MECHANICAL AND MINERAL COMPOSITIONS OF RAISED GLACIOMARINE SEDIMENTS FROM THE SYOWA STATION AREA, ANTARCTICA

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Abstract: The sixteen raised glaciomarine and two lake sediments of the Quaternary age from the east coast of Lützow-Holm Bay, East Antarctica, collected by the wintering party of the 22nd Japanese Antarctic Research Expedition (1980–1982), were analyzed for the mechanical and mineral compositions as a clue to elucidate the origin of glaciomarine sediments.

On the basis of grain size, heavy mineral and light mineral compositions, these glaciomarine sediments are classified as immature, feldspathic, wacke-type muddy sand or sandy mud which were redeposited by the gravity flow. It can be considered that most constituents of sediments have been derived from the metamorphic rocks which are exposed on the east coast of Lützow-Holm Bay.

It became clear that contents of graphite in sediments are affected by the geographical distribution of outcrops of graphite bearing gneiss.

1. Introduction

It is well known that the glaciomarine sediments have general relations to the erosion of basement rocks and the transportation of clastic materials by moving continental ice sheets, and their deposition and retransportation around the periglacial area, and also the deposition of particles released from the bottom of icebergs on the sea floor. And LISITZIN (1978) concluded that it was necessary to investigate the character of detrital materials contained in ice sheets and land moraines in order to elucidate the origin of glaciomarine sediments. WRIGHT and ANDERSON (1982) and MIALL (1983) pointed out that the gravity flow of sediments played an important role in the formation of glaciomarine sediments.

According to MORIWAKI (1978) the Quaternary glaciomarine sediments in Lützow-Holm Bay were deposited on the sea floor, especially near the trough center. Some of these sediments are exposed on the ground of 0 to 30 m high above sea level, and cover unconformably the pre-Cambrian metamorphic rocks. NOMURA (1983) supposed that these raised marine sediments were originally deposited in water shallower than 30 to 50 m in depth. YOSHIDA (1983) dated these sediments as 930 ± 90 to 34000^{+3000}_{-2000} years B.P. by the C^{14} method. MORIWAKI and YOSHIDA (1983), and SASAKI (1984) concluded from the direction of glacial striae retained on the surface of basement rocks of the east coast of Lützow-Holm Bay that the past ice sheet moved towards west to northwest. The present study is intended to interpret the origin of these raised glaciomarine sediments near the Syowa Station area by the analysis of their textures and mineral compositions.

SATO *et al.* (1965) studied the recent marine sediments off the Prince Olav Coast, East Antarctica, and divided the depositional area into four subprovinces. LISITZIN (1978) investigated the continental shelf sediments off the East Antarctic continent, and pointed out that some of glaciomarine sediments are rich in garnet, amphibole and ore minerals, showing good dependence on the heavy mineral composition of the provenance rocks. Furthermore, BARDIN (1982) found that the moraine deposits at Mt. Collins, Queen Maud Land are rich in hornblende in the heavy mineral fraction.

2. Methods

2.1. Sampling

The sampling was made on the outcrops of Quaternary raised glaciomarine sediments after the detailed geological survey in this area using the geological maps composed by YANAI *et al.* (1974a, b), ISHIKAWA *et al.* (1976, 1977) and YOSHIDA *et al.* (1976).

2.2. Grain size analysis

Wet samples of 50 to 150 g by weight were dispersed in water with a mixer after

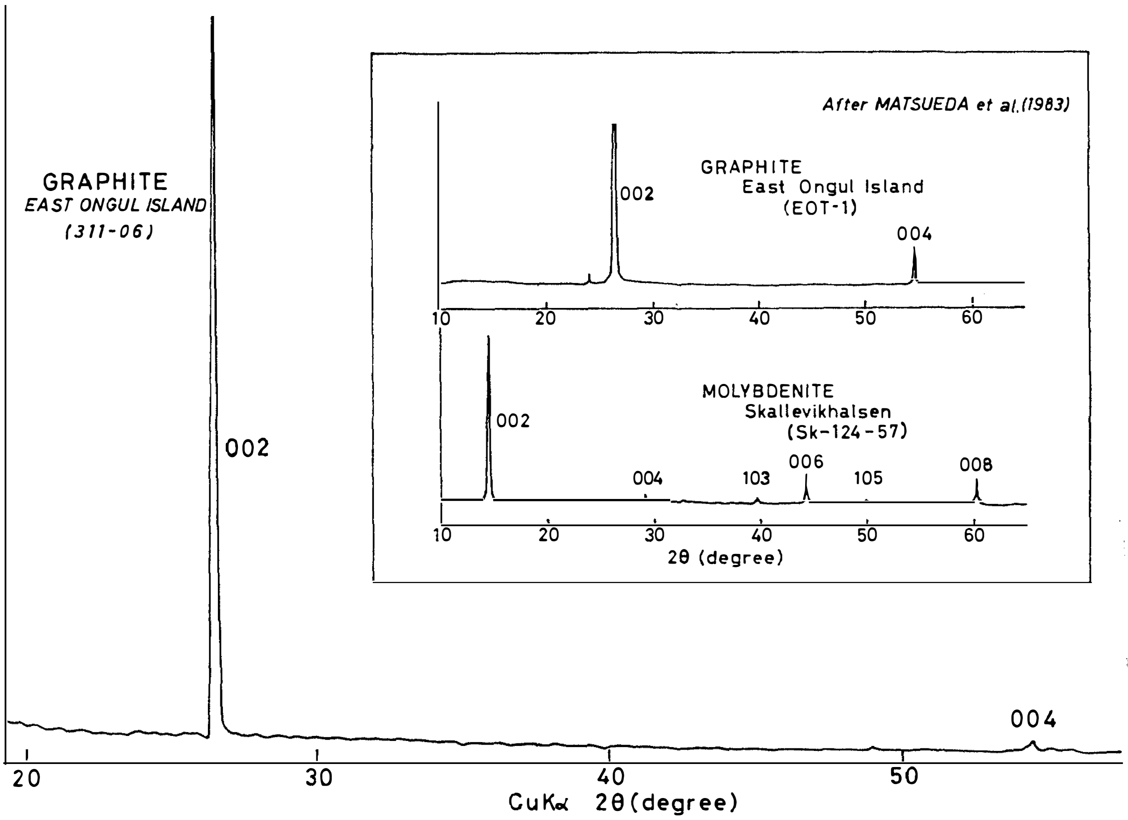

Fig. 1. X-ray diffraction pattern of graphite in sample 311-06 from East Ongul Island, and of graphite and molybdenite in metamorphic rocks.

