	25. 7′	71	
137	16. 2′	30. 3′	145		189	10. 8′	25. 9′	20	
138	17. 9′	36. 0′	183		190	10. 6′	25. 8′	182	
139	18. 1′	36. 7′	212		191	10. 2′	25. 3′	148	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
S-192	69°10. 0′	39°25. 4′	114		S-244	69°31. 0′	39°21. 7′	777	*730913
193	9. 9′	26. 2′	151		245	31. 6′	20. 3′	732	*
194	10. 0′	27. 0′	162		246	32. 0′	20. 8′	766	*
195	10. 1′	27. 7′	139		247	32. 6′	20. 3′	782	*
196	10. 1′	28. 8′	239	*	248	33. 1′	20. 0′	792	*
197	10. 2′	29. 6′	165		249	33. 7′	19. 7′	825	*
198	10. 3′	30. 5′	325		250	34. 3′	19. 4′	793	*
199	10. 4′	31. 3′	332		251	34. 8′	19. 1′	459	*
200	10. 4′	32. 0′	188		252	35. 3′	18. 6′	330	
201	10. 5′	32. 7′	247		253	35. 9′	18. 5′	384	
202	10. 7′	33. 3′	247		254	36. 3′	18. 2′	464	
203	10.87′	34.40′	248		255	36. 9′	17. 9′	396	
204	10.92′	35.00′	353		256	37. 1′	17. 7′	166	
205	10.95′	35.60′	406		257	37. 2′	18. 0′	59	
206	10.97′	36.00′	410		258	37. 1′	18. 8′	80	730914
207	11.01′	36.85′	338		259	37. 0′	19. 3′	123	
208	11.02′	37.30′	176		260	37. 0′	20. 9′	341	
209	25. 6′	25. 5′	82	730912	261	36. 8′	22. 3′	485	
210	25. 8′	25. 4′	79		262	36. 7′	23. 8′	545	
211	26. 4′	25. 0′	146		263	36. 4′	25. 3′	308	
212	26. 9′	24. 6′	219		264	36. 2′	26. 6′	506	
213	27. 4′	24. 4′	315		265	36. 1′	28. 2′	609	
214	28. 0′	23. 9′	248		266	36. 0′	29. 7′	642	
215	28. 6′	23. 4′	245		267	35. 8′	30. 7′	659	
216	29. 0′	22. 8′	455		268	35. 4′	29. 7′	935	
217	29. 5′	22. 7′	503		269	35. 1′	28. 4′	910	
218	29. 9′	22. 4′	581		270	34. 8′	27. 3′	959	
219	30. 4′	22. 0′	700		271	34. 5′	26. 0′	1016	
220	30. 3′	23. 0′	487		272	34. 0′	24. 3′	947	
221	30. 1′	25. 5′	241		273	33. 8′	23. 0′	879	
222	29. 9′	26. 6′	353		274	33. 4′	21. 6′	847	
223	29. 7′	28. 2′	298		275	33. 9′	22. 0′	861	
224	29. 4′	29. 9′	371		276	34. 4′	22. 2′	849	
225	29. 1′	31. 0′	288		277	35 0′	22. 6′	861	
226	29. 0′	32. 2′	145		278	35. 4′	23. 0′	529	
227	28. 9′	32. 8′	71		279	35. 9′	23. 5′	503	
228	28. 7′	33. 4′	100		280	36. 4′	23. 9′	547	
229	28. 6′	32. 9′	102	*	281	36. 9′	24. 2′	480	
230	28. 4′	32. 4′	84		282	37. 2′	24. 5′	292	
231	28. 2′	31. 8′	123		283	37. 5′	24. 8′	139	
232	28. 0′	31. 0′	157		284	37. 0′	25. 0′	241	
233	27. 8′	30. 4′	199		285	35. 9′	25. 4′	577	
234	27. 5′	30. 1′	140		286	35. 5′	25. 4′	918	
235	27. 3′	29. 7′	39		287	34. 9′	25. 7′	905	
236	27. 1′	29. 2′	96		288	34. 4′	26. 1′	1032	*
237	26. 8′	28. 7′	32		289	33. 8′	26. 2′	935	
238	26. 5′	28. 2′	27		290	33. 3′	26. 6′	834	
239	26. 2′	27. 7′	172		291	32. 8′	27. 0′	677	
240	25. 9′	27. 0′	236		292	32. 2′	27. 4′	443	730915
241	25. 7′	26. 0′	236		293	31. 7′	27. 6′	369	
242	25. 4′	26. 4′	235		294	31. 2′	27. 9′	446	
243	25. 3′	26. 0′	178		295	30. 6′	28. 3′	128	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
S-296	69°30. 2′	39°28. 8′	64		S-348	69°31. 2′	39°38. 6′	185	
297	29. 8′	29. 2′	139		349	31. 4′	39. 1′	154	
298	29. 2′	29. 7′	252		350	31. 6′	39. 6′	118	
299	28. 8′	30. 2′	52		351	31. 8′	40. 2′	74	
300	28. 2′	30. 9′	172		352	32. 0′	40. 8′	70	
301	27. 7′	31. 5′	97		353	31. 8′	41. 5′	138	
302	27. 2′	31. 8′	106		354	31. 6′	42. 2′	162	
303	26. 7′	32. 0′	127		355	31. 5′	42. 5′	151	
304	26. 3′	32. 3′	135		356	31. 3′	43. 0′	264	
305	26. 0′	29. 3′	156		357	31. 1′	43. 6′	146	
306	26. 3′	29. 3′	143		358	31. 0′	43. 2′	140	
307	27. 5′	28. 4′	75		359	30. 9′	42. 4′	95	
308	28. 2′	28. 0′	138		360	30. 9′	40. 9′	128	
309	28. 6′	27. 5′	233		361	30. 7′	39. 2′	135	
310	29. 2′	27. 2′	298		362	30. 6′	37. 5′	111	
311	29. 7′	26. 8′	285		363	30. 6′	36. 0′	69	
312	30. 7′	26. 2′	208		364	30. 6′	34. 7′	74	
313	31. 3′	25. 8′	280		365	30. 4′	32. 1′	20	
314	31. 8′	25. 4′	713		366	30. 4′	31. 9′	42	
315	32. 4′	25. 0′	509		367	30. 5′	30. 3′	44	
316	32. 8′	24. 7′	684		368	30. 4′	28. 7′	50	
317	33. 4′	24. 6′	900		369	30. 4′	27. 2′	81	
318	33. 8′	24. 3′	868		370	30. 4′	25. 7′	224	
319	34. 3′	24. 1′	942		371	30. 4′	24. 2′	258	
320	34. 8′	23. 7′	873		372	31. 8′	22. 7′	578	730917
321	36. 4′	23. 1′	526		373	32. 2′	24. 0′	560	
333	36. 6′	26. 2′	316		374	32. 6′	25. 2′	697	
323	37. 1′	27. 2′	235		375	33. 0′	26. 5′	754	
324	37. 4′	28. 2′	117		376	33. 3′	27. 5′	835	
325	36. 9′	28. 9′	360	730916	377	33. 6′	28. 9′	904	
326	36. 3′	29. 4′	504		378	34. 0′	30. 1′	966	
327	35. 8′	29. 7′	652		379	34. 8′	32. 1′	1082	
328	35. 2′	30. 0′	915		380	35. 4′	33. 6′	1082	
329	34. 8′	30. 4′	1023		381	34. 9′	33. 9′	1006	
330	34. 3′	30. 8′	941		382	34. 3′	34. 5′	861	
331	33. 8′	31. 2′	830		383	33. 8′	35. 0′	642	
332	33. 2′	31. 6′	647		384	33. 3′	35. 5′	267	
333	32. 8′	32. 0′	375		385	32. 9′	36. 0′	162	
334	32. 2′	32. 4′	216		386	32. 4′	36. 7′	145	
335	31. 6′	32. 8′	151		387	31. 9′	37. 2′	157	
336	31. 1′	33. 2′	95		388	31. 3′	37. 6′	137	
337	30. 6′	33. 5′	44		389	31. 6′	39. 0′	116	
338	30. 0′	34. 0′	43		390	32. 0′	40. 3′	102	
339	29. 6′	34. 2′	50		391	32. 4′	39. 5′	92	
340	29. 5′	34. 1′	54		392	32. 9′	38. 9′	108	
341	29. 4′	34. 1′	38		393	33. 5′	38. 3′	130	
342	30. 0′	35. 5′	32		394	34. 0′	37. 4′	326	
343	30. 2′	36. 0′	100		395	34. 5′	37. 0′	362	
344	30. 4′	36. 6′	69		396	35. 1′	36. 4′	1027	
345	30. 5′	37. 1′	117		397	35. 5′	36. 2′	1027	
346	30. 6′	37. 6′	133		398	35. 5′	37. 5′	1027	
347	30. 9′	38. 1′	150		399	35. 0′	38. 0′	947	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
