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NO. 6

LATE QUATERNARY RAISED BEACH DEPOSITS AND RADIOCARBON DATES OF MARINE FOSSILS AROUND LÜTZOW-HOLM BAY

EXPLANATORY TEXT

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and Kiichi MORIWAKI

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9–10, Kaga 1-chome, Itabashi-ku, Tokyo 173-8515

Explanatory Text of *Late Quaternary Raised Beach Deposits and Radiocarbon Dates of Marine Fossils around Lützow-Holm Bay*

ERRATA

P. 2, line 10	*For Skallen* (1:25,000, 1974) *read Skallen* (1:25,000, 1973)
P. 3, Table 1	Under column Number of dating and References *For* Miura *et al.*, 1998 read Miura *et al.*, 1998a, b
P. 5, line 1	*For* relative *read* relatively
P. 5, line 19	*For* intersive *read* intensive
P. 5, line 36	*For* Miura *et al.* (1998, 1999) *read* Miura *et al.* (1998a, b)
P. 6, line 13	*For* Miura *et al.* (1998, 1999) *read* Miura *et al.* (1998a, b)
P. 10, line 31	*For* 3,590 *read* 3,330
P. 10, line 33	*For* Miura *et al.* (1998) *read* Miura *et al.* (1998a)
P. 11, line 26-27	*For* Miura *et al.* (1998, 1999) *read* Miura *et al.* (1998a, b)
P. 11, line 32	*For* bed rock *read* bedrock
P. 11, line 36-37	*For* Miura *et al.* (1998) *read* Miura *et al.* (1998a)
P. 11, line 40	*For* Miura *et al.* (1998) *read* Miura *et al.* (1998a)
P. 12, Table 4	Under column References *For* Hirakawa and Sawagaki, 1988 *read* Hirakawa and Sawagaki, 1998 and *For* Miura *et al.*, 1998 *read* Miura *et al.*, 1998a
P. 14, line 1	*For* occurr *read* occur
P. 14, line 18-19	*For* Miura *et al.* (1998, 1999) *read* Miura *et al.* (1998a, b)
P. 14, line 23	*For* % *read* ‰
P. 15, Table 5	Under column Sample No., Shizuoka *Delete* Shizuoka
P. 15, Table 5	Under column Lab. of Univ. for $\delta^{18}O$ measurement, 960206-1n *Insert* Shizuoka
P. 24, Fig. 10	Data sources *For* Miura *et al.* (1998, 1999) *read* Miura *et al.* (1998a, b)
P. 26, line 15	*For* (Miura *et al.*, 1998) *read* (Miura *et al.*, 1998a)
P. 28, line 51-52	*For* MIURA, H., MAEMOKU, H., SETO, K. and MORIWAKI, K. (1998): Fluctuations of the east Antarctic ice sheet margin since the last glaciation from the stratigraphy of raised beach deposits along the Sôya Coast. *read* MIURA, H., MAEMOKU, H., SETO, K. and MORIWAKI, K. (1998a): Late Quaternary East Antarctic melting event in the Sôya Coast region based on stratigraphy and oxygen isotopic ratio of fossil molluscs.
P. 28, line 54	*For* 1999 *read* 1998b
P. 28, line 56	*For* (in press) *read* , 297-301
P. 28, line 64	*For* NihonChishitsugaku *read* Nihon Chishitsugaku
P. 30, Appendix I.	Under column Sample code & number, East Ongul Island Northern part *For* 6702131 *read* 670213
P. 30-35, Appendix I.	Under column Reference *For* Miura *et al.*, 1998 *read* Miura *et al.*, 1998a
P. 33, Appendix I.	Under column Deposit form, Kominato-higashi Beach E-trnch, Elevation (m asl) 5.9 *For* ? *read in situ*
P. 33, Appendix I.	Under column Material, South of Mizukuguri Cove, 69°11' 45", 39°37' 35" *For* fragment of shell *read* fragment of shell (*La*)
P. 33, Appendix I.	Under column Material, South of Mizukuguri Cove, 69°11' 52", 39°37' 25" *For* fragment of shell *read* fragment of shell (*La*)

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Explanatory Text

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Contents

1. Introduction

Lützow-Holm Bay, located within the quadrangle 69-70°S and 35-40°E, is a large bay about 220 km wide, indenting the eastern coast of Dronning Maud Land, East Antarctica (Fig. 1). The Sôya Coast, east coast of Lützow-Holm Bay, and the Prince Olav Coast are studded with many ice-free rocks, whose landforms are characterized by low-relief hills and monadnocks, controlled by the geologic structures of the gneiss bedrock and glaciations as evidenced by striations and scattered erratic boulders in every locality. In Lützow-Holm Bay, several deep submarine troughs are located immediately offshore of outlet glaciers. These landforms must have been sculptured by an ice sheet during a glacial maximum stage of unknown age.

On several ice-free rocks, step-like raised beaches and emerged marine deposits are distributed around pocket beaches and lakes, and many fossils of molluscs, which are now living in the littoral zone, are found in the deposits. Their features are very important evidence for estimating sea-level, ice advance and environmental change after a glacial maximum stage in East Antarctica. This sheet shows the distribution of raised beach deposits and localities of 246 marine fossils with radiocarbon dating ages, which have been collected from the Sôya and the Prince Olav Coasts by the Japanese Antarctic Research Expeditions (JARE) from JARE-1 (1956-1958) to JARE-37 (1995-1996).

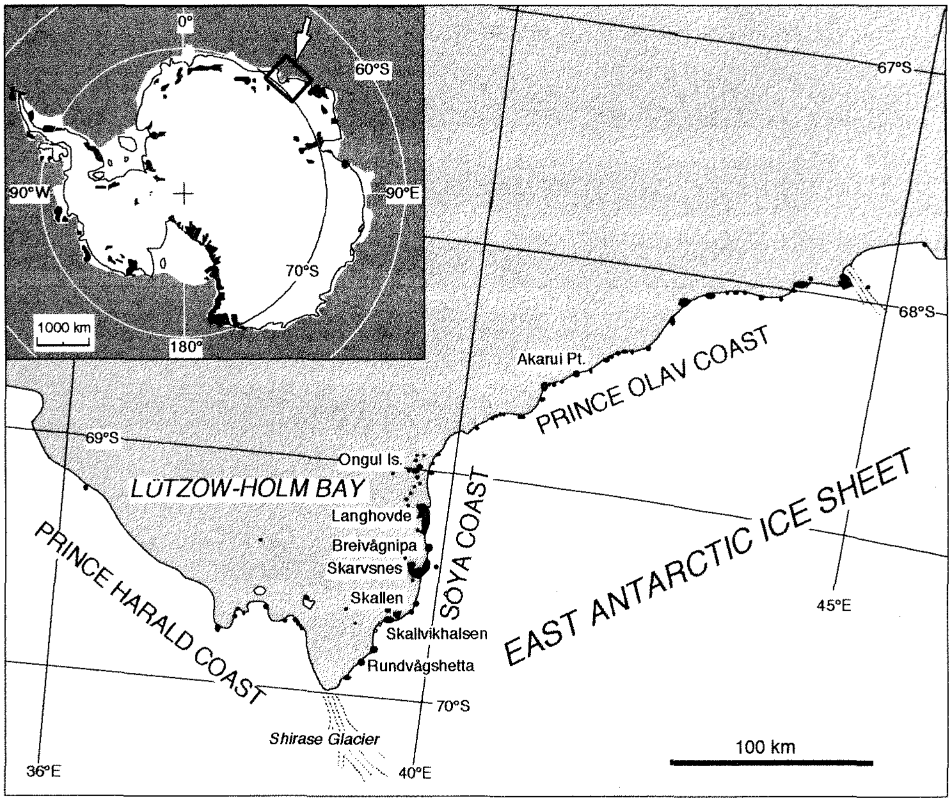

Fig. 1. Index map around Lützow-Holm Bay.

Many data were first compiled on topographic maps printed on one sheet, of the Sôya Coast and western part of the Prince Olav Coast (1:250,000), the Ongul Islands (1:20,000), Langhovde (1:50,000), Skarvsnes (1:50,000), and Skallen and Skallevikhalsen (1:50,000). The sheet also contains two figures: one is the cross section at Ko-minato higashi Beach in the northern part of Langhovde; the other is the relationship between AMS radiocarbon dating ages and sampling elevation of marine fossils, and the frequency distribution of AMS radiocarbon dating ages of marine fossils. Contours of the base maps are taken from topographic maps of *Lützow-Holm Bay* (1:250,000, 1989), *Prince Olav Coast* (1:250,000, 1990), *Langhovde* (1:25,000, 1987), *Skarvsnes* (1:25,000, 1987), *Honnör oku-iwa rock* (1:25,000, 1984), *Trillingbukuta* (1:25,000, 1987) and *Skallen* (1:25,000, 1974) published by the Geographical Survey Institute, Japan, and *Syôwa Kiti Syûhen Sagyôzu* (Working Map of Area Around Syowa Station) (1:10,000, 1993) published by National Institute of Polar Research. Isobaths of the base map are quoted from *Bathymetric chart of Lützow-Holmbukta* (MORIWAKI and YOSHIDA, 1990). All data including radiocarbon dates of marine fossils obtained from the raised beaches around Lützow-Holm Bay are also listed in Appendix 1.

Two methods are available for radiocarbon dating: the β-ray counting method, and the Accelerator Mass Spectrometry (AMS) method. We call radiocarbon dating by the β-ray counting method "β-ray dating", and that by the AMS method "AMS dating", respectively, in this paper.

2. Historical Background

The history of investigations of raised beach deposits around Lützow-Holm Bay can be divided into two periods (Table 1). In the earlier period from 1957 to 1977, raised beach deposits and marine fossils were discovered, and fossils were dated by the β-ray dating method. In the later period since 1991, AMS dating was used and the detailed stratigraphy of raised beach deposits was revealed by excavating trenches.

2.1. The earlier period: Discovery of raised beach deposits and radiocarbon dating by β-ray counting method of marine fossils

Marine fossils in raised beach deposits were discovered by members of JARE-1 on the Ongul Islands and Langhovde (Fig. 2). YOSHIKAWA and TOYA (1957) suggested that both areas were uplifted about 15 to 20 m after the retreat of the Antarctic ice sheet. Since then, several field parties have conducted investigations of raised beaches, and sampled marine fossils.
A pioneer study on radiocarbon dating of marine fossils, which were sampled on East Ongul Island from 1960 to 1962, was carried out by Professor K. KIGOSHI of Gakushuin University (MEGURO *et al.*, 1964). These radiocarbon dates were 3,840 yBP and older than 22,800 yBP. MEGURO *et al.* (1964) pointed out that the retreat of the ice sheet from the Ongul Islands took place at least 23,000 yBP, but probably not over 40,000 yBP. On the other hand, they and UCHIO (1966) pointed out that fossil foraminifera in the same sediments were deposited on the

Table 1. Field works on raised beaches, and marine fossils sampled from the Sôya and Prince Olav coasts.

Year	Expedition	Investigator(s)	Note	Number of dating and References	
1957	JARE-1	Yoshikawa, T. and Toya, H.	Discovery of raised beach and fossil shells in the Ongul Islands and Langhovde.		Yoshikawa and Toya, 1957
1960-61	JARE-4	Yoshida, Y.	Collection of fossil shells for first β -^{14}C dating from East Ongul Island.	2	Meguro *et al.*, 1964
1961-62	JARE-5, 6	Fujiwara, K., Meguro, H. and Koaze, T.	Collection of fossil shells and foraminifera from East Ongul Island.	6	Meguro *et al.*, 1964
1967-68	JARE-8	Yoshida, Y.	First collection of fossil shells from Skarvsnes and Langhovde.	11	Yoshida, 1970, 1983
1968-69	JARE-9	Fujiwara, K.	Detailed description of topography around Mizukumi Stream in East Ongul Island.		Fujiwara, 1973
1969-70	JARE-10	Omoto, K.	Collection of fossil shells from East Ongul Island and Skarvsnes.	4	Omoto *et al.*, 1974
1972	JARE-13	Moriwaki, K. and Ishikawa, T.	Collection of fossil shells from West Ongul Island and Langhovde.	5	Moriwaki, 1974; Ishikawa, 1974
1972-74	JARE-14	Omoto, K.	Collection of fossil shells from Langhovde and Skarvsness.	5	Omoto, 1976, 1977, 1978
1974-75	JARE-15	Moriwaki, K.	Collection of fossil shells from Akarui Point, Prince Olav Coast and Skarvsnes.	2	Moriwaki, 1976
1975-76	JARE-16	Hayashi, M. and Yoshida, Y.	Collection of fossil shells from Langhovde and Skarvsnes.	13	Hayashi and Yoshida, 1994
1976	JARE-17	Nogami, M.	Collection of fossil shells from Langhovde and Skarvsnes.	21	Nogami, 1977; Hayashi and Yoshida, 1994
1991-93	JARE-33	Igarashi, A.	First AMS-^{14}C dating, first fossil shells and foraminifera from Breivågnipa and Skallen.	41	Igarashi *et al.*, 1995a, 1995b
1992-94	JARE-34	Hayashi, M.	Collection of fossil shells from Langhovde and AMS-^{14}C dating.	9	Hayashi and Yoshida, 1994
1993-94	JARE-34, 35	Hirakawa, K. and Sawagaki,T	First collection of fossil shells for dating from Rundvågshetta and Slallevikhalsen.	40	Hirakawa and Sawagaki, 1998
1995-96	JARE-37	Miura, H., Maemoku, H. and Saigusa, S.	Identification of *in situ* fossil shells by excavatinging trench, and AMS -^{14}C dating.	88	Maemoku *et al.*, 1997; Miura et al., 1998

sea bottom at depths of about 100 m. This contradicted the fact that the raised marine features are hardly found beyond the height of 20 m asl on East Ongul Island.

YOSHIDA (1970) extensively surveyed the Sôya and Prince Olav coasts, and recognized former shorelines below 20 m elevation in the Sôya Coast region and below 30 m elevation in the Prince Olav Coast region. He also sampled fossil shells in the emerged marine deposit of Skarvsnes and dated them to be from 3,180 yBP to 31,600 yBP. He suggested that the fossil shells in the Sôya Coast region could be divided into two age groups, younger than 6,000 yBP and older than 20,000 yBP. FUJIWARA (1973) conducted a detailed geomorphological study of the raised beach on East Ongul Island, and recognized marine terraces at five levels, 14.0-11.5 m, 10.0-9.5 m, 7.0-6.0 m, 4.5-3.0 m and below 2.0 m.

MORIWAKI (1974, 1976) obtained radiocarbon dates of fossil shells from West Ongul Island and Akarui Point, including ages of 10,250 yBP and 23,830 yBP from Langhovde. OMOTO (1977) studied the geomorphic development of the Sôya Coast. He identified stepped topography up to 39 m asl as raised beaches and distinguished many steps on the ice-free rocks. In addition to the previous studies, he provided considerable radiocarbon dates of marine fossils together with modern radiocarbon dates to account for the reservoir effect (OMOTO, 1976, 1977, 1978, 1983). He also drew a eustatic curve in which the Ongul Islands were about 100 m deep during a time prior to postglacial emergence, judging from results on foraminifera species in the beach deposits by UCHIO (1966).

HAYASHI and NOGAMI also collected many samples of marine fossils from West Ongul Island, Langhovde and Skarvsnes, and dated their radiocarbon ages (HAYASHI and YOSHIDA, 1994; NOGAMI, 1977).

Based on the earlier period studies in the Sôya and Prince Olav coast region, YOSHIDA (1983) summarized the characteristics of raised marine features and the glacial history as follows: 1) Major retreat of the ice sheet from the region took place prior to 30,000 yBP; since then, most of the present ice-free areas have not been covered by the ice sheet. 2) The ice-free

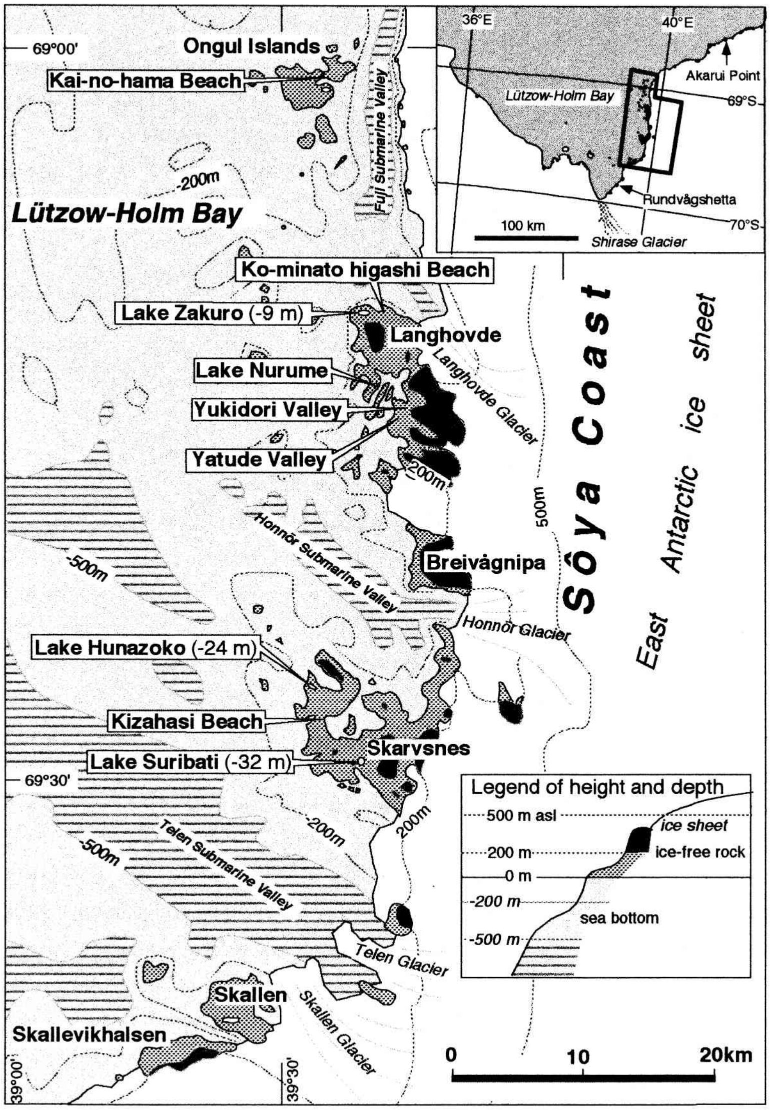

Fig. 2. Location map of the northern part of the Sôya Coast. Contour lines of 200 m and 500 m on land are quoted from the 1:250,000 topographic map (Lützow-Holm Bay) published by the Geographical Survey Institute, Japan. Isobaths of 500 m and 200 m are quoted from MORIWAKI and YOSHIDA (1990).

area were inundated partially by the sea around 30,000 yBP. 3) The sea-level dropped relative to land after 22,000 yBP, and raised marine features emerged from the sea. 4) Probably due to post-Glacial eustasy, sea level rose again, a trend which culminated around 6,000 yBP. 5) After 6,000 yBP, the raised beach topography was formed by crustal uplift of the region at levels lower than 20 m high on the Sôya Coast and 30 m high on the Prince Olav Coast.

However, some problems have still remained unresolved, as follows:

1) Although the radiocarbon ages of many molluscan shells could be divided into two groups, post glacial and older than 20,000 yBP, some doubts have been cast on the reliability of ^{14}C ages older than 20,000 yBP for the Antarctic region (*e.g.*, OMOTO, 1977; ADAMSON and PICKARD, 1986).

2) It is unknown why older fossil shells occur in close proximity to younger fossil shells in location and elevation on the beaches of the Ongul Islands and Langhovde.

3) What is the connection between the stepped features and their ages?

2.2. Recent period: Application of Accelerator Mass Spectrometry (AMS) for radiocarbon dating and detailed description of raised beach stratigraphy

In the 1980s, a new technique to establish ^{14}C ages, AMS ^{14}C dating, has become available. In this method, the amount of ^{14}C in graphite obtained from only about 15 mg of calcium carbonate sample can be counted precisely, and the maximum age detection has been extended to about 60,000 yBP with smaller statistical errors. An intersive raised beach study was performed in the Sôya Coast region from 1991 to 1997.

Using the AMS system of Nagoya University, HAYASHI and YOSHIDA (1994) first reported the ^{14}C ages of molluscan shell fossils sampled from the raised beach deposits in Langhovde. They compiled the coastal geomorphology with special reference to Holocene raised beaches in the Lützow-Holm Bay region on the new data in addition to reviewing previous work. IGARASHI *et al.* (1995a, b) also used the AMS system of Nagoya University, and reported the ^{14}C ages of marine fossils sampled from the raised beaches on the Sôya Coast. They showed that the fossils are clearly classified into two groups, the younger group being 3,000-8,000 yBP and the older one 33,000-42,000 yBP without reservoir corrections; and that the expansion of the East Antarctic Ice Sheet during the Last Glacial Maximum in the northern hemisphere (LGM) was slight on the basis of the occurrence and distribution of older fossils.

HIRAKAWA and SAWAGAKI (1998) first reported ^{14}C ages by the β-ray counting method for marine fossils from Skallevikhalsen and Rundvågshetta. They also dated three samples (940125-2, 940127-1 and 940127-4) from East and West Ongul islands by both the AMS and β-ray methods (Appendix 1). The ages of 940125-2 and 940127-4 by β-ray dating were much younger than those by AMS dating.

MAEMOKU *et al.* (1997) and MIURA *et al.* (1998, 1999) excavated some trenches on East Ongul Island, the northern and southern parts of Langhovde and Skarvsnes. They found shells, still possessing articulated valves of extremely fragile *Laternula elliptica*, suggesting that remain in their *in situ* form, and collected more than 80 fossils. All of the AMS ^{14}C ages of the marine fossils sampled from Kai-no-hama Beach on East Ongul Island were during the late

Pleistocene ranging from 30,360 yBP to 43,810 yBP. In the northern part of Langhovde, the beach deposits including *in situ* fossil shells are clearly divided stratigraphically into two marine sediment layers, the AMS ^{14}C ages of the fossil shells of the upper layer ranged from 4,000 to 5,000 yBP and those of the lower layer ranged from 32,000 to 46,000 yBP without a reservoir correction, respectively. In Skarvsnes, the long trench showed that step-like topography consists of deltaic sediments including *in situ Laternula elliptica*. All of the AMS ^{14}C ages of the fossil shells showed Holocene ages ranging from 4,060 yBP to 7,170 yBP. These are the first precise stratigraphical observations of raised beach deposits around Lützow-Holm Bay, and stratigraphy and many fossil shells provide useful discussions about glacial history, sea-level change and paleoenvironmental history. Detailed description of stratigraphy and geomorphology with ^{14}C ages and geochemical data will be described in Chapter 5.

The results of recent studies (HAYASHI and YOSHIDA, 1994; IGARASHI *et al.*, 1995a, b; MAEMOKU *et al.*, 1997; HIRAKAWA and SAWAGAKI, 1998; and MIURA *et al.*, 1998, 1999), can be summarized as follows;

1) AMS ^{14}C ages of marine fossils in the raised beach deposits along the Sôya Coast are clearly classified into two age groups, those of Holocene age and those from the late Pleistocene age older than 30,000 yBP.

2) Some ^{14}C ages ranging from 10,000 yBP to 30,000 yBP determined by the β-ray counting method, were derived from samples containing both younger and older fossils (Fig. 3), because a relatively large amount of fossils is necessary for the method, and both young and old fossils are often present in the same locality.

3) The ice sheet retreated from the northernmost part of Sôya Coast prior to the last interstadial, and expansion of the ice sheet during the LGM was slight, because *in situ* and unbroken fossil shells older than LGM remain in the raised beach sediments of East Ongul Island and the northern part of Langhovde.

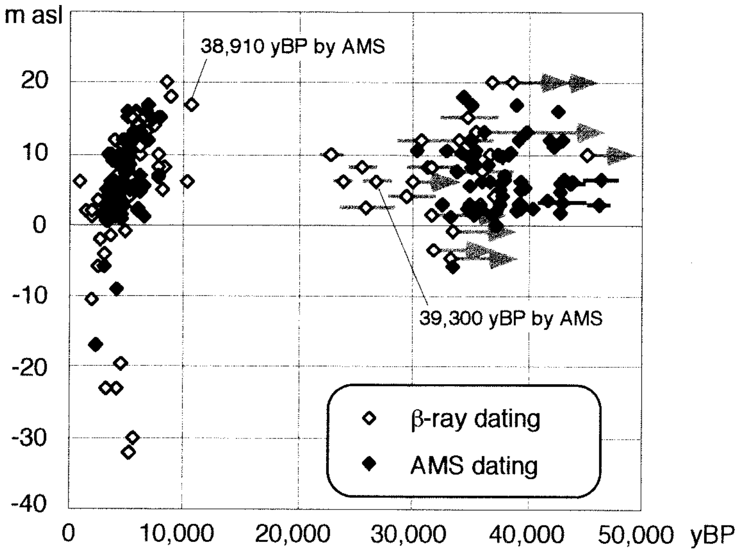

Fig. 3. Sampling elevations and ^{14}C ages of 248 samples collected from the Lützow-Holm Bay region.