the Sasaki's method (SASAKI and USHIJIMA, 1967), then were sifted with a 250 mesh Tyler screen. The residue on the 250 mesh screen was dried in an oven, and was sifted through 5, 9, 16, 32, 60, 115 and 250 sieves mesh respectively. The finer particles passing through the 250 mesh screen (0.0625 mm in diameter) were analyzed by the Andreasen pipet method.

2.3. *Mineral analysis*

5 to 10 g of sand particles of each sample ranging from 2.00 to 3.25ϕ in diameter were separated into two groups of light and heavy minerals using acetylene tetrabromide. One thin section was made for each group, and more than 300 grains per one section were counted under the polarizing microscope for determining the mineral composition.

Graphite was examined both qualitatively and quantitatively, by the X-ray diffraction method and by binocular microscopic observation, in which 3000 to 5000 grains of light minerals per one sample were counted. The X-ray diffraction pattern of graphite is shown in Fig. 1.

3. Samples

Sixteen samples of raised glaciomarine sediments and two samples of lake sediments which were used in the analysis are listed in Table 1 where locality, sample

Table 1. List of samples analyzed.

Locality	Sample number	Elevation above sea level (m)	Fossil shell	Basements	Remarks
East Ongul Island	320–10	2.5	+	Hb-gn	Southwest of Antenna Island
Northwest area	310–03	15	+	Hb-gn, Px-gn	Mizukumi Stream (down)
	311–06	15	+	Ga-gn	Mizukumi Stream (middle)
	320–06	16	+	Px-gn	Mizukumi Stream (upper)
Southwest area	311–02	0	+	Hb-gn	Kitami Beach
	311–01	0	+	Hb-gn, (Px-gn)	Near Naka-no-seto Strait
	315–07	10–12.5	+	Hb-gn	South of No. 311–02
	315–05	2.5	+	Px-gn	Kai-no-hama Beach
	315–05′	2.5	+	Px-gn	Kai-no-hama Beach
	315–04	17.5–20	—	Hb-gn, Px-gn	Lake Ebosi (lake sediment)
	315–02	30	—	Hb-gn, Px-gn	Lake Kamome (lake sediment)
West Ongul Island	415–01	10	+	Px-gn, Hb-gn	South of Lake Ô-ike
Hamna	1111–02	10	+	Ga-Bi-gn	Near Hamna Icefall
Skarvsnes	X18–02	20–30	+	Px-gn	Near Lake Suribati
Skallen	X17–03	6	?	Alternation of brown gneiss and metabasite	Magoke Point
	X17–02	4	?		
	X17–01	1	+		
	X17–04	10	?		

+; Contained, —; not contained, ?; questionable,
Hb-gn; hornblende gneiss, Px-gn; pyroxene gneiss, Ga-gn; garnet gneiss,
Ga-Bi-gn; garnet biotite gneiss.

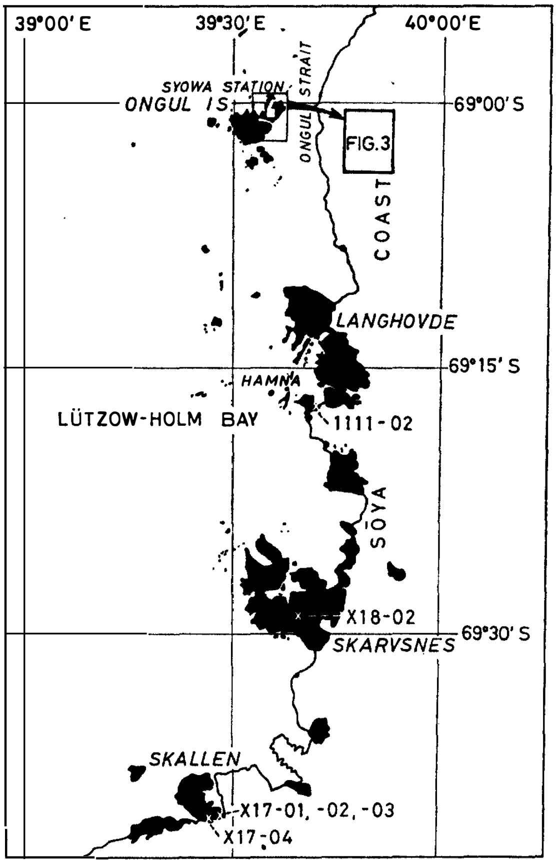

Fig. 2. *Sampling localities on the eastern coast of Lützow-Holm Bay. Sampling localities on Ongul Islands are shown in Fig. 3.*