S-400	69°34. 6′	39°39. 3′	626		O-011	69°13. 9′	39°16. 6′	218	
401	34. 1′	39. 2′	278		012	15. 3′	15. 2′	225	
402	33. 8′	37. 8′	230		013	16. 0′	14. 4′	288	
403	33. 6′	36. 4′	295		014	16. 9′	13. 5′	289	
404	33. 3′	35. 1′	234		015	17. 7′	12. 7′	510	
405	33. 1′	33. 4′	301		016	18. 3′	12. 0′	809	
406	32. 6′	32. 2′	296		017	19. 1′	11. 0′	763	
407	33. 0′	30. 6′	260		018	20. 0′	10. 1′	547	
408	32. 1′	29. 3′	292		019	21. 1′	09. 2′	289	
409	31. 8′	28. 1′	546		020	22. 5′	07. 4′	400	
410	31. 5′	26. 9′	615		021	24. 0′	05. 8′	428	
411	31. 2′	25. 6′	272		022	25. 5′	04. 3′	590	
412	30. 9′	24. 5′	466		023	27. 0′	02. 7′	908	
413	30. 7′	23. 6′	541		024	28. 6′	01. 0′	761	
414	30. 6′	23. 3′	560		025	30. 0′	38°58. 8′	584	*
415	30. 5′	22. 6′	581		026	31. 5′	38°57. 0′	502	
416	30. 4′	20. 9′	847		027	32. 9′	38°54. 7′	462	*731014
417	30. 0′	19. 4′	887		028	33. 8′	38°53. 6′	442	*
418	30. 6′	19. 0′	893		029	32. 3′	39°02. 0′	581	*
419	31. 1′	18. 2′	984		030	30. 7′	03. 6′	692	*
420	31. 6′	17. 7′	1063	*	031	29. 1′	05. 3′	925	*
421	32. 1′	17. 4′	813	*	032	27. 6′	06. 9′	651	*
422	32. 8′	17. 0′	802		033	26. 5′	08. 3′	509	*
423	33. 2′	16. 6′	800		034	25. 2′	09. 9′	386	*
424	33. 7′	16. 2′	700	*	035	23. 6′	11. 4′	389	*731015
425	34. 3′	15. 7′	470		036	22. 2′	13. 2′	383	
426	34. 8′	15. 0′	387		037	20. 7′	15. 4′	560	
427	35. 3′	14. 2′	470		038	19. 4′	17. 5′	422	
428	35. 9′	13. 2′	569		039	18. 0′	19. 6′	474	
429	36. 2′	13. 1′	488		040	16. 6′	21. 7′	401	
430	29. 5′	19. 6′	764	*730919	041	15. 9′	23. 0′	320	
431	28. 7′	19. 8′	592		042	18. 5′	22. 8′	455	
432	28. 3′	20. 0′	483		043	19. 6′	22. 6′	418	
433	27. 7′	20. 0′	330		044	20. 7′	22. 7′	292	
434	27. 1′	20. 0′	335		045	21. 5′	21. 9′	466	
435	26. 5′	19. 9′	470		046	22. 2′	21. 4′	581	
436	26. 0′	19. 8′	566		047	23. 1′	20. 8′	385	
437	25. 5′	19. 7′	561		048	24. 0′	20. 0′	395	
438	25. 0′	19. 6′	569	*	049	25. 0′	19. 0′	554	
439	25. 2′	22. 0′	209		050	26. 5′	17. 4′	421	
440	25. 3′	24. 2′	102		051	28. 0′	15. 6′	561	
441	25. 3′	25. 7′	35	*	052	29. 5′	13. 6′	627	
O-001	11. 3′	31. 4′	161	731012	053	30. 9′	11. 9′	1149	*
002	11. 3′	30. 0′	271		054	31. 4′	11. 2′	964	*731016
003	11. 3′	28. 4′	256		055	32. 4′	10. 1′	347	
004	11. 3′	27. 0′	185		056	33. 8′	08. 4′	276	
005	11. 3′	25. 4′	283		057	35. 2′	06. 4′	279	
006	11. 3′	24. 0′	278		058	36. 6′	03. 5′	428	
007	11. 3′	25. 4′	114		059	36. 7′	02. 3′	587	*
008	11. 3′	21. 0′	261		060	36. 9′	05. 3′	486	
009	11. 3′	19. 4′	354		061	36. 1′	09. 4′	603	
010	12. 1′	18. 5′	335		062	35. 6′	11. 9′	403	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
O-063	69°34. 7′	39°13. 9′	311		O-115	69°38. 56′	39°19. 92′	395	
064	40. 83′	24. 60′	293	*731017	116	38. 63′	20. 66′	369	
065	40. 68′	23. 50′	219		117	38. 70′	21. 40′	237	
066	40. 55′	22. 86′	134		118	38. 78′	20. 55′	295	
067	40. 42′	22. 15′	236		119	38. 83′	19. 78′	279	
068	40. 28′	21. 56′	185		120	38. 87′	19. 02′	263	
069	40. 15′	20. 86′	199		121	38. 85′	18. 10′	266	
070	40. 01′	20. 25′	197		122	39. 32′	18. 49′	118	
071	39. 85′	19. 70′	160		123	39. 25′	19. 25′	173	
072	39. 72′	19. 06′	76		124	39. 16′	20. 05′	231	
073	39. 56′	18. 36′	87		125	39. 10′	20. 76′	178	
074	39. 43′	17. 65′	125		126	40. 35′	23. 30′	39	731018
075	39. 27′	17. 08′	193		127	40. 49′	23. 50′	80	
076	39. 13′	16. 45′	165		128	40. 62′	23. 67′	124	
077	38. 95′	15. 73′	98		129	40. 74′	23. 85′	271	
078	39. 39′	16. 27′	202		130	40. 86′	24. 02′	219	
079	39. 64′	16. 10′	333		131	41. 00′	24. 25′	68	
080	39. 92′	15. 96′	199		132	40. 36′	24. 35′	296	
081	40. 18′	15. 74′	118		133	40. 46′	23. 10′	68	
082	40. 45′	15. 68′	66		134	40. 66′	22. 70′	236	
083	40. 70′	15. 58′	41		135	40. 77′	22. 47′	81	
084	40. 98′	15. 45′	33		136	40. 88′	22. 30′	23	
085	41. 25′	15. 38′	33		137	40. 98′	22. 03′	16	
086	41. 05′	15. 92′	37		138	40. 86′	22. 08′	37	
087	40. 85′	16. 51′	70		139	40. 73′	22. 17′	79	
088	40. 65′	17. 05′	89		140	40. 62′	22. 22′	251	
089	40. 45′	17. 62′	73		141	40. 49′	22. 30′	242	
090	40. 25′	18. 16′	108		142	40. 33′	22 35′	79	
091	40. 03′	18. 80′	247		143	39. 64′	18. 76′	104	
092	39. 63′	19. 85′	129		144	40. 78′	19. 81′	10	
093	39. 44′	20. 32′	176		145	23. 95′	39. 69′	49	***731026
094	39. 25′	20. 85′	164		146	27. 75′	40. 57′	28	
095	39. 05′	21. 35′	216		147	27. 62′	40. 68′	84	
096	38. 86′	21. 80′	66		148	27. 48′	40. 81′	55	
097	39. 15′	21. 70′	84		149	27. 33′	40. 95′	37	
098	39. 42′	21. 54′	42		150	27. 45′	41. 25′	81	
099	39. 93′	20. 85′	128		151	27. 55′	41. 43′	92	
100	40. 18′	20. 54′	289		152	27. 67′	41. 60′	76	
101	40. 40′	20. 24′	212		153	27. 78′	41. 78′	12	
102	40. 65′	19. 96′	32		154	27. 66′	41. 88′	44	
103	40. 57′	19. 23′	65		155	27. 67′	42. 19′	47	
104	40. 49′	18. 46′	10		156	27. 68′	42. 50′	23	
105	40. 35′	17. 92′	80		157	27. 70′	42. 85′	17	
106	39. 83′	17. 50′	202		158	27. 67′	41. 19′	43	
107	39. 55′	17. 39′	241		159	27. 62′	40. 35′	80	
108	39. 00′	17. 02′	226		160	27. 48′	40. 35′	135	
109	38. 73′	16. 92′	216		161	27. 35′	40. 38′	111	
110	38. 48′	16. 90′	85		162	27. 22′	40. 40′	74	
111	38. 23′	16. 89′	17		163	27. 08′	40. 42′	91	
112	38. 35′	17. 64′	162		164	26. 96′	40. 45′	108	
113	38. 42′	18. 35′	293		165	26. 85′	40. 45′	69	
114	38. 48′	19. 15′	343		166	28. 35′	40. 02′	23	

