GEOLOGY OF THE BELGICA MOUNTAINS

Hideyasu Kojima,

Institute of Mining Geology, Mining College, Akita University, 1-1, Tegatagakuen-cho, Akita 010

Keizo Yanai

National Institute of Polar Research, 9-10, Kaga 1-chome, Itabashi-ku, Tokyo 173

and

Tamio Nishida

Institute of Earth Science, Faculty of Education, Saga University, 1, Honjo-machi, Saga 840

Abstract: The Belgica Mountains lie at the east end of the East Queen Maud Land, located at 72°18′S-72°43′S latitude and 30°57′E-31°20′E longitude.

Crystalline basement rocks of this area are the Belgica group which is divided into the Belgica upper formation and the Belgica lower formation. Geological map and sections are given. Various rock types constitute the Belgica group: They are (1) granitic gneiss, (2) marble and skarn, (3) amphibolite, (4) hornblende-biotite gneiss, (5) augen gneiss, (6) clinopyroxene gneiss, (7) garnet-biotite gneiss, and (8) dyke rocks (basic-metadyke, syenite, granodiorite-diorite and pink granite). Brief petrography of these rock types includes 16 bulk chemical analyses. The results of 6 whole rocks K-Ar dating range from 382 to 472 Ma suggesting that the metamorphism in these mountains occurred during the early Palaeozoic time.

Gentle to open folds with wave length of several kilometers of two generations are developed throughout the region.

1. Introduction

The Belgica Mountains, located at 72°18′S-72°43′S latitude and 30°57′E-31°20′E longitude, lie about midway between the Yamato Mountains and the Sør-Rondane Mountains, East Queen Maud Land, Antarctica. Syowa Station on the Sôya Coast is situated 500 km southwest of the Belgica Mountains (Fig. 1).

It was in 1958 that the Belgian party reached the mountains for the first time from the Base Roi Baudouin by air and carried out surveying. The Belgian party revisited the mountains in 1967 and collected rock samples from four sites. A brief description of those rock specimens was given by Autenboer and Loy (1972).

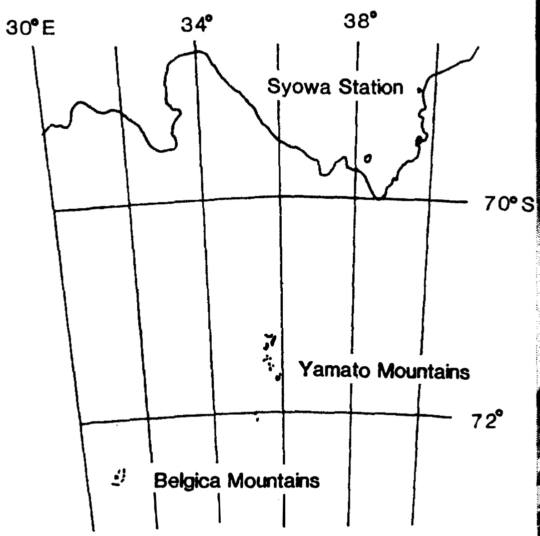

Fig. 1. Location diagram.

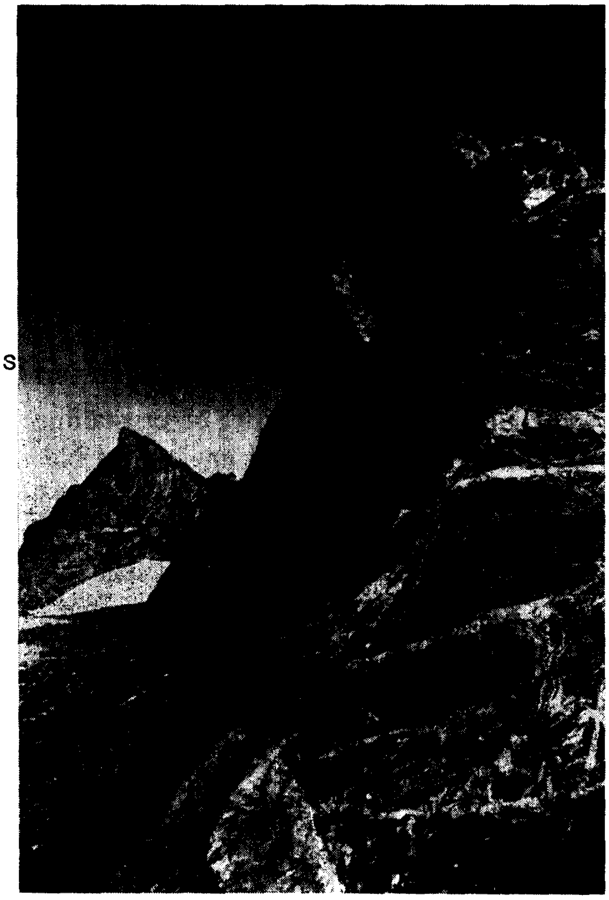

Fig. 2. A needle-like peak at the west end of the northwest massif, composed of the hornblende-biotite gneiss and the amphibolite.

In December 1979, the traverse party of the 20th Japanese Antarctic Research Expedition (JARE-20) visited the mountains and carried out geological survey and meteorites search during a period of two weeks.