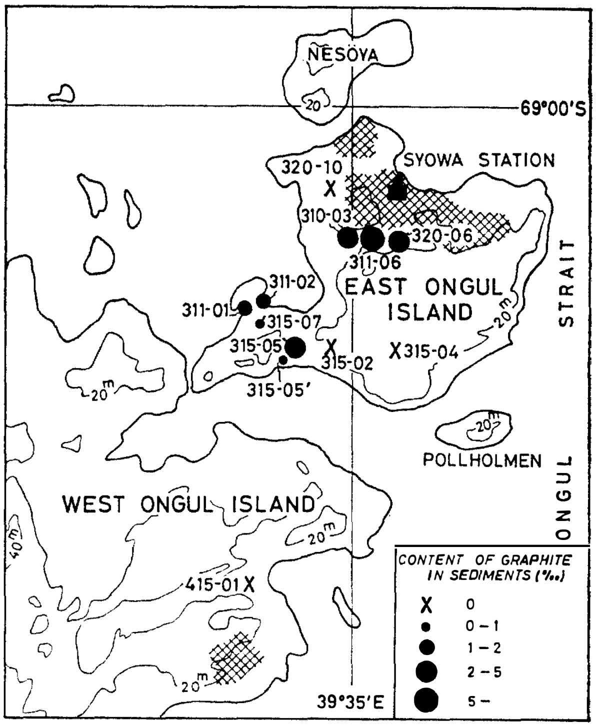

Fig. 3. *Detailed sampling localities on Ongul Islands showing outcrops of graphite-bearing pyroxene gneiss (mesh pattern) and distribution of graphite content of sediments.*

number, elevation above sea level, fossil shell, basement and remarks are indicated. These massive marine sediments including shell fragments were collected by the wintering party of the 22nd Japanese Antarctic Research Expedition 1980–1982 (JARE-22). Samples X17–01, X17–02 and X17–03 were collected successively in a vertical direction at the same outcrop, near the Magoke Point, Skallen area, where the Quaternary raised marine sediments cover unconformably the basement biotite-pyroxene gneiss. The two samples of lake sediments were analyzed for the purpose of comparison with the other raised sediments. The sampling points are shown in Figs. 2 and 3.

4. Results and Discussion

4.1. Grain size distribution

Results of grain size analysis are shown in Tables 2 and 3.

All cumulative curves of grain size of these sediments show unimodal distribution (Fig. 4). The arithmetic average of mean size ($M\phi$) for 16 samples is $2.4\,\phi$ in diameter. The samples from the Skallen area show the value $4.3\,\phi$.

Table 2. Results of grain size analysis on sediments.

Sample number	Phi mean diameter	Phi sorting measure	Phi skewness measure	Phi kurtosis measure
Raised glaciomarine sediments				
Northwestern East Ongul Island				
320–10	1.6	1.8	+0.03	1.69
310–03	2.6	2.7	+0.19	0.61
311–06	3.1	1.2	−0.13	1.08
320–06	3.2	3.3	+0.24	0.74
Southwestern East Ongul and West Ongul Islands				
311–02	1.3	1.9	−0.08	0.96
311–01	1.5	1.5	+0.13	1.25
315–07	2.7	2.9	−0.09	0.34
315–05	1.9	1.9	+0.11	0.66
315–05′	2.3	2.5	+0.36	1.06
415–01	0.7	1.0	−0.30	2.70
Hamna and Skarvsnes				
1111–02	0.9	2.9	−0.28	0.55
X18–02	1.7	2.1	+0.14	0.81
Skallen				
X17–03	3.6	1.6	−0.09	1.09
X17–02	4.7	1.6	+0.06	1.34
X17–01	4.4	1.6	−0.03	1.25
X17–04	4.3	2.7	−0.04	0.61
Lake sediments				
East Ongul Island				
315–04	1.6	1.6	+0.25	1.13
315–02	1.4	3.0	+0.10	0.65

Table 3. Average value ($\bar{X}$) of coefficient of mechanical composition and standard deviation (SD) on sediments of Lützow-Holm Bay and surrounding areas.

Sampling party	Coefficient of mechanical composition	All of sediments		Raised marine sediments			
				Ongul Islands		Skallen	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
JARE-22*	Mϕ	2.4	1.2	2.1	0.8	4.3	0.4
	Soϕ	2.1	0.7	2.1	0.7	1.9	0.5
	Skϕ	+0.83	0.18	+0.05	0.19	−0.03	0.05
	Kuϕ	1.03	0.52	1.11	0.64	1.07	0.28
JARE-2**	Mϕ	2.5	1.8				
	Soϕ	1.3	0.7				
	Skϕ	−0.04	0.30				
JARE-5***	Mϕ	4.2	1.0				
	Soϕ	2.2	0.7				
	Skϕ	+0.26	0.16				

* Values calculated based on analytical data in this work, and $\bar{X}$ and SD for all of sediments calculated excepting lake ones.

** Values calculated from data for marine sediments off western Prince Olav Coast to Cape Cook (SHOJI and SATO, 1959).

*** Values calculated from data for marine sediments off eastern Prince Olav Coast to Cape Cook (SATO *et al.*, 1965).

Mϕ; phi mean diameter, Soϕ; phi sorting measure, Skϕ; phi skewness measure, Kuϕ; phi kurtosis measure.