*** Positions of inner bayment of Skjegget differ 2′ westward compared with the map of Skarvsnes, published by Geogr. Inst. Jap.

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
O-167	69°28.12′	39°39.85′	11		O-219	69°25. 8′	39°47. 8′	43	
168	28.12′	39.46′	32		220	26. 0′	47. 1′	121	
169	28.07′	38.70′	14		221	26. 1′	46. 5′	116	
170	28.05′	38.35′	34		222	26.18′	45.00′	90	
171	27.98′	38.05′	42		223	26.30′	44.47′	153	
172	28.15′	38.05′	15		224	26.40′	43.90′	59	
173	28.19′	37.76′	26		225	26.37′	43.25′	73	
174	28.15′	37.42′	31		226	26.35′	42.78′	76	
175	28.01′	37.33′	48		227	26.37′	42.38′	47	
176	27.87′	37.33′	57		228	26.43′	42.00′	38	
177	27.75′	37.33′	42		229	26.52′	41.60′	30	
178	27.62′	37.33′	27		230	26.58′	41.35′	48	
179	27.55′	37.70′	17		231	26.65′	41.00′	57	
180	27.62′	38.90′	15	731027	232	26.87′	40.25′	68	
181	27.51′	39.10′	27		233	26.98′	40.12′	65	
182	27.53′	38.76′	41		234	27.10′	39.96′	64	
183	27.63′	38.51′	44		235	27.23′	39.85′	76	
184	27.78′	38.60′	18		236	27.38′	39.73′	27	
185	27.72′	38.26′	48		237	27.38′	40.08′	95	
186	27.82′	38.02′	59		238	27.52′	40.08′	116	
187	27.91′	37.72′	65		239	27.67′	40.08′	77	
188	28.05′	37.18′	33		240	27.80′	40.08′	76	
189	27.95′	36.95′	20		241	27.92′	40.08′	64	
190	27.83′	36.86′	32		242	27.85′	39.80′	14	
191	27.69′	36.78′	20		243	28.08′	40.03′	37	
192	27.73′	37.18′	41		244	25.00′	34.94′	63	731028
193	27.74′	37.60′	54		245	25.08′	34.60′	71	
194	27.66′	37.94′	50		246	25.16′	34.25′	37	
195	27.56′	38.11′	12		247	25.21′	34.53′	39	
196	27.48′	38.40′	25		248	25.22′	34.94′	84	
197	27.41′	38.70′	33		249	25.23′	35.33′	64	
198	27.30′	39.01′	18		250	25.37′	35.30′	121	
199	27.19′	39.18′	10		251	25.53′	35.33′	118	
200	27.09′	39.42′	20		252	25.66′	35.33′	103	
201	26.98′	39.76′	20		253	25.80′	35.33′	107	
202	26.89′	40.00′	57		254	25.94′	35.33′	54	
203	26.68′	40.22′	69		255	26.07′	35.33′	12	
204	26.56′	40.40′	60		256	26.00′	35.68′	76	
205	26.52′	40.82′	54		257	25.97′	36.00′	116	
206	26.40′	40.58′	42		258	25.92′	36.35′	139	
207	26.24′	40.58′	36		259	25.85′	36.68′	105	
208	26.10′	40.58′	64		260	26.00′	36.68′	153	
209	25.97′	40.60′	85		261	26.13′	36.68′	109	
210	25.99′	41.26′	33		263	26.26′	36.71′	52	
211	25.99′	42.58′	207		263	26.38′	36.70′	12	
212	25.99′	43.33′	258		264	26.35′	37.13′	25	
213	25.99′	44.01′	123		265	26.29′	37.42′	52	
214	25.05′	44.60′	86		266	26.25′	37.70′	50	
215	25. 8′	45. 7′	93		267	26.20′	38.00′	21	
216	25. 7′	46. 4′	122		268	26.10′	37.63′	79	
217	25. 5′	47. 1′	111		269	26.02′	37.40′	90	
218	25. 4′	47. 6′	25		270	25.93′	37.10′	123	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
O-271	69°26.04′	39°36.95′	154		O-323	69°17.80′	39°41.57′	46	
272	26.12′	37.24′	148		324	17.40′	41.10′	106	
273	26.18′	37.55′	118		325	17.24′	40.53′	103	
274	26.32′	37.95′	26		326	17.07′	39.96′	71	
275	26.36′	37.63′	36		327	16.18′	39.15′	33	
276	26.22′	37.12′	81		328	16.25′	39.85′	137	
277	26.07′	36.42′	122		329	16.30′	40.50′	154	
278	26.12′	36.00′	62		330	16.35′	41.24′	134	
279	26.18′	35.32′	76		331	16.37′	41.90′	28	
280	26.31′	36.38′	25		332	16.43′	42.57′	62	
281	26.23′	36.03′	10		333	16.50′	43.61′	116	
282	26.18′	35.67′	7		334	16.53′	44.25′	106	
283	25.98′	35.05′	26		335	16.68′	44.01′	73	
284	25.86′	34.82′	32		336	16.75′	43.72′	80	
285	25.75′	34.57′	17		337	16.85′	43.32′	59	
286	25.59′	34.65′	32		338	16.78′	43.32′	68	
287	25.45′	34.72′	39		339	16.45′	43.32′	133	
288	25.30′	34.76′	74		340	16.31′	43.39′	138	
289	25.35′	35.53′	109		341	16.17′	43.45′	54	
290	25.47′	35.68′	85		342	16.05′	42.80′	166	
291	25.58′	35.88′	79		343	16.01′	42.13′	171	
292	25.70′	36.08′	133		344	15.95′	41.44′	172	
293	25.74′	36.41′	130		345	15.92′	40.70′	44	
294	25.82′	36.25′	140		346	15.86′	40.05′	46	
295	25.86′	35.85′	130		347	16.05′	39.50′	114	
296	25.74′	35.63′	128		348	16. 5′	22. 8′	280	731031
297	25.63′	35.49′	108		349	15. 9′	22. 6′	337	
298	25.42′	35.03′	96		350	15. 4′	22. 2′	299	
299	25.56′	34.96′	60		351	14. 9′	22. 0′	431	
300	25.71′	34.96′	50		352	14. 3′	21. 7′	368	
301	25.92′	35.63′	90		353	13. 8′	21. 4′	301	
302	26.07′	36.73′	137	731030	354	13. 3′	21. 0′	316	
303	19. 2′	43. 3′	56	*56.4	355	12. 8′	20. 8′	303	
304	19. 1′	42. 1′	125		356	12. 2′	20. 5′	246	
305	18.78′	42.25′	223		357	11. 7′	20. 2′	251	
306	18.48′	42.25′	268		358	11. 2′	20. 0′	278	
307	18.22′	42.25′	154	*155.6	359	10. 6′	19. 6′	246	
308	18.08′	41.62′	141		360	10. 1′	19. 4′	197	
309	17.93′	41.03′	213		361	09. 6′	19. 1′	193	
310	17.68′	40.70′	68		362	09. 0′	18. 6′	258	
311	17.45′	40.35′	123		363	08. 5′	18. 4′	153	
312	17.20′	40.00′	63		364	08. 0′	18. 0′	127	
313	17.23′	39.47′	63		365	07. 4′	17. 6′	164	
314	17.52′	39.43′	38		366	06. 8′	17. 2′	252	
315	17.75′	39.40′	39		367	06. 3′	17. 0′	129	
316	17.87′	39.30′	271		368	05. 7′	16. 7′	207	
317	17.90′	39.95′	153		369	05. 1′	16. 2′	164	
318	17.82′	40.35′	154		370	04. 5′	15. 8′	156	
319	17.73′	40.82′	97		371	03. 9′	15. 6′	141	
320	17.62′	41.25′	103		372	03. 3′	15. 3′	145	
321	17.55′	41.57′	28		N-001	14.42′	42.75′	133	731103
322	17.68′	41.57′	38		002	14.05′	42.97′	92	