3. Materials and Methods for Radiocarbon Dating of Marine Fossils

Data of 248 radiocarbon ages of marine fossils with reference to A.D. 1950 are listed in Appendix 1. The fossils were sampled from raised beaches of the Sôya Coast with the exception of one sample from Akarui Point on the Prince Olav Coast.

3.1. Materials for radiocarbon dating

Most of the materials used for dating are shells of bivalves (*Laternula elliptica*, *Adamussium colbecki*); the others include tubes of polychaeta (*Diopatra neapolitana*), tests of foraminifera, seal bones, coralline algae, diatoms and unidentified organic clay (probably diatomaceous earth).

In these organic materials, the Antarctic lamellibranch *Laternula elliptica* is the most common species throughout the region and accounts for about half of the dated samples. *Laternula elliptica* is a predominantly shallow-water species which lived in depths from 1 to 500 m, but mostly less than 100 m and probably mostly shallower than 20 m (DELL, 1990; AHN, 1994). The shells of *Laternula elliptica* often still remain in their *in situ* form with fragile valves in the raised beach sediments. On the other hand, the free-swimming Antarctic scallop *Adamussium colbecki* occurs on soft and mixed surfaces from 4 to 800 m depth (FISHER and HUREAU, 1985). The *in situ* fossil *Adamussium colbecki* seldom occurs.

3.2. Dating methods and laboratories

Most of the ^{14}C ages by β-ray dating were obtained by Professor K. KIGOSHI of Gakushuin University (laboratory code: GaK), Tokyo, Japan. Other ^{14}C ages by β-ray dating were supplied by The Japan Radioisotope Association (laboratory code: N), Tokyo, Japan; Tohoku University (laboratory code: TH), Sendai, Japan; and Lawrence Livermore National Laboratory, California, USA through Beta Analytic Inc. (laboratory code: Beta), Florida, USA. The AMS ^{14}C dating was done by Nagoya University (laboratory code: NUTA), Nagoya, Japan; and by Lawrence Livermore National Laboratory through Beta Analytic Inc. (laboratory code: Beta). All data are based on the Libby mean-life of 5,568 years or 5,570 years, with reference to 1950.

The capability of maximum ^{14}C age detection depends on a ^{14}C background in the AMS system at the measurement (*e.g.*, NAKAMURA and NAKAI, 1988). The ^{14}C ages measured at Gakushuin University, The Japan Radioisotope Association and Tohoku University were not reexamined by either $\delta^{13}C$ or background corrections. On the other hand, the ^{14}C ages measured at Nagoya University, with the exception of those measured by IGARASHI *et al.* (1995a, b), were reexamined by both $\delta^{13}C$ correction (for isotopic fractionation effect on $^{14}C/^{13}C$ ration) and background correction, although the backgrounds in apparent ages are unknown. The ages measured by IGARASHI *et al.* (1995a) were reexamined only by $\delta^{13}C$ correction, and the ages measured by IGARASHI *et al.* (1995b) were reexamined only by background correction (Table 2).

Table 2. Method and correction of radiocarbon dating age in the sheet.

Laboratory Code (Reference)	Laboratory	Dating method	Half life of ^{14}C (years)	^{14}C age (yBP) Raw ^{14}C age	Only $\delta^{13}C$ corrected ^{14}C age	Only background corrected ^{14}C age	Both $\delta^{13}C$ and background corrected ^{14}C age	Error
GaK-	Gakushuin University	β	5,570	shown in Appendix I and map	none	none	none	$\pm 1\sigma$
N-	The Japan Radioisotope Association	β	5,568	shown in Appendix I and map	none	none	none	$\pm 1\sigma$
TH-	Tohoku University	β	5,570	shown in Appendix I and map	none	none	none	$\pm 1\sigma$
NUTA- ? (Igarashi et al., 1995a)	Nagoya University	AMS	5,570	none	shown in Appendix I and map	none	none	$\pm 1\sigma$
NUTA- ? (Igarashi et al., 1995b)	Nagoya University	AMS	5,570	shown in Appendix I	none	shown in Appendix I and map	none	$\pm 1\sigma$
other NUTA-	Nagoya University	AMS	5,570	none	none	shown in Appendix I and map	shown in Appendix I	$\pm 1\sigma$
Beta-	Lawrence Livermore National Laboratory	AMS or β	5,568	none	none	shown in Appendix I and map	shown in Appendix I	$\pm 1\sigma$

The ^{14}C ages measured by AMS at Nagoya University and Lawrence Livermore National Laboratory were reexamined by the $\delta^{13}C$ correction for isotopic fractionation effect on $^{14}C/^{13}C$ ratio as follows (IGARASHI *et al.*, 1995a):

$$t = -8033\ln\{(^{14}C/^{13}C)_{sample}[1-(25+\delta^{13}C)/1000]/0.7459(^{14}C/^{13}C)_{NBS}[1-(25+(^{13}C/^{12}C)_{PDB})/1000]\},$$

$$\delta^{13}C=[\{(^{13}C/^{12}C)_{sample}-(^{13}C/^{12}C)_{PDB}\}/(^{13}C/^{12}C)_{PDB}]\times 1000$$

where $(^{13}C/^{12}C)_{PDB} = 0.0112372$.

3.3. Problem with reservoir effects

Radiocarbon dating of marine fossils around Antarctica is problematic because of depletion of ^{14}C due to dilution with glacier melt water and upwelling of deep and old oceanic water (OMOTO, 1983; STUIVER *et al.*, 1986).

Regarding the reservoir effect, many modern radiocarbon dates have been obtained. OMOTO (1972) dated sea water, lake water and CO2 of air in the Lützow-Holm Bay region and pointed out that those include carbon of low ^{14}C concentration. YOSHIDA and MORIWAKI (1979) attempted to obtain a reasonable correction value of 1,120 years for radiocarbon dates from the Lützow-Holm Bay region based on dating of living marine organisms ranging from 860 to 1,190 yBP ^{14}C ages. These modern radiocarbon dates in this region are listed in Table 3.

Table 3. Inventory of modern radiocarbon dates from the Lützow-Holm Bay region.

Locality (Latitude, Longitude, Altitude)	^{14}C age (yBP) ($\delta^{14}C$ ‰)	$\delta^{13}C$ (%)	Laboratory code and method	Material	Collector year of collection	Reference
45km NW from East Ongul Island (68°01.0'S, 38°42.0'E, -10 m)	880 ± 115 (-101 ± 12)		N-860 β	sea water	Omoto 1969	Omoto, 1972
East Ongul Island (69°00.0'S, 39°35.5'E, +10 m)	Modern (+487 ± 17)		N-922 β	CO2 in air	Omoto 1969	Omoto, 1972
East Ongul Island (69°00.0'S, 39°35.5'E, +10 m)	Modern (+315 ± 45)		N-923 β	CO2 in air	Omoto 1969	Omoto, 1972
South of East Ongul Island (69°01.1'S, 39°36.5'E, -10 m)	2,860 ± 125 (-292 ± 11)		N-858 β	sea water	Omoto 1969	Omoto, 1972
Sea bottom near East Ongul Island (ca 69°00'S, 39°35'E, -9 m)	150 ± 80		GaK-3666 β	living sea urchin (shell)	Hoshiai 1970	Yoshida, 1973
Sea bottom near East Ongul Island (ca 69°00'S, 39°35'E, -15 m)	1,160 ± 110 (-148.4 ± 8.8)	-19.4	GaK-6792 β	*Trematomus* *berunacchi*	Hoshiai 1975	Yoshida and Moriwaki,1979
Sea bottom near East Ongul Island (ca 69°00'S, 39°35'E, -17 m)	860 ± 110		GaK-6791b β	*Sterechinus* *neumayeri* (shell)	Hoshiai 1975	Yoshida and Moriwaki,1979
Sea bottom near East Ongul Island (ca 69°00'S, 39°35'E, -17 m)	1,160 ± 110 (-134.4 ± 12.2)	-10.5	GaK-6791a β	*Sterechinus* *neumayeri* (flesh)	Hoshiai 1975	Yoshida and Moriwaki,1979
Sea bottom near East Ongul Island (ca 69°00'S, 39°35'E, -17 to 35 m)	1,190 ± 90 (-137.9 ± 9.2)	-19.1	GaK-6789a β	*Neoliuccinum* *eatoni* (flesh)	Hoshiai 1975	Yoshida and Moriwaki,1979
Sea bottom near East Ongul Island (ca 69°00'S, 39°35'E, -17 to 5 m)	1,300 ± 900		GaK-6789b β	*Neoliuccinum* *eatoni* (shell)	Hoshiai 1975	Yoshida and Moriwaki,1979
Sea bottom near East Ongul Island (ca 69°00'S, 39°35'E, -92 m)	1,070 ± 90 (-124.6 ± 9.7)	-12.9	GaK-6790a β	*Ophionotus* *victoriae* (flesh)	Hoshiai 1975	Yoshida and Moriwaki,1979
Sea bottom near East Ongul Island (ca 69°00'S, 39°35'E, -92 m)	1,210 ± 100		GaK-6790b β	*Ophionotus* *victoriae* (shell)	Hoshiai 1975	Yoshida and Moriwaki,1979
Ongulsundet (strait) (ca 69°00'S, 39°35'E, -500 m)	1,010 ± 110 (-118.2 ± 12.5)	-21.6	GaK-6793 β	Zoarcidae sp.	Hoshiai 1975	Yoshida and Moriwaki,1979
Naka-no-tani Valley, Langhovde (69°12'40S, 39°43'10E, ?)	Modern		GaK-6381 β	moss	Nogami 1976	Nogami, 1977
Cape, Koyubi, Langhovde (69°12'50S, 39°38'30E, ?)	1,210 ± 110		GaK-6385 β	piece of penguin egg	Nogami 1976	Nogami, 1977
Cape, Koyubi, Langhovde (69°13'00S, 39°38'30E, ?)	490 ± 80		GaK-6386 β	algae (fresh water?)	Nogami 1976	Nogami, 1977
Cape, Koyubi, Langhovde (69°00'48S, 39°34'13E, +1 m)	1,030 ± 100		GaK-6387 β	*Laternula elliptica* with dried flesh	Nogami 1976	Nogami, 1977
Ungane (island) off Langhovde (69°16'S, 39°29'E, 0 m)	1,455 ± 110		TH-052 β	seal skin (died in 1973.2)	Omoto 1973	Omoto, 1983
Skallen (69°40.0'S, 39°23.5'E, -0.5 m)	Modern (+278 ± 19)		N-859 β	lake water	Omoto 1969	Omoto, 1972
Skallen (69°40.0'S, 39°23.5'E, -0.5 m)	Modern (+253 ± 19)		N-861 β	lake water	Omoto 1969	Omoto, 1972

Besides the Lützow-Holm Bay region, ADAMSON and PICKARD (1983) reported a reservoir correction value from 950 to 1,300 years for modern shells in the Vestfold Hills. STUIVER and BRAZIUNAS (1985) obtained a correction ranging from 420 to 1,610 years for modern molluscan shells in the McMurdo Sound region. However, those materials are contaminated with ^{14}C produced by nuclear weapon tests. Some examinations have been carried out for the pre-bomb species, mainly penguins and seals, and a reservoir correction between 750 and 1,300 years has been adopted for Antarctic marine organisms (HARKNESS, 1979; STUIVER *et al.*, 1981; MABIN, 1985, 1986; WHITEHOUSE *et al.*, 1989; GORDON and HARKNESS, 1992). Recently, about 1,300 years for reservoir correction has been provided based on pre-bomb mollusc samples (BERKMAN and FORMAN, 1996).

In spite of those works, we treat ^{14}C ages without a reservoir correction in this sheet and text, because the correction for Pleistocene ages is not known and the values of reservoir correction range from 420 to 1,600 years at present.

4. Outline of Raised Beaches

Raised beaches on the Ongul Islands, Langhovde, Breivågnipa, Skarvsnes, Skallen, Skallevikhalsen, Rundvågshetta and Akarui Point (Fig. 3) have been investigated since 1957 (Table 1).

4.1. The Ongul Islands

The Ongul Islands, consisting of many small islands, are situated at the east entrance of Lützow-Holm Bay, 5 to 10 km from the margin of continental ice. A drowned glacial trough, the Fuji Submarine Valley, deeper than 600 m, extending northwards from Langhovde Glacier, exists under Ongul Strait. West Ongul Island (7.8 km^2) and East Ongul Island (2.6 km^2), the larger islands of the group show low-lying, undulating features strongly controlled by geologic structure. The highest points are 47.6 m asl on West Ongul Island and 44 m asl on East Ongul Island, respectively.

Terrace-like surfaces and raised beaches are found generally below 20 m elevation on the Ongul Islands. On East Ongul Island, raised beaches have been recognized at Kai-no-hama Beach and Kitami Beach on the western part of the island since 1957 (YOSHIKAWA and TOYA, 1957). They extend up to 15 m asl, exhibiting terrace-like surfaces. Fossil bivalves, mainly *Laternula elliptica* and *Adamussium colbecki*, are often found even on their beach surfaces. The beach deposits are composed of coarse sand with gravel. Other raised beaches are developed along Mizukumi Stream and the northwestern coast of the island. On West Ongul Island, raised beaches occur sporadically along low places and the coast.

The highest altitudes of reliable beach deposits with dated materials are about 20 m asl on both East Ongul and West Ongul islands (HIRAKAWA and SAWAGAKI, 1998; Table 4). The AMS ^{14}C ages of marine fossils from East Ongul and West Ongul islands are clearly classified into middle Holocene age ranging from 3,590 yBP to 4,800 yBP and late Pleistocene age from 30,360 yBP to 43,810 yBP (IGARASHI *et al.*, 1995a, b; HIRAKAWA and SAWAGAKI, 1998; MIURA *et al.*, 1998, this paper).

4.2. Langhovde

Langhovde, 20 to 30 km south of the Ongul Islands, is the second largest ice-free area (52 km^2) with the highest point of 496.5 m in the Lützow-Holm Bay region. The ice-free area is bounded on the east by the Langhovde Glacier which drains from the East Antarctic Ice Sheet. The total area of Langhovde was once completely covered by ice sheet and experienced glacial scouring, as indicated by mammilated peaks and stoss-and-lee topography on hilly lands. The relief is strongly controlled by lithology and geological structure (HIRAKAWA *et al.*, 1984). The ice-free area is divided topographically by a conspicuous glacial trough, Naka-no-tani Valley, into two parts, the northern and southern parts (YOSHIKAWA and TOYA, 1957). Weathering of the ground surface is more intense in the northern part than in the southern part. This suggests that the northern Langhovde became free from the ice sheet earlier than the southern part (YOSHIDA, 1983; HIRAKAWA *et al.*, 1984).

In the northern part of Langhovde, raised beaches are distributed below 20 m asl along the coast (YOSHIDA, 1983; Table 4). They occur in the form of pocket beaches such as Ko-minato Inlet occupying glacial depressions. Hyper-saline Lake Zakuro, with water level of 9 m below the present sea level, is surrounded by a raised beach whose maximum altitude is about 12 m asl. The lowest sill between the lake and Ko-minato Inlet stands at 6 m asl and is covered with marine deposits. Lake Itiziku also is a hyper saline lake, 14 m below the present sea level. The lowest sill between the lake and Ko-minato Inlet stands about 20 m asl. There is no evidence of marine action at the saddle or around Lake Itiziku (HAYASHI and YOSHIDA, 1994). This suggests that the previous sea level never exceeded 20 m in this area. The beach deposits around Ko-minato Inlet and Lake Zakuro contain abundant *in situ* fossil shells of *Laternula elliptica* (Photo 7). On the southern coast of Mizukuguri Cove, marine deposits, including shell fragments, make a marine boulder pavement. Raised beaches, including marine fossils, also develop sporadically at depressions in the Dokkene area, for instance around Lake Nurume and Lake Oyayubi. The AMS ^{14}C ages of *in situ* fossil shells from the northern part of Langhovde are also clearly classified into middle Holocene age ranging from 3,220 yBP to 6,140 yBP and late Pleistocene age ranging from 32,430 yBP to 46,420 yBP (HAYASHI and YOSHIDA, 1994; IGARASHI *et al.*, 1995a, b; MAEMOKU *et al.*, 1997; HIRAKAWA and SAWAGAKI, 1998; MIURA *et al.*, 1998, this paper).

The southern part of Langhovde forms massive hills with precipitous cliffs, and the greater part of the coastline is rocky and bounded by steep slopes. Therefore, raised beaches exist only in a few places (YOSHIDA, 1983). Raised beaches occur around the mouths of the Yukidori and the Yatude valleys, which are linear and narrow valleys along joint systems of the bed rock, and around a small cove, Simo-kama. At the mouths of Yukidori and Yatude valleys, small but distinct terraces are developed. They reach 20 m asl at the mouth of Yukidori Valley, and 18 m asl at the northern mouth and 11 m asl at the southern mouth of Yatude Valley, respectively (Photo 9). The terraces are composed of considerably coarse gravel with boulders covered by 1.0-1.5 m thick marine sand including *in situ Laternula elliptica* (MIURA *et al.*, 1998). Beach deposits are also distributed below 10 m asl around the mouth of Yatude Valley and Simo-kama. The AMS ^{14}C ages of *in situ* fossil shells from the southern part of Langhovde are limited only to Holocene age, ranging from 3,170 yBP to 6,810 yBP. The beach deposits including marine fossils are found only below 20 m asl (MIURA *et al.*, 1998; Table 4).

Table 4. The highest elevation of raised beach in each area along the Sôya Coast region.

Area	Altitude	fossil in deposits	Reference
East Ongul and West Ongul islands	22 m	unconfirmed	Omoto, 1977
East Ongul Island	20 m	confirmed	Hirakawa and Sawagaki, 1998
West Ongul Island	20 m	confirmed	Hirakawa and Sawagaki, 1988
Langhovde	27 m	unconfirmed	Omoto, 1977
Northern part	< 20 m	unconfirmed	Yoshida, 1983
Southern part	20 m	confirmed	Miura *et al.*, 1998
Breivågnipa	10 m	unconfirmed	Yoshida, 1983
Skarvsnes	39 m	unconfirmed	Omoto, 1977
	23 m	unconfirmed	Hayashi and Yoshida, 1994
	26? m	confirmed	Hirakawa and Sawagaki, 1998
Skallen	32 m	unconfirmed	Omoto, 1977
	15 m	unconfirmed	Yoshida, 1983
	12 m	confirmed	Igarashi *et al.*, 1995a
Skallevikhalsen	24 m	unconfirmed	Omoto, 1977
	22 m	unconfirmed	Yoshida, 1983
	14 m	confirmed	Hirakawa and Sawagaki, 1988
Rundvågshetta	23 m	unconfirmed	Omoto, 1977
	16 m	confirmed	Hirakawa and Sawagaki, 1988

4.3. Breivågnipa

Breivågnipa (11.3 km^2), located between Langhovde and Skarvsnes, is a massive hill composed of several mammilated peaks lower than 325 m asl. The northeastern margin is still covered by an ice sheet forming shear plane moraines (KOAZE, 1963). The western and southern margins face the sea, and form rocky and steep slopes. Therefore, beach deposits are found at a few places along the west coast of Breivågnipa. The AMS ^{14}C ages of shell fragments (*Laternula elliptica*) sampled from the beaches show Holocene ages of 4,550 yBP and 6,430 yBP (IGARASHI *et al.*, 1995b; IGARASHI, unpublished data).

4.4. Skarvsnes

Skarvsnes is the largest ice-free area (61 km^2) and has the highest peak, Skjegget, 400 m asl, in the Lützow-Holm Bay region. It protrudes westward into Lützow-Holm Bay from the continental ice, and is indented by several coves. Raised beaches are developed in many places around the coves and lakes. Well-marked stepped topography is developed on raised beaches along the shoreline of a conspicuous cove, Osen; the largest is named Kizahasi Hama meaning "stairs beach". On Kizahasi Beach, more than ten steps can be distinguished below 18-19 m asl, and a small steep slope is formed along the present strandline, cutting the lowest part of the beach. The beach deposits are mainly composed of coarse sand and an overlying veneer of flattened gravel.

Beach sediments including marine fossils are also found around hyper-saline lakes, Lake Suribati and Lake Hunazoko, which are situated in deep glacial depressions below the present sea level. The sorting of those sediments is very poor, but a sand and gravel bed found near Lake Hunazoko has well-defined lamination indicating the effect of moving water (YOSHIDA, 1983). The highest sampling site of marine fossils is 9 m around Lake Hunazoko, and the lowest sill between Lake Hunazoko and the sea is 1.5-2 m (HIRAKAWA and SAWAGAKI, 1998). On the other hand, the highest sampling site of marine fossils is 20 m around Lake Suribati

(HIRAKAWA and SAWAGAKI, 1998), and the lowest sill between Lake Suribati and Osen is lower than 15 m (HAYASHI and YOSHIDA, 1994).

HAYASHI and YOSHIDA (1994) found raised beaches up to 23 m asl on the coast, at the eastern extremity of Osen, and up to 22 m on the coast facing Trillingbukta (bay). They inferred that the Holocene marine limit was below 23 m asl in the Skarvsnes area. On the other hand, HIRAKAWA and SAWAGAKI (1998) inferred that to be about 26 m based on their observation of the sediments including *Adamussium colbecki* (8,840 yBP: GaK-18337) around Lake Suribati (Table 4); however, the altitude of their sampling site was -10 m asl on the topographic map of Skarvsnes (Fig. 3-2 in HIRAKAWA and SAWAGAKI, 1998). The AMS ^{14}C dates of marine fossils from Skarvsnes are Holocene ages ranging from 2,340 yBP to 7,170 yBP. The β ^{14}C dates of marine fossils are also of Holocene age, ranging from 2,000 yBP to 8,860 yBP, with the exception of one Pleistocene age of 31,600 yBP reported from the raised beach around Lake Hunazoko by YOSHIDA (1970). Among them young fossils found around lakes below the present sea level may have lived in a period after the lakes were separated from the sea.

4.5. Skallen and Skallevikhalsen

Skallen (14.4 km^2) is located 20 km southwest of the southern extremity of Skarvsnes; it is a small peninsula protruding northwestward from the ice sheet. It shows a gently undulating topography with many hills lower than 186 m asl. Glacial striations and polished faces are preserved well in the area. This suggests that ice sheet retreated from Skallen considerably later than from the Ongul Island, Langhovde and Skarvsnes. The floating ice tongue of Skallen Glacier flows northward close to the eastern coast of Skallen. Raised beaches are found along the eastern coast and around Lake Skallen Ô-ike below probably 15 m and possibly 10 m asl (YOSHIDA, 1983). IGARASHI *et al.* (1995a) collected shell fragments of *Laternula elliptica* at 12 m asl from the deposits east of Lake Skallen Ô-ike (Table 4).

Skallevikhalsen (7.6 km^2), separated from Skallen by a narrow inlet, Skallevika, is a rocky hill fringing the ice sheet, its characteristic feature is the stepped topography with steep slopes and flat tops. The highest top is 290 m asl. YOSHIDA (1983) found raised beaches below 22 m, deposits containing fragments of marine molluscan shells below 25 m, and ra aised deltaic fan below 5 m. HIRAKAWA and SAWAGAKI (1998) sampled marine fossils (*Laternula elliptica*) from the raised deltaic fan and obtained its β ^{14}C age of 3,930 yBP. They found the Holocene marine limit to be 14 m asl (Table 4).

Though *in situ* fossils have not yet been found in the Skallen area, all ^{14}C dates of fossil shells indicate Holocene ages ranging from 3,180 yBP to 7,810 yBP.

4.6. Rundvågshetta

Rundvågshetta is a small and low ice-free area (2.8 km^2; maximum height: 159.3 m asl). It is located 25 km SSW of Skallevikhalsen and 15 km NE of the snout of Shirase Glacier. A gently undulating lowland with several depressions extends in the northern half of Rundvågshetta, and Maruwan Lake occupies one of the depressions. Beach deposits containing marine fossils also occurr in depressions below 15 m asl (HIRAKAWA and SAWAGAKI, 1998). Below 5 m asl, a beach ridge runs parallel to the present shoreline (OMOTO, 1977). HIRAKAWA and SAWAGAKI (1998) sampled fragments of marine fossils at 15 m asl and 11 m asl from the raised beach deposits, and obtained β ^{14}C dates ranging from 3,470 yBP to 6,460 yBP. They suggest the Holocene marine limit to be 16 m asl (Table 4).

4.7. Akarui Point, Prince Olav Coast

Akarui point is a small ice-free rock (3.3 km^2) protruding northwestward from the Prince Olav Coast with the highest elevation of about 150m. The coast is rocky and steep for the most part, and evidence of former marine action is scarce. However, beach deposits containing shell fragments are found in a glacial depression near the northwestern extremity of Akarui Point. Deposits consisting of sand and gravel form a flat surface about 10 m asl, abutting on the nearby bedrock. MORIWAKI (1976) collected shell fragments (*Laternula elliptica*) and obtained the β ^{14}C date of 7,730 yBP. This is the only radiocarbon age on the Prince Olav Coast.