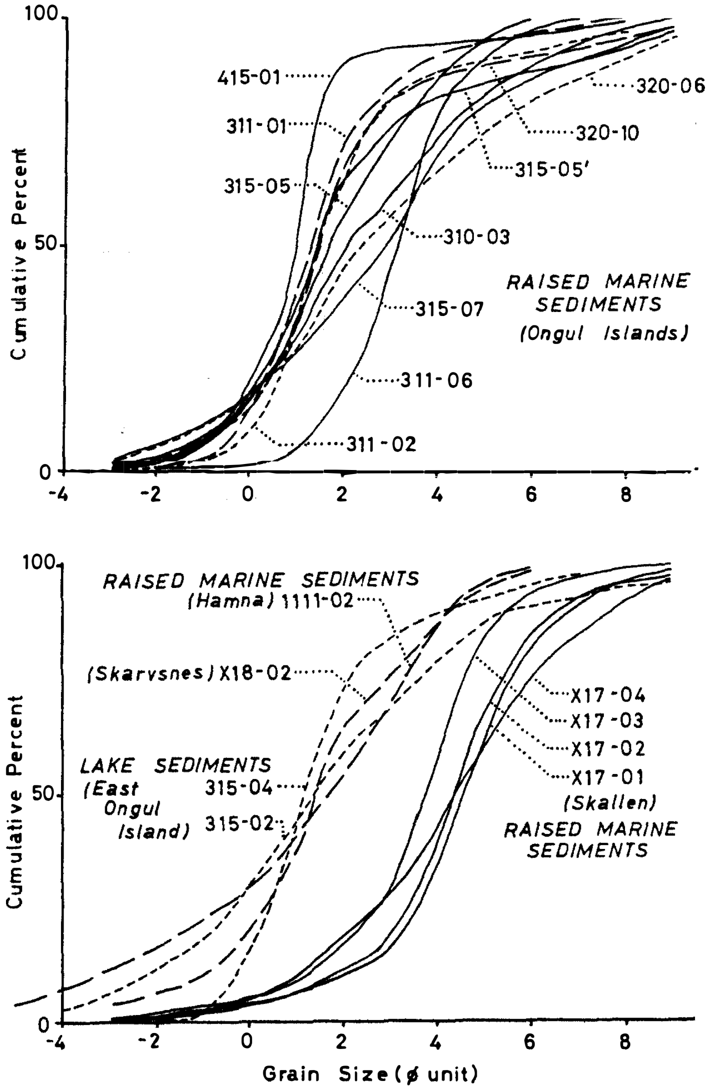

Fig. 4. Cumulative curves on raised marine and lake sediments of the study area.

The arithmetic average of sorting coefficients [$So\phi=(\phi_{84}-\phi_{16})/2$] (INMAN, 1952) is 2.1, which is in general agreement with that of typical glaciomarine sediment given by LISITZIN (1978). The $M\phi$-$So\phi$ diagram (Fig. 5) shows that the samples between 2.5–3.0 ($M\phi$) are poorly sorted compared with other samples in this area. Such tendency is quite contrary to the results of normal marine sediments. Values of phi skewness [$Sk\phi=(M\phi-Md\phi)/So\phi$] (INMAN, 1952) range from $+0.4$ to -0.4, and show that the distribution pattern of these clastic particles is symmetrical. Contents of mud fraction finer than 62.5 μm in diameter increase together with $M\phi$ (Fig. 6). On the gravel-sand-mud diagram (Fig. 7), samples from the Skallen area are plotted on the field of slightly gravelly sandy mud, and all other samples are plotted on the slightly gravelly muddy sand field. This feature suggests that these raised glaciomarine sediments were originally slightly sorted, rolled, and suspended in water at the time of deposition. According to NOMURA (1983), those of Ongul Islands were deposited in water shallower than 30 to 50 m in depth. MORIWAKI (1978) and SASAKI (inprepa-

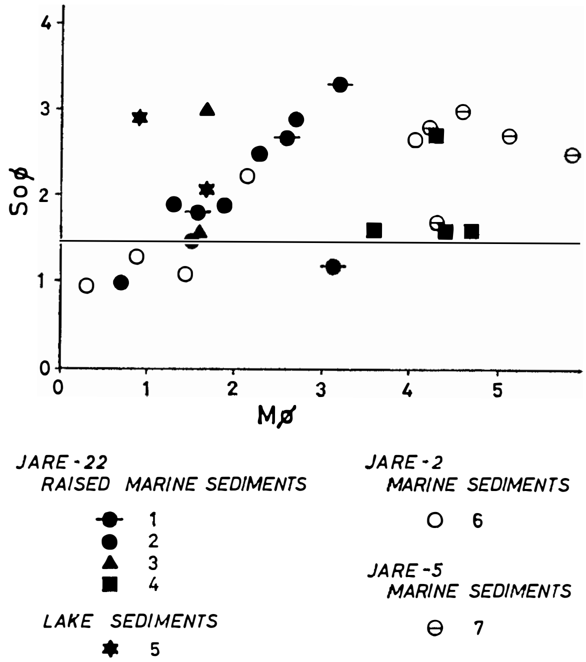

Fig. 5. Mφ-Soφ diagram on sediments from Lützow-Holm Bay and surrounding areas. JARE-22; based on analytical data in this work, JARE-2; based on data for marine sediments off western Prince Olav Coast to Cape Cook (SHOJI and SATO, 1959), JARE-5; based on data for marine sediments off eastern Prince Olav Coast to Cape Cook (SATO et al., 1965). 1; northwest area of East Ongul Island, 2; southwest area of East Ongul Island and West Ongul Island, 3; Hamna and Skarvsnes, 4; Skallen, 5; East Ongul Island, 6; off western Prince Olav Coast to Cape Cook, 7; off eastern Prince Olav Coast to Cape Cook.