The mountains consist of three massifs and several nunataks (Fig. 2). These three massifs, called northwest, southeast and southwest massifs in this paper, occupy the main part of the mountains. Mts. Prince de Ligne are situated about 20 km north of the Belgica Mountains, and the Minami-Belgica Nunataks lie about 5 km south of the main massifs. Most of the massifs and nunataks have gentle ridges and steep wings. The northern wall of Mt. Verhaegen of the northwest massif is 400 m high and Mt. N.-D. de Lorette has some needle-like peaks (Fig. 2).

In this area, most of the peaks are 2300 to 2600 m high. The highest peak is Mt. Victor, over 2600 m in elevation. Ice surface of the eastern area of the mountains is about 300 m higher than that of the western. There are two large glaciers, Glacier Giaever between the southwest and the southeast massifs and Glacier Norsk Polarinstitutt between the northwest and the southeast massifs. Some outlet glaciers flow over the southeast and the southwest massifs from southeast to northwest. One of them is the Glacier Giaever. On the other hand, bare ice is distributed mainly on the west side of the massifs. The moraine fields covering the ice are recognized in several areas adjacent to the massifs, especially the northwest side of the massifs and the moraine also covers some part of basement rocks.

2. General Geology

The mountains consist of crystalline basement rocks such as granitic gneiss, hornblende-biotite banded gneiss, marble with skarn, amphibolite, and dyke rocks. The rocks are called the Belgica group (KOJIMA *et al.*, 1981). The Belgica group is divided into the Belgica upper formation and the Belgica lower formation according to tectonic and petrological features.

The lower formation is distributed in the southern half of the main massifs.

Table 1. K-Ar ages of rocks from the Belgica Mountains.

No.	Sample No.	Rock type	Analyzed material	% K	scc Ar^{40Rad} /g $\times 10^{-5}$	$\%Ar^{40Rad}$	Age(Ma)
1	A79121411	Pyroxenite	Whole rock	3.28	6.51	97.5	442±22
				3.30	6.31	97.6	
2	A79121504	Hornblende-	Whole rock	1.02	1.79	93.9	401±20
		biotite gneiss		1.01	1.76	93.8	
3	K79121914	Pink granite	Whole rock	4.23	7.10	88.2	386±19
				4.25	7.08	88.0	
4	K79122014	Granitic gneiss	Whole rock	2.54	4.21	95.4	382±19
				2.52	4.15	95.8	
5	A79122401	Hornblende-	Whole rock	0.94	1.97	93.0	472±24
		biotite gneiss		0.95	2.00	94.4	
6	K79122607	Syenite	Whole rock	5.55	9.87	98.3	411±21
				5.57	10.1	98.3	

The constants for the age calculation are: $\lambda_\beta=4.962\times10^{-10}a^{-1}$, $\lambda_\varepsilon=0.581\times10^{-10}a^{-1}$, $K^{40}=1.167\times10^{-4}$ atom per atom of natural potassium.

Localities:
1. Central part of the northwest massif.
2. Northern end of the northwest massif.
3. Central part of the southeast massif.
4. Northwest part of the southwest massif.
5. Central part of the northwest massif.
6. Northern part of Mt. Bastin.

Analyst: Teledyne Isotopes Co., N.J., U.S.A.

This formation consists mainly of granitic gneiss and interlayered amphibolite and marble and skarn beds.

The upper formation is exposed in the southeast massif and in part of the northwest massif. This formation is characterized by alternation of hornblende-biotite gneiss, biotite gneiss and quartz-feldspathic gneiss with well developed banded structure and amphibolite. Hornblende-biotite gneiss occupies the main part of the both massifs. Furthermore, some layers of crystalline limestone and thin beds of garnet-biotite gneiss, clinopyroxene gneiss and augen gneiss are also distributed. The transition from the lower formation to the upper formation is gradational, and no obvious unconformity is recognized. There are two stages of foldings. Early stage four folds, gentle to open type, trend northwest-southeast. The later one trending northeast-southwest is gentle folding and is superposed on the former.

The whole rock K-Ar measurements of three gneisses and three dyke rocks were carried out, the results are shown in Table 1. The ages range from 382 to 472 Ma. These ages are nearly the same as the K-Ar ages of the Sør-Rondane Mountains (PICCIOTTO *et al.*, 1964). Granitic gneiss shows the youngest age, 382 Ma. But clinopyroxene rock that intruded the granitic gneiss shows 442 Ma, older age than the granitic gneiss. It seems that the age of the granitic gneiss is lower than that of the actual age of rock formation. This is probably due to the argon losses by alteration of some K-feldspars.