Table 2 (Continued)

Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks	Station	Latitude (S)	Longitude (E)	Depth (m)	Remarks
N-003	69°13.88′	39°43.00′	63		N-058	69°14.00′	39°43.74′	48	
004	13.70′	43.10′	46		059	14.13′	44.01′	44	
005	13.58′	42.85′	86		060	14.26′	44.22′	28	
006	13.45′	42.54′	52		061	13.36′	42.16′	52	
007	13.25′	42.68′	84		062	13.22′	41.15′	32	
008	13.97′	42.45′	80		063	13.09′	41.15′	17	
009	14.21′	42.28′	144		064	13.02′	40.39′	32	
010	14.38′	42.05′	175		065	13.47′	40.97′	32	
011	14.55′	41.90′	116		066	13.73′	40.58′	42	
012	14.70′	41.75′	76		067	13.98′	40.30′	57	
013	14.86′	41.60′	130		068	14.21′	39.92′	52	
014	15.02′	41.45′	116		069	14.38′	39.45′	177	
015	15.18′	41.30′	140		070	14.22′	38.90′	215	
016	15.35′	41.15′	145		071	14.01′	38.40′	194	
017	15.50′	41.05′	124		072	13.70′	38.70′	82	
018	15.65′	40.86′	103		073	13.52′	39.22′	30	
019	15.80′	40.73′	106		074	13.49′	39.67′	28	
020	16.00′	40.59′	127		075	13.37′	39.70′	100	
021	16.15′	40.50′	143		076	13.25′	39.70′	111	
022	16.28′	40.30′	148		077	13.20′	39.40′	98	
023	16.46′	40.15′	41		078	13.17′	39.05′	54	
024	16.63′	39.90′	14		079	13.30′	39.20′	112	
025	16.77′	39.76′	48		080	13.40′	38.97′	66	
026	16.90′	39.55′	10		081	13.55′	38.90′	60	
027	16.75′	40.15′	59		082	14.75′	38.98′	77	
028	16.59′	40.69′	36		083	14.96′	38.98′	204	
029	16.20′	41.42′	146		084	15.18′	38.95′	81	
030	15.70′	41.75′	132		085	15.62′	38.79′	151	
031	15.45′	41.95′	90		086	15.85′	38.69′	123	
032	15.21′	42.22′	59		087	15.92′	39.08′	149	
033	14.76′	42.44′	95		088	18.24′	38.25′	250	
034	14.34′	41.50′	93		089	18.31′	39.13′	317	
035	14.34′	40.88′	84		090	18.34′	39.95′	177	
036	14.08′	41.09′	36		091	18.40′	40.81′	322	
037	14.61′	40.65′	98		092	18.05′	39.97′	273	
038	14.86′	40.46′	87		093	10. 9′	20. 0′	274	
039	15.15′	40.37′	157		094	10. 4′	20. 6′	219	
040	15.42′	40.22′	76		095	09. 9′	21. 1′	251	
041	15.72′	40.04′	41		096	09. 4′	21. 8′	113	*113
042	15.97′	39.90′	171		097	08. 9′	22. 4′	95	* 94
043	16.21′	39.69′	135		098	08. 4′	22. 9′	160	*159
044	16.52′	39.59′	77		099	07. 8′	23. 2′	223	
045	16.77′	39.43′	36		100	07. 3′	22. 5′	187	
046	17.02′	39.39′	50		101	06. 8′	21. 7′	123	
047	16.32′	41.85′	149		102	06. 4′	21. 1′	156	
048	16.22′	42.18′	167		103	05. 9′	20. 4′	207	
049	16.13′	42.43′	153		104	05. 4′	19. 5′	165	
050	15.93′	42.97′	42		105	04. 9′	18. 9′	224	
051	15.84′	42.33′	208		106	04. 5′	18. 1′	101	
052	15.58′	42.42′	129		107	04. 0′	17. 4′	117	
053	15.76′	40.45′	65		108	03.55′	16. 7′	86	
054	15.50′	40.70′	107		109	03.15′	15. 9′	129	
055	15.23′	40.98′	137		110	02. 1′	16. 0′	150	
056	15.46′	41.24′	36		111	00.95′	18. 9′	91	
057	14.48′	43.10′	66	731104					

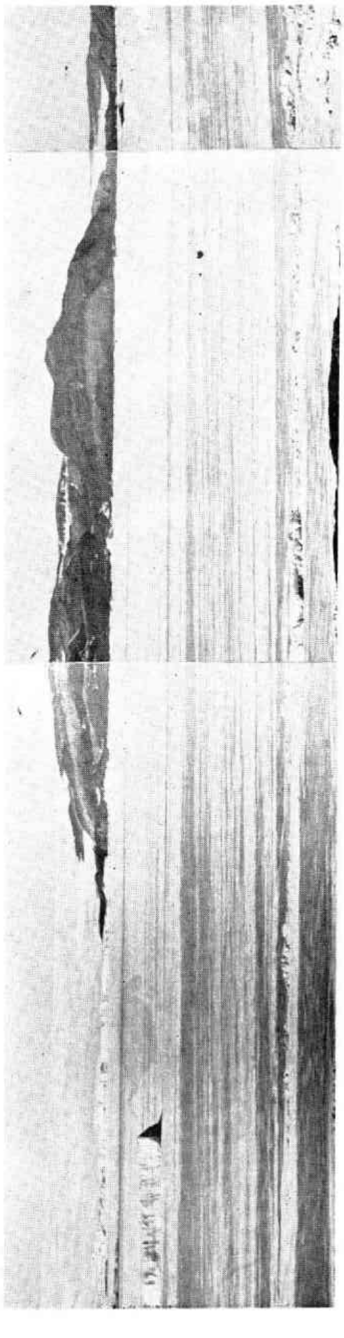

Photo 1 Langhovde Glacier (left) and North Langhovde (right) viewed from Teöya Island. The highest peak is Mt. Tyôto (378.4 m a.s.l.).