5. Stratigraphy of Beach Deposits, AMS ^{14}C Age and Oxygen Isotopic Ratio of Fossil Shells, Obtained from East Ongul Island, Langhovde and Skarvsnes

In the austral summer season of 1995-96, several trenches were excavated for the purpose of investigating stratigraphy and sampling *in situ* fossils in the raised beach deposits of East Ongul Island, Langhovde and Skarvsnes (MAEMOKU *et al.*, 1997; MIURA *et al.*, 1998, 1999). Altitude was measured without tidal correction with an auto-leveling unit and staff. Radiocarbon ages of fossils are treated without a reservoir correction in this work as mentioned above.

The oxygen isotopic ratio of organisms is a function of both water temperature and isotopic composition of surrounding water. The Antarctic ice is depleted by about 30-60% in $\delta^{18}O$ compared to standard mean ocean water (*e.g.*, LORIUS *et al.*, 1979, 1985; JOHNSEN *et al.*, 1972). Therefore, a huge influx of melt water must have a greater effect on epipelagic organism isotopic composition than sea-water temperature variation, especially in the cold Antarctic sea. Fifty-one smashed bulk samples of *in situ* fossil shells (*Laternula elliptica*) were analyzed for oxygen isotopic components. The isotopic measurement followed the procedure by WADA *et al.* (1984). The carbonate tests were reacted in saturated pyrophosphoric acid at 60.00°C, and the resulting CO2 gas was analyzed with the Delta-S mass spectrometer of Shimane University and the MAT-250 mass spectrometer of Shizuoka University. The value thus obtained was converted into a value against a PDB standard by using NBS 20. The analysis is accurate to within ± 0.05‰. The obtained results are also shown in Table 5 and Figs. 4, 5, 6, 7, 8 and 9.

Table 5. AMS radiocarbon ages and oxygen isotopic ratio of in situ fossil shells (Laternula elliptica) obtained from raised beach in the Sôya Coast region.

Region Locality	Samples No.	Altitude (m asl)	^{14}C age (yBP) without correction	$\delta^{13}C$ (‰)	^{14}C age (yBP) with $\delta^{13}C$ correction	Code for radiocarbon measurement	$\delta^{18}O_{PDB}$ (‰)	Lab. of Univ. for $\delta^{18}O$ measurement
East Ongul								
Kai-no-hama Beach	960206-1a	10.2	37,980 ± 640	+0.8	38,400 ± 640	Beta-100322	3.586 ± 0.116	Shizuoka
	960206-1b	10.1	33,670 ± 400	+0.3	34,090 ± 400	Beta-100323	3.367 ± 0.024	Shizuoka
	960206-1c	10.3	34,900 ± 520	+0.3	35,320 ± 520	Beta-100324	3.537 ± 0.083	Shizuoka
	960206-1e	10.1	29,940 ± 290	+0.4	30,360 ± 290	Beta-100325	3.289 ± 0.044	Shizuoka
	960206-1h	9.6	34,210 ± 500	+1.4	34,650 ± 500	Beta-100327	3.824 ± 0.071	Shizuoka
	960206-1i	9.6	37,320 ± 490	+1.4	37,740 ± 490	Beta-100328	3.831 ± 0.049	Shizuoka
	960206-1k	8.6	34,720 ± 350	+1.7	35,160 ± 350	Beta-100330	3.646 ± 0.104	Shizuoka
	960206-1l	6.9	37,400 ± 570	+1.8	37,840 ± 570	Beta-100331	4.182 ± 0.020	Shizuoka
	960206-1n	6.2	43,380 ± 1,100	+1.1	43,810 ± 1,100	Beta-100332	4.166 ± 0.035	Shizuoka
	960206-1o	5.8	43,280 ± 980	+1.0	43,710 ± 980	Beta-100333	3.431 ± 0.056	Shizuoka
	960206-1q	6.0	36,290 ± 420	+1.3	36,730 ± 420	Beta-100334	4.241 ± 0.051	Shizuoka
	960206-1r	6.6	42,400 ± 930	+1.8	42,840 ± 930	Beta-100335	4.160 ± 0.053	Shizuoka
	960206-1s	4.9	37,140 ± 470	+0.2	37,560 ± 470	Beta-100336	4.112 ± 0.025	Shizuoka
	960206-1t	4.4	37,270 ± 470	+1.1	37,700 ± 470	Beta-100337	3.924 ± 0.049	Shizuoka
	960206-1u	3.1	37,120 ± 470	+1.7	37,560 ± 470	Beta-100338	3.970 ± 0.083	Shizuoka
	960206-1v	3.0	38,850 ± 600	+1.6	39,290 ± 600	Beta-100339	4.130 ± 0.059	Shizuoka
Langhovde, North								
Kominato E-trench	951227-1a	10.2	4,480 ± 60	+1.4	4,920 ± 60	Beta-94669	4.106 ± 0.022	Shimane
	951227-1b	10.1	4,440 ± 60	0.0	4,850 ± 60	Beta-94670	4.249 ± 0.001	Shimane
	951227-1c	10.2	4,850 ± 60	+0.8	5,270 ± 60	Beta-94671	4.226 ± 0.002	Shimane
	951227-1d	10.1	3,920 ± 70	+1.1	4,350 ± 70	Beta-94672	4.043 ± 0.017	Shimane
	951227-1e	10.1	4,460 ± 60	+1.7	4,900 ± 60	Beta-94673	4.246 ± 0.000	Shimane
	951227-1f	10.0	4,580 ± 50	+0.7	5,000 ± 50	Beta-94674	4.171 ± 0.021	Shimane
	951227-1g	9.8	4,650 ± 50	+0.7	5,070 ± 50	Beta-109395	4.296 ± 0.030	Shimane
	951227-1i	9.6	35,550 ± 410	+0.1	35,970 ± 410	Beta-94675	3.065 ± 0.000	Shimane
	951227-1j	8.5	37,200 ± 390	+0.3	37,620 ± 390	Beta-109396	3.207 ± 0.006	Shimane
	951227-1k	8.6	39,330 ± 600	+0.9	39,760 ± 600	Beta-94676	3.119 ± 0.001	Shimane
	951227-1l	6.8	39,000 ± 590	+0.5	39,420 ± 590	Beta-109397	3.397 ± 0.030	Shimane
	951227-1m	6.5	42,310 ± 920	+1.0	42,710 ± 920	Beta-94677	3.643 ± 0.001	Shimane
Kominato W-trench	951220-1i	2.2	39,020 ± 580	+0.7	39,440 ± 580	Beta-100345	2.876 ± 0.015	Shizuoka
	951220-1j	2.8	32,010 ± 270	+0.1	32,430 ± 270	Beta-100346	3.248 ± 0.001	Shimane
East of L.Zakuro	951223-2e	3.2	45,680 ± 1,000	+1.7	46,120 ± 1,000	Beta-94668	3.067 ± 0.040	Shizuoka
Langhovde, South								
Yatude terrace	960108-5a	17.0	6,390 ± 60	+0.2	6,810 ± 60	Beta-94685	4.269 ± 0.011	Shimane
YatudeValley	960106-1a	5.4	3,750 ± 50	+1.2	4,180 ± 50	Beta-94678	4.472 ± 0.021	Shimane
	960106-1b	5.0	5,390 ± 80	+1.2	5,820 ± 80	Beta-94679	4.578 ± 0.024	Shimane
	960106-1c	2.7	4,360 ± 60	+0.6	4,780 ± 60	Beta-94680	4.470 ± 0.002	Shimane
	960106-1d	1.1	2,750 ± 70	+0.5	3,170 ± 70	Beta-94681	4.118 ± 0.008	Shimane
	960106-1e	1.2	3,020 ± 50	+0.8	3,440 ± 50	Beta-94682	4.130 ± 0.007	Shimane
	960106-1f	1.0	3,460 ± 50	+1.0	3,890 ± 50	Beta-94683	4.116 ± 0.001	Shimane
Yukidori Valley	960107-1a	10.0	3,870 ± 90	+0.7	4,280 ± 90	Beta-109400	3.903 ± 0.001	Shimane
Skarvsnes								
Kizahasi Beach	960116-1a	3.7	3,840 ± 60	+0.4	4,260 ± 60	Beta-94687	4.200 ± 0.003	Shimane
	960116-1b	4.8	3,660 ± 60	-0.4	4,060 ± 60	Beta-94688	4.179 ± 0.003	Shimane
	960116-1c	5.4	3,980 ± 60	+0.6	4,400 ± 70	Beta-94689	4.090 ± 0.003	Shimane
	960116-1d	5.5	3,970 ± 50	-0.1	4,380 ± 50	Beta-94690	4.065 ± 0.013	Shimane
	960116-1e	6.0	4,020 ± 60	-0.1	4,430 ± 60	Beta-94691	4.204 ± 0.001	Shimane
	960116-1f	5.9	4,140 ± 60	+0.1	4,560 ± 60	Beta-94692	4.409 ± 0.021	Shimane
	960116-1g	8.0	4,520 ± 60	+0.4	4,670 ± 60	Beta-94693	4.053 ± 0.004	Shimane
	960116-1h	8.7	4,440 ± 60	+0.5	4,860 ± 60	Beta-94694	4.096 ± 0.009	Shimane
	960116-1i	9.8	4,520 ± 50	-1.2	4,910 ± 50	Beta-94695	4.245 ± 0.011	Shimane
	960116-1j	9.8	4,790 ± 60	-0.5	5,190 ± 60	Beta-94696	4.193 ± 0.009	Shimane
	960116-1k	12.3	4,880 ± 70	-0.2	5,290 ± 70	Beta-94697	4.162 ± 0.012	Shimane
	960116-1l	16.0	6,750 ± 60	+0.4	7,170 ± 60	Beta-94698	4.170 ± 0.004	Shimane

5.1. Kai-no-hama Beach on East Ongul Island

A trench was excavated perpendicularly to the present shore line at Kai-no-hama Beach (Fig. 3). It was 1.0 to 1.5 m in depth, 1.0 m in width and 73 m in length ranging from 2.0 m to 10.9 m asl (960206-1; Fig. 4, Photos 1, 2 and Appendix 2). This revealed that the beach

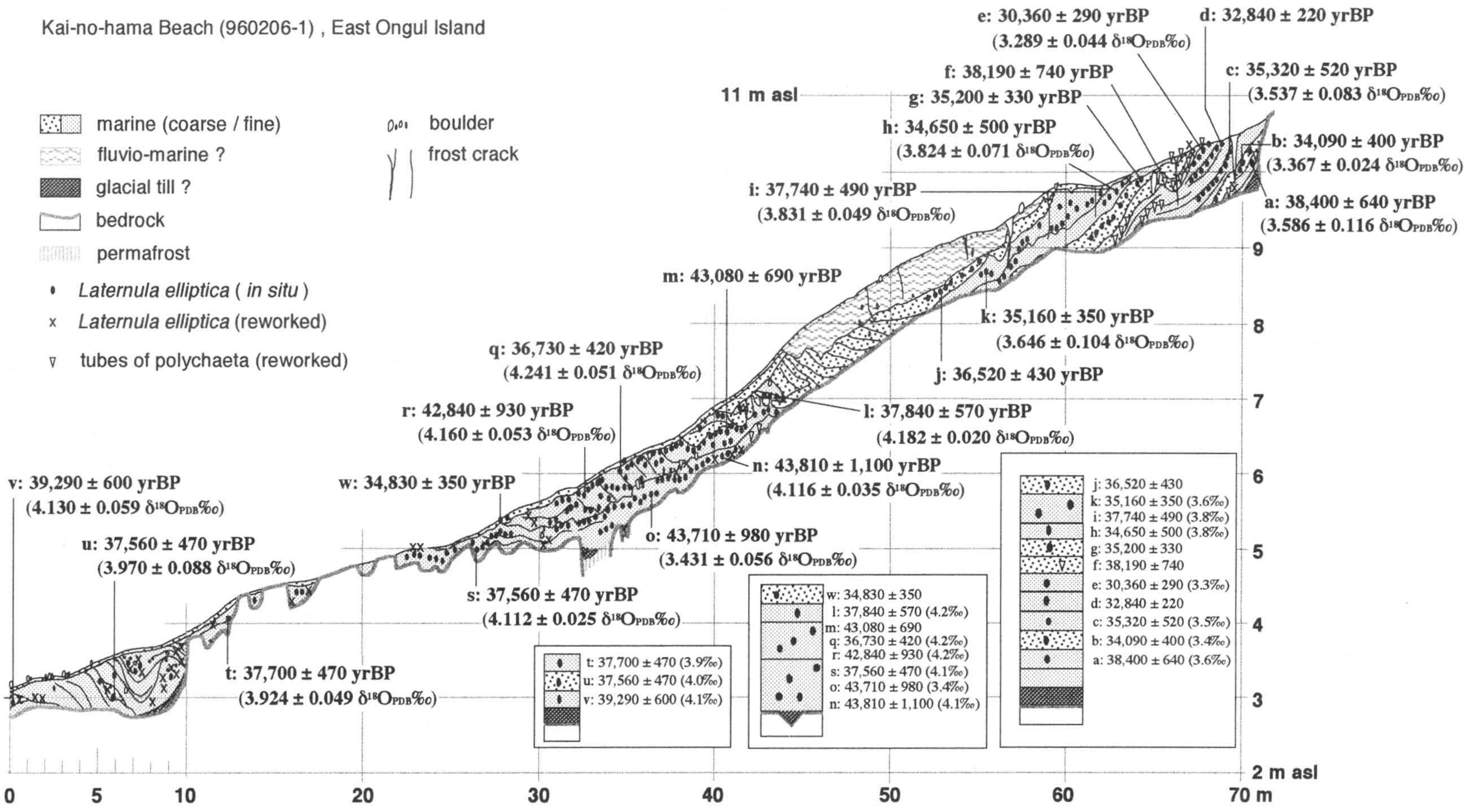

Fig. 4. Profile of the trench (960206-1), AMS ^{14}C ages with $\delta^{13}C$ correction and oxygen isotopic ratios ($\delta^{18}O_{PDB}$‰) of fossil shells at Kai-no-hama Beach, East Ongul Island.

consists of many marine layers including *in situ* fossil shells of *Laternula elliptica*. All of the marine sediment layers, which are composed of well-sorted fine to medium-grained sand with granules, are truncated obliquely by a postdated marine, fluvial and/or subaerial process at or just below the present ground surface. The marine layers seem to be separated by rather coarse sand layers without *in situ* fossils. The lower layers seem to show the transgression onlap facies containing fossils of AMS ^{14}C ages ranging from 36,730 ± 420 yBP to 43,810 ± 1,100 yBP, while the upper layers seem to show the deltaic regression offlap facies containing fossils of AMS ^{14}C ages ranging from 30,360 ± 290 yBP to 38,400 ± 640 yBP. The $\delta^{18}O$ (PDB) values of the lower layers ranged from 3.4 to 4.2‰, and those of the upper layers ranged from 3.3 to 3.8‰. The former tends to be higher than the latter. Marine layers and *in situ* fossil shells were not disturbed by ice sheet loading or scouring.

5.2. Ko-minato higashi Beach in the northern part of Langhovde

Two trenches were excavated into the raised beach deposits on the left bank of a meltwater stream at Ko-minato higashi Beach (Fig. 3 and Photo 3). They were named the East trench (E-trench: 951227-1) and the West trench (W-trench: 951220-1). The E-trench was 1.0 to 1.5 m in depth, 1.0 m in width and 43 m in length ranging from 4.0 m to 9.6 m asl. The W-trench was 0.5 to 1.5 m in depth, 1.0 m wide and 30 m in length ranging from 0.8 m to 5.1 m asl at 60 m seaward of the E-trench. These trench profiles revealed marine sediment layers with several bedding planes containing *in situ* fossil shells of *Laternula elliptica* and unbroken shells of *Adamussium colbecki* (Fig. 5, Photo 4 and the sheet). Most of the beds are composed of well-sorted fine- to medium-grained sand with granules or pebble size gravel. Such facies with *in situ* marine fossils indicate that most deposits were formed under a beach and/or river mouth environment. The beach sediment layers, which are cut obliquely by subaerial processes at the ground surface, are divided into upper and lower layers by a clear unconformity.

It seems that the lower marine layer had extended to higher than 7 m asl but the higher part has been removed by subsequent erosion. The lower layer is subdivided into two sublayers. The lower sublayer is composed of fine- to medium-grained sand with *in situ* fossils of *Laternula elliptica*. The ^{14}C ages of fossils range from 46,420 ± 1,500 yBP to 37,620 ± 390 yBP. The upper sublayer, conformably overlying the lower, is composed of medium- to coarse-grained sand with pebble-size gravel. The upper part of the upper sublayer is interbedded with pebble to cobble size gravel beds in the E-trench (Photo 5), and has a deltaic foreset structure in the W-trench. The ^{14}C ages of *in situ* fossil shells collected from the upper sublayer are 35,970 ± 410 yBP (E-trench) and 32,430 ± 270 yBP (W-trench). A shell aged 3,930 ± 60 yBP in the lower layer (951220-1-f, in W-trench) was yielded just below the present ground surface. It is inferred to have lived in the older layer exposed at the sea bottom in a younger age.

The fluvial gravels overlie the lower marine layer with rugged unconformity. They appear to consist of cut-and-fill deposits, suggesting deposition under a stronger fluvial process than present meltwater activity, because the present meltwater does not transport boulder

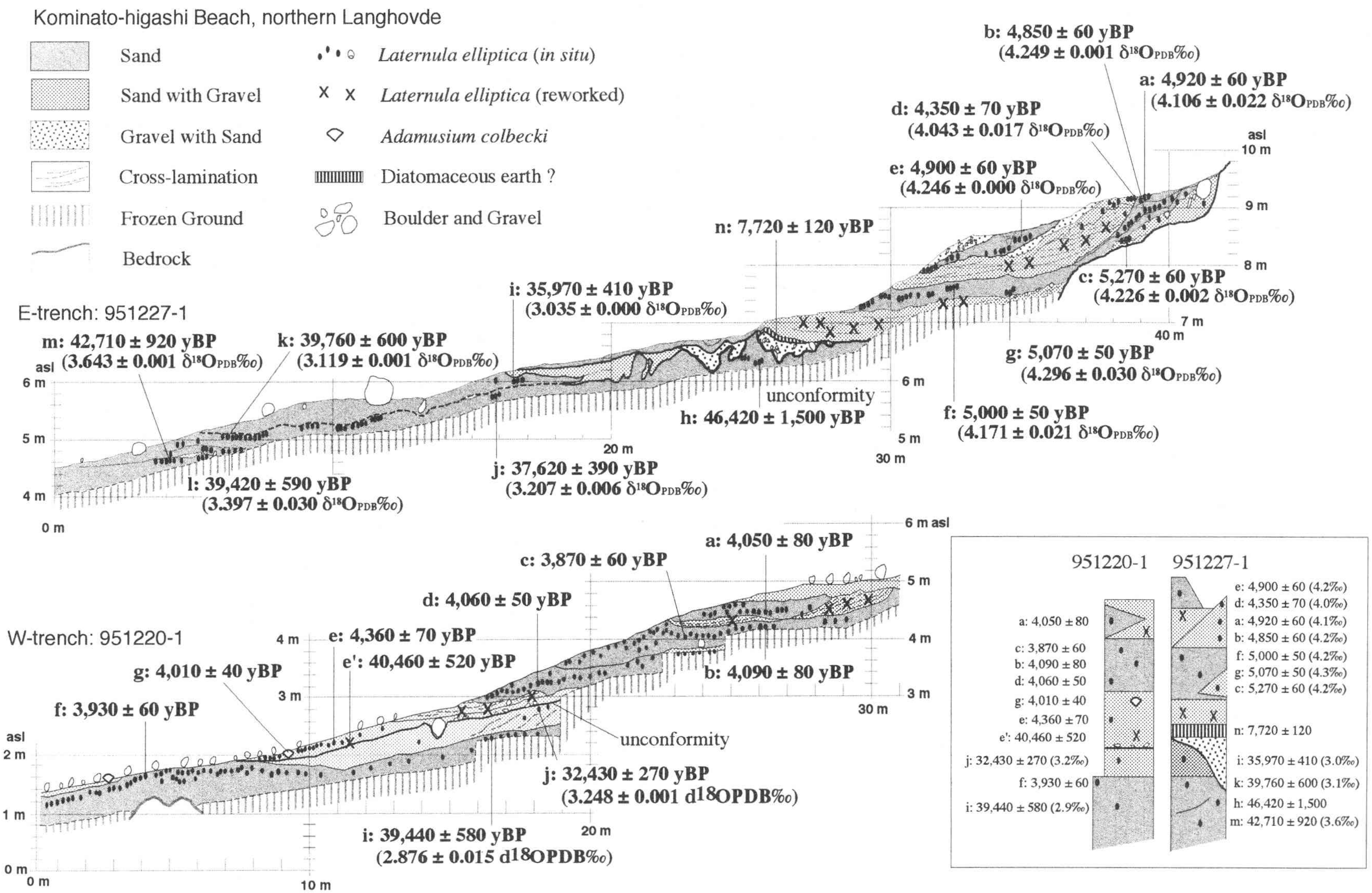

Fig. 5. Profiles of the E-trench (951227-1) and W-trench (951220-1), and AMS ^{14}C ages with $\delta^{13}C$ correction and oxygen isotopic ratios ($\delta^{18}O_{PDB}$‰) of fossil shells, at Kominato-higashi Beach, northern Langhovde.

gravels in the area. Diatomaceous(?) earth (951227-1-n; Photo 6) on the fluvial gravel was 3-4 cm thick, and dated 7,720 ± 120 yBP.

The upper sediment layer is composed of alternating fluvial or quite shallow marine sublayers with reworked shell fragments, and marine sublayers containing *in situ* fossil shells. The lowermost sublayer does not yield *in situ* fossil shells, but yields reworked shell fragments interstratified in coarse-grained sand beds with cross-lamination. The ^{14}C age of reworked fragments (951220-1-e' in the W-trench) shows 40,460 ± 520 yBP. This sublayer is inferred to have been laid down in very shallow water such as a river mouth, and is overlain by a marine sublayer. The marine sublayer contains abundant *in situ* fossils of *Laternula elliptica*, whose ^{14}C ages range from 4,850 ± 60 yBP to 5,270 ± 60 yBP. Another fluvial or shallow water sediment unconformably overlies the marine sub-layer. The fluvial or shallow water sediment is composed of medium to coarse-grained sand with granules to pebble-size gravel, and yields only reworked shell fragments in coarse-grained sand beds with cross-lamination. The uppermost sublayer is composed of medium-grained sand with granules to pebble-size gravel, and contains *in situ* fossil shells of *Laternula elliptica*. The ^{14}C ages of these fossils range from 3,870 ± 60 yBP to 4,920 ± 60 yBP. In the W-trench, the upper part of this sublayer scours underlying sediments, and contains reworked shell fragments with cross-lamination. On the other hand, an unsorted angular to sub-angular pebble gravel is laid on the sublayer and forms a terrace scarp in the E-trench. They are regarded as products of a fluvial or near shore process.

The values of the $\delta^{18}O$ (PDB) were clearly divided into two groups. One ranged from about 4.0 to 4.3‰ for the Holocene shells in the upper layer, and the other ranged from 2.9 to 3.6‰ for the late Pleistocene shells in the lower layer. The $\delta^{18}O$ (PDB) values of the upper layers are obviously higher than those of the lower layers.

5.3. Around Lake Zakuro in the northern part of Langhovde

Three trenches were excavated into the raised beach surrounding Lake Zakuro (Fig. 3). The 951223-2 trench, 1 m wide and 1 m deep, was situated at 4 m asl on the sill between Lake Zakuro and Ko-minato Inlet. The sediment was divided into four layers which are composed of well-sorted fine- to medium-grained sand with granules. Abundant *in situ* fossil shells of *Laternula elliptica* were yielded in three layers (Fig. 6 and Photo 8). The ^{14}C ages of fossils in the upper two layers were Holocene (from 3,910 ± 40 yBP to 3,690 ± 40 yBP), while the ^{14}C age of the fossil in the lowest layer was 46,120 ± 1,000 yBP. The $\delta^{18}O$ (PDB) of the oldest sample was 3.1‰.

The 951227-4 trench, 1.1 m wide and 0.8 m deep, was excavated at a lower place on the sill than the 951223-2 trench. The beach sediment was divided into four layers which are composed of well-sorted fine- to medium-grained sand with granules. The upper three layers yield abundant *in situ* fossil shells of *Laternula elliptica* (Fig. 6). All ^{14}C ages were Pleistocene ages ranging from 34,720 ± 330 yBP to 42,820 ± 690 yBP.