3. Petrography

Figure 3 shows the geological map and geological cross sections of the Belgica Mountains. The crystalline basement rocks exposed in this region are classified into eleven rock types on the basis of their mode of occurrences and petrographical features as follows:

- 3.1. Granitic gneiss (Ggr)
- 3.2. Marble and skarn (UMb & LMb)
  - 3.2.1. Marble
  - 3.2.2. Green clinopyroxene rock
  - 3.2.3. Phlogopite rock
  - 3.2.4. Dark brown garnet rock
- 3.3. Amphibolite (UAm & LAm)
- 3.4. Hornblende-biotite banded gneiss and alternating rocks (Ghb)
  - 3.4.1. Hornblende-biotite gneiss
  - 3.4.2. Clinopyroxene-hornblende-biotite gneiss
  - 3.4.3. Quartz-feldspathic gneiss
- 3.5. Augen gneiss (Gpo)
- 3.6. Clinopyroxene gneiss (Gp)
  - 3.6.1. Clinopyroxene gneiss

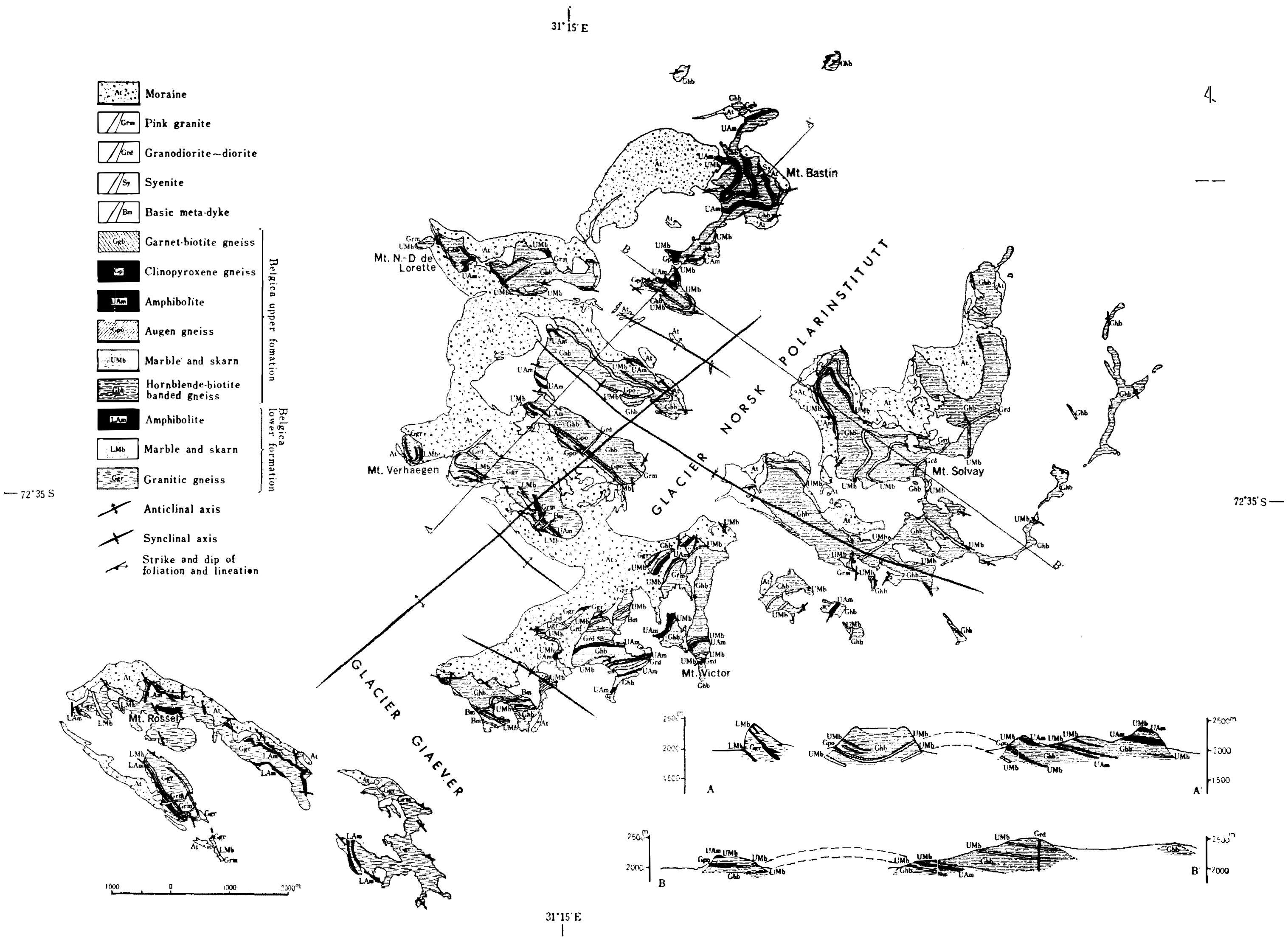

Fig. 3. Geological map and geological cross sections of the Belgica Mountains.

Fig. 4. Occurrence of the granitic gneiss in the southwest massif.

Fig. 5. The marble and skarn, and hornblende-biotite banded gneiss in the central part of the northwest massif.