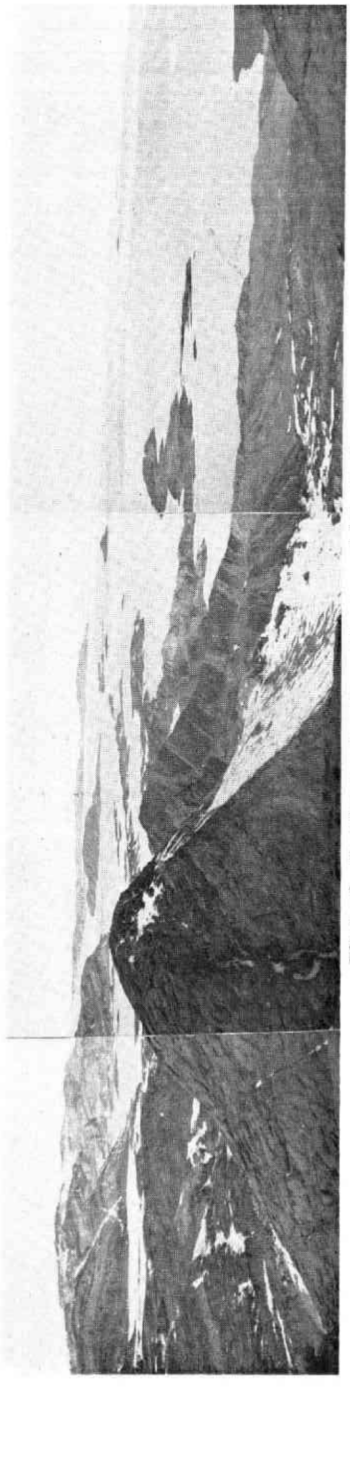

Photo 2 Southern view from the top of Mt. Tyôto.

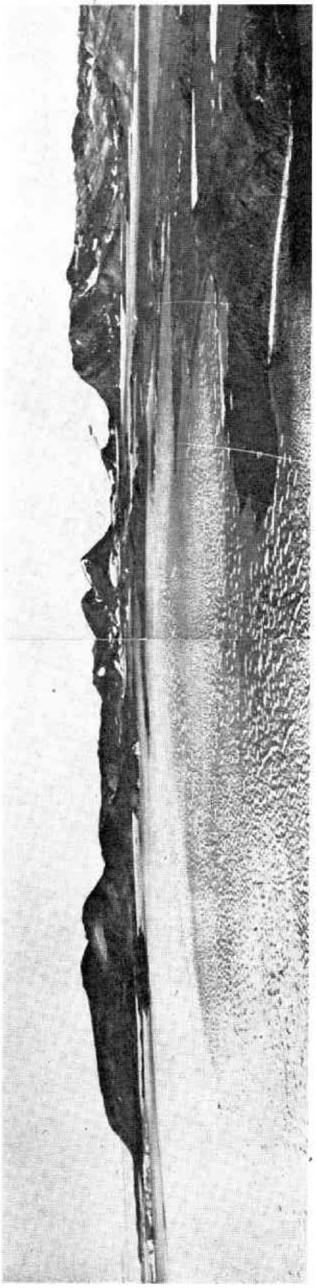

Photo 3 West coast of north (left) and middle (right) Langhovde.

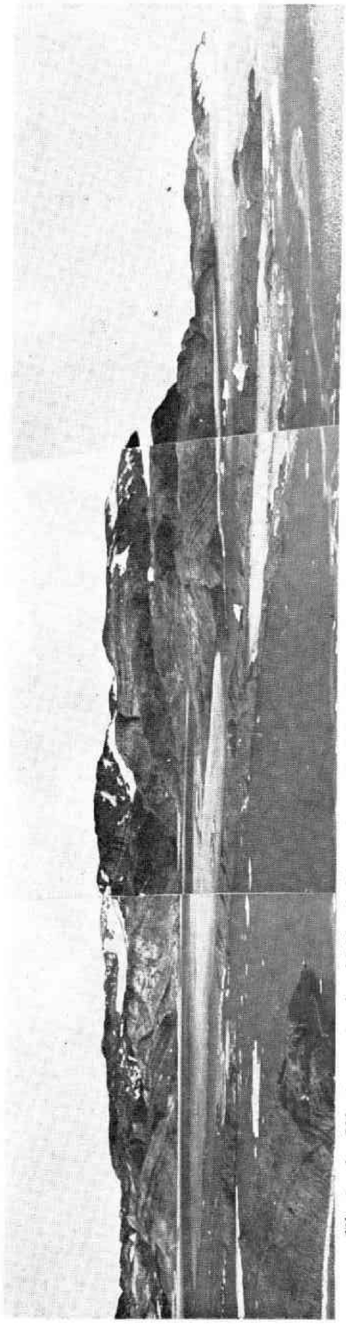

Photo 4 West coast of middle (left) and south (right) Langhovde. Hamna Glacier looks white in right center.

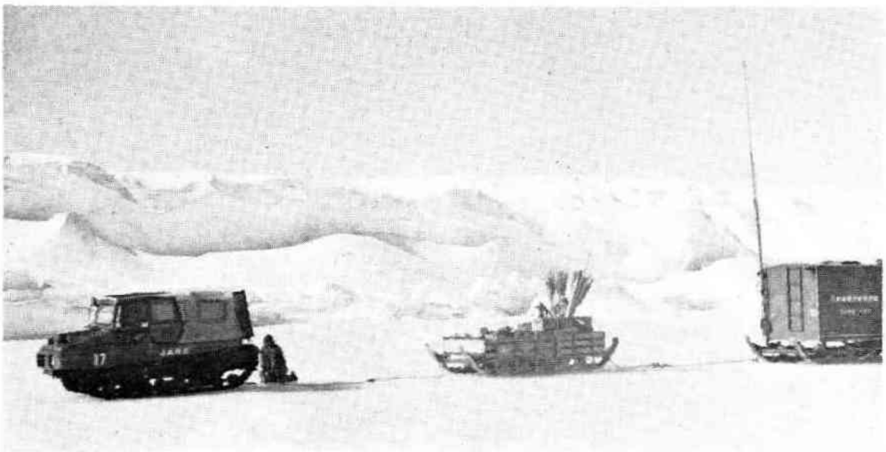

Photo 5 Snow-car, sledge and caboose sledge used by echo-sounding traverse party.

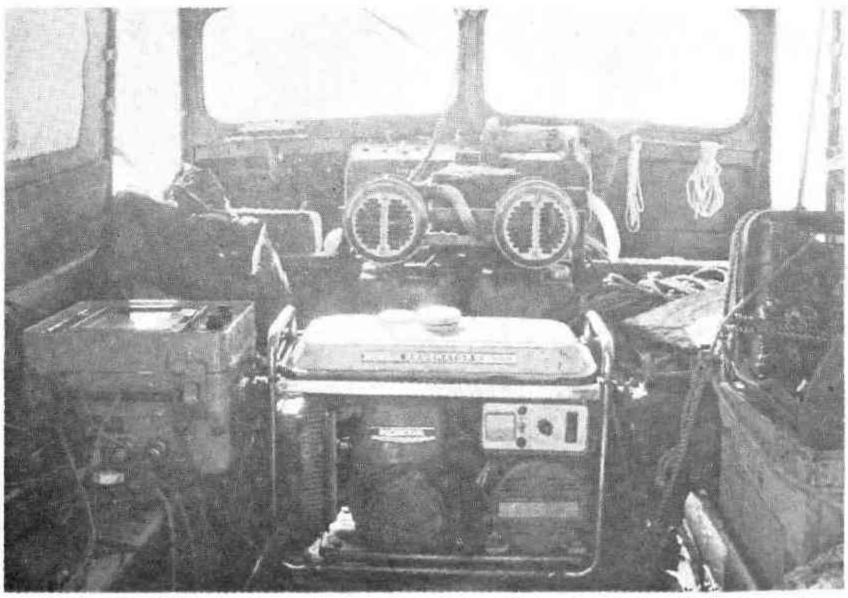

Photo 6 Inside view of snow-car. Echo-sounder (Recorder unit is fixed on left rear seat. Generator is fixed in the center of the cabin.

Photo 7 Equipment for echo-sounding; sander, pickel, core drill, wire for plummet and tranceducers from right to left.