The 951224-1 trench, 0.9 m wide and 0.8 m deep, was excavated 300 m west of the western extremity of Lake Zakuro. The sediment was subdivided into five layers which are composed of well-sorted fine- to medium-grained sand with granules and yielded abundant *in* *situ* fossil shells of *Laternula elliptica*, especially in the upper two layers (Fig. 6). The ^{14}C ages of the shells are clearly divided into two groups: those of the upper two layers are of Holocene age (3,480 ± 70 yBP and 4,040 ± 60 yBP) and those of the lower two layers are late Pleistocene age (41,630 ± 960 yBP and 42,930 ± 2,000 yBP). The oxygen isotopic ratios have not yet been measured.

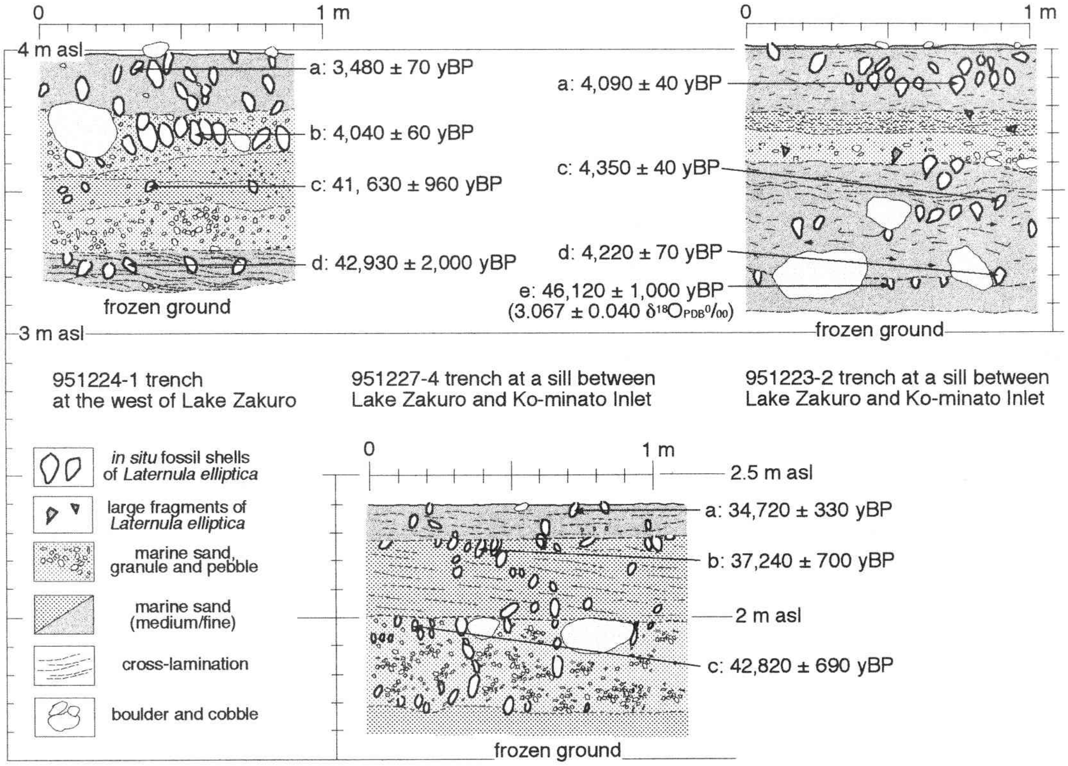

Fig. 6. Profiles of the trenches (951224-1, 951227-4 and 9601223-2), and AMS ^{14}C ages with $\delta^{13}C$ correction and oxygen isotopic ratios ($\delta^{18}O_{PDB}$‰) of fossil shells, around Lake Zakuro, northern Langhovde.

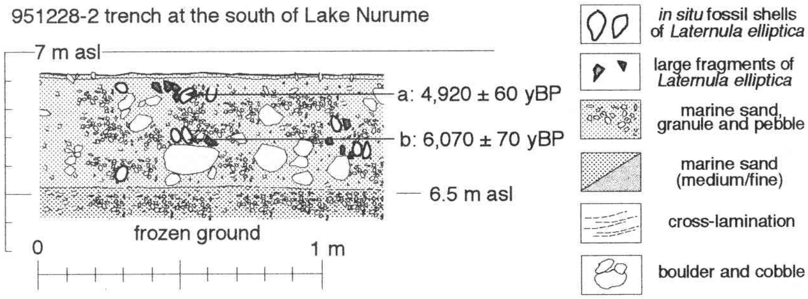

Fig. 7. Profile of the trench (951227-4) and AMS ^{14}C ages with $\delta^{13}C$ correction south of Lake Nurume in Dokkene, Langhovde.

5.4. South of Lake Nurume in Dokkene, Langhovde

Saline Lake Nurume (Fig. 3) is separated from the sea by a sill, 1 m asl. A shallow trench (951228-1) was excavated into the beach sediment at 7 m asl south of Lake Nurume

(Fig. 7). It was 1.2 m wide and 0.5 m deep. The sediment was divided into two layers. They are deposits, not well-sorted, composed of fine- to medium-grained sand with granules and cobbles, and yield abundant shell fragments. The upper layer yields *in situ* fossil shells of *Laternula elliptica*. Two radiocarbon ages of *in situ* shells were Holocene, 4,920 ± 60 yBP and 6,070 ± 70 yBP. The oxygen isotopic ratios have not yet been measured.

5.5. Around the mouth of Yatude Valley in the southern part of Langhovde

Two small trenches were excavated into the small but distinct terraces located on both sides of the mouth of Yatude Valley (Fig. 3 and Photo 9). One was excavated on the higher right bank terrace at 18 m asl, and the other was excavated on the lower left bank at 11 m asl.

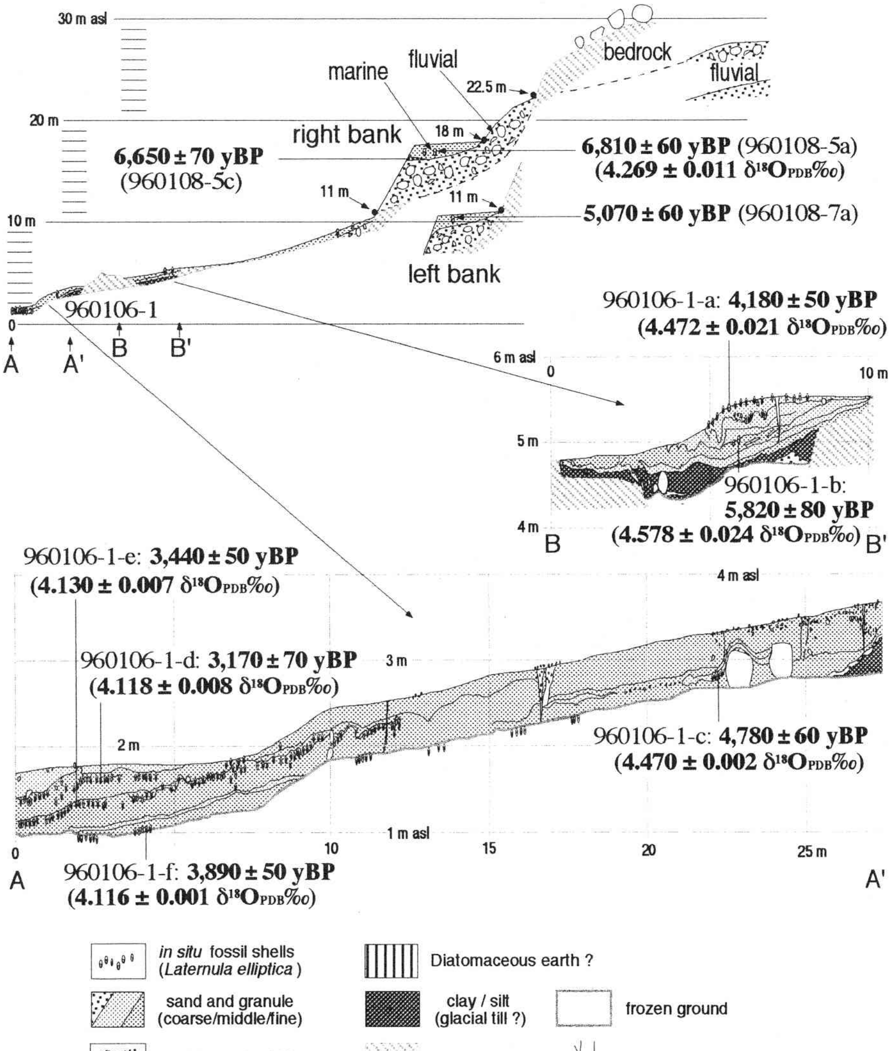

Fig. 8. Schematic profile around the mouth of Yatude Valley, and profiles of trenches (960106-1), and AMS ^{14}C ages with $\delta^{13}C$ correction and oxygen isotopic ratios ($\delta^{18}O_{PDB}$‰) of fossil shells in the southern part of Langhovde.

Both terraces are composed of coarse gravel with boulders in the lower layer, and well-sorted fine to medium-grained sand with granules in the upper layer. The upper layer, less than 1.5 m in thickness, containing *in situ* fossils of *Laternula elliptica*, appesrs to be a marine deposit. The ^{14}C date and values of the $\delta^{18}O$ (PDB) of the fossil sampled from the right bank terrace were 6,810 ± 60 yBP (960108-5a) and 4.3‰, respectively. The ^{14}C date of that from the lower terrace was 5,070 ± 60 yBP (960108-7a). The lower layer, about 5 m in thickness on the right bank, containing boulders larger than 2 m in diameter, appears to be a fluvial deposit affected by large quantities of meltwater. A few centimeters thick diatomaceous (?) earth is situated on the top of the lower layer on the right bank terrace. The ^{14}C date of the earth was 6,650 ± 70 yBP. A schematic profile of the lower reach of Yatude Valley is shown at the top of Fig. 8. Two *in situ* fossils of *Laternula elliptica* were also obtained from the raised beach sediments situatied on the left bank of Yukidori Valley which is located about 200 m north of the mouth of Yatude Valley. One (960107-2-a) was sampled at 12 m asl, and dated to 6,810 ± 60 yBP. The other (960107-1a) was sampled at 10 m asl. The ^{14}C date and values of the $\delta^{18}O$ (PDB) of it were 4,280 ± 90 yBP and 3.9‰.

A long trench (960106-1; Photo 10), interrupted by basement rock, was excavated on a raised beach lower than 11 m asl near the mouth of Yatude Valley, as shown in Fig. 8 and Appendix 3. The lower reach of the trench was 1.0 m in depth, 1.0 m in width and 28 m in length ranging from 1.8 m to 3.7 m asl. The upper reach was 1.0 m in depth and width, 10 m in length ranging from 4.9 m to 5.5 m asl. The deposits are clearly divided into several marine layers including *in situ* fossil shells of *Laternula elliptica*. The ^{14}C dates of the fossils were of Holocene age, ranging from 3,170 ± 70 yBP to 5,820 ± 80 yBP, and the values of the $\delta^{18}O$ (PDB) ranged from 4.1 to 4.6‰.

5.6. Kizahasi Beach in Skarvsnes

A long trench (960116-1) was excavated at Kizahasi Beach (Fig. 3, Photo 11 and Appendix 4), where conspicuous stepped topography is developed as raised beaches. It was 1.0 m in depth and 180 m in length at altitudes between 0.3 m and 16.0 m (Fig. 9). Each step is rather small and low, ranging 20 to 100 cm in relative height, and extends along the present shoreline. The deposits, composed of well-sorted fine to medium-grained sand, show several series of deltaic structure (Photo 12). This sedimentary structure indicates that the beach extended seaward with growth of the delta and, probably, marine regression. The sand beds containing *in situ* fossil shells are fundamentally judged as foreset-bottom beds and marine sediments, and the sand beds without *in situ* fossil shells are judged to be topset-foreset beds and fluvio-marine sediments. Sand beds between 12 m and 14 m asl yield no in situ fossils. This fact suggests the occurrence of a rapid regression, from 12 m to 14 m above the present sea level, in a period between 5,400 yBP and 7,000 yBP. The ^{14}C ages of *in situ* fossils range from 7,170 ± 60 yBP to 4,060 ± 60 yBP, and the values of $\delta^{18}O$ (PDB) of those range from 4.1 to 4.4‰. No fossil dated prior to Holocene and between 5,400 yBP and 7,000 yBP was discovered in the trench. The time-series variations of oxygen isotopic ratio seem to have no tendency.

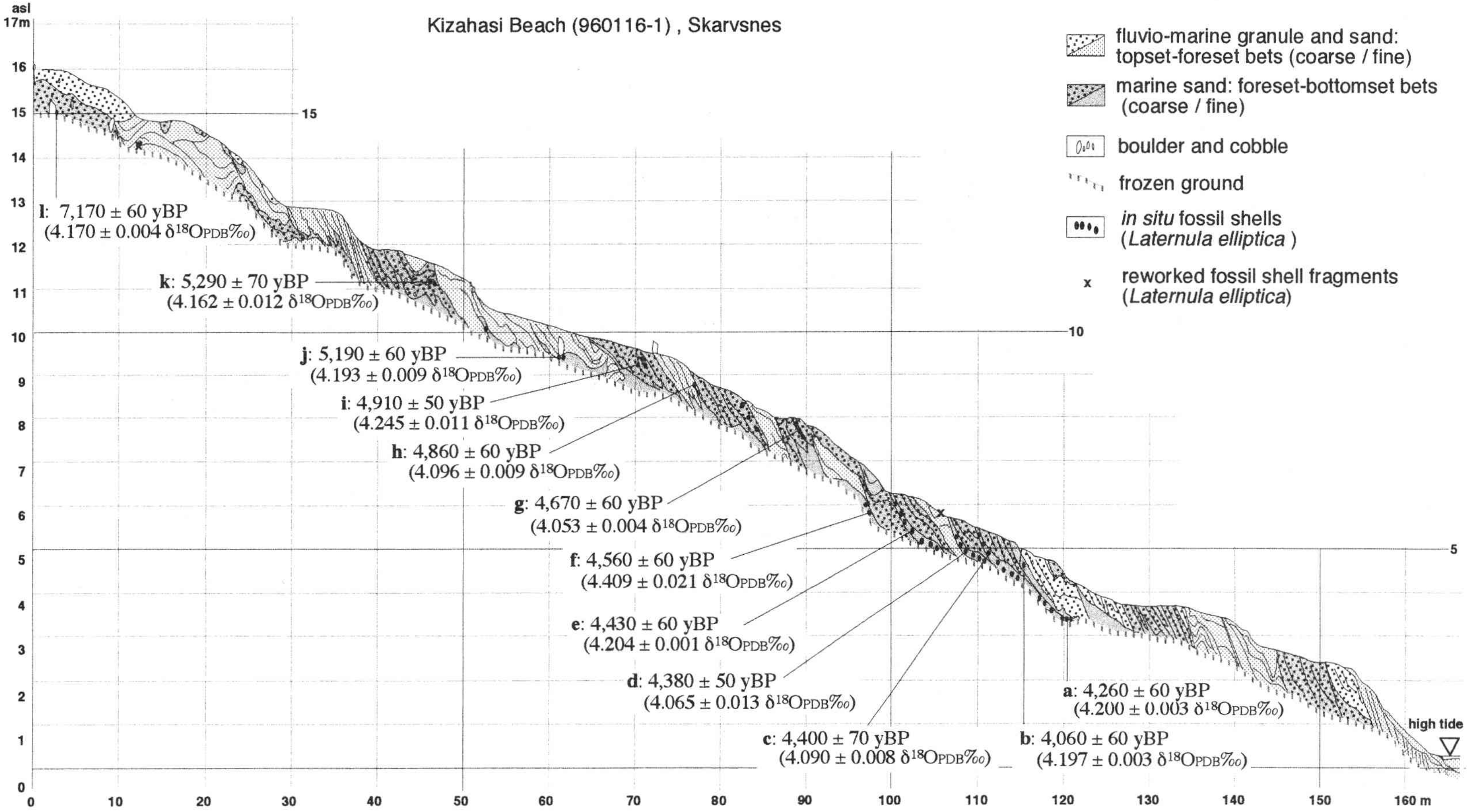

Fig. 9. Profile of the trench (960116-1), AMS ^{14}C ages with $\delta^{13}C$ correction and oxygen isotopic ratios ($\delta^{18}O_{PDB}$‰) of fossil shells at Kizahasi Beach, Skarvsnes.

6. Late Quaternary Environment along the Northern Sôya Coast

The paleoenvironment during the late Quaternary along the northern Sôya Coast can be estimated on the basis of the raised beach stratigraphy, AMS ^{14}C ages and oxygen isotopic ratios of the fossil shells, which were mentioned in Chapter 5.

The AMS ^{14}C dating revealed that the ^{14}C ages of *in situ* fossil shells are clearly classified into two groups: the younger group is 3,000-8,000 yBP, in the Holocene, and the older is 30,000-46,000 yBP, in the late Pleistocene, probably the last interstadial, without the reservoir corrections (Fig. 10). The locality containing the late Pleistocene *in situ* fossils is confined to East and West Ongul islands and the northern part of Langhovde, the northernmost part of the Sôya Coast region. This fact indicates that marine transgression occurred twice during the late Quaternary in that region.

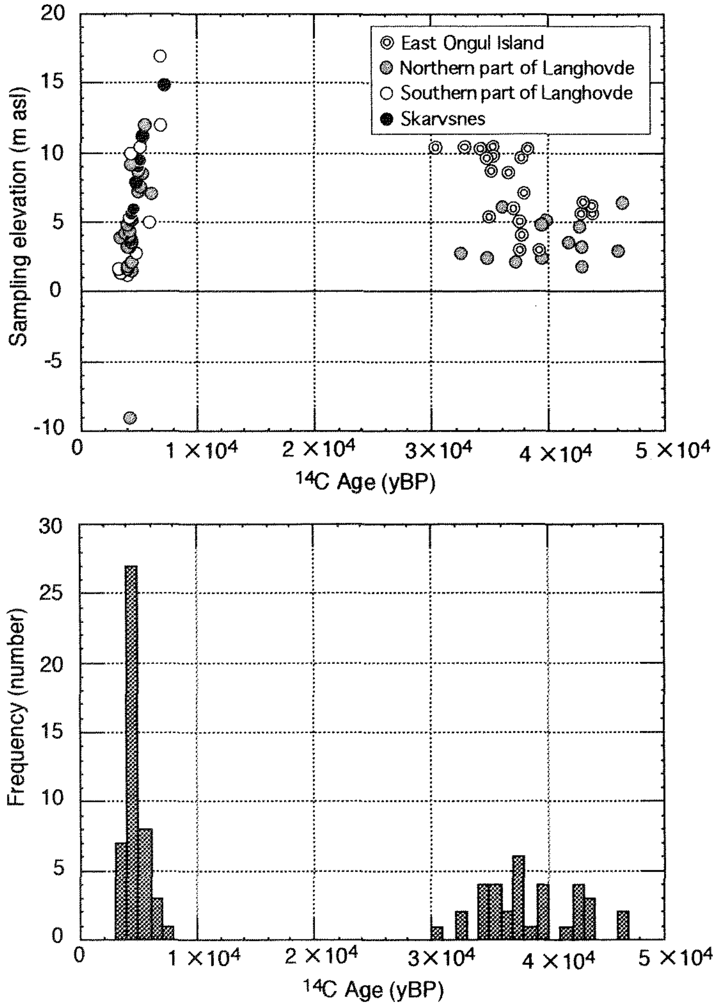

Fig. 10. The relationship between AMS ^{14}C ages and sampling elevations (upper), and the frequency distribution of AMS ^{14}C ages (lower) of in situ Laternula elliptica fossils, in the Sôya Coast region. All ^{14}C ages were treated with $\delta^{13}C$ and background corrections, without reservoir correction.
Data sources: MAEMOKU et al. (1997) and MIURA et al. (1998, 1999).

The lower limit of transgression during the last interstadial is marked by *in situ* marine fossils at 10.4 m asl in the Ongul Islands (Fig. 4). Holocene high sea level is marked by the marine terrace at 20 m asl in the southern part of Langhovde, where other marine terraces of 18 m and 11 m asl have also been found (Photo 9). They contain *in situ* marine fossils. The ^{14}C age of the fossil on the higher terrace is 6,810 ± 60 yBP, and that of the lower terrace is 5,070 ± 60 yBP (Fig. 8). These figures suggest that two stable sea levels occurred during the Holocene. A rapid regression in the Holocene is suggested by deltaic sediments without *in situ* fossils, which occurred between 12 m and 14 m asl, at Kizahasi Beach in Skarvsnes (Fig. 9). The rapid regression probably occurred between 5,400 yBP and 7,000 yBP in ^{14}C age.

At Ko-minato higashi Beach in the northern part of Langhovde, Holocene marine sediments overlie unconformably on the last interstadial marine sediments (Fig. 5). The Holocene sediments are composed of fine marine sand with interbedded coarse deltaic sand and gravel. *In situ* fossil shells of *Laternula elliptica* are yielded in the marine sand layer and partially in the deltaic sediments. The deltaic sediments also included reworked shell fragments, suggesting that minor regression(s) occurred during the Holocene transgression.

In the northernmost part of the Sôya Coast region, extremely fragile shells of *Laternula elliptica*, dated in the last interstadial, retain their living form *in situ* in the raised beach sediments without removal or shattering by the ice sheet. This fact indicates that the East Antarctic Ice Sheet had retreated at least from the Ongul Islands and the northern part of Langhovde by the last interstadial, and did not advance over the Ongul Islands and the northern part of Langhovde again, even during the LGM.

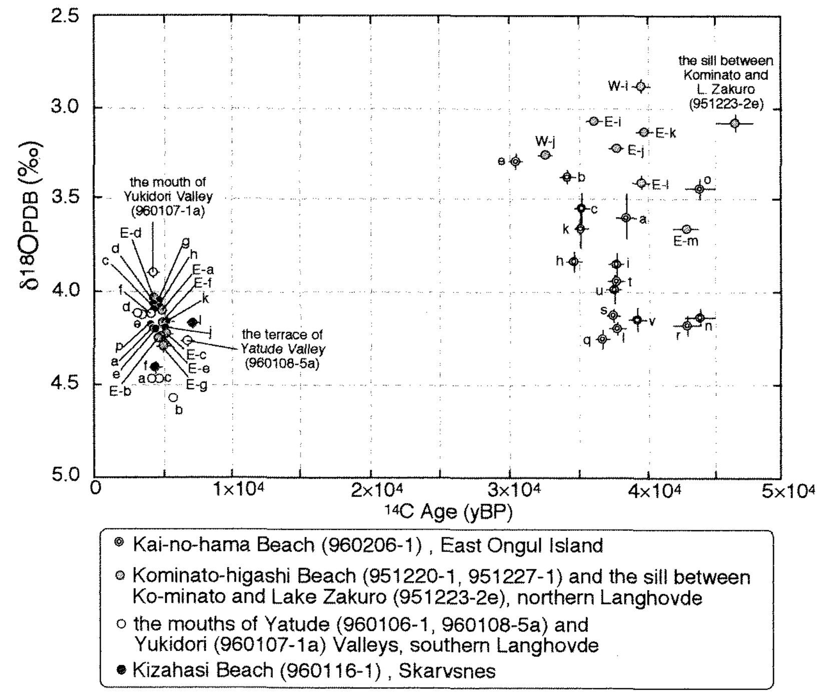

Fig. 11. Oxygen isotopic ratio ($\delta^{18}O_{PDB}$‰) of in situ fossil shells obtained from raised beach deposits in the Sôya Coast region, plotted against AMS ^{14}C ages (yBP) calibrated by $\delta^{13}C$ corrections but not corrected for the reservoir effect. Each letter corresponds to the sample numbers in the trenches.

It is not clear whether the southern part of Sôya Coast was free from the East Antarctic Ice Sheet during the interstadial or not. However, most ice-free rocks on the southern part of the Sôya Coast had become free from the East Antarctic Ice Sheet by the middle of the Holocene.

The values of $\delta^{18}O$ (PDB) for the Holocene shells range from about 3.9 to 4.6‰; on the other hand the values for the last interstadial shells range from about 2.9 to 4.2‰. The difference of oxygen isotopic ratio between the Holocene and the last interstadial is about 0.5-1.5 degree ‰ (Fig. 11 and Table 5). If the difference was caused by a difference of water temperature between each period, sea-water temperature during the last interstadial was estimated to be 2-6 °C higher than that in the Holocene by a transfer function (*e.g.*, EPSTEIN *et al.*, 1953). Such high temperature was a virtual impossibility in sea water close to the ice sheet. The difference of oxygen isotopic ratio between the Holocene and the last interstadial is considered to mostly depend on ^{18}O-depleted melt water from the Antarctic ice sheet. This also suggests that melting of the East Antarctic Ice Sheet during the last interstadial had been more active than that in the Holocene, at least in the Sôya Coast region (MIURA *et al.*, 1998). The oxygen isotopic ratio of Holocene shells seems to have no relationship to age.