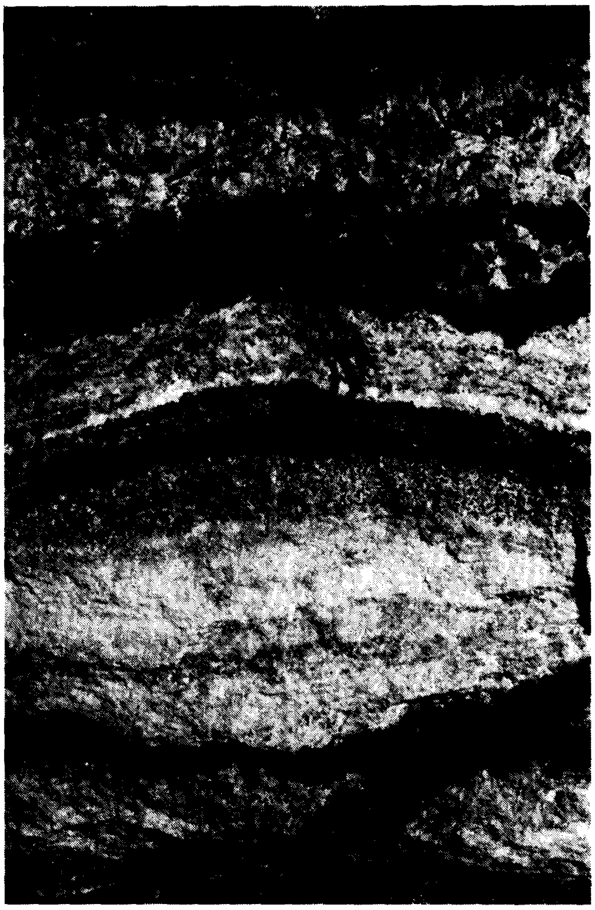

Fig. 6. Occurrence of the phlogopite rock and the impure marble in the northwest massif.

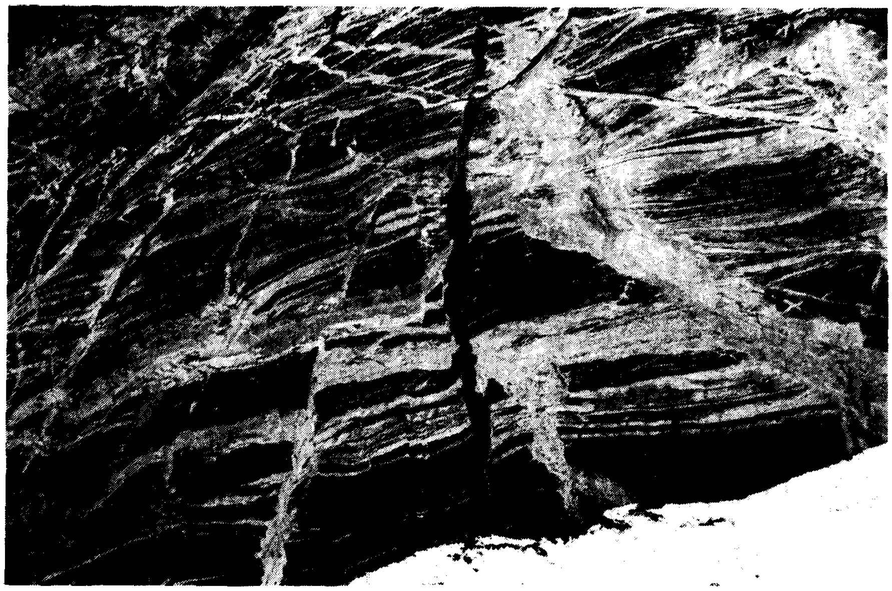

Fig. 7. Occurrence of the amphibolite and the hornblende-biotite gneiss with the granite dykes in the northwest massif.

3.1. Granitic gneiss (Ggr)

Granitic gneiss is the main constituent of the Belgica lower formation. It is distributed in the southern part of the northwest massif and throughout the southwest massif. This rock occupies the lowermost horizon of crystalline basement rocks in this region. Sometimes it shows migmatitic and agmatitic structures in some portions of the southwest massif. There are some heterogeneous inclusions of amphibolite which range in size from several centimeters to several decimeters in granitic gneiss. It is leucocratic, pinkish gray to gray in color, fine- to medium-grained and strongly foliated characterized by the abundance of pink, occasionally white, K-feldspar (Fig. 4). The constituent minerals are biotite, K-feldspar, plagioclase and quartz, with minor amounts of primary muscovite and zircon. In hand specimen, this rock appears fresh, but under the microscope most of plagioclase are characteristically altered into carbonate and sericite. Biotite shows reddish-brown, brown to yellow pleochroism. Some biotite are altered into chlorite. K-feldspar, fine- to coarse-grained, shows a microcline structure. Quartz is characteristically smoky.

Result of the chemical analysis of this rock show that the SiO_2 content ranges from 73.85 to 74.05% and the K_2O content is relatively high (Table 2).