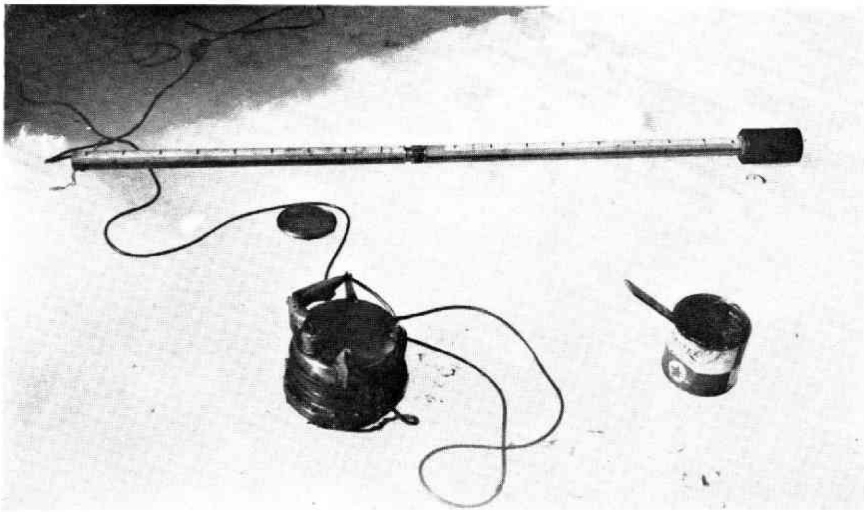

Photo 8 Tranceducer for over-ice type (lower), and under-ice type (upper). A grease-can is seen in right.

Photo 9 Langhovde Glacier (left) and south to middle Langhovde (upper right)*.

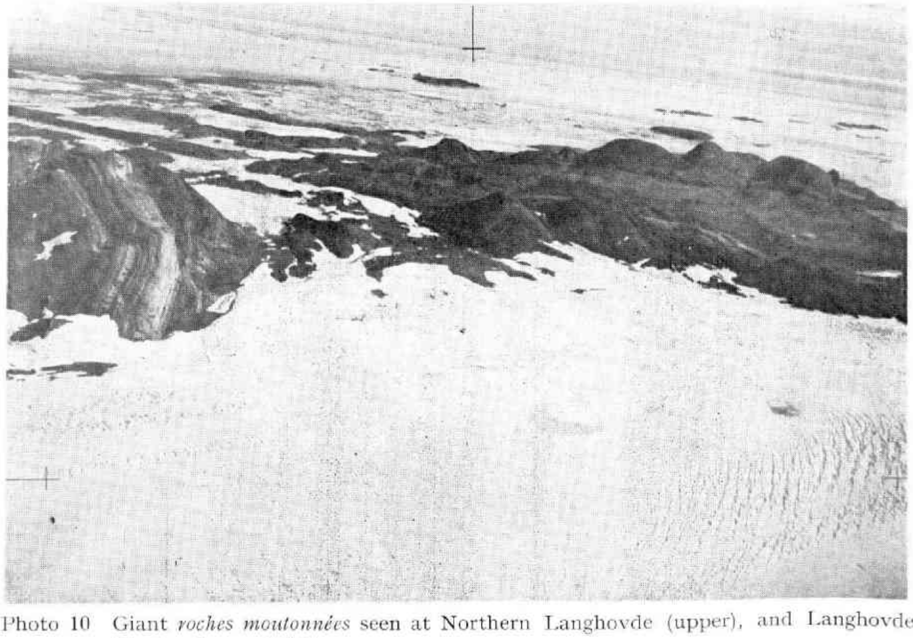

Photo 10 Giant *roches moutonnées* seen at Northern Langhovde (upper), and Langhovde Glacier (lower left)*.

Photo 11 South of Langhovde and Hamnenabben (upper left). Hamna Glacier looks white in left.*

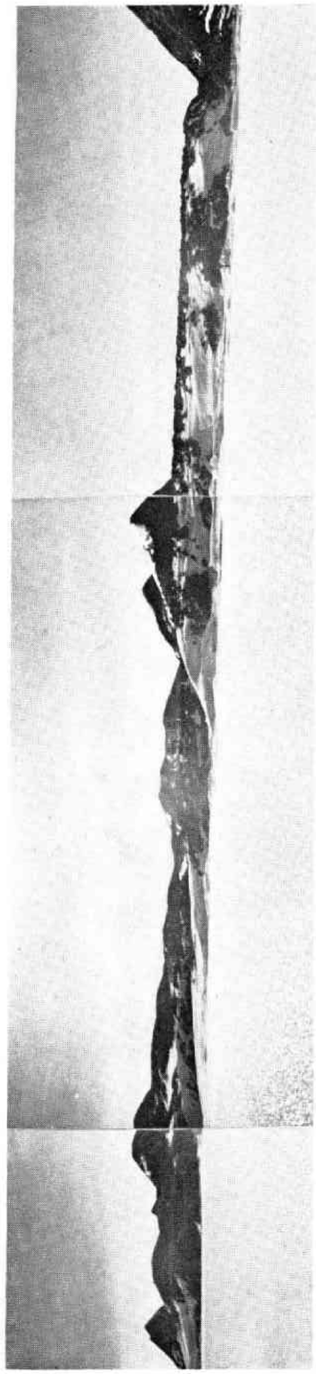

Photo 12 Coastal landform of northwest and middle Langhovde looks like wave cut platform.

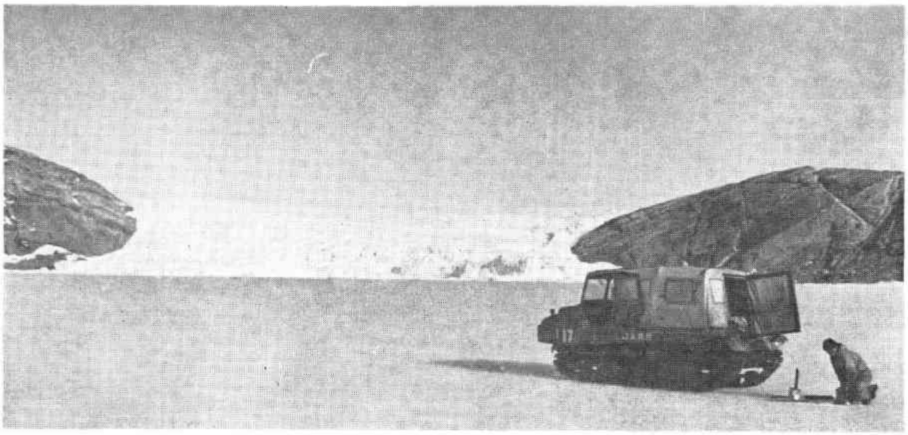

Photo 13 Ice fall of Hamna Glacier.

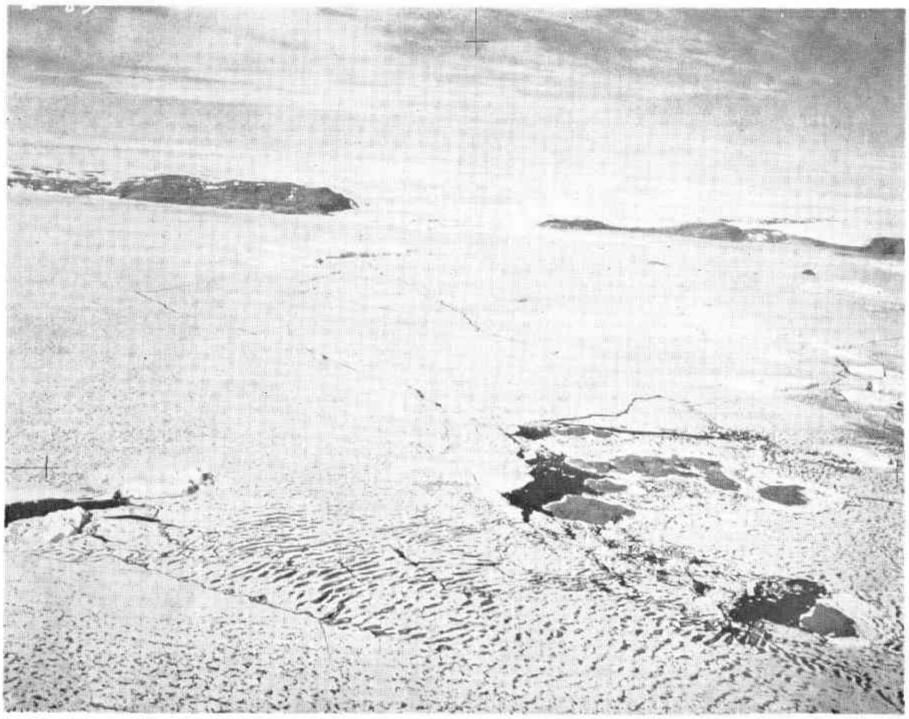

Photo 14 Breidvågnipa (left), Honnör Glacier (center), and Byvåg Åsane (right) viewed from west off Skarvsnes*.