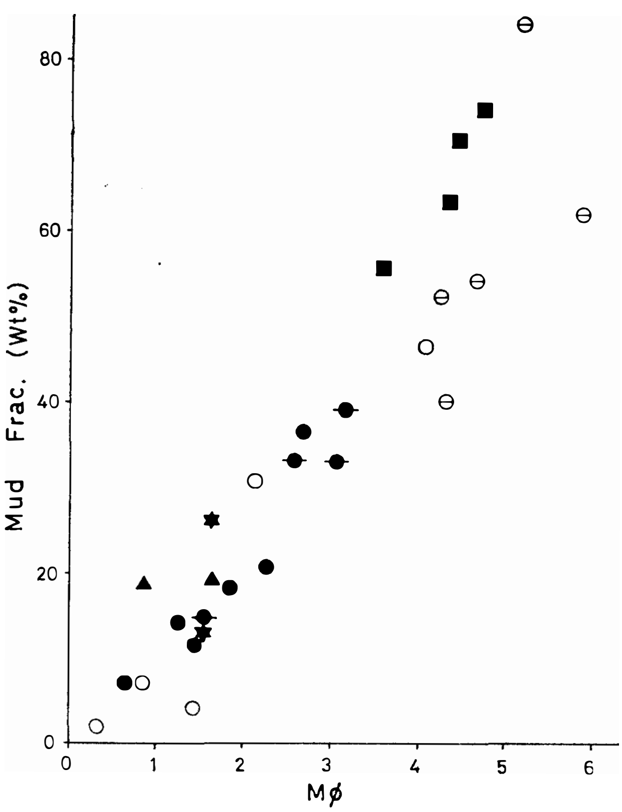

Fig. 6. Mφ-Mud fraction (finer than 62.5 μm in diameter) diagram on sediments from Lützow-Holm Bay and surrounding areas. Symbols as in Fig. 5.

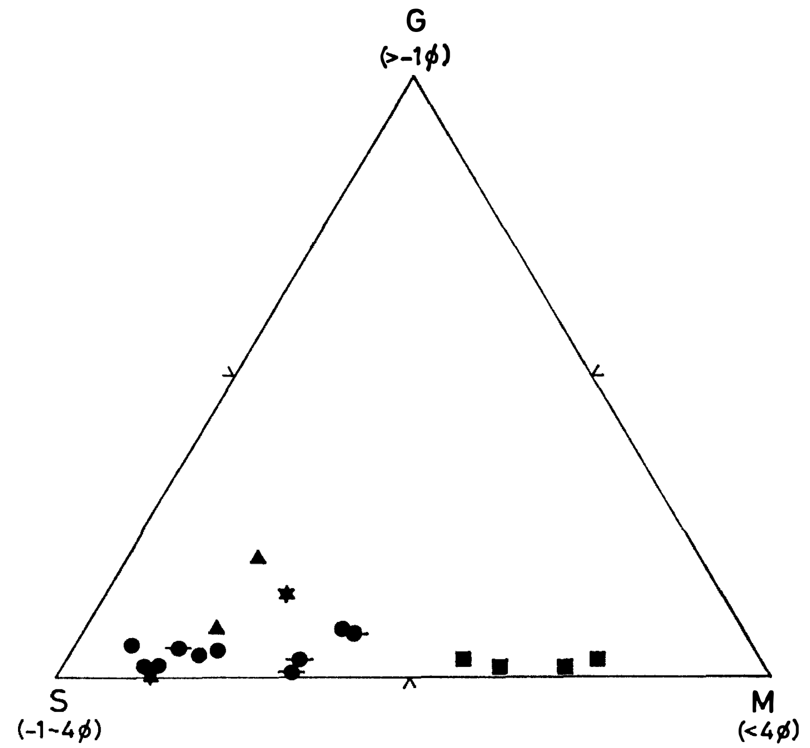

Fig. 7. G (gravel)-S (sand)-M (mud) diagram on sediments of the study area. Symbols as in Fig. 5.

ration) state that no sediments are distributed on the steep submarine slopes near the both banks of the Ongul Strait.

From these facts, it may be inferred that the raised glaciomarine sediments in this area are immature sandy mud or muddy sand formed by the short-distance downslope movement of primary marine sediments.

4.2. *Heavy mineral composition*

Contents of heavy minerals of the 16 samples range from 8.6 to 35.9% in weight (Table 4). Arithmetic average of those of the Ongul Islands is 22.9% with standard deviation (SD) 6.2 and those of the Skallen area is 12.7 with SD 2.6 (Table 5a).

Heavy mineral grains are mostly angular in shape and fresh in alteration. The compositions of heavy minerals are shown in Table 4, where the total contents of amphibole, pyroxene and garnet occupy about 85% in number of grains in both Ongul Islands and the Skallen area. The similar tendency on the heavy mineral composition is also recognized in both the offshore marine sediments off the Prince Olav Coast (Sato *et al.*, 1965) and the moraine deposites around Mt. Collins, Queen Maud Land (Bardin, 1982).

From the fact mentioned above, it may be said that the Quaternary sediments (including both glaciomarine and raised glaciomarine) of the northern marginal area of Queen Maud Land and its offshore basin area are characterized by the heavy mineral composition rich in amphibole and garnet.

On the garnet-hornblende-pyroxene triangular diagram (Fig. 8), there is a tendency

Table 4. Assemblages (% in number of grains) and contents (% in weight) of heavy minerals (2.00–3.25 phi) in sediments analyzed.

Mineral	Sample number								
	320–10	310–03	311–06	320–06	311–02	311–01	315–07	315–05	315–05′
Biotite	0.8	3.1	3.6	1.9	3.3	16.9	0.6	6.7	0.8
Hb (G-Bg)	37.9	30.5	11.9	35.7	32.9	33.8	34.6	28.5	32.8
Hb (B)	11.3	10.6	6.0	6.4	9.9	7.7	3.1	4.2	10.1
Ortho-Px	29.6	31.4	40.5	21.7	30.3	23.8	21.3	32.1	28.6
Clino-Px	7.1	7.0	20.3	5.1	11.9	1.5	8.6	8.5	13.5
Garnet	8.8	10.2	4.8	15.9	3.9	4.6	13.0	7.3	9.2
Epidote	0.0	0.4	1.2	0.6	0.7	0.8	0.3	0.0	0.0
Zircon	0.8	0.4	1.2	0.6	0.0	1.5	1.2	2.4	0.8
Sphene	0.4	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Rutile	0.4	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Tourmaline	0.0	0.4	1.2	0.6	0.7	0.8	0.6	1.2	0.0
Spinel	0.4	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Mt+Il	1.6	5.2	7.2	8.9	2.6	7.7	15.5	8.5	2.5
Indetermined grains	0.8	0.5	1.2	2.5	2.0	0.8	0.6	0.6	1.7
Total	99.9	99.7	100.3	99.9	99.5	99.9	100.0	100.0	100.0
Content of heavy mineral	16.4	21.6	45.6	22.1	27.9	29.2	16.4	22.7	20.7