3.2. Marble and skarn (UMb & LMb)

Several beds of marble and skarn are intercalated in the lower formation and four to six beds are distributed in the upper formation (Fig. 5). The rocks occur as beds and irregular lenses. These beds range in thickness from several meters to approximately fifty meters. Lenses range from a few centimeters and several tens of centimeters to several tens of centimeters and several meters in dimensions. Marble and skarn beds distributed in the northwest of Mt. Rossel and in the central part of the northwest massif are two of the thickest beds. Thickness of these beds is variable. Generally marble and pale green to green, massive clinopyroxene rock are predominant in these beds. The marble and skarn are classified into the following four types which are layered or randomly mixed with one another and form irregular lenses: (1) marble, (2) green clinopyroxene rock, (3) phlogopite rock, and (4) dark brown garnet rock. Occasionally small-sized irregular

Table 2. Chemical compositions and calculated CIPW norms of rocks from the Belgica Mountains.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SiO_2	73.85	74.05	72.42	50.69	55.55	55.76	57.34	63.44	47.23	49.19	48.63	43.86	73.14	55.54	57.70	53.04
TiO_2	0.10	0.06	0.41	1.06	1.52	2.27	0.68	0.91	2.36	3.65	2.11	0.95	0.17	1.94	1.29	1.85
Al_2O_3	13.99	14.93	11.48	18.58	11.84	14.27	14.43	10.82	10.21	14.66	12.65	14.92	14.24	15.53	13.35	14.07
Fe_2O_3	0.61	0.62	3.09	3.55	0.94	2.82	6.60	1.26	3.87	4.97	2.84	4.72	0.23	1.97	2.07	2.84
FeO	0.71	0.63	2.25	4.71	5.86	7.02	4.91	5.17	7.77	8.53	9.90	9.18	1.67	5.62	3.84	5.76
MnO	—	—	0.06	0.16	0.14	0.14	0.23	0.21	0.22	0.20	0.26	0.23	0.02	0.12	0.12	0.13
MgO	—	0.21	0.80	5.53	6.57	3.43	2.59	3.19	10.56	3.76	6.20	6.73	0.24	2.37	5.95	6.83
CaO	1.86	1.66	3.18	7.41	5.82	6.51	5.97	12.23	12.34	7.12	11.89	14.43	1.24	4.04	4.95	7.29
Na_2O	2.75	4.27	3.26	5.85	0.58	2.70	3.66	2.49	1.43	2.13	2.25	1.10	4.59	1.55	1.43	2.15
K_2O	4.11	4.10	0.83	1.76	7.37	1.85	1.74	0.22	1.23	1.82	1.00	1.20	4.45	7.10	6.41	2.09
P_2O_5	0.03	0.04	0.10	0.23	1.75	0.86	0.34	0.22	0.18	1.22	0.16	0.12	0.04	1.34	0.74	0.70
$H_2O(+)$	0.77	0.14	0.68	0.86	0.84	1.07	0.91	0.43	0.93	1.20	0.64	0.73	0.46	0.98	0.79	1.38
$H_2O(-)$	0.32	0.22	0.24	0.28	0.30	0.33	0.24	0.25	0.37	0.58	0.27	0.23	0.41	0.42	0.50	0.46
CO_2	—	—	0.26	0.21	0.11	0.86	0.52	—	0.39	—	0.37	0.70	—	0.52	0.59	0.52
Total	99.10	100.93	99.06	100.88	99.19	99.89	100.16	100.85	99.09	99.03	99.17	99.10	100.89	99.04	99.73	99.11
Q	37.84	29.19	42.34	—	5.23	15.08	15.32	23.60	—	10.33	—	—	25.53	9.37	8.47	8.83
Or (F)	24.49	24.49	5.01	10.57	43.41	11.13	10.02	1.11	7.23	10.57	6.12	7.23	26.14	41.74	37.84	12.24
Ab (F)	23.07	36.18	27.79	31.59	4.72	23.07	30.93	20.97	12.06	17.83	18.87	9.04	38.80	13.11	12.06	18.35
An (F)	9.18	8.34	14.19	19.19	8.07	21.14	18.08	17.80	17.80	25.31	21.42	31.99	5.28	9.18	11.13	22.53
Ne	—	—	—	9.59	—	—	—	—	—	—	—	0.21	—	—	—	—
C	—	—	—	—	—	—	—	—	—	—	—	—	—	1.94	—	—
Wo	—	—	—	—	—	—	—	1.51	—	—	—	—	—	—	—	—
Wo (di)	—	—	—	5.79	4.05	0.23	2.59	15.50	16.32	1.02	14.52	14.37	0.36	—	2.21	2.44
En (di)	—	—	—	4.67	2.93	0.14	1.91	9.07	13.43	0.68	8.92	9.36	0.08	—	1.88	2.00
Fs (di)	—	—	—	1.11	1.13	0.23	0.67	6.43	2.89	0.34	5.60	5.02	0.28	—	0.33	0.44
En (Hy)	—	0.57	2.17	—	14.85	9.44	5.08	—	10.81	9.62	7.89	—	0.86	6.71	13.76	16.10
Fs (Hy)	0.79	0.46	0.76	—	5.37	5.99	1.62	—	2.33	4.65	5.07	—	2.21	5.01	2.42	3.94
Fo (ol)	—	—	—	7.26	—	—	—	—	4.14	—	0.50	6.91	—	—	—	—
Fa (ol)	—	—	—	1.76	—	—	—	—	0.96	—	0.33	3.65	—	—	—	—
Mt	0.93	0.85	4.40	5.09	1.39	4.17	9.49	1.85	5.56	7.18	4.17	6.95	0.23	2.78	3.01	4.17
Il	—	—	0.76	1.97	2.88	4.25	1.37	1.67	4.55	6.98	3.95	1.82	0.30	3.64	2.43	3.49
cc	—	—	—	0.50	0.30	2.00	1.20	—	0.90	—	0.80	1.60	—	1.20	1.30	1.20
Ap	—	—	—	0.62	3.72	1.86	0.62	0.62	—	2.79	—	—	—	2.79	1.55	1.55

Analyst: R. SUGISAKI.