7. Summary

The maps on the sheet present the distribution of raised beach deposits and localities of marine fossils, with ^{14}C ages, which have been collected from the Sôya and Prince Olav coasts since 1961. All specimens were recovered by the Japanese Antarctic Research Expedition. The total number of radiocarbon dates is 248, that of AMS ^{14}C dates is 145, and that of confirmed *in situ* ones 114. The total number of *in situ* and AMS ^{14}C dates is 93. Some ^{14}C ages determined by the β-ray counting method are doubtful (*e.g.*, 10,590 ± 160: 940127-4 (1) in East Ongul). They were probably collected as a mixed sample of the younger and older fossils. In spite of this problem, most of the β-ray ^{14}C dates are valuable, especially *in situ* ones and those of localities without the AMS ^{14}C date as shown in Fig. 12. Raised beach deposits containing *in situ* fossil shells developed most extensively below 20 m asl in this region.

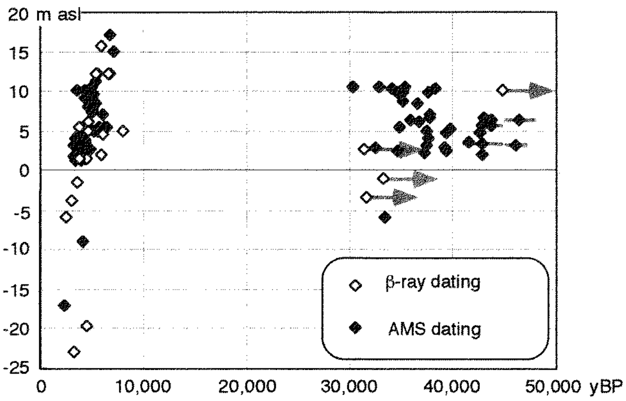

Fig. 12. Sampling elevations and ^{14}C ages of in situ marine fossils.

The late Quaternary paleoenvironmental history around the Lützow-Holm Bay region is summarized as follows:

1) The East Antarctic Ice Sheet had retreated from the ice-free rocks in the northernmost part of Sôya Coast by the late Pleistocene, probably the last interstadial, on the basis of the AMS ^{14}C dating, and marine transgression had occurred there. Although the absolute high sea level during that period is unknown, the relative sea level reached at least 10 m above the present sea level. Melting of the East Antarctic Ice Sheet during the last interstadial had been conspicuously active judging from the $\delta^{18}O$ (PDB) values of fossil shells.
2) During the LGM, sea level had fallen; however, the East Antarctic Ice Sheet did not re-advance, at least on to the ice-free rocks on the northernmost part of the Sôya Coast.
3) Probably after the LGM, meltwater process became active, then partially eroded the former raised beach and formed fluvial deposits. The East Antarctic Ice Sheet retreated from the present ice-free rocks along the Sôya Coast by the middle of the Holocene.
4) Holocene marine transgression occurred from 3,000 yBP to 7,200 yBP in ^{14}C age. High sea level had reached at least 20 m asl without taking isostatic rebound into consideration. The transgression was probably interrupted by minor regressions. Relatively stable sea-level period occurred twice, around 20 m and 11 m above the present sea level. Melting of the East Antarctic Ice Sheet during the Holocene transgression was less active than during the last interstadial, judging from the $\delta^{18}O$ (PDB) values of fossil shells.

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Appendix I. Inventory of radiocarbon dates of marine fossils around Lützow-Holm Bay (1).

Locality	South Latitude	East Longitude	Elevation (m asl)	Deposit form	Material	^{14}C age (yBP) raw	^{14}C age (yBP) with background correction	^{14}C age (yBP) with $\delta^{13}C$ correction	Error (yr)	$\delta^{13}C$ ($^0/_{00}$)	Dating method	Laboratory code & number	Sample code & number	Collector(s)	Date of collection	Reference	Code of map in the sheet
Prince Olav Coast																	
NW beach of Akarui Point	68°27'30"	41°26'10"	10.0	?	fragment of shell (*La*)	**7,730**			± 110		β	GaK-5839	75020602	Moriwaki	1975.2.6	Moriwaki, 1976	I
East Ongul Island																	
Island near Kita-no-seto Strait	69°00'11"	39°34' 30"	1.5	?	coralline algae	**3,540**			± 90		β	GaK-3665	-	Hoshiai	1967	Yoshida, 1973	II A
Island near Kita-no-seto Strait	69°00'11"	39°34' 30"	0.5	?	coralline algae	**3,340**			± 90		β	GaK-3664	-	Hoshiai	1967	Yoshida, 1973	II A
North beach	69°00'15"	39°35'12"	1.0	?	*Adamussium colbecki*	**2,040**			± 90		β	GaK-3667	-	Hoshiai	1967	Yoshida, 1983	II A
Northwest beach	69°00'22"	39°34'39"	7.0	?	*Laternula elliptica*		3,790	**4,230**	± 80	+1.5	β	Beta-80998	940127-6	Hirakawa	1994.1.27	Hirakawa & Sawagaki, 1998	II A
Northwest beach	69°00'28"	39°34'36"	10.0	*in situ*	*Laternula elliptica*		44,630	**45,070**	<	+1.6	β	Beta-80997	940127-5	Hirakawa	1994.1.27	Hirakawa & Sawagaki, 1998	II A
Northwest beach	69°00'29"	39°34'30"	2.0	?	*Adamussium colbecki*	**2,510**			± 110		β	N-925	-	Omoto	1970	Omoto *et al.*, 1974	II A
ditto	69°00'29"	39°34'30"	2.0	?	*Adamussium colbecki*	**1,450**			± 110		β	TH-021	-	Omoto	1970	Omoto *et al.*, 1974	II A
Northern part	69°00'23"	39°35'56"	16.0	?	fragment of shell	**5,850**			± 100		β	GaK-2032	6702131	Yoshida	1967.2.13	Yoshida, 1970	II A
Mizukumi Stream	69°00'31"	39°34'57"	12.0	?	fragment of shell	**30,700**			± 2,000		β	GaK-2033	670301	Yoshida	1967.3.1	Yoshida, 1970	II A
Kitami Beach	69°00'46"	39°34'05"	6.0	?	fragment of shell	**30,000**			<		β	GaK- ?	610125B	Meguro	1961.1.25	Meguro *et al.*, 1964	II A
Kitami Beach	69°00'48"	39°34'03"	8.0	?	fragment of shell	**25,400**			± 1,200		β	GaK-285	620119C1	Fujiwara & Koaze	1962.1.19	Meguro *et al.*, 1964	II A
Kitami Beach	69°00'48"	39°34'03"	8.0	?	foraminifera	**31,200**			+/- $^{2,500}/_{1,900}$		β	GaK-289	620119C2	Fujiwara & Koaze	1962.1.19	Meguro *et al.*, 1964	II A
Kitami Beach	69°00'49"	39°34'13"	12.0	?	fragment of shell	**34,000**			+/- $^{3,000}/_{2,000}$		β	GaK-286	620119D	Fujiwara & Koaze	1962.1.19	Meguro *et al.*, 1964	II A
Kitami Beach	69°00'50"	39°34'14"	15.0	?	fragment of shell (*Ad, La*, po)	**34,570**			± 2,510		β	GaK-18351	940127-3	Hirakawa	1994.1.27	Hirakawa & Sawagaki, 1998	II A
Southeast beach	69°00'50"	39°36'32"	4.0	?	tubes of polychaeta		36,650	**37,060**	± 950	0.0	β	Beta-80999	940129-5	Hirakawa	1994.1.29	Hirakawa & Sawagaki, 1998	II A
Kai-no-hama Beach	69°00'52"	39°34'27"	10.0	?	fragment of shell	**22,800**			± 1,000		β	GaK-288	620119E	Fujiwara & Koaze	1962.1.19	Meguro *et al.*, 1964	II A
Kai-no-hama Beach	69°00'55"	39°34'21"	4.0	?	fragment of shell	**29,500**			+/- $^{2,400}/_{1,800}$		β	GaK-287	620119F	Fujiwara & Koaze	1962.1.19	Meguro *et al.*, 1964	II A
Kai-no-hama Beach	69°00'56"	39°34'17"	4.0	?	*Adamussium colbecki*	**3,840**			± 110		β	GaK- ?	600303A	Yoshida	1960.3.3	Meguro *et al.*, 1964	II A
Kai-no-hama Beach	69°01'00"	39°33'52"	3.0	?	*Adamussium colbecki*		35,280	**35,690**	± 1,630	-0.1	β	Beta-90954	940130-6	Hirakawa	1994.1.30	Hirakawa & Sawagaki, 1998	II A
Northwest beach	69°00'18"	39°34'47"	1.0	?	*Adamussium colbecki*	32,350	**33,190**		± 390		AMS	NUTA- ?	Nu-1	Igarashi	1993.1.23	Igarashi *et al.*, 1995b	II A
Northern part	69°00'22"	39°35'30"	13.0	?	fragment of shell	33,170	35,710	**36,180**	± 630		AMS	NUTA- ?	Ar-1	Igarashi	1993.1.23	Igarashi *et al.*, 1995a, b	II A
Northwest beach	69°00'23"	39°34'44"	10.0	rework	fragment of shell (*La*)	37,220	42,000	**37,420**	± 720		AMS	NUTA- ?	Nu-2	Igarashi	1993.1.23	Igarashi *et al.*, 1995a, b	II A
Mizukumi Stream	69°00'31"	39°34'47"	13.0	?	fragment of shell (*Ad, La*, po)	**35,370**			<		β	GaK-18350	940127-1(1)	Hirakawa	1994.1.27	Hirakawa & Sawagaki, 1998	II A
ditto	69°00'31"	39°34'47"	13.0	?	tubes of polychaeta		39,400	**39,810**	± 610	-0.2	AMS	Beta-90957	940127-1(2)	Hirakawa	1994.1.27	Hirakawa & Sawagaki, 1998	II A
Mizukumi Stream	69°00'32"	39°34'53"	11.0	?	fragment of shell (*La*)		41,850	**42,270**	± 1,070	+0.5	AMS	Beta-110488	Nu-7	Igarashi	1993.1.23	unpublished	II A
Kitami Beach	69°00'47"	39°34'02"	7.5	?	*Adamussium colbecki*		4,340	**4,800**	± 50	+2.8	AMS	Beta-80996	940127-2	Hirakawa	1994.1.27	Hirakawa & Sawagaki, 1998	II A
Kitami Beach	69°00'49"	39°33'59"	7.5	?	fragment of shell (*La*)	32,960	**33,700**		± 300		AMS	NUTA- ?	Km-7	Igarashi	1993.1.23	Igarashi *et al.*, 1995b	II A
Kitami Beach	69°00'50"	39°34'09"	12.0	?	fragment of shell (*La*)		38,800	**39,230**	± 950	+1.2	AMS	Beta-110487	Km-6	Igarashi	1993.1.23	unpublished	II A
Southeast beach	69°00'51"	39°36'30"	6.0	?	*Adamussium colbecki*		3,480	**3,920**	± 60	+1.4	AMS	Beta-83803	940129-3	Hirakawa	1994.1.29	Hirakawa & Sawagaki, 1998	II A
Kai-no-hama Beach	69°00'51"	39°34'28"	12.0	?	fragment of shell (*La*)		41,510	**41,960**	± 1,100	+2.3	AMS	Beta-110486	Kh-8	Igarashi	1993.1.23	unpublished	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	10.2	*in situ*	*Laternula elliptica*		37,980	**38,400**	± 640	+0.8	AMS	Beta-100322	960206-1-a	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	10.2	*in situ*	*Laternula elliptica*		33,670	**34,090**	± 400	+0.3	AMS	Beta-100323	960206-1-b	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	10.4	*in situ*	*Laternula elliptica*		34,900	**35,320**	± 520	+0.8	AMS	Beta-100324	960206-1-c	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	10.4	*in situ*	*Laternula elliptica*		32,400	**32,840**	± 220	+1.6	AMS	Beta-116846	960206-1-d	Miura & Maemoku	1996.2.6	unpublished	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	10.4	*in situ*	*Laternula elliptica*		29,940	**30,360**	± 290	+0.4	AMS	Beta-100325	960206-1-e	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	9.8	rework	tubes of polychaeta		37,780	**38,190**	± 740	0.0	AMS	Beta-100326	960206-1-f	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	9.8	*in situ*	*Laternula elliptica*		34,780	**35,200**	± 330	+0.8	AMS	Beta-116847	960206-1-g	Miura & Maemoku	1996.2.6	unpublished	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	9.7	*in situ*	*Laternula elliptica*		34,210	**34,650**	± 500	+1.4	AMS	Beta-100327	960206-1-h	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	9.7	*in situ*	*Laternula elliptica*		37,320	**37,740**	± 490	+0.4	AMS	Beta-100328	960206-1-i	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	8.5	*in situ*	*Laternula elliptica*		36,080	**36,520**	± 430	+1.7	AMS	Beta-100329	960206-1-j	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	8.6	*in situ*	*Laternula elliptica*		34,720	**35,160**	± 350	+1.7	AMS	Beta-100330	960206-1-k	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A

Appendix I. Inventory of radiocarbon dates of marine fossils around Lützow-Holm Bay (2).

Locality	South Latitude	East Longitude	Elevation (m asl)	Deposit form	Material	^{14}C age (yBP) raw	^{14}C age (yBP) with background correction	^{14}C age (yBP) with $\delta^{13}C$ correction	Error (yr)	$\delta^{13}C$ (‰)	Dating method	Laboratory code & number	Sample code & number	Collector(s)	Date of collection	Reference	Code of map in the sheet
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	7.0	*in situ*	*Laternula elliptica*		37,400	**37,840**	**± 570**	+1.8	AMS	Beta-100331	960206-1-l	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	6.5	*in situ*	*Laternula elliptica*		42,660	**43,080**	**± 690**	+0.7	AMS	Beta-116848	960206-1-m	Miura & Maemoku	1996.2.6	unpublished	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	6.2	*in situ*	*Laternula elliptica*		43,380	**43,810**	**± 1,100**	+1.1	AMS	Beta-100332	960206-1-n	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	5.7	*in situ*	*Laternula elliptica*		43,280	**43,710**	**± 980**	+1.0	AMS	Beta-100333	960206-1-o	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	6.0	*in situ*	*Laternula elliptica*		36,290	**36,730**	**± 420**	+1.3	AMS	Beta-100334	960206-1-q	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	5.7	*in situ*	*Laternula elliptica*		42,400	**42,840**	**± 930**	+1.8	AMS	Beta-100335	960206-1-r	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	5.0	*in situ*	*Laternula elliptica*		37,140	**37,560**	**± 470**	+0.2	AMS	Beta-100336	960206-1-s	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	4.1	*in situ*	*Laternula elliptica*		37,270	**37,700**	**± 470**	+1.1	AMS	Beta-100337	960206-1-t	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	3.0	*in situ*	*Laternula elliptica*		37,120	**37,560**	**± 470**	+1.7	AMS	Beta-100338	960206-1-u	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	2.9	*in situ*	*Laternula elliptica*		38,850	**39,290**	**± 600**	+1.6	AMS	Beta-100339	960206-1-v	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach, trench	69°00'52"	39°34'28"	5.4	*in situ*	*Laternula elliptica*		34,390	**34,830**	**± 350**	+1.5	AMS	Beta-100340	960206-1-w	Miura & Maemoku	1996.2.6	Miura *et al.*, 1998	II A
Kai-no-hama Beach	69°00'57"	39°34'03"	17.0	?	tubes of polychaeta		38,510	**38,910**	**± 550**	-0.5	AMS	Beta-90958	940127-4(2)	Hirakawa	1994.1.27	Hirakawa & Sawagaki, 1998	II A
ditto	69°00'57"	39°34'03"	17.0	?	fragment of shell (*Ad, La*, po)	**10,590**			**± 160**		β	GaK-18352	940127-4(1)	Hirakawa	1994.1.27	Hirakawa & Sawagaki, 1998	II A
West Ongul Island																	
West of Naka-no-ura (cove)	69°01'04"	39°32'51"	20.0	?	fragment of shell (*La*, po)	**36,790**			<		β	GaK-18347	940126-1	Hirakawa	1994.1.26	Hirakawa & Sawagaki, 1998	II A
West of Naka-no-ura (cove)	69°01'04"	39°33'11"	8.0	?	fragment of shell (*Ad, La*)	**35,520**			<		β	GaK-18348	940126-6	Hirakawa	1994.1.26	Hirakawa & Sawagaki, 1998	II A
West of Naka-no-ura (cove)	69°01'24"	39°32'43"	7.5	?	tubes of polychaeta	**36,000**			**± 2,450**		β	GaK-18345	940124-2	Hirakawa	1994.1.24	Hirakawa & Sawagaki, 1998	II A
North beach	69°01'10"	39°31'37"	6.0	?	*Adamussium colbecki*	**930**			**± 90**		β	GaK-5832	720211	Moriwaki	1972.2.11	Moriwaki, 1976	II A
East of Zakuroisi Ridge	69°01'37"	39°31'48"	20.0	?	*Adamussium colbecki*	**38,580**			<		β	GaK-18349	940130-2	Hirakawa	1994.1.30	Hirakawa & Sawagaki, 1998	II A
East beach	69°01'38"	39°34'55"	10.0	?	tubes of polychaeta		36,250	**36,660**	**± 1,480**	+0.2	β	Beta-80994	940124-3	Hirakawa	1994.1.24	Hirakawa & Sawagaki, 1998	II A
East beach	69°01'40"	39°33'55"	2.5 ?	*in situ*	*Laternula elliptica*	**31,510**			<		β	GaK-6382	760213-18	Nogami	1976.2.13	Nogami, 1977	II A
East beach	69°01'48"	39°33'57"	5.0	?	*Adamussium colbecki*		2,870	**3,330**	**± 80**	+2.7	β	Beta-81000	940130-5	Hirakawa	1994.1.30	Hirakawa & Sawagaki, 1998	II A
West beach	69°01'05"	39°29'50"	3.5 ?	?	*Adamussium colbecki*	**25,840**			**± 2,450**		β	GaK-6372	760210-9	Nogami	1976.2.10	Nogami, 1977	II A
West of Naka-no-seto Strait	69°00'59"	39°32'58"	16.0	?	fragment of shell (*Ad*)		42,190	**42,630**	**± 1,120**	+2.0	AMS	Beta-110485	Wo-58	Igarashi	1992.12.16	unpublished	II A
West of Naka-no-ura (cove)	69°01'06"	39°32'38"	12.0	?	fragment of shell (*La*)	34,070	**34,930**		**± 370**		AMS	NUTA- ?	Wo-54	Igarashi	1992.12.16	Igarashi *et al*., 1995b	II A
Do. (cross chech of Wo-54)	69°01'06"	39°32'38"	12.0	?	fragment of shell (*La*)		42,530	**42,930**	**± 990**	-1.1	AMS	Beta-90140	Do. (Wo-54)	Igarashi	1992.12.16	unpublished	II A
Northern shore of Lake O-ike	69°01'22"	39°34'20"	12.0	?	fragment of shell (*La*)	33,960	**34,810**		**± 520**		AMS	NUTA- ?	Wo-32	Igarashi	1992.12.16	Igarashi *et al*., 1995b	II A
West of Zakuroisi Ridge	69°01'23"	39°31'04"	18.0	?	fragment of shell	34,190	37,140	**34,350**	**± 550**		AMS	NUTA- ?	Wo-28	Igarashi	1992.12.15	Igarashi *et al*., 1995a, b	II A
West beach	69°01'24"	39°30'13"	6.0	?	*Adamussium colbecki*		38,860	**39,300**	**± 580**	+1.9	AMS	Beta-90959	940125-2(2)	Hirakawa	1994.1.25	Hirakawa & Sawagaki, 1998	II A
West beach	69°01'24"	39°30'13"	6.0	?	*Laternula elliptica*	**26,740**			**± 1,040**		β	GaK-18346	940125-2(1)	Hirakawa	1994.1.25	Hirakawa & Sawagaki, 1998	II A
West beach	69°01'42"	39°30'40"	10.0	*in situ*	*Laternula elliptica*		3,140	**3,590**	**± 50**	+2.4	AMS	Beta-80995	940126-3	Hirakawa	1994.1.26	Hirakawa & Sawagaki, 1998	II A
East beach	69°01'56"	39°33'55"	17.0	?	fragment of shell (*Ad*)	34,880	38,160	**35,040**	**± 480**		AMS	NUTA- ?	Wo-48	Igarashi	1992.12.16	Igarashi *et al.*, 1995a, b	II A
Northern part of Langhovde																	
North of Lake Zakuro	69°10'35"	39°38'25"	-3.4	*in situ*	*Laternula elliptica*	**31,700**			<		β	GaK-6376	760113-13-2	Nogami	1976.1.13	Nogami, 1977	II B
North of Lake Zakuro	69°10'35"	39°38'25"	-4.6	?	*Adamussium colbecki*	**33,200**			<		β	GaK-6375	760113-13-1	Nogami	1976.1.13	Nogami, 1977	II B
East of Lake Zakuro	69°10'40"	39°38'58"	-1.0	*in situ*	*Laternula elliptica*	**33,400**			<		β	GaK-4149	720203-08	Moriwaki	1972.2.3	Moriwaki, 1974	II B
West of Ko-minato Inlet	69°10'41"	39°39'20"	6.0	*in situ*	*Laternula elliptica*	**4,640**			**± 90**		β	GaK-18332	940101-3	Hirakawa	1994.1.1	Hirakawa & Sawagaki, 1998	II B
West of Ko-minato Inlet	69°10'42"	39°39'20"	6.0	?	*Adamussium colbecki*	**10,250**			**± 210**		β	GaK-4150	720203-07	Moriwaki	1972.2.3	Moriwaki, 1974	II B
West of Ko-minato Inlet	69°10'42"	39°39'20"	5.0	*in situ*	*Laternula elliptica*	**4,570**			**± 120**		β	GaK-6374	760113-10	Nogami	1976.1.13	Nogami, 1977	II B
South of Ko-minato Inlet	69°10'48"	39°40'36"	5.0	?	*Adamussium colbecki*	**5,160**			**± 100**		β	N-2603	75051301	Hayashi	1975.5.13	Hayashi & Yoshida, 1994	II B
Southeast of Ko-minato Inlet	69°10'48"	39°41'10"	1.5	?	*Adamussium colbecki*	**4,290**			**± 90**		β	GaK-4151	720203-04	Moriwaki	1972.2.3	Moriwaki, 1974	II B
Southeast of Ko-minato Inlet	69°10'48"	39°41'10"	1.5	?	*Adamussium colbecki*	**3,305**			**± 130**		β	TH-044	-	Omoto	1973.11.7	Omoto, 1976	II B
Southeast of Ko-minato Inlet	69°10'49"	39°41'15"	6.0	?	*Laternula elliptica*		4,050	**4,460**	**± 90**	-0.5	β	Beta-90955	940101-2	Hirakawa	1994.1.1	Hirakawa & Sawagaki, 1998	II B
Southeast of Ko-minato Inlet	69°10'49"	39°41'15"	6.0	?	*Laternula elliptica*	**23,830**			**± 910**		β	GaK-4148	720203-03	Moriwaki	1972.2.3	Moriwaki, 1974	II B

Appendix I. Inventory of radiocarbon dates of marine fossils around Lützow-Holm Bay (3).