Mineral	Sample number								
	415–01	X18–02	1111–02	X17–03	X17–02	X17–01	X17–04	315–04	315–02
Biotite	2.9	1.8	2.9	1.6	2.0	2.5	4.3	22.1	1.1
Hb (G-Bg)	25.2	34.7	33.3	17.2	19.8	20.7	22.2	29.3	26.2
Hb (B)	12.6	2.4	7.4	6.1	4.5	5.8	4.3	6.4	2.6
Ortho-Px	33.0	16.5	22.8	24.0	22.1	24.5	15.0	23.6	38.7
Clino-Px	10.7	11.2	8.2	32.4	31.5	32.5	44.9	2.9	11.8
Garnet	5.8	11.8	16.4	5.9	8.6	7.1	3.8	3.6	9.6
Epidote	0.0	0.0	1.2	0.5	1.4	0.4	0.9	0.7	0.4
Zircon	1.0	0.6	1.2	1.2	0.2	0.4	0.4	1.4	0.7
Sphene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Rutile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Tourmaline	1.0	0.0	0.0	1.2	0.5	0.0	0.0	0.7	0.4
Spinel	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mt+Il	5.9	20.0	4.6	9.2	9.0	5.0	3.9	7.8	7.0
Indetermined grains	1.0	1.2	2.3	0.7	0.5	1.2	0.4	1.4	0.7
Total	100.1	100.2	100.3	100.0	100.1	100.1	100.1	99.9	100.0
Content of heavy mineral	35.9	18.9	18.3	8.6	14.9	12.2	15.2	22.0	12.3

Hb; hornblende, Px; pyroxene, Mt+Il; magnetite and ilmenite, G-Bg; green to brownish green color, B; brown color.

Table 5a–5c. Average value ($\bar{X}$) and standard deviation (SD) of data on heavy mineral composition in sediments from Lützow-Holm Bay and surrounding areas.

Table 5a.

	Content of heavy mineral (% in weight)		Content of total of hornblende, pyroxene and garnet (% in number of grains)	
	$\bar{X}$	SD	$\bar{X}$	SD
JARE-22*				
All of raised marine sediments	19.4	6.5	84.7	7.4
Raised marine sediments from Ongul Islands	22.9	6.2	85.3	6.8
Raised marine sediments from Skallen	12.7	2.6	88.2	2.2
JARE-5**				
All of marine and raised marine sediments	13.0	4.4	83.8	4.5
Raised marine sediments from East Ongul Isalnd	18.0	2.8	77.9	2.9

Table 5b.

	Relative content of hornblende, pyroxene and garnet (% in number of grains)					
	All of marine and raised marine sediments		Raised marine sediments			
			Ongul Islands		Skallen	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
JARE-22*						
Hb/Hb+Px+Ga	41.3	10.4	44.6	9.5	28.3	1.1
Px/Hb+Px+Ga	48.8	12.4	45.8	10.6	64.3	1.9
Ga/Hb+Px+Ga	9.8	4.5	9.5	4.2	7.2	2.0
JARE-5**						
Hb/Hb+Px+Ga	46.8	23.7	47.8	3.0		
Px/Hb+Px+Ga	37.8	16.4	46.3	6.4		
Ga/Hb+Px+Ga	16.1	11.1	6.3	3.5		

Hb; hornblende, Px; pyroxene, Ga; garnet.

Table 5c.

	Content of ortho- and clinopyroxenes in heavy mineral fraction (% in number of grains)					
	All of raised marine sediments		Riased marine sediments			
			Ongul Islands		Skallen	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
JARE-22*						
Orthopyroxene	26.6	6.7	29.6	6.0	21.4	3.8
Clinopyroxene	15.0	11.1	9.1	4.9	35.3	5.6

* Values calculated based on analytical data in this work.

** Values calculated from data for marine sediments off eastern Prince Olav Coast to Cape Cook and raised marine sediments from East Ongul Island (SATO *et al.*, 1965).