1. A79122004 Granitic gneiss in the central part of the southwest massif.
2. K79122014 Granitic gneiss in the northwest part of the southwest massif.
3. A79122401 Biotite gneiss in the north part of the northwest massif.
4. K79122001 Hornblende-biotite gneiss in the west end of the southwest massif.
5. K79122601 Clinopyroxene-biotite gneiss in the northwest side of Mt. Bastin.
6. N79122602 Hornblende-biotite gneiss north part of the northwest massif.
7. N79123101 Hornblende-biotite gneiss in the northeast end of the southeast massif.
8. K79121610 Clinopyroxene gneiss in the north part of the northwest massif.
9. K79121517 Clinopyroxene amphibolite in the central part of the northwest massif.
10. K79121521 Amphibolite in the central part of the northwest massif.
11. A79121902 Amphibolite in the central part of the southeast massif.
12. A79122002 Amphibolite in the central part of the southwest massif.
13. K79121914 Pink granite in the central part of the southeast massif.
14. N79122403 Hornblende syenite in the north part of the southeast massif.
15. K79122607 Syenite in the north side of Mt. Bastin.
16. K79121913 Diorite in the central part of the southeast massif.

xenolithic blocks of scapolite occur in association with these rocks. Scapolite is very coarse-grained, white to pale blue in color and euhedral.

Existence of dolomite and humite seems to indicate that the beds are rich in Mg.

3.2.1. Marble

Marble is abundant in lower two beds of the upper formation that are distributed in the central part of the northwest and southeast massifs. The marble is leucocratic, white to very pale yellow in color, coarse- to very coarse-grained and equigranular in texture. It consists mainly of calcite with minor amounts of forsterite, clinopyroxene and apatite. The amount of colored minerals such as forsterite and clinopyroxene is variable. Where these minerals are abundant, the marble grades into the impure marble. Forsterite is commonly altered to serpentine. Spinel-humite-dolomite-calcite rock is one of the members of the impure marble. This rock occurs in association with thin beds or irregular elongated lenses of the phlogopite rock. It is leucocratic, with scattered colored minerals, medium- to coarse-grained, and equigranular in texture. Humite is pale orange to orange in color with an euhedral to subhedral granular texture, and shows orange to pale yellow pleochroism. Spinel is bluish gray and euhedral. There are varieties of color of spinel of this region. Small amounts of phlogopite and forsterite are also found. Humite shows the gradual color change from the center of the bed to the margin. Humite of the margin is darker in color than that of the center.

3.2.2. Green clinopyroxene rock

This rock is one of the most abundant rocks in the marble and skarn beds. The rock is pale green to green in color, medium- to coarse-grained, and equigranular in texture, being composed mostly of clinopyroxene. Small amounts of phlogopite, amphibole, scapolite and calcite are contained.

3.2.3. Phlogopite rock

Phlogopite rock occurs as thin layers or irregular lenses in the marble and skarn beds (Fig. 6). The layers are several centimeters to several tens of centimeters thick. Phlogopite is inequigranular, coarse- to very coarse-grained and characteristically golden yellow.

3.2.4. Dark brown garnet rock

This rock is associated with other limy rocks, but sometimes it occurs as nodules in the hornblende-biotite gneiss. In the latter case, dark green clinopyroxene rock (several centimeters thick) covers the surface of the garnet rock like a crust. Constituent minerals are garnet, clinopyroxene, amphibole, epidote, calcite and plagioclase. Garnet, dark brown in color and anhedral, shows a poikilitic texture with clinopyroxene and epidote inclusions.

3.3. Amphibolite (UAm & LAm)

Amphibolite is distributed throughout this region. In the lower formation, amphibolite is a minor constituent and interlayered with the granitic gneiss. Occasionally this rock shows an agmatite structure. In the upper formation, amphibolite occurs in close association with the hornblende-biotite gneiss. The rock is several centimeters to several tens of meters thick and alternating with the hornblende-biotite gneiss. A large amount of amphibolite is estimated to the distributed in the northwest margine near Mt. Bastin judging from the geological survey.

This rock is generally greenish black in color and medium- to coarse-grained. Under the microscope, it shows a granoblastic to lepidoblastic texture. It contains pale green clinopyroxene which occurs as spots and occasionally as thin layers. Constituent minerals are clinopyroxene, hornblende, biotite, scapolite, plagioclase and quartz, with minor amounts of sphene, apatite and zircon. The amount of clinopyroxene and biotite is variable. Clinopyroxene is fine- to medium-grained, anhedral, colorless to pale green and pleochroic. Hornblende is green and brown in color and subhedral to anhedral.

Results of the chemical analysis of the amphibolite show that the SiO_2 content ranges from 43.86 to 49.19%. The SiO_2 content of one of the analyzed specimens of this rock (A79122002) is remarkably low.