Locality	South Latitude	East Longitude	Elevation (m asl)	Deposit form	Material	^{14}C age (yBP) raw	^{14}C age (yBP) with background correction	^{14}C age (yBP) with $\delta^{13}C$ correction	Error (yr)	$\delta^{13}C$ (‰)	Dating method	Laboratory code & number	Sample code & number	Collector(s)	Date of collection	Reference	Code of map in the sheet
Southeast of Ko-minato Inlet	69°10'49"	39°41'15"	3.0	?	*Laternula elliptica*	**3,120**			**± 110**		β	TH-186	-	Omoto	1973.11.5	Omoto, 1978	II B
Southeast of Ko-minato Inlet	69°10'50"	39°41'20"	9.0	?	*Laternula elliptica*	**5,070**			**± 100**		β	GaK-18331	940101-1	Hirakawa	1994.1.1	Hirakawa & Sawagaki, 1998	II B
South of Hukuro Cove	69°12'52"	39°39'10"	12.0	?	*Laternula elliptica*	**4,000**			**± 90**		β	GaK-18333	940102-1	Hirakawa	1994.1.2	Hirakawa & Sawagaki, 1998	II B
South of Hukuro Cove	69°12'55"	39°38'10"	5.5	*in situ*	*Laternula elliptica*	**3,730**			**± 220**		β	GaK-6388	760115-28-3	Nogami	1976.1.15	Nogami, 1977	II B
South of Hukuro Cove	69°12'55"	39°38'10"	1.5	*in situ*	*Laternula elliptica*	**4,540**			**± 360**		β	GaK-6378	760115-28-2	Nogami	1976.1.15	Nogami, 1977	II B
North of Lake Nurume	69°13'03"	39°39'55"	15.0	?	*Laternula elliptica*	**6,440**			**± 140**		β	GaK-18334	940102-5	Hirakawa	1994.1.2	Hirakawa & Sawagaki, 1998	II B
Oyayubi Island	69°14'41"	39°42'55"	2.0	?	fragment of shell	**2,000**			**± 220**		β	GaK- ?	-	Yoshida	1967.10.10	Yoshida, 1983	II B
West of Lake Zakuro	69°10'41"	39°37'35"	3.0	?	fragment of shell	33,910	**34,750**		**± 410**		AMS	NUTA- ?	Ko-5	Igarashi	1993.1.16	Igarashi *et al.*, 1995b	II B
West of L. Zakuro, trench (1)	69°10'41"	39°37'35"	3.9	*in situ*	*Laternula elliptica*		3,060	**3,480**	**± 70**	+0.5	AMS	Beta-109391	951224-1a	Miura & Maemoku	1995.12.24	unpublished	II B
West of L. Zakuro, trench (1)	69°10'41"	39°37'35"	3.7	*in situ*	*Laternula elliptica*		3,620	**4,040**	**± 60**	+0.7	AMS	Beta-109392	951224-1b	Miura & Maemoku	1995.12.24	unpublished	II B
West of L. Zakuro, trench (1)	69°10'41"	39°37'35"	3.5	*in situ*	*Laternula elliptica*		41,200	**41,630**	**± 960**	+1.2	AMS	Beta-109393	951224-1c	Miura & Maemoku	1995.12.24	unpublished	II B
West of L. Zakuro, trench (1)	69°10'41"	39°37'35"	3.2	*in situ*	*Laternula elliptica*		42,500	**42,930**	**± 2,000**	+1.2	AMS	Beta-109394	951224-1d	Miura & Maemoku	1995.12.24	unpublished	II B
West of L. Zakuro, trench (2)	69°10'43"	39°37'44"	1.8	*in situ*	*Laternula elliptica*		3,520	**3,960**	**± 60**	+1.6	AMS	Beta-110482	951227-2a	Miura & Maemoku	1995.12.27	unpublished	II B
West of L. Zakuro, trench (2)	69°10'43"	39°37'44"	1.5	*in situ*	*Laternula elliptica*		3,880	**4,300**	**± 60**	+0.8	AMS	Beta-110483	951227-2b	Miura & Maemoku	1995.12.27	unpublished	II B
Lake Zakuro	69°10'43"	39°38'10"	-6.0	?	*Laternula elliptica*		2,620	**3,050**	**± 60**	+1.0	AMS	Beta-90956	940101-4	Hirakawa	1994.1.1	Hirakawa & Sawagaki, 1998	II B
Lake Zakuro	69°10'43"	39°38'10"	-9.0	*in situ*	*Laternula elliptica*		3,720	**4,140**	**± 60**	+0.5	AMS	Beta-109399	951221-2d	Miura & Maemoku	1995.12.21	unpublished	II B
Lake Zakuro	69°10'43"	39°38'10"	-6.0	*in situ*	*Laternula elliptica*	33,280	35,860	**33,410**	**± 510**		AMS	NUTA- ?	Ko-14	Igarashi	1993.1.16	Igarashi *et al.*, 1995a, b	II B
East of Lake Zakuro	69°10'38"	39°39'07"	6.5	*in situ*	tubes of polychaeta		37,480	**37,890**	**± 360**	0.0	AMS	Beta-116852	951223-1a	Miura & Maemoku	1995.12.23	unpublished	II B
East of Lake Zakuro	69°10'40"	39°38'50"	2.0	?	foram (*Elphidium magellanicum*)		38,500	**38,920**	**± 900**	+0.4	AMS	Beta-109421	Ko-19	Igarashi	1993.1.16	unpublished	II B
East of Lake Zakuro	69°10'40"	39°38'50"	0.0	?	fragment of shell (*La*)	37,030	41,650	**37,200**	**± 910**		AMS	NUTA- ?	Ko-20	Igarashi	1993.1.16	Igarashi *et al.*, 1995a, b	II B
East of Lake Zakuro	69°10'41"	39°38'50"	6.0	?	fragment of shell (*La*)	3,490	3,550	**3,660**	**± 100**		AMS	NUTA- ?	Ko-16	Igarashi	1993.1.16	Igarashi *et al.*, 1995a, b	II B
East of Lake Zakuro	69°10'40"	39°39'20"	8.0	?	*Adamussium colbecki*	34,780	38,000	**34,940**	**± 460**		AMS	NUTA- ?	Ko-21	Igarashi	1993.1.16	Igarashi *et al.*, 1995a, b	II B
East of Lake Zakuro, trench	69°10'41"	39°39'12"	2.4	*in situ*	*Laternula elliptica*		34,300	**34,720**	**± 330**	+0.6	AMS	Beta-109403	951227-4a	Miura & Maemoku	1995.12.27	unpublished	II B
East of Lake Zakuro, trench	69°10'41"	39°39'12"	2.1	*in situ*	*Laternula elliptica*		36,800	**37,240**	**± 700**	+1.5	AMS	Beta-109404	951227-4b	Miura & Maemoku	1995.12.27	unpublished	II B
East of Lake Zakuro, trench	69°10'41"	39°39'12"	1.8	*in situ*	*Laternula elliptica*		42,400	**42,820**	**± 690**	+0.2	AMS	Beta-109405	951227-4c	Miura & Maemoku	1995.12.27	unpublished	II B
East of Lake Zakuro, trench	69°10'42"	39°39'12"	4.0	*in situ*	*Laternula elliptica*		3,690	**4,090**	**± 40**	-0.5	AMS	Beta-94666	951223-2-a	Miura & Maemoku	1995.12.23	Miura *et al.*, 1998	II B
East of Lake Zakuro, trench	69°10'42"	39°39'12"	3.5	*in situ*	*Laternula elliptica*		3,910	**4,350**	**± 40**	+1.5	AMS	Beta-94667	951223-2-c	Miura & Maemoku	1995.12.23	Miura *et al.*, 1998	II B
East of Lake Zakuro, trench	69°10'42"	39°39'12"	3.2	*in situ*	*Laternula elliptica*		3,770	**4,220**	**± 70**	+2.1	AMS	Beta-109401	951223-2-d	Miura & Maemoku	1995.12.23	Miura *et al.*, 1998	II B
East of Lake Zakuro, trench	69°10'42"	39°39'12"	3.0	*in situ*	*Laternula elliptica*		45,680	**46,120**	**± 1,000**	+1.7	AMS	Beta-94668	951223-2-e	Miura & Maemoku	1995.12.23	Miura *et al.*, 1998	II B
East of Ko-minato Inlet	69°10'41"	39°41'10"	5.0	*in situ*	*Laternula elliptica*		5,330	**5,540**	**± 80**	+0.18	AMS	NUTA-2993	930116F4-1	Hayashi	1993.1.16	Hayashi & Yoshida, 1994	II B
East of Ko-minato Inlet	69°10'41"	39°41'10"	5.0	*in situ*	*Laternula elliptica*		5,930	**6,140**	**± 90**	+1.21	AMS	NUTA-2994	930116F4-2	Hayashi	1993.1.16	Hayashi & Yoshida, 1994	II B
East of Ko-minato Inlet	69°10'41"	39°41'10"	5.0	*in situ*	*Laternula elliptica*		5,030	**5,250**	**± 90**	+1.96	AMS	NUTA-2995	930116F4-3	Hayashi	1993.1.16	Hayashi & Yoshida, 1994	II B
South of Kominato Inlet	69°10'47"	39°40'38"	1.5	?	fragment of shell	34,160	**35,230**		**± 550**		AMS	NUTA- ?	Ko-27	Igarashi	1993.1.16	Igarashi *et al.*, 1995b	II B
South of Kominato Inlet	69°10'47"	39°40'38"	3.0	rework	fragment of shell (*Ad*)		38,700	**39,220**	**± 540**	+6.4	AMS	Beta-109422	Ko-24	Igarashi	1993.1.16	unpublished	II B
Southeast of Ko-minato Inlet	69°10'48"	39°41'16"	3.0	*in situ*	*Laternula elliptica*		3,100	**3,320**	**± 70**	+1.35	AMS	NUTA-2996	930116F5-1	Hayashi	1993.1.16	Hayashi & Yoshida, 1994	II B
Southeast of Ko-minato Inlet	69°10'48"	39°41'16"	3.0	*in situ*	*Laternula elliptica*		3,000	**3,220**	**± 70**	+1.56	AMS	NUTA-2997	930116F5-2	Hayashi	1993.1.16	Hayashi & Yoshida, 1994	II B
Southeast of Ko-minato Inlet	69°10'48"	39°41'16"	3.0	*in situ*	*Laternula elliptica*		4,020	**4,240**	**± 70**	+1.60	AMS	NUTA-3024	930116F5-3	Hayashi	1993.1.16	Hayashi & Yoshida, 1994	II B
Ko-minato higashi Beach																	
W-trench	69°10'50"	39°41'10"	4.5	*in situ*	*Laternula elliptica*		3,610	**4,050**	**± 80**	+1.4	AMS	Beta-100341	951220-1-a	Miura & Maemoku	1995.12.20	Maemoku *et al.*, 1997	II B
W-trench	69°10'50"	39°41'10"	4.3	*in situ*	*Laternula elliptica*		3,670	**4,090**	**± 80**	+0.8	AMS	Beta-100342	951220-1-b	Miura & Maemoku	1995.12.20	Maemoku *et al.*, 1997	II B
W-trench	69°10'50"	39°41'10"	4.2	*in situ*	*Laternula elliptica*		3,470	**3,870**	**± 60**	-0.6	AMS	Beta-109406	951220-1-c	Miura & Maemoku	1995.12.20	Miura *et al.*, 1998	II B
W-trench	69°10'50"	39°41'10"	3.3	*in situ*	*Laternula elliptica*		3,600	**4,060**	**± 50**	+2.5	AMS	Beta-100343	951220-1-d	Miura & Maemoku	1995.12.20	Maemoku *et al.*, 1997	II B
W-trench	69°10'50"	39°41'10"	2.2	*in situ*	*Laternula elliptica*		3,910	**4,360**	**± 70**	+2.2	AMS	Beta-100344	951220-1-e	Miura & Maemoku	1995.12.20	Maemoku *et al.*, 1997	II B
W-trench	69°10'50"	39°41'10"	2.2	rework	*Laternula elliptica*		40,040	**40,460**	**± 520**	+0.2	AMS	Beta-116850	951220-1-e'	Miura & Maemoku	1995.12.20	unpublished	II B

Appendix I. Inventory of radiocarbon dates of marine fossils around Lützow-Holm Bay (4).

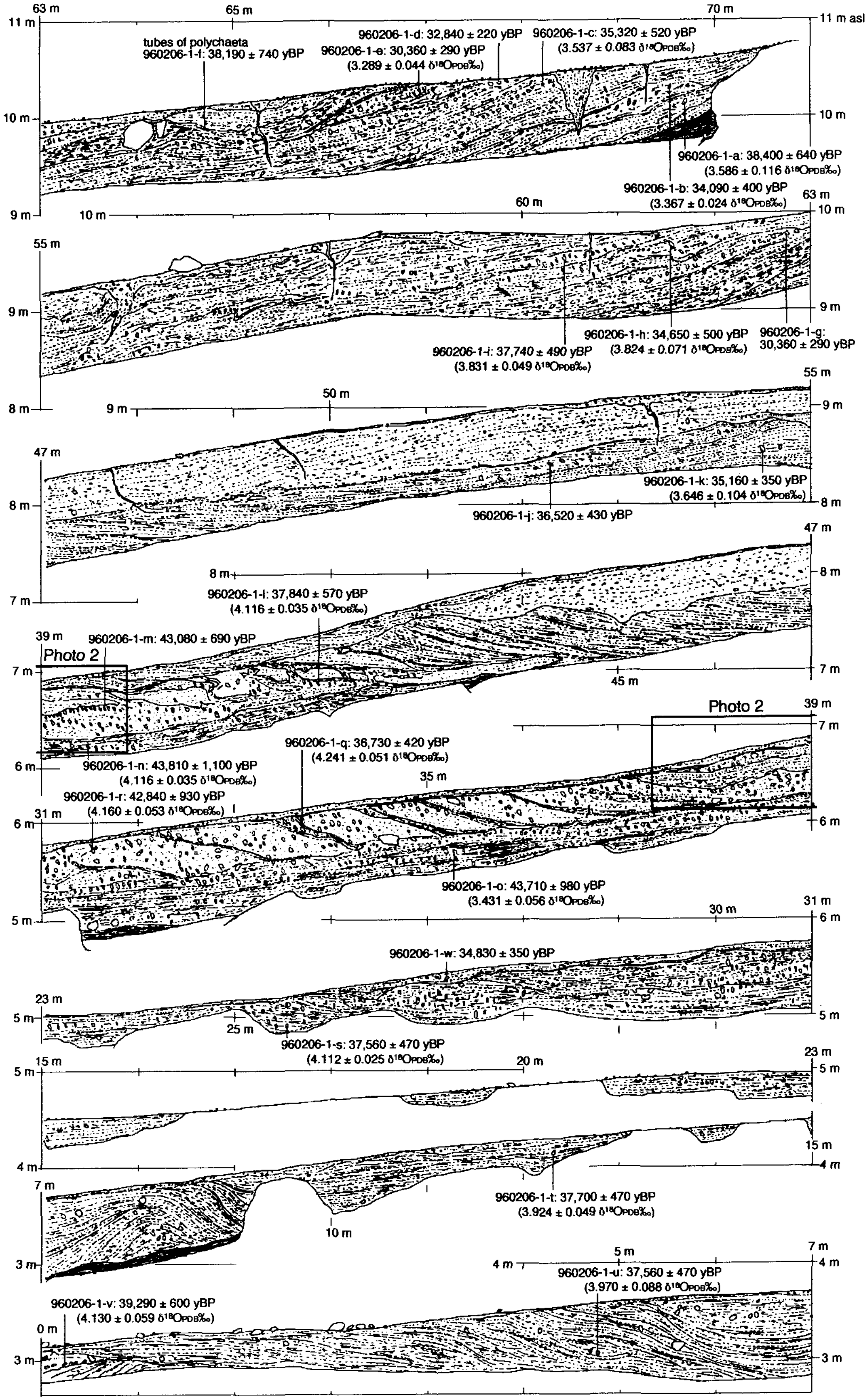
Locality	South Latitude	East Longitude	Elevation (m asl)	Deposit form	Material	^{14}C age (yBP) raw	^{14}C age (yBP) with background correction	^{14}C age (yBP) with $\delta^{13}C$ correction	Error (yr)	$\delta^{13}C$ (‰)	Dating method	Laboratory code & number	Sample code & number	Collector(s)	Date of collection	Reference	Code of map in the sheet
W-trench	69°10'50"	39°41'10"	1.7	*in situ*	*Laternula elliptica*		3,490	**3,930**	± 60	+1.3	AMS	Beta-109407	951220-1-f	Miura & Maemoku	1995.12.20	Miura *et al.*, 1998	II B
W-trench	69°10'50"	39°41'10"	2.1	?	*Adamussium colbecki*		3,550	**4,010**	± 40	+2.9	AMS	Beta-116851	951220-1-g	Miura & Maemoku	1995.12.20	unpublished	II B
W-trench	69°10'50"	39°41'10"	2.4	*in situ*	*Laternula elliptica*		39,020	**39,440**	± 580	+0.7	AMS	Beta-100345	951220-1-i	Miura & Maemoku	1995.12.20	Maemoku *et al.*, 1997	II B
W-trench	69°10'50"	39°41'10"	2.8	*in situ*	*Laternula elliptica*		32,010	**32,430**	± 270	+0.1	AMS	Beta-100346	951220-1-j	Miura & Maemoku	1995.12.20	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	9.2	*in situ*	*Laternula elliptica*		4,480	**4,920**	± 60	+1.4	AMS	Beta-94669	951227-1-a	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	8.9	*in situ*	*Laternula elliptica*		4,440	**4,850**	± 60	0.0	AMS	Beta-94670	951227-1-b	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	8.5	*in situ*	*Laternula elliptica*		4,850	**5,270**	± 60	+0.8	AMS	Beta-94671	951227-1-c	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	9.2	*in situ*	*Laternula elliptica*		3,920	**4,350**	± 70	+1.1	AMS	Beta-94672	951227-1-d	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	8.6	*in situ*	*Laternula elliptica*		4,460	**4,900**	± 60	+1.7	AMS	Beta-94673	951227-1-e	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	7.7	*in situ*	*Laternula elliptica*		4,580	**5,000**	± 50	+0.7	AMS	Beta-94674	951227-1-f	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	7.5	*in situ*	*Laternula elliptica*		4,650	**5,070**	± 50	+0.7	AMS	Beta-109395	951227-1-g	Miura & Maemoku	1995.12.27	Miura *et al.*, 1998	II B
E-trench	69°10'51"	39°41'15"	6.4	*in situ*	*Laternula elliptica*		45,970	**46,420**	± 1,500	+2.4	AMS	Beta-100347	951227-1-h	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	6.2	*in situ*	*Laternula elliptica*		35,550	**35,970**	± 410	+0.1	AMS	Beta-94675	951227-1-i	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	5.9	?	*Laternula elliptica*		37,200	**37,620**	± 390	+0.3	AMS	Beta-109396	951227-1-j	Miura & Maemoku	1995.12.27	Miura *et al.*, 1998	II B
E-trench	69°10'51"	39°41'15"	5.2	*in situ*	*Laternula elliptica*		39,330	**39,760**	± 600	+0.9	AMS	Beta-94676	951227-1-k	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	4.8	*in situ*	*Laternula elliptica*		39,000	**39,420**	± 590	+0.5	AMS	Beta-109397	951227-1-l	Miura & Maemoku	1995.12.27	Miura *et al.*, 1998	II B
E-trench	69°10'51"	39°41'15"	4.7	*in situ*	*Laternula elliptica*		42,310	**42,710**	± 920	-1.0	AMS	Beta-94677	951227-1-m	Miura & Maemoku	1995.12.27	Maemoku *et al.*, 1997	II B
E-trench	69°10'51"	39°41'15"	6.8	?	diatomaceous earth ?		7,610	**7,720**	± 120	-18.0	AMS	Beta-109398	951227-1-n	Miura & Maemoku	1995.12.27	unpublished	II B
Southeast of Ko-minato Inlet	69°10'51"	39°41'30"	12.0	*in situ*	*Laternula elliptica*		5,020	**5,450**	± 70	+1.1	AMS	Beta-110481	951227-5a	Miura & Maemoku	1995.12.27	unpublished	II B
South of Mizukuguri Cove	69°11'45"	39°37'35"	2.3	rework	fragment of shell		35,300	**35,720**	± 1,000	+0.5	AMS	Beta-110484	Mk-4	Igarashi	1993.1.15	unpublished	II B
South of Mizukuguri Cove	69°11'52"	39°37'25"	1.5	rework	fragment of shell	35,510	**36,790**		± 540		AMS	NUTA- ?	Mk-14	Igarashi	1993.1.15	Igarashi *et al.*, 1995b	II B
North of Lake Nurume	69°13'13"	39°40'25"	12.0	?	fragment of shell	**5,370**			± 70		AMS	NUTA- ?	Ky-9	Igarashi	1993.1.17	Igarashi *et al.*, 1995b	II B
South of L. Nurume, trench	69°13'31"	39°40'01"	7.2	*in situ*	*Laternula elliptica*		4,490	**4,920**	± 60	+1.0	AMS	Beta-110479	951228-2a	Miura & Maemoku	1995.12.28	unpublished	II B
South of L. Nurume, trench	69°13'31"	39°40'01"	7.0	*in situ*	*Laternula elliptica*		5,640	**6,070**	± 70	+1.3	AMS	Beta-110480	951228-2b	Miura & Maemoku	1995.12.28	unpublished	II B
Southern part of Langhovde																	
Mouth of Yatude Valley	69°14'42"	39°43'30"	4.0	?	*Laternula elliptica*	**5,330**			± 125		β	N-2605	75051701	Hayashi	1975.5.17	Hayashi & Yoshida, 1994	II B
Northwest of Simokama	69°15'52"	39°43'55"	1.5	*in situ*	*Laternula elliptica*	**3,840**			± 90		β	GaK-4850	-	Ishikawa	1972	Ishikawa, 1974	I
Northwest of Simokama	69°15'52"	39°43'55"	1.5	?	*Laternula elliptica*	**3,080**			± 90		β	N-2604	75051602	Hayashi	1975.5.16	Hayashi & Yoshida, 1994	I
Mouth of Yukidori Valley	69°14'35"	39°43'31"	10.0	*in situ*	*Laternula elliptica*		3,870	**4,280**	± 90	0.0	AMS	Beta-109400	960107-1a	Miura & Maemoku	1996.1.7	Miura *et al.*, 1998	II B
Mouth of Yukidori Valley	69°14'35"	39°43'39"	12.0	*in situ*	*Laternula elliptica*		6,400	**6,810**	± 60	0.0	AMS	Beta-94684	960107-2-a	Miura & Maemoku	1996.1.7	unpublished	II B
Near mouth of Yatude Valley	69°14'38"	39°42'55"	2.8	rework	fragment of shell (*La*)	**4,570**			± 160		AMS	NUTA- ?	Yz-14	Igarashi	1993.1.11	Igarashi *et al.*, 1995b	II B
Near mouth of Yatude Valley	69°14'38"	39°42'55"	2.4	?	foram (*Globocassidulina biora*)	**6,040**			± 120		AMS	NUTA- ?	Yz-20	Igarashi	1993.1.11	Igarashi *et al.*, 1995b	II B
Near mouth of Yatude Valley																	
trench	69°14'39"	39°43'20"	5.3	*in situ*	*Laternula elliptica*		3,750	**4,180**	± 50	+1.2	AMS	Beta-94678	960106-1-a	Miura & Maemoku	1996.1.6	Miura *et al.*, 1998	II B
trench	69°14'39"	39°43'20"	5.0	*in situ*	*Laternula elliptica*		5,390	**5,820**	± 80	+1.2	AMS	Beta-94679	960106-1-b	Miura & Maemoku	1996.1.6	Miura *et al.*, 1998	II B
trench	69°14'39"	39°43'20"	2.7	*in situ*	*Laternula elliptica*		4,360	**4,780**	± 60	+0.6	AMS	Beta-94680	960106-1-c	Miura & Maemoku	1996.1.6	Miura *et al.*, 1998	II B
trench	69°14'39"	39°43'20"	1.7	*in situ*	*Laternula elliptica*		2,750	**3,170**	± 70	+0.5	AMS	Beta-94681	960106-1-d	Miura & Maemoku	1996.1.6	Miura *et al.*, 1998	II B
trench	69°14'39"	39°43'20"	1.3	*in situ*	*Laternula elliptica*		3,020	**3,440**	± 50	+0.8	AMS	Beta-94682	960106-1-e	Miura & Maemoku	1996.1.6	Miura *et al.*, 1998	II B
trench	69°14'39"	39°43'20"	1.1	*in situ*	*Laternula elliptica*		3,460	**3,890**	± 50	+1.0	AMS	Beta-94683	960106-1-f	Miura & Maemoku	1996.1.6	Miura *et al.*, 1998	II B
Mouth of Yatude Valley	69°14'40"	39°43'40:	17.0	*in situ*	*Laternula elliptica*		6,390	**6,810**	± 60	+0.2	AMS	Beta-94685	960108-5-a	Miura & Maemoku	1996.1.8	Miura *et al.*, 1998	II B
Mouth of Yatude Valley	69°14'40"	39°43'40:	16.0	?	diatomaceous earth ?		6,520	**6,650**	± 70	-17.3	AMS	Beta-109402	960108-5c	Miura & Maemoku	1996.1.8	unpublished	II B
Mouth of Yatude Valley	69°14'41"	39°43'38"	9.0	?	*Laternula elliptica*		3,570	**3,990**	± 40	+0.2	AMS	Beta-116849	960109-1a	Miura & Maemoku	1996.1.9	unpublished	II B
Mouth of Yatude Valley	69°14'43"	39°43'38"	10.5	*in situ*	*Laternula elliptica*		4,640	**5,070**	± 60	+0.9	AMS	Beta-94686	960108-7-a	Miura & Maemoku	1996.1.8	unpublished	II B
Near Mouth of Yatude Valley	69°15'00"	39°42'50"	3.0	?	fragment of shell (*La*)		3,420	**3,860**	± 70	+1.4	AMS	Beta-109423	Yt-14	Igarashi	1993.1.14	unpublished	II B

Appendix I. *Inventory of radiocarbon dates of marine fossils around Lützow-Holm Bay (5).*