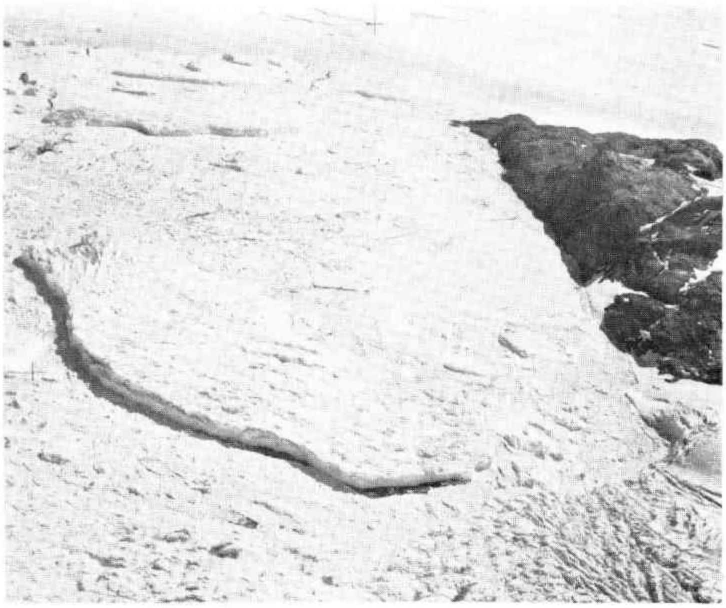

Photo **15** Honnör Glacier and steep fjord wall of southernmost of Breidvågnipa, viewed seaward from ice sheet*.

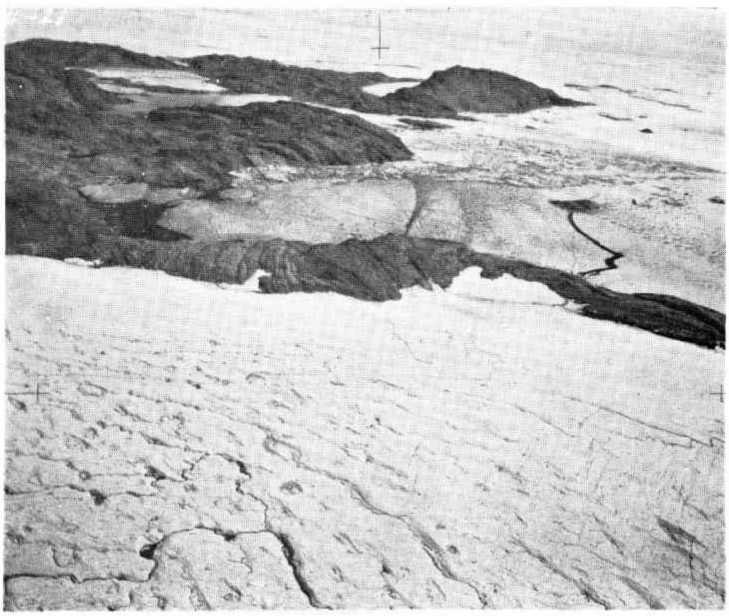

Photo 16 Honnör Glacier (lower), Byvåg Åsane and Skarvsnes (upper).*

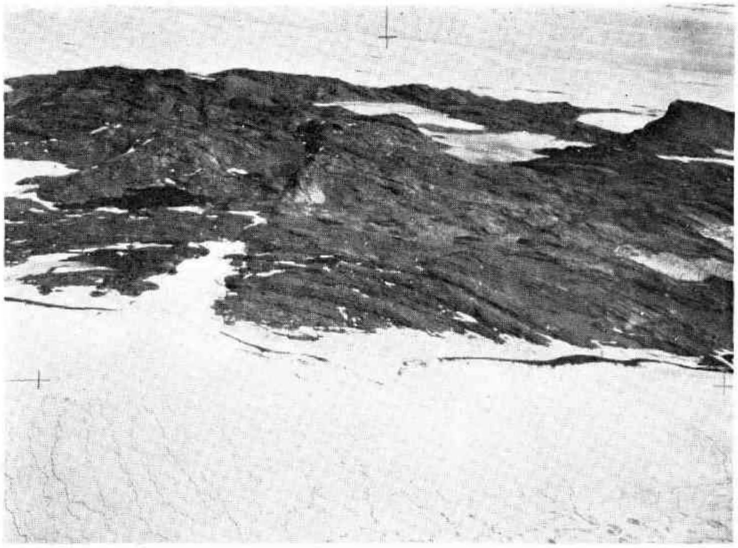

Photo 17 Central part of Skarvsnes viewed from ice sheet. The right upper peak is Skjegget (400.4 m a.s.l.)*.

Photo 18 Skarvsnes viewed from seaward. Skjegget peak and Langpollen (Bay) are seen in upper center*.

Photo 19 Northern fjord wall of Skjegget and Langpollen (Bay). The southern fjord wall has lost.

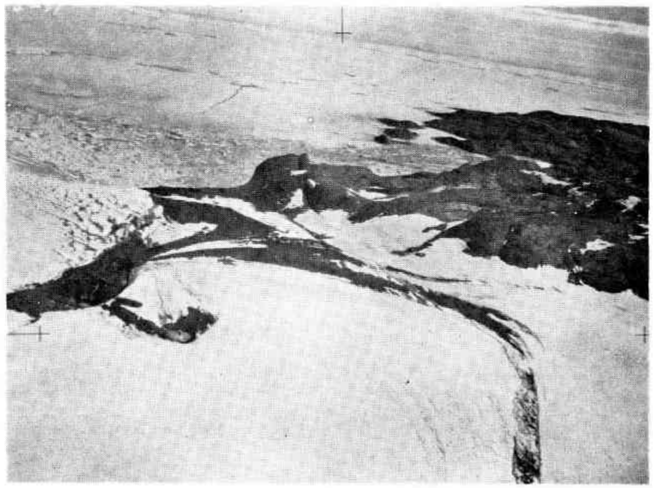

Photo 20 Tenpyo Glacier (lower) and southeast of Skarvsnes. The peak in center is Mt. Tenpyo (254 m a.s.l.)*.

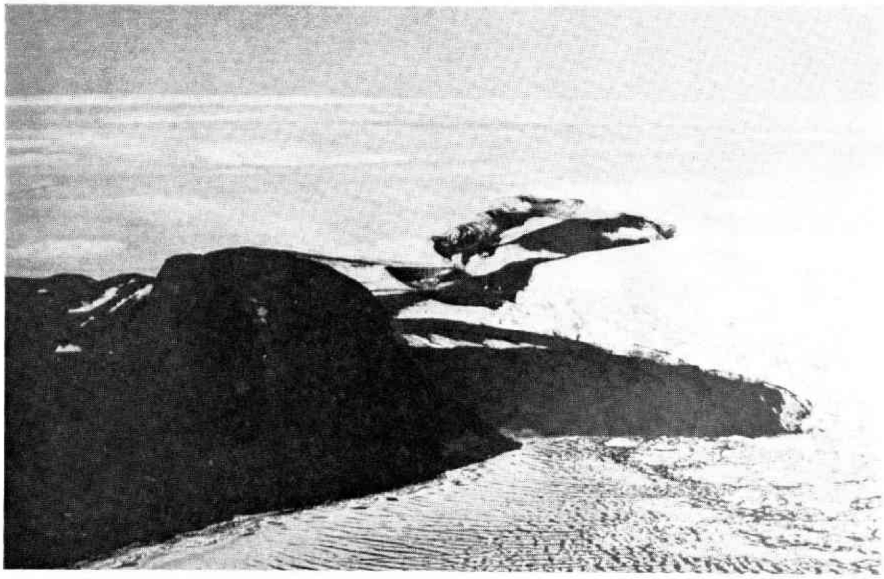

Photo 21 Mt. Tenpyo (left), Tenpyo Glacier (right) and Antarctic ice sheet (upper)*.