3.4. Hornblende-biotite banded gneiss and alternating rocks (Ghb)

In this region, hornblende-biotite gneiss is predominant and occupies a main part of the upper formation. The gneiss is alternating with the amphibolite, biotite gneiss, quartz-feldspathic gneiss and clinopyroxene gneiss (Fig. 7). Banded structure of the gneiss is well developed in the region. The rock is divided into the clinopyroxene bearing type and the clinopyroxene free type. Furthermore, the relative amounts of hornblende and biotite are variable; so the rock type grades from hornblende-biotite gneiss to biotite-hornblende gneiss. In this paper, however, hornblende-biotite gneiss and biotite-hornblende gneiss are described as hornblende-biotite gneiss.

The SiO_2 content ranges from 50.69 to 72.42%. One specimen (No. A79122401) shows a high content of SiO_2. This rock lacks hornblende and constitutes the leucocratic part of the alternation with amphibolite. Other samples show a relatively low SiO_2 content (Table 2).

3.4.1. Hornblende-biotite gneiss

This rock is melanocratic, dark gray to brownish black in color, fine- to medium-grained, and shows a granoblastic to lepidoblastic texture. It is composed mainly of hornblende, biotite, plagioclase, K-feldspar and quartz, with minor amounts of apatite, zircon, sphene and opaque minerals. Hornblende is subhedral to anhedral and pleochroic brownish green to yellow. Biotite shows dark brown to brownish yellow or reddish brown to yellow pleochroism. K-feldspar shows a microcline structure and quartz shows wavy extinction.

3.4.2. Clinopyroxene-hornblende-biotite gneiss

A small amount of the clinopyroxene-hornblende-biotite gneiss is interlayered with the hornblende-biotite gneiss. This rock is melanocratic, dark gray to brownish black in color, fine- to medium-grained and shows a granoblastic to lepidoblastic texture. It consists mainly of clinopyroxene, hornblende, biotite, plagioclase and quartz, with minor amounts of apatite, zircon, sphene and opaque minerals.

3.4.3. Quartz-feldspathic gneiss

This gneiss is distributed throughout the upper formation, and alternating with the hornblende-biotite gneiss. It is several centimeters to several meters thick, leucocratic, white to light gray in color, and medium- to coarse-grained. The rock is strongly foliated due to parallel orientation of quartz and feldspar. Constituent minerals are K-feldspar, plagioclase and quartz with minor amounts of biotite and muscovite. K-feldspar shows a microcline structure and plagioclase is mostly altered to carbonate and sericite.

3.5. Augen gneiss (Gpo)

A small amount of the augen gneiss is associated with another alternating gneiss in the central part of the northwest massif. The rock is approximately ten centimeters to several meters thick, mesocratic and coarse- to very coarse-grained. This rock is relatively meranoclatic. It consists mainly of biotite, K-feldspar, plagioclase and quartz.

3.6. Clinopyroxene gneiss (Gp)

3.6.1. Clinopyroxene gneiss

This rock occurs in a peak of the nearly central part of the northwest massif. It is several meters to approximately ten meters thick. The rock is dark greenish gray in color, medium-grained and shows a granoblastic to lepidoblastic texture. Constituent minerals are mainly clinopyroxene, plagioclase, quartz and sphene, with minor amounts of hornblende and opaque minerals. Hornblende shows green to bluish green pleochroism, and seems to be a secondary mineral derived from clinopyroxene. Clinopyroxene is subhedral to anhedral and is colorless to pale green and pleochroic. Medium grained, pale brown sphene is abundant. Sphene is one to two millimeters across, euhedral and pleochroic reddish brown to pale brown.

3.6.2. Clinopyroxene-biotite gneiss

A small amount of the clinopyroxene-biotite gneiss occurs in the northern wing of Mt. Bastin. It is concordant with the hornblende-biotite gneiss. This rock is melanocratic, black to brownish black in color, and fine- to medium-grained. In hand specimen, K-feldspar shows schillarization. Constituent minerals are mainly clinopyroxene, biotite, K-feldspar and quartz, with accessory sphene and apatite. K-feldspar shows a distinct perthite structure. Clinopyroxene is approximately one millimeter across, anhedral and shows colorless to pale yellow pleochroism. Biotite is pleochroic varying from reddish brown to pale brownish yellow.

This gneiss is rich in K_2O. And chemical compositions are similar to syenite.

3.7. Garnet-biotite gneiss (Ggb)

3.7.1. Garnet-biotite gneiss

Only one layer of garnet-biotite gneiss, several meters thick, is found in the northwestern margin of the northwest massif. This rock is brown in color, medium-grained and shows compositional banding with ferromagnesian and quartz-feldspathic bands. Main constituents are garnet, plagioclase, K-feldspar and quartz, with accessory zircon, apatite and opaque minerals. Garnet is several millimeters across, anhedral and shows a poikiloblastic texture. Biotite shows brown to pale yellow pleochroism.

3.7.2. Garnet gneiss

This rock is found in association with the garnet-biotite gneiss. It is only fifteen centimeters thick, leucocratic, pale brown in color and granoblastic equigranular in texture. In hand specimen, the rock is similar to the garnet gneiss distributed near Syowa Station on East Ongul Island. Under the microscope, the later garnet gneiss of the later includes K-feldspar, but the former usually lacks it and consists of garnet, plagioclase and quartz with minor biotite.