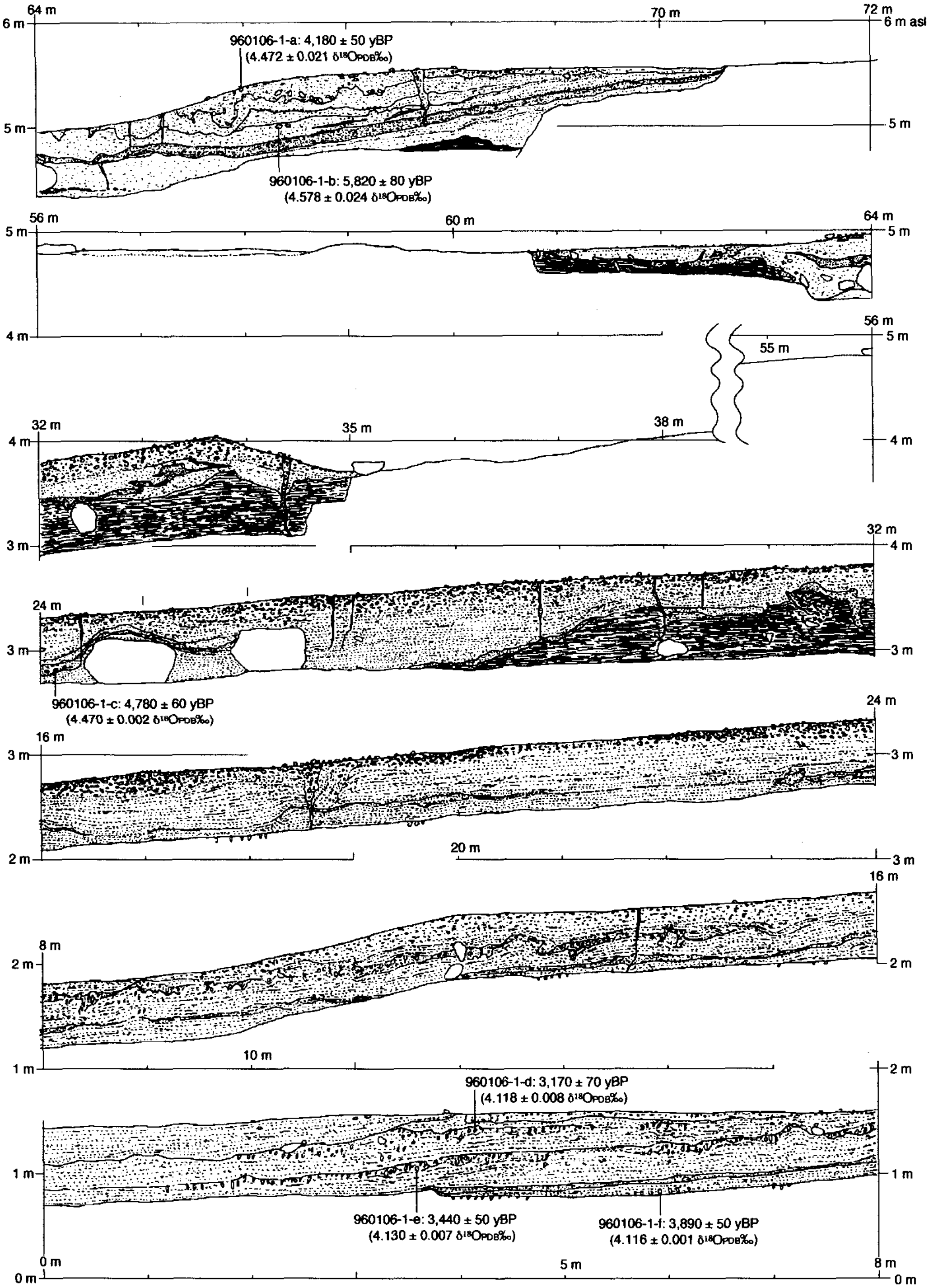
Locality	South Latitude	East Longitude	Elevation (m asl)	Deposit form	Material	^{14}C age (yBP) raw	with background correction	with $\delta^{13}C$ correction	Error (yr)	$\delta^{13}C$ (‰)	Dating method	Laboratory code & number	Sample code & number	Collector(s)	Date of collection	Reference	Code of map in the sheet
North of Simokama	69°15'45"	39°44'21"	5.5	*in situ*	*Laternula elliptica*		6,290	**6,510**	± 60	1.49	AMS	NUTA-2984	930108F2-1	Hayashi	1993.1.8	Hayashi & Yoshida, 1994	I
North of Simokama	69°15'45"	39°44'21"	5.5	*in situ*	*Laternula elliptica*		5,990	**6,200**	± 70	0.18	AMS	NUTA-2985	930108F2-2	Hayashi	1993.1.8	Hayashi & Yoshida, 1994	I
North of Simokama	69°15'45"	39°44'21"	5.5	*in situ*	*Laternula elliptica*		5,450	**5,670**	± 70	1.10	AMS	NUTA-2986	930108F2-3	Hayashi	1993.1.8	Hayashi & Yoshida, 1994	I
Breivågnipa, west coast	69°20'43"	39°46'00"	0.8	rework	fragment of shell (*La*)		4,120	**4,550**	± 50	+0.9	AMS	Beta-109429	Bn-2	Igarashi	1993.2.2	unpublished	I
West coast	69°20'59"	39°45'42"	1.0	?	fragment of shell (*La*)	**6,430**			± 60		AMS	NUTA- ?	Bn-8	Igarashi	1993.2.2	Igarashi *et al*., 1995b	I
Northwestern part of Skarvsnes																	
Southeast of Skjegget	69°26'20"	39°39'20"	12.0	*in situ*	*Laternula elliptica*	**5,370**			± 160		β	GaK-6389	760124-32	Nogami	1976.1.24	Nogami, 1977	II C
Southeast of Skjegget	69°26'20"	39°39'33"	11.5	?	*Laternula elliptica*	**4,870**			± 75		β	N-2607	76012403	Hayashi	1976.1.24	Hayashi & Yoshida, 1994	II C
Southeast of Skjegget	69°26'26"	39°39'31"	9.0	?	fragment of shell	**5,130**			± 95		β	N-2606	76012402	Hayashi	1976.1.24	Hayashi & Yoshida, 1994	II C
Northwest of Lake Hunazoko	69°26'32"	39°33'10"	9.0	?	*Laternula elliptica*	**3,870**			± 90		β	GaK-18341	940106-6	Hirakawa	1994.1.6	Hirakawa & Sawagaki, 1998	II C
Northwest of Lake Hunazoko	69°26'33"	39°33'15"	-10.5	*in situ*	*Laternula elliptica*	**2,000**			± 120		β	GaK-6383	760122-18-1	Nogami	1976.1.22	Nogami, 1977	II C
Northwest of Lake Hunazoko	69°26'33"	39°33'15"	-4.0	*in situ*	*Laternula elliptica*	**3,120**			± 110		β	GaK-6384	760122-18-2	Nogami	1976.1.22	Nogami, 1977	II C
Northwest of Lake Hunazoko	69°26'36"	39°33'12"	8.0	?	fragment of shell	**31,600**			+/- $^{2,800}/_{2,100}$		β	GaK-2036	-	Yoshida	1967.2.3	Yoshida, 1970	II C
Northwest of Lake Hunazoko	69°26'36"	39°33'20"	-23.0	?	fragment of shell	**3,200**			± 130		β	TH-051	-	Omoto	1973.2.6	Omoto, 1977	II C
Northwest of Lake Hunazoko	69°26'36"	39°33'20"	-1.0	?	*Laternula elliptica*	**4,830**			± 150		β	TH-054	-	Omoto	1973.2.6	Omoto, 1977	II C
South of Lake Hunazoko	69°26'51"	39°33'52'	3.5	?	*Laternula elliptica*	**2,540**			± 160		β	GaK-5834	75012802	Hayashi	1975.1.28	Yoshida, 1983	II C
South of Lake Hunazoko	69°26'51"	39°34'05"	-23.0	?	*Laternula elliptica*	**4,190**			± 100		β	GaK-2037	-	Yoshida	1967.2.3	Yoshida, 1970	II C
South of Lake Hunazoko	69°26'52"	39°34'10"	-23.0	*in situ*	*Laternula elliptica*	**3,200**			± 130		β	GaK-6377	760122-15-1	Nogami	1976.1.22	Nogami, 1977	II C
South of Lake Hunazoko	69°26'52"	39°33'55"	-6.0	*in situ*	*Laternula elliptica*	**2,510**			± 110		β	GaK-6379	760122-16-2	Nogami	1976.1.22	Nogami, 1977	II C
South of Lake Hunazoko	69°26'52"	39°33'55"	-1.5	*in situ*	*Laternula elliptica*	**3,530**			± 130		β	GaK-6380	760122-16-3	Nogami	1976.1.22	Nogami, 1977	II C
South of Lake Hunazoko	69°26'52"	39°34'05"	-19.6	*in situ*	diatom	**4,540**			± 360		β	GaK-6378	760122-16-4-1	Nogami	1976.1.22	Nogami, 1977	II C
South of Lake Hunazoko	69°26'54"	39°34'10"	-2.0	?	fragment of shell (*Ad, La*)	**2,670**			± 90		β	GaK-18340	940106-5	Hirakawa	1994.1.6	Hirakawa & Sawagaki, 1998	II C
South of Skjegget	69°26'51"	39°38'39"	11.0	?	*Laternula elliptica*	**4,690**			± 70		β	N-2608	76012404	Hayashi	1976.1.24	Hayashi & Yoshida, 1994	II C
Kizahasi Beach	69°27'41"	39°35'43"	8.0	?	*Adamussium colbecki*	**4,700**			± 100		β	GaK-2034	-	Yoshida	1967.2.1	Yoshida, 1970	II C
Kizahasi Beach	69°27'41"	39°35'45"	2.0	?	*Adamussium colbecki*	**3,600**			± 100		β	GaK-2035	-	Yoshida	1967.2.1	Yoshida, 1970	II C
Kizahasi Beach	69°27'42"	39°35'23"	11.0	?	*Laternula elliptica*	**5,580**			± 180		β	GaK-5835	75013001	Hayashi	1975.1.30	Yoshida, 1983	II C
Kizahasi Beach	69°27'43"	39°35'25"	5.0	*in situ*	*Laternula elliptica*	**8,130**			± 200		β	GaK-6390	760124-34-1	Nogami	1976.1.24	Nogami, 1977	II C
Kizahasi Beach	69°27'43"	39°35'25"	12.0	*in situ*	*Laternula elliptica*	**6,700**			± 180		β	GaK-6391	760124-34-2	Nogami	1976.1.24	Nogami, 1977	II C
Kizahasi Beach	69°27'43"	39°35'25"	15.5	*in situ*	*Laternula elliptica*	**5,860**			± 170		β	GaK-6392	760124-34-3	Nogami	1976.1.24	Nogami, 1977	II C
Kizahasi Beach	69°27'43"	39°35'25"	12.0	?	*Laternula elliptica*	**5,720**			± 110		β	GaK-18339	940106-3	Hirakawa	1994.1.6	Hirakawa & Sawagaki, 1998	II C
Kizahasi Beach	69°27'59"	39°35'45"	12.0	?	*Laternula elliptica*	**4,960**			± 100		β	GaK-18338	940106-2	Hirakawa	1994.1.6	Hirakawa & Sawagaki, 1998	II C
Northwest of Lake Hunazoko	69°26'35"	39°33'25"	-17.0	*in situ*	*Laternula elliptica*	**2,340**			± 90		AMS	NUTA- ?	Fn-17	Igarashi	1991.12.31	Igarashi *et al*., 1995b	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	3.7	*in situ*	*Laternula elliptica*		3,840	**4,260**	± 60	+0.4	AMS	Beta-94687	960116-1-a	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	4.9	*in situ*	*Laternula elliptica*		3,660	**4,060**	± 60	-0.4	AMS	Beta-94688	960116-1-b	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	5.2	*in situ*	*Laternula elliptica*		3,980	**4,400**	± 70	+0.6	AMS	Beta-94689	960116-1-c	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	5.1	*in situ*	*Laternula elliptica*		3,970	**4,380**	± 50	-0.1	AMS	Beta-94690	960116-1-d	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	5.6	*in situ*	*Laternula elliptica*		4,020	**4,430**	± 60	-0.1	AMS	Beta-94691	960116-1-e	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	6.0	*in situ*	*Laternula elliptica*		4,140	**4,560**	± 60	+0.1	AMS	Beta-94692	960116-1-f	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	7.9	*in situ*	*Laternula elliptica*		4,520	**4,670**	± 60	+0.4	AMS	Beta-94693	960116-1-g	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	9.0	*in situ*	*Laternula elliptica*		4,440	**4,860**	± 60	+0.5	AMS	Beta-94694	960116-1-h	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	9.4	*in situ*	*Laternula elliptica*		4,520	**4,910**	± 50	-1.2	AMS	Beta-94695	960116-1-i	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	9.5	*in situ*	*Laternula elliptica*		4,790	**5,190**	± 60	-0.5	AMS	Beta-94696	960116-1-j	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	11.2	*in situ*	*Laternula elliptica*		4,880	**5,290**	± 70	-0.2	AMS	Beta-94697	960116-1-k	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C
Kizahasi Beach, trench	69°27'43"	39°35'20"	14.9	*in situ*	*Laternula elliptica*		6,750	**7,170**	± 60	+0.4	AMS	Beta-94698	960116-1-l	Miura & Maemoku	1996.1.16	Miura *et al*., 1998	II C

Appendix I. *Inventory of radiocarbon dates of marine fossils around Lützow-Holm Bay (6).*

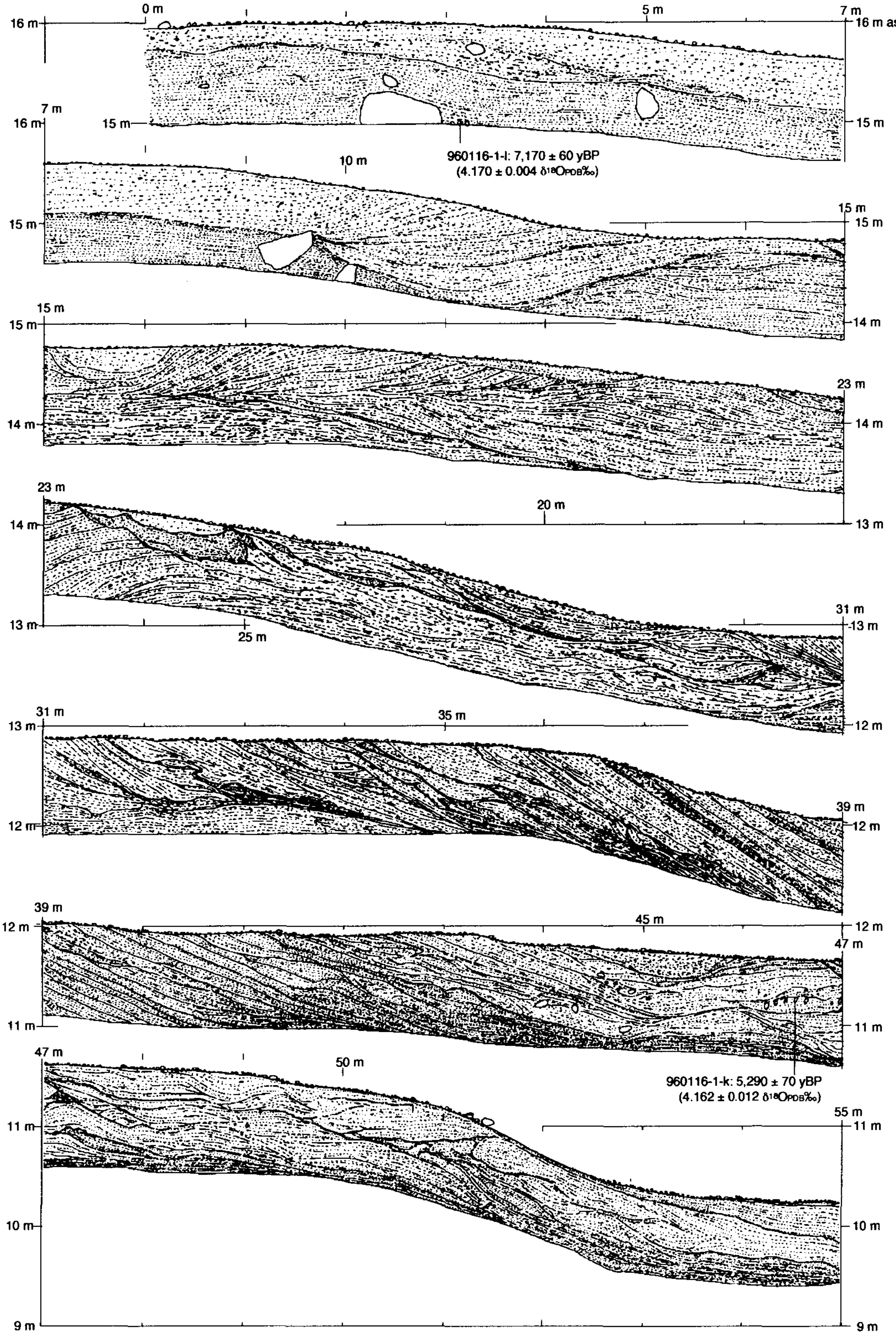
Locality	South Latitude	East Longitude	Elevation (m asl)	Deposit form	Material	^{14}C age (yBP) raw	with background correction	with $\delta^{13}C$ correction	Error (yr)	$\delta^{13}C$ (‰)	Dating method	Laboratory code & number	Sample code & number	Collector(s)	Date of collection	Reference	Code of map in the sheet
Southeastern part of Skarvsnes																	
South of Osen	69°28'26"	39°39'11"	8.0	?	tubes of polychaeta	8,370			± 270		β	GaK-5833	75013102	Hayashi	1975.1.31	Yoshida, 1983	II C
Northwest of Lake Oyako	69°28'27"	39°36'45"	5.0	?	*Laternula elliptica*	3,570			± 95		β	N-2609	76012501	Hayashi	1976.1.25	Hayashi & Yoshida, 1994	II C
South of Osen	69°28'31"	39°39'14"	6.0	?	*Laternula elliptica*	4,430			± 90		β	GaK-5841	75013002	Hayashi	1975.1.30	Yoshida, 1983	II C
South of Osen	69°28'41"	39°39'15"	18.0	?	tubes of polychaeta	8,860			± 160		β	GaK-18335	940104-3	Hirakawa	1994.1.4	Hirakawa & Sawagaki, 1998	II C
South of Osen	69°28'46"	39°39'10"	8.0	?	tubes of polychaeta	7,680			± 250		β	GaK-6369	760121-4	Nogami	1976.1.21	Nogami, 1977	II C
Northeast of Torinosu Cave	69°28'46"	39°36'00"	10.0	?	*Laternula elliptica*		2,950	3,370	± 70	+0.8	β	Beta-80991	940107-4	Hirakawa	1994.1.7	Hirakawa & Sawagaki, 1998	II C
Northeast of Torinosu Cave	69°28'47"	39°35'54"	0.5	?	*Laternula elliptica*	3,180			± 250		β	GaK-2039	-	Yoshida	1967.2.2	Yoshida, 1970	II C
North of Lake Suribati	69°28'58"	39°40'21"	-32.0	?	seal bone	5,230			± 155		β	TH-053	-	Omoto	1973.2.4	Omoto, 1977	II C
Northwest of Lake Suribati	69°28'50"	39°39'20"	2.0	*in situ*	tubes of polychaeta	5,870			± 210		β	GaK-6370	760121-5	Nogami	1976.1.21	Nogami, 1977	II C
Northwest of Lake Suribati	69°28'50"	39°39'15"	15.0	?	*Laternula elliptica*		4,530	4,970	± 70	+1.6	β	Beta-80990	940104-5	Hirakawa	1994.1.4	Hirakawa & Sawagaki, 1998	II C
Northwest of Lake Suribati	69°29'05"	39°39'40"	4.5	*in situ*	tubes of polychaeta	6,180			± 260		β	GaK-6371	760121-7-1	Nogami	1976.1.21	Nogami, 1977	II C
South of Lake Suribati	69°29'26'	39°40'48"	15.0	?	tubes of polychaeta	7,830			± 280		β	GaK-5837	75012905	Hayashi	1975.1.29	Yoshida, 1983	II C
South of Lake Suribati	69°29'31"	39°41'09"	-30.0	?	tubes of polychaeta	5,640			± 130		β	GaK-2038	-	Yoshida	1967.10.7	Yoshida, 1970	II C
South of Lake Suribati	69°29'37"	39°41'10"	10.0	?	tubes of polychaeta	6,090			± 120		β	GaK-18336	940104-8	Hirakawa	1994.1.4	Hirakawa & Sawagaki, 1998	II C
South of Lake Suribati	69°29'37"	39°41'10"	6.0	?	tubes of polychaeta	6,090			± 90		β	GaK-5840	740523	Moriwaki	1974.5.23	Moriwaki, 1976	II C
South of Lake Suribati	69°29'37"	39°41'20"	13.0	?	tubes of polychaeta	6,630			± 230		β	GaK-6373	760121-9A	Nogami	1976.1.21	Nogami, 1977	II C
South of Lake Suribati	69°29'39"	39°41'10"	20.0	?	*Adamussium colbecki*	8,440			± 140		β	GaK-18337	940104-8b	Hirakawa	1994.1.4	Hirakawa & Sawagaki, 1998	II C
Near Lake Suribati	?	?	14.0	?	*Laternula elliptica*	7,450			± 135		β	N-926	-	Omoto	1969	Omoto *et al*., 1974	-
Near Lake Suribati	?	?	14.0	?	*Laternula elliptica*	6,020			± 175		β	TH-020	-	Omoto	1969	Omoto *et al*., 1974	-
North of Trillingbukta	69°30' 01"	39°39' 00"	3.0	?	*Laternula elliptica*	3,370			± 120		β	GaK-5836	75012902	Hayashi	1975.1.29	Yoshida, 1983	II C
Northwest of Lake Suribati	69°28'50"	39°39'15"	13.0	?	foraminifera (*Cibicides spp.*)	5,640			± 120		AMS	NUTA- ?	Bc-8	Igarashi	1992.1.5	Igarashi *et al*., 1995b	II C
Northwest of Lake Suribati	69°28'50"	39°39'15"	16.0	?	fragment of shell (*La*)	4,970			± 80		AMS	NUTA- ?	Bc-11	Igarashi	1992.1.5	Igarashi *et al*., 1995b	II C
Northwest of Lake Suribati	69°28'54"	39°39'23"	10.5	?	fragment of shell (*La*)		5,010	5,460	± 60	+2.0	AMS	Beta-109425	Bc-1	Igarashi	1992.1.5	unpublished	II C
Northwest of Lake Suribati	69°28'54"	39°39'23"	15.0	?	tubes of polychaeta		7,530	7,950	± 50	+0.6	AMS	Beta-109426	Bc-5	Igarashi	1992.1.5	unpublished	II C
South of Lake Suribati	69°29'35"	39°41'05"	13.0	?	foraminifera (*Cibicides spp.*)	6,140			± 120		AMS	NUTA- ?	Sb-7	Igarashi	1991.12.3C	Igarashi *et al*., 1995b	II C
Skallen																	
Eastern shore of Skallen	69°39'18"	39°26'42"	2.0	?	fragment of shell (*La*)	2,810		3,240	± 50	+0.9	AMS	Beta-109428	Mm-5	Igarashi	1993.1.27	Igarashi, unpublished	II D
Eastern shore of Skallen	69°40'11"	39°27'45"	0.7	?	fragment of shell (*La*)	2,830		3,290	± 60	+2.9	AMS	Beta-109727	Mp-3	Igarashi	1993.1.28	unpublished	II D
West of Lake Skallen O-ike	69°40'18"	39°20'30"	12.0	?	fragment of shell (*La*)	4,560	4,620	4,720	± 90		AMS	NUTA- ?	Ok-1	Igarashi	1993.1.26	Igarashi *et al*., 1995a, b	II D
West of Lake Skallen O-ike	69°40'21"	39°24'20"	7.0	?	fragment of shell (*Ad*)	7,630	7,720	7,810	± 130		AMS	NUTA- ?	Ok-2	Igarashi	1993.1.26	Igarashi *et al*., 1995a, b	II D
Magoke Point	69°40'58"	39°29'30"	5.0	?	fragment of shell (*La*)	3,010	3,060	3,180	± 90		AMS	NUTA- ?	Mp-14	Igarashi	1993.1.28	Igarashi *et al*., 1995a, b	II D
Magoke Point	69°41'00"	39°30'02"	1.0	?	fragment of shell (*La*)	3,610	3,670	3,790	± 180		AMS	NUTA- ?	Mp-12	Igarashi	1993.1.28	Igarashi *et al*., 1995a, b	II D
Skallevikhalsen, NE of L. Dairi	69°41'02"	39°30'35"	5.0	?	*Laternula elliptica*	3,930			± 70		β	GaK-18342	940109-1	Hirakawa	1994.1.9	Hirakawa & Sawagaki, 1998	II D
Rundvågshetta																	
NW pocket beach	69°54'10"	39°39'05"	5.0	?	*Laternula elliptica*		3,040	3,470	± 70	+1.3	β	Beta-80992	940112-3	Hirakawa	1994.1.12	Hirakawa & Sawagaki, 1998	I
NW pocket beach	69°54'12"	39°00'42"	15.0	?	*Laternula elliptica*	6,460			± 100		β	GaK-18343	940112-4	Hirakawa	1994.1.12	Hirakawa & Sawagaki, 1998	I
Northwest of Maruwan Lake	69°54'19"	39°01'20"	11.0	?	*Laternula elliptica*		5,660	6,090	± 80	+1.8	β	Beta-80993	940114-3b	Hirakawa	1994.1.14	Hirakawa & Sawagaki, 1998	I
Northwest of Maruwan Lake	69°54'19"	39°01'20"	15.0	?	*Laternula elliptica*	5,380			± 120		β	GaK-18344	940114-3a	Hirakawa	1994.1.14	Hirakawa & Sawagaki, 1998	I