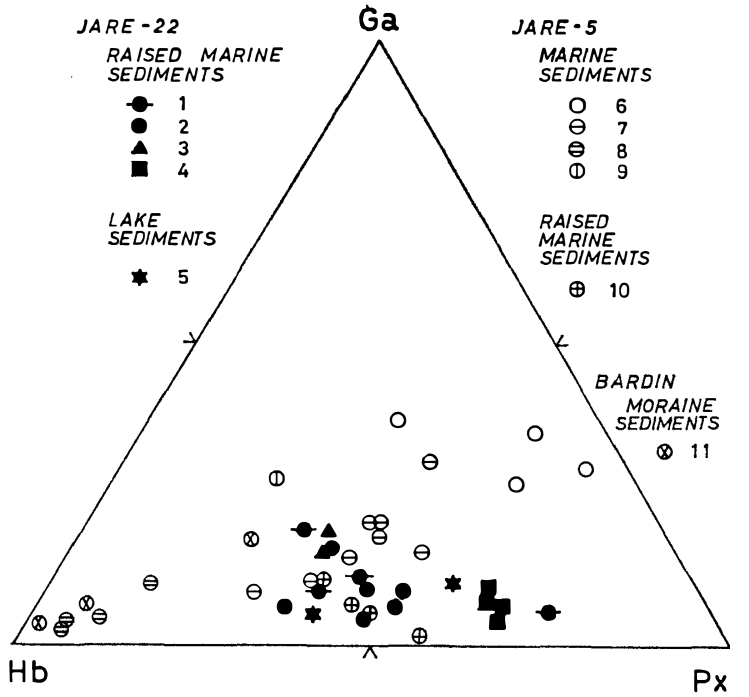

Fig. 8. Ga (garnet)-Hb (hornblende)-Px (pyroxene) diagram on sediments from Lützow-Holm Bay and surrounding areas.
JARE-22; based on analytical data in this work,
JARE-5; based on data for marine sediments off eastern Prince Olav Coast to Cape Cook and raised marine sediments of East Ongul Island collected by JARE-5 (SATO et al., 1965),
BARDIN; based on data for moraine sediments around Mt. Collins, Queen Maud Land (BARDIN, 1982).
Nos. 1–5 are same as in Fig. 5. 6; Amundsen Bay, 7; off eastern Prince Olav Coast, 8; off western Prince Olav Coast, 9; off Cape Cook of the Riiser-Larsen Peninsula, 10; East Ongul Island, 11; around Mt. Collins.

that the raised marine sediments from the study area are poorer in garnet than the marine sediments from Amundsen Bay off Enderby Land, and richer in pyroxene than the moraine deposites from Mt. Collins and the marine sediments from the sea floor off eastern Prince Olav Coast. On the same diagram, the samples of Ongul Islands are richer in hornblende but poorer in clinopyroxene (Table 5c) than those of the Skallen area. Framboidal pyrite discovered in sample 311–06 (East Ongul Island) may have been formed authigenetically.

4.3. Light mineral composition

The compositions of light minerals of the sediments from the study area are shown in Table 6. Quartz, feldspar, rock fragments, graphite, fragments of calcareous and siliceous organisms and mud aggregates are identified under the polarizing microscope. They are mostly angular in shape, excepting the subrounded to rounded mud aggregates. All of light mineral grains show no evidence of alteration. They are rich in quartz, plagioclase and monoclinic potassium feldspar. Some of the sediments are

Table 6. Light mineral compositions (% in number of grains) and contents of graphite in sediments (2.00–3.25φ) analyzed.

Mineral	Sample number								
	320–10	310–03	311–06	320–06	311–02	311–01	315–07	315–05	315–05′
Monocrystalline quartz	7.0	2.5	11.8	1.7	11.9	11.1	20.1	22.4	24.2
Polycrystalline quartz	1.8	0.0	0.9	0.0	0.0	0.0	1.3	0.7	0.8
Plagioclase	32.5	34.7	37.1	21.6	38.9	43.8	31.3	36.6	36.7
M. K-feldspar	54.4	49.2	46.2	44.8	47.6	43.2	37.3	38.8	36.7
Microcline	1.8	1.7	0.9	2.6	1.6	0.6	0.7	0.7	0.8
Rock fragments									
Qz+Px	2.6	0.0	0.9	0.0	0.0	0.0	0.0	0.7	0.0
Qz+Hb	0.0	0.0	0.9	0.0	0.0	0.6	0.0	0.0	0.0
Qz+Graphite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feld+Graphite	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
Graphite	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Fragment of org.	0.0	0.8	0.0	0.0	0.0	0.0	2.0	0.0	0.0
Mud aggregate	0.0	11.0	0.0	29.3	0.0	0.0	7.3	0.0	0.0
Indetermined grains	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.8
Total	100.1	99.9	99.8	100.0	100.0	99.9	100.0	99.9	100.0
Contents of graphite*	0.0	2.5	5.9	2.8	1.2	1.0	0.5	4.0	0.9

Mineral	Sample number								
	415–01	X18–02	1111–02	X17–03	X17–02	X17–01	X17–04	315–04	315–02
Monocrystalline quartz	14.7	18.5	16.1	3.1	5.2	9.6	11.6	19.0	9.2
Polycrystalline quartz	0.0	2.8	0.0	0.0	0.8	0.0	0.0	0.0	0.8
Plagioclase	44.1	33.3	32.1	11.4	22.6	19.2	24.9	48.5	16.5
M. K-feldspar	38.0	42.4	48.2	15.0	35.3	26.4	20.3	28.5	14.8
Microcline	2.5	1.9	0.0	0.5	0.8	0.0	2.9	1.0	0.8
Rock fragments									
Qz+Px	0.6	0.9	0.0	0.0	0.0	0.0	0.0	1.0	0.0
Qz+Hb	0.0	0.0	1.8	0.5	0.0	0.0	1.0	0.0	0.0
Qz+Graphite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
Feld+Graphite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Graphite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fragment of org.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.3
Mud aggregate	0.0	0.0	0.9	69.3	34.9	44.7	39.4	0.0	47.6
Indetermined grains	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0
Total	99.9	99.8	100.0	99.8	99.6	99.9	100.1	100.0	100.0
Contents of graphite*	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0

* Numbers of graphite per 1000 grains of light mineral.
M. K-feldspar; monoclinic potassium feldspar, Qz; quartz, Px: pyroxene,
Hb; hornblende, org; calcareous and siliceous organisms.