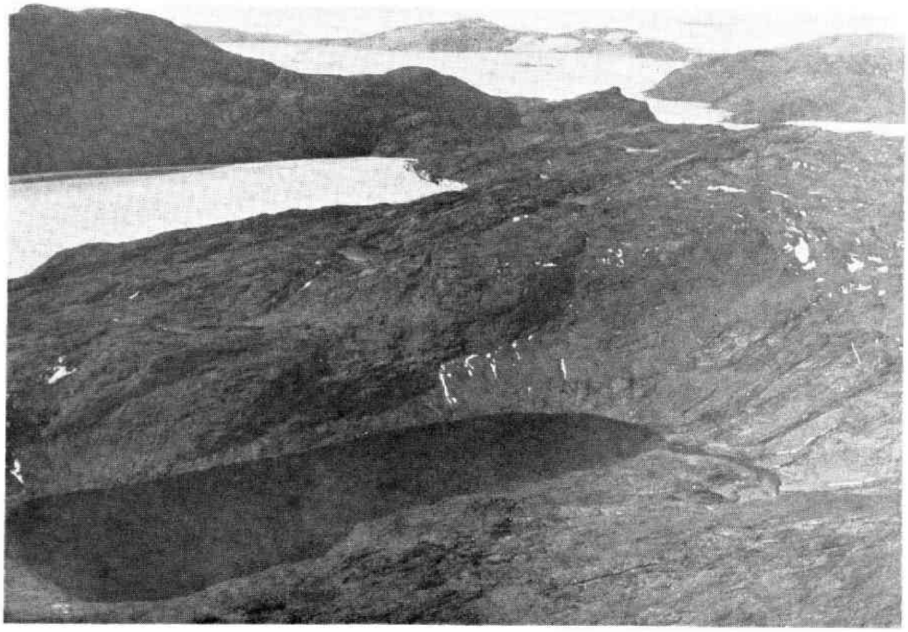

Photo 22 Skjegget peak and Langpollen in upper left, and Hunazoko-ike (Lake) in lower*.

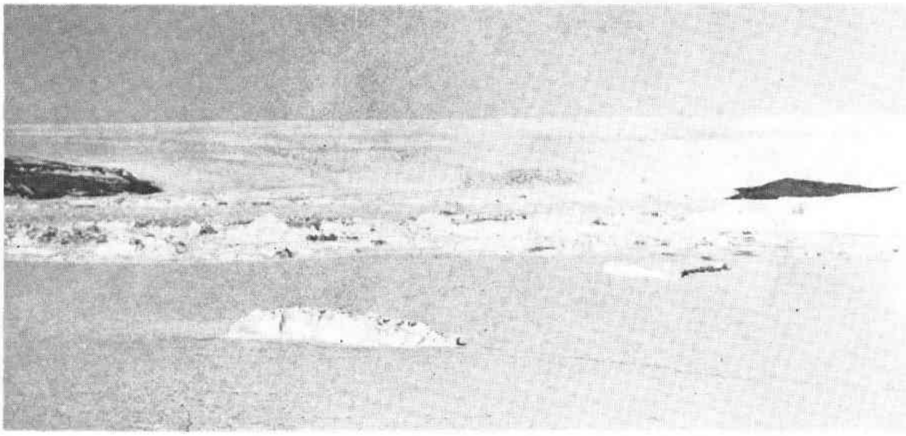

Photo 23 Telen Glacier in center. Ice free barerocks are Telen (left) and Kjuka (right)*.

Photo 24 Telen, Skallen and Skallevikhalsen Glaciers and ice free barerock areas of Telen, Kjuka, Skallen and Skallevikhalsen from left to right. An island in lower middle is Hjartöy Island*.

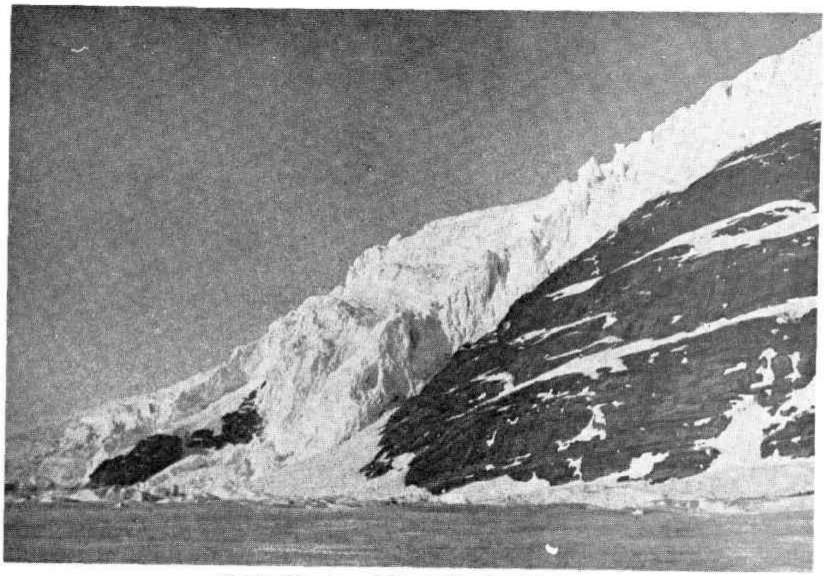

Photo 25 Ice fall of Skallevikhalsen.

Photo 26 Skallevikhalsen Glacier. Ice free areas are Skallevikhalsen (left), Skallen (right) and Hjartöy Island (upper left)*.

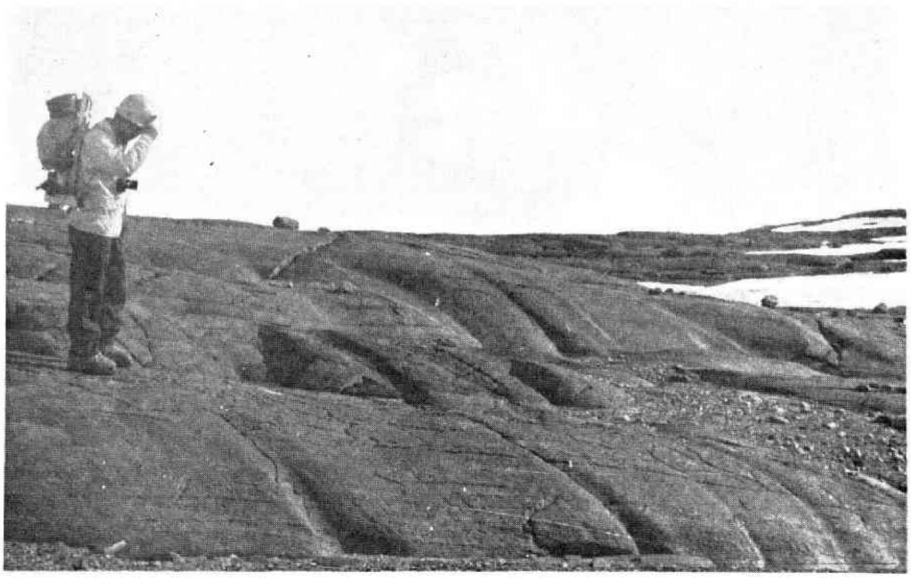

Photo 27 Glacial striations, crescentic gouges, glacial grooves and erratic boulders on bedrocks at Skallen.

Note: * shows oblique photo from air.