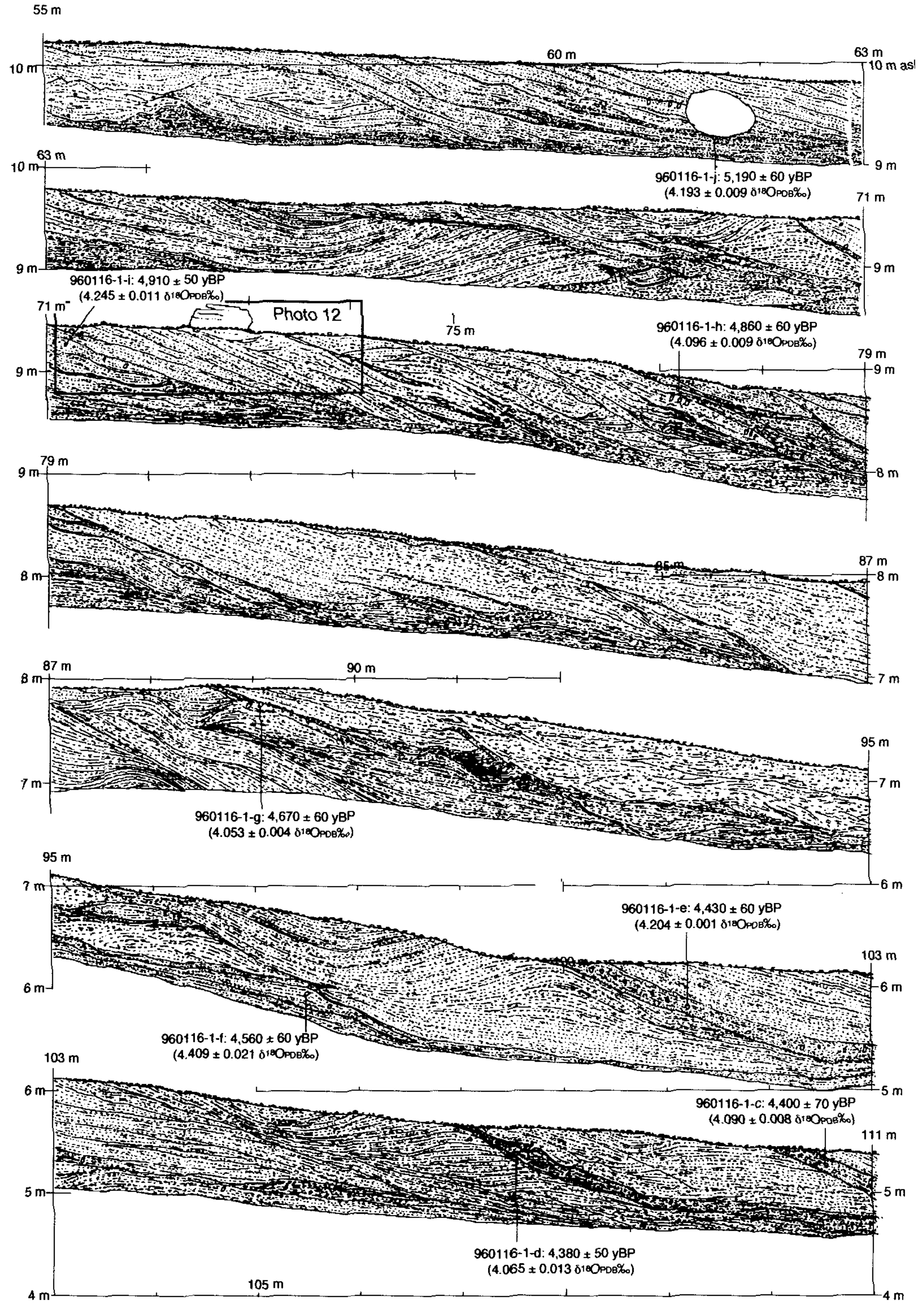
Appendix 2. Sketch of cross section at Kai-no-hama Beach in East Ongul Island.



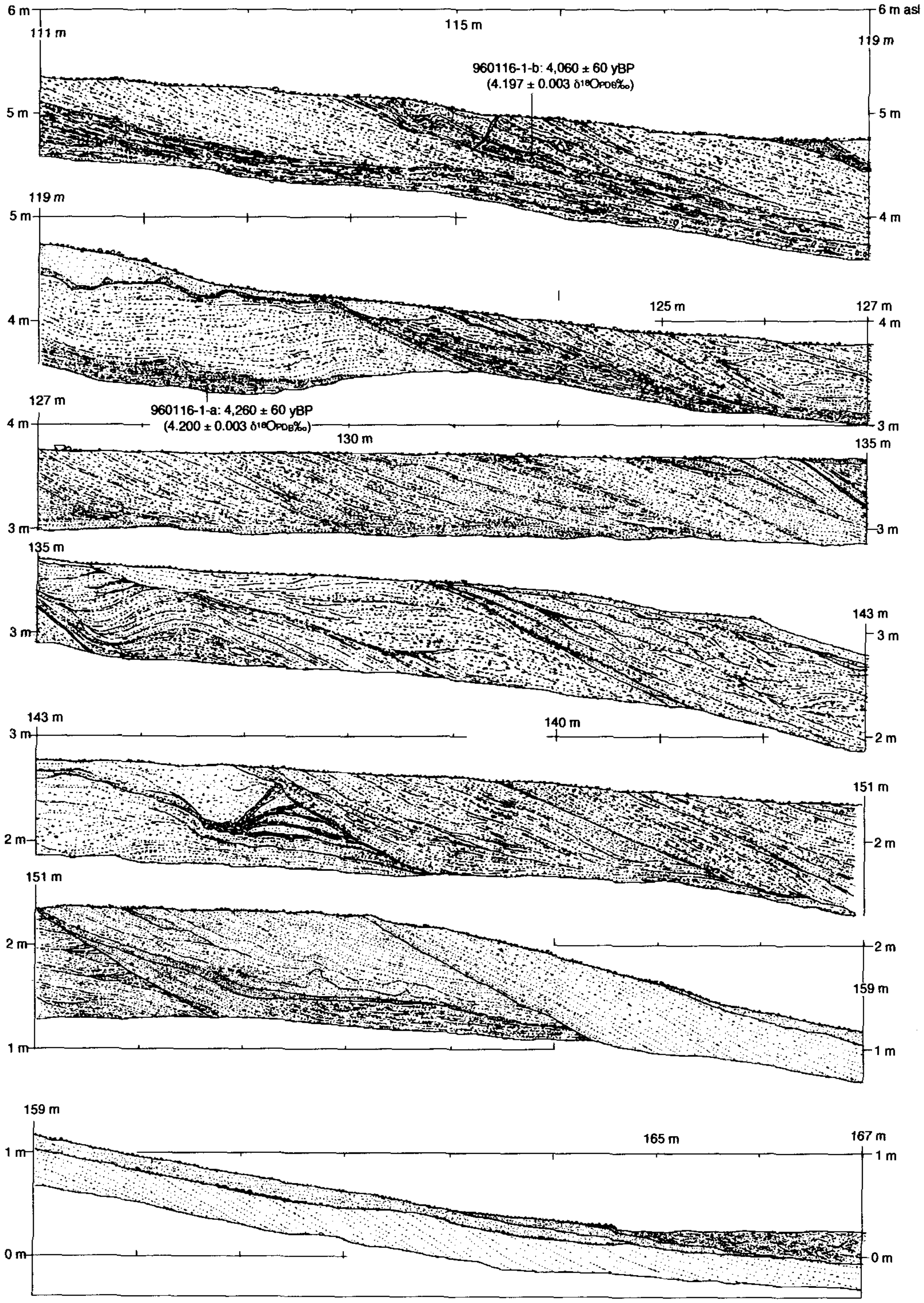
Appendix 3. Sketch of cross section near the mouth of Yatude Valley in the southern part of Langhovde.



Appendix 4. Sketch of cross section at Kizahasi Beach in Skarvsnes.



Appendix 4 (continued).



Appendix 4 (continued).

Photo 1. Trench (960206-1) at Kai-no-hama Beach, East Ongul Island (see Fig. 4 and Appendix 2).

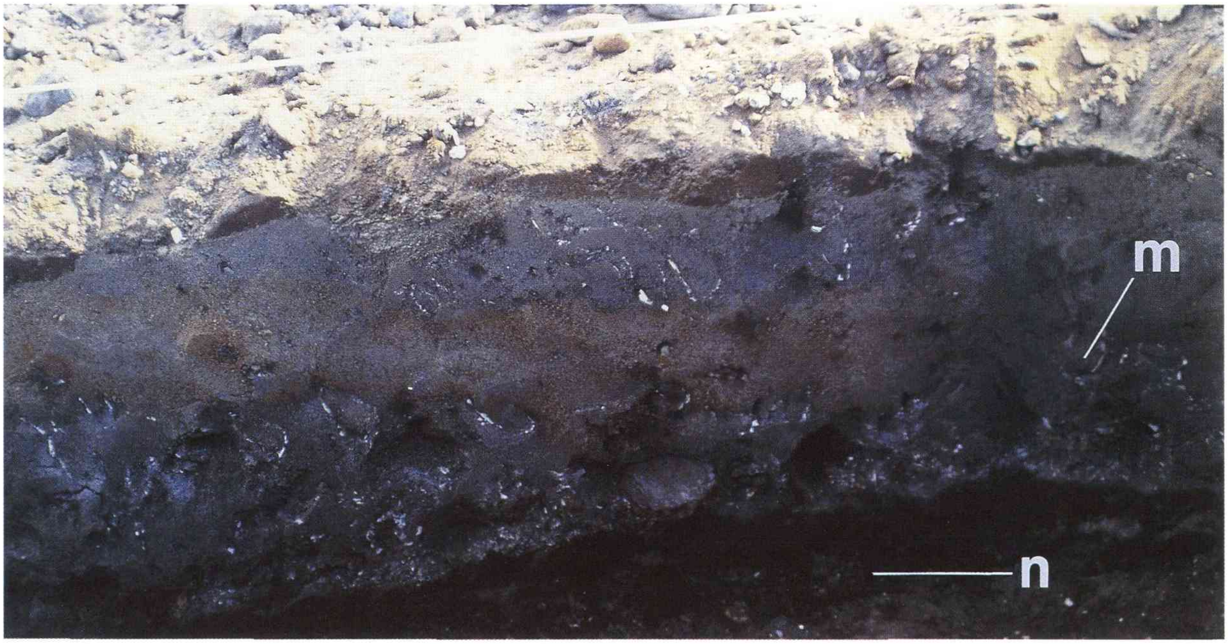


Photo 2. Cross section around 960206-1-m and -n in the trench (960206-1) at Kai-no-hama Beach (see Fig. 4 and Appendix 2).

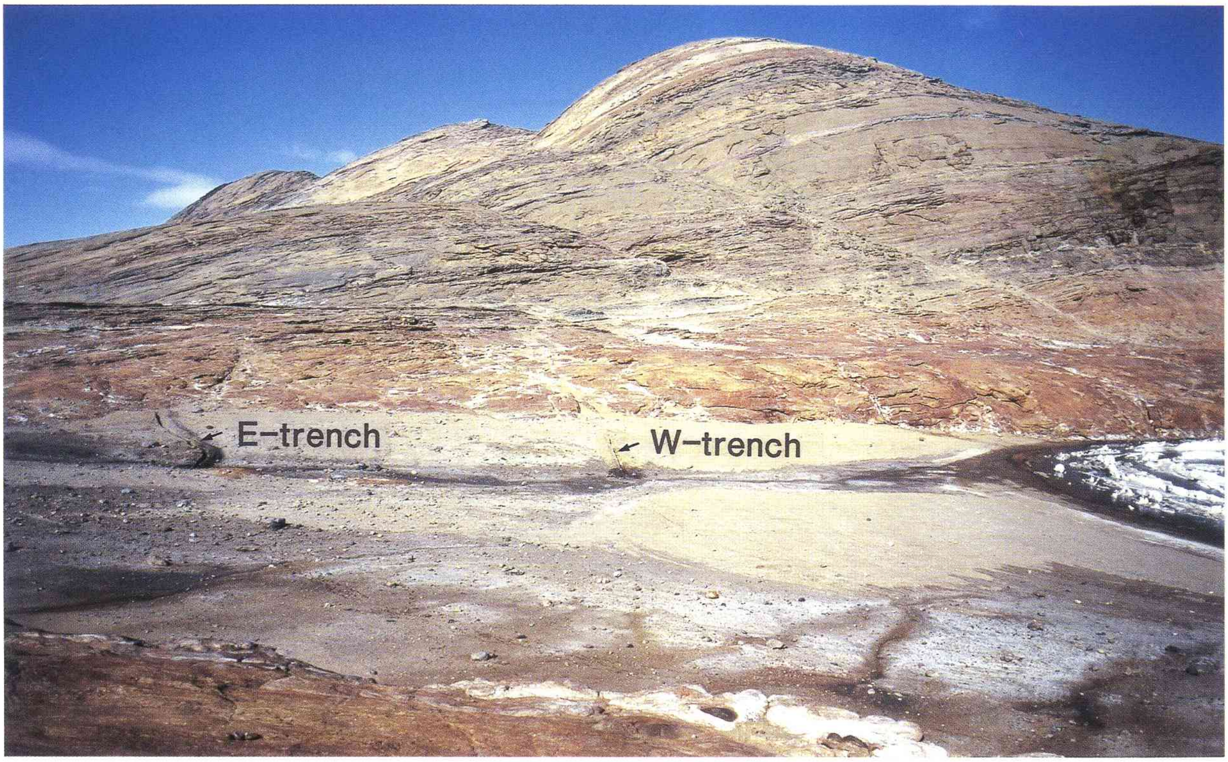


Photo 3. Raised beach (Kominato-higashi beach), east of Ko-minato Inlet in the northern part of Langhovde.

Photo 4. In situ fossil shells in the upper part of W-trench at Kominato-higashi beach (see Fig. 5)

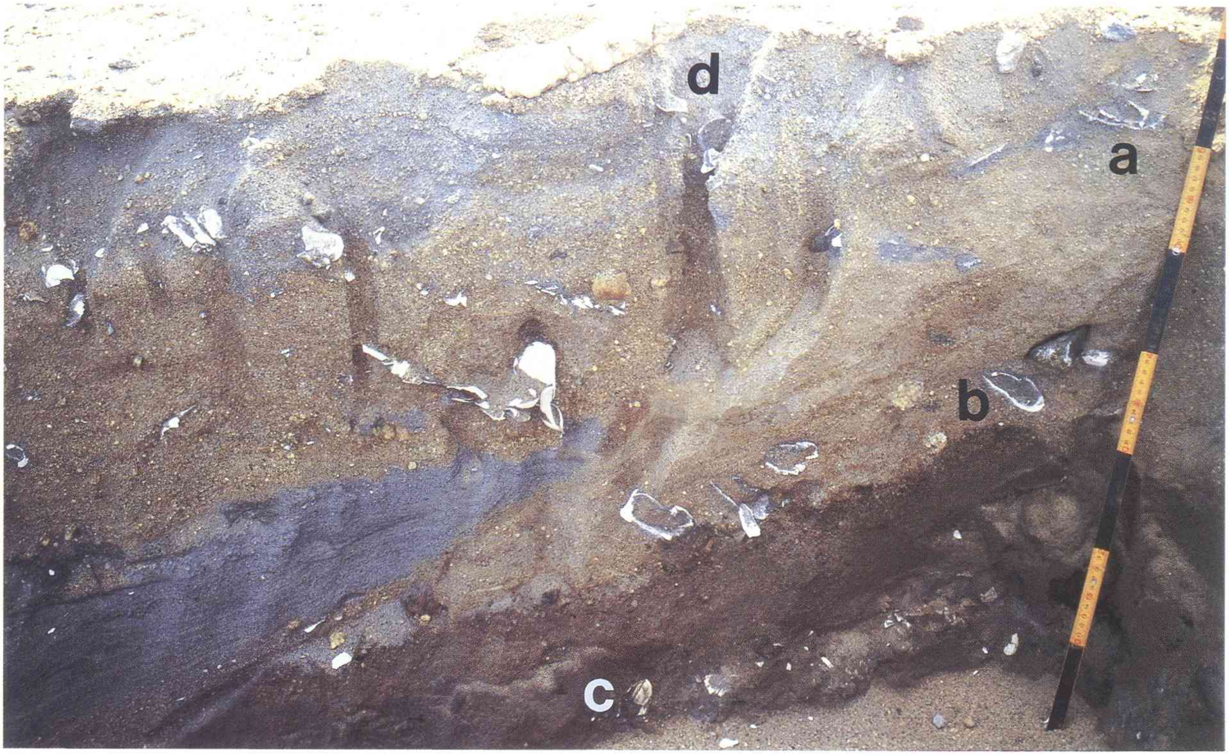


Photo 5. Cross section at the uppermost part of E-trench (951227-1) in Kominato-higashi beach. a - d: sample code of shell (see Fig. 5).

Photo 6. Cross section at the middle part of E-trench (951227-1) in Kominato-higashi beach. n: sample code of diatomaceous earth (see Fig. 5).

Photo 7. *In situ fossil shells exposed at the ground surface, near the W-trench in Kominato-higashi beach.*

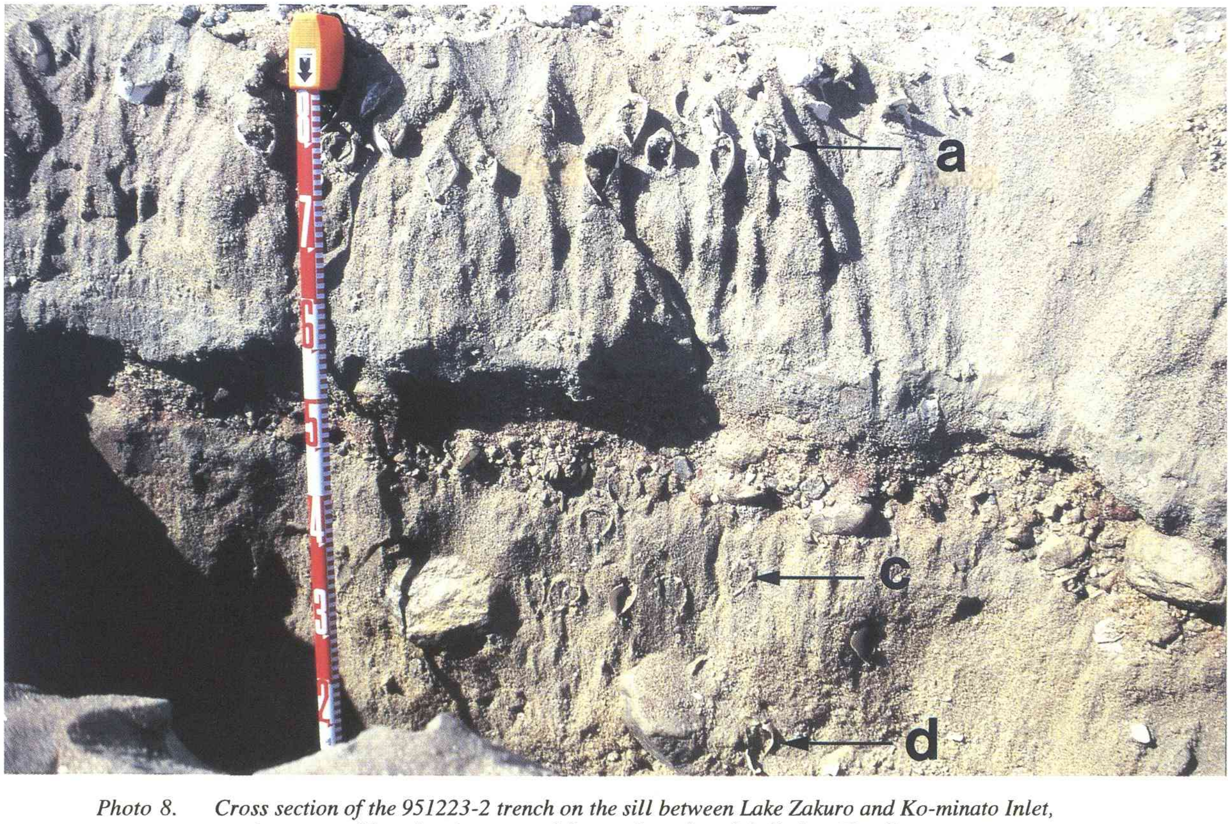


Photo 8. *Cross section of the 951223-2 trench on the sill between Lake Zakuro and Ko-minato Inlet, northern part of Langhovde. a, c and d: sample codes of shells (see Fig. 6).*

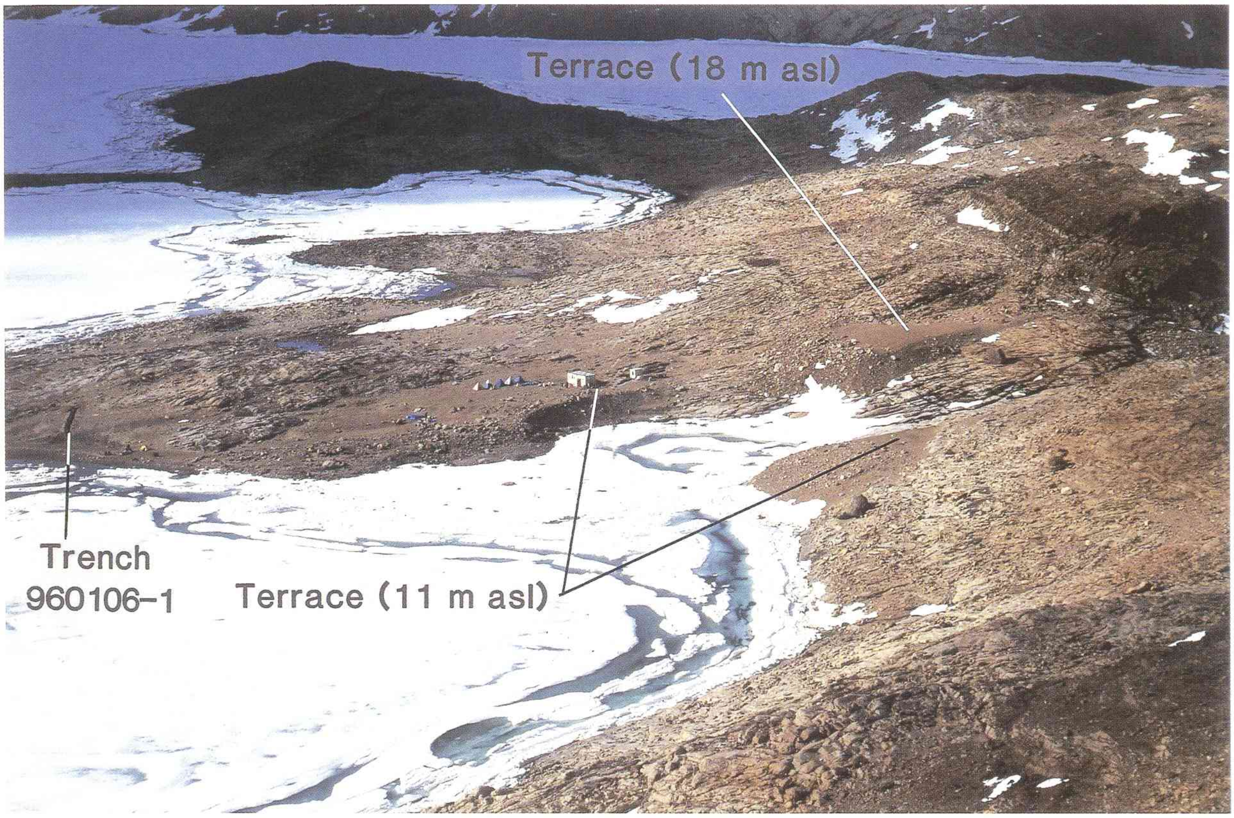


Photo 9. Raised beach and marine terraces around the mouth of Yatude Valley, southern part of Langhovde (see Fig. 8 and Appendix 3).

Photo 10. In situ fossil shells exposed on the section of 960106-1 trench, near the mouth of Yatude Valley.

Photo 11. The 960116-1 trench excavated in the step-like topography of raised beach, Kizahasi Beach in Skarvsnes (see Fig. 9 and Appendix 4).

Photo 12. Cross section around in situ fossil shell of Laternula elliptica (960116-1-i) in the trench.

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