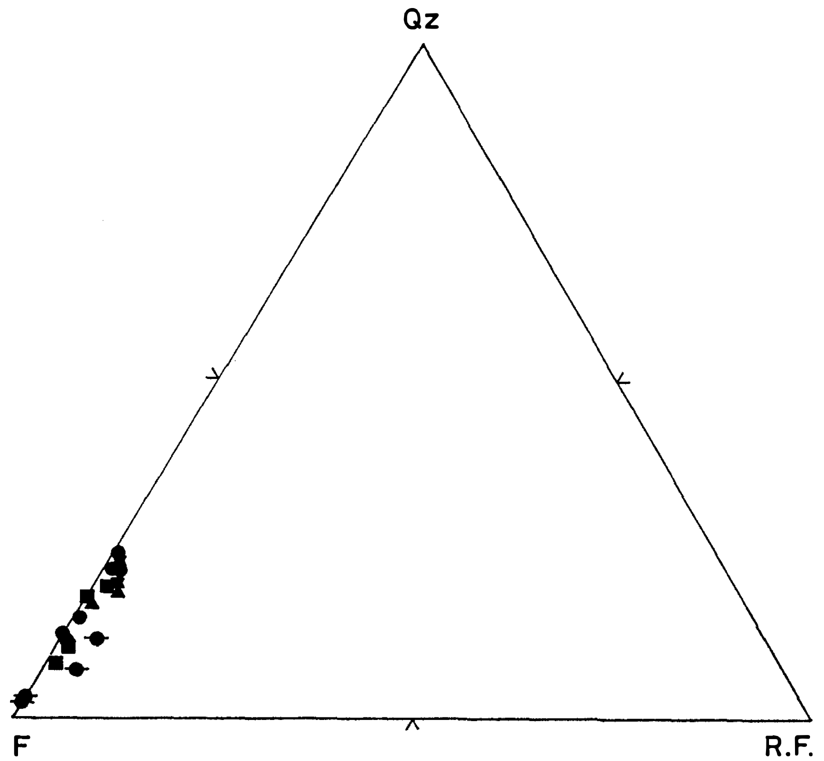

Fig. 9. Qz (quartz)-F (feldspar)-R.F. (rock fragments) diagram on sediments of the study area. Symbols as in Fig. 5.

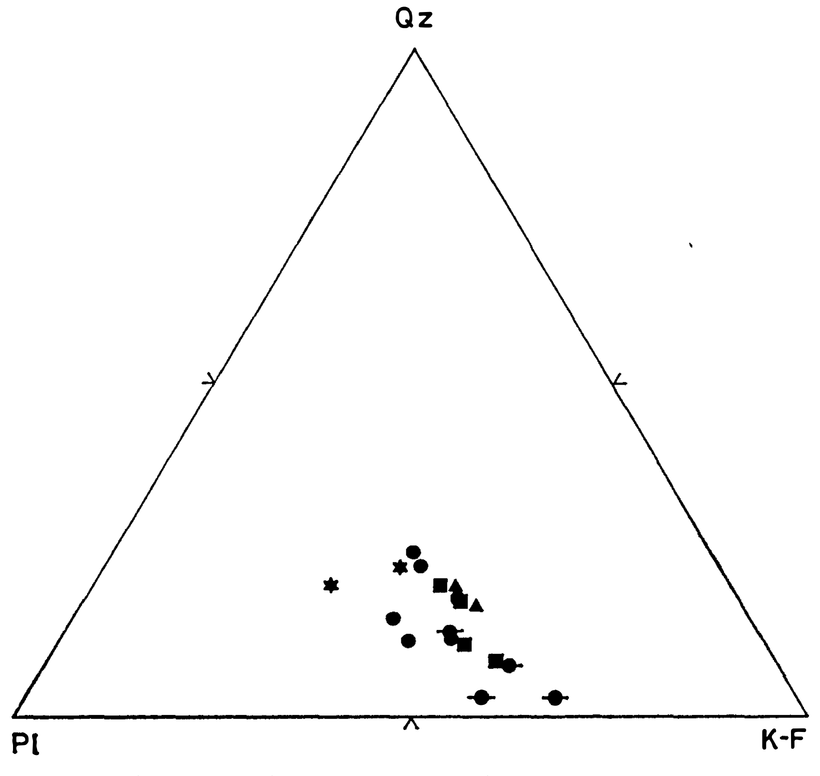

Fig. 10. Qz (quartz)-Pl (plagiocalase)-K-F (potassium feldspar) diagram on sediments of the study area. Symbols as in Fig. 5.

rich in mud aggregates. The quartz-feldspar-rock fragments diagram (Fig. 9) shows that quartz and rock fragments are relatively poor but rich in feldspar which is unstable sedimentologically. Moreover, the quartz-plagioclase-potassium feldspar diagram (Fig. 10) shows that potassium feldspar which is the most unstable mineral sedimentologically overweighs the plagioclase.

These data suggest that no chemical weathering had affected the sediments of this area in the course of their deposition, because of the cold and less humid climate of the high latitude region. These sediments may be classified as the feldspathic, wacke-type sand or mud according to the above-mentioned mineralogical analysis.

The contents of graphite are under 1.0% in number of grains. This mineral is distributed more abundantly in the area nearer to the outcrops of the graphite-bearing gneiss, such as the Mizukumi Stream route of East Ongul Island (Fig. 2). This fact supports the idea that the main source of these raised marine sediments is the metamorphic rocks exposed near the Syowa Station area.

5. Summary

The results of analysis about the texture and mineral composition of the raised glaciomarine sediments from the Syowa Station area, East Antarctica, are summarized as follows:

(1) Textural data indicate that these sandy or muddy sediments are abundant in mud fractions.

(2) Amphibole, pyroxene and garnet are predominant in the heavy mineral composition. This tendency is quite in agreement with those found in the East Antarctic sediments reported by many worker.

(3) In light mineral composition, feldspar, especially potassium one which is unstable sedimentologically, is abundant, and quartz and rock fragments are relatively poor. The graphite contents are relatively high in those sediments nearer to the outcrop of the graphite-bearing gneiss.

(4) In conclusion, these sediments are the immature, feldspathic wacke-type sand or mud, redeposited by downslope gravity flow, and their main source is metamorphic rocks exposed on the east coast of Lützow-Holm Bay.

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