3.8. Basic meta-dyke (Bm)

This dyke consists of biotite clinopyroxene rock and amphibolite, and is distributed mainly in the vicinity of Mt. Lahaye, Mt. Van Mieghem and Mt. Perov, central members of the mountains. It is some tens of centimeters to several tens of meters thick, and discordant with wall rocks.

3.9. Syenite (Sy)

Small dykes of syenite intrude the hornblende-biotite gneiss and the amphibolite. These dikes are a few meters to approximately ten meters wide, melanocratic, fine- to medium-grained and show strong foliation. The syenite comprises of clinopyroxene-bearing type and clinopyroxene-free type. The former intrudes the hornblende-biotite gneiss at the northern end of the southeast massif, and the latter is situated in the northern wing of Mt. Bastin. The clinopyroxene syenite is cut by some dykes of coarse pink granite.

Constituent minerals of the clinopyroxene syenite are clinopyroxene, hornblende, biotite, plagioclase, K-feldspar and quartz, with minor sphene, zircon and apatite. Clinopyroxene is pale yellowish green and partly altered to hornblende. Biotite shows dark brown to pale yellow pleochroism and bears pleochroic halo. K-feldspar shows a microcline structure.

3.10. Granodiorite–diorite dykes (*Grd*)

These rocks are distributed in the northwest massif and the southeast massif. These occur as clean-cut dykes ranging in width from several meters to approximately ten meters. They are melanocratic to mesocratic and fine- to medium-grained. Constituent minerals are clinopyroxene, hornblende, biotite, K-feldspar, plagioclase, quartz and minor apatite, zircon and sphene.

3.11. Pink granite (*Grm*)

The pink granite is subdivided into two types. One occurs in the upper formation as a network dyke ranging in width from scores of centimeters to several meters. The other is a straight and clear-cut dyke. The former is leucocratic, medium-grained and occasionally grades into pegmatite. The latter cuts the former and is leucocratic, pink to reddish gray in color and medium-grained. The both dykes are composed of biotite, K-feldspar, plagioclase and quartz.

4. Geologic Structure

The geologic structure of the region is generally gentle to moderate with gentle to open folding structures. The folds are grouped into two generations. One group is a series of northwest-southeast trending four folds, gentle to open type, developed in the northwest and southeast massifs. The other one is a gentle anticline, trending northeast-southwest and is superposed on the former. It is developed from the center of Glacier Norsk Polarinstitutt to the southwest massif.

The dips of foliations are generally gentle, ranging from 10 to 45° in the southwest and northwest massifs. But in the southwestern part of the southeast massif, dips are relatively steep, 50 to 80°.

5. Summary and Correlation with the Sør-Rondane Mountains

The basement rocks exposed in the Belgica Mountains are classified into the following eleven types: (1) granitic gneiss, (2) marble and skarn, (3) amphibolite, (4) hornblende-biotite gneiss, (5) augen gneiss, (6) clinopyroxene gneiss, (7) garnet-biotite gneiss, (8) basic meta-dyke, (9) syenite, (10) granodiorite-diorite, (11) pink granite.

On the other hand, in the Sør-Rondane Mountains about 200 km west of the Belgica Mountains, the Teltet-Vengen group and the Nils Larsenfjellet group are distributed (AUTENBOER, 1969). The former consists of migmatite, quartzite, graphite schist, amphibolite, carbonate rocks and various gneisses such as biotite gneiss, hornblende-biotite gneiss, biotite-garnet gneiss and quartz-feldspathic gneiss. The latter is composed of gabbroic and dioritic gneisses.

So the constituent rocks of the Belgica Mountains seem to be more similar to the Teltet-Vengen group of the Sør-Rondane Mountains than to the Yamato Mountains, the later being characterized by widely distributed charnockitic sequences (SHIRAISHI and KIZAKI, 1979).

The ages of gneisses and dyke rocks in the Belgica Mountains range from 382 to 472 Ma. In the Sør-Rondane Mountains, the ages obtained by K-Ar total rock measurement range from 350 to 475, and range from 457 to 593 by Rb-Sr and Pb-U methods (PICCIOTTO *et al*., 1964). Taking into account the argon loss, the K-Ar ages of the basement rocks of the Belgica Mountains may be related to those of the Sør-Rondane Mountains.

Acknowledgments

The authors thank the members of the Yamato-Belgica traverse party of JARE-20 for their help in geological survey. The authors also thank Dr. R. SUGISAKI for analyzing bulk chemical compositions of rocks.

References

AUTENBOER, T. B. (1969): Geology of the Sør Rondane Mountains. Geologic Map of Antarctica, ed. by V. C. BUSHNELL and C. CRADDOCK. New York, Am. Geogr. Soc., pl. VIII (Antarct. Map Folio Ser., Folio 12).

AUTENBOER, T. B. and LOY, W. (1972): Recent geological investigations in the Sør-Rondane Mountains, Belgicafjella and Sverdrupfjella, Dronning Maud Land. Antarctic Geology and Geophysics, ed. by R. J. ADIE. Oslo, Universitetsforlaget, 563–571.

KOJIMA, H., YANAI, K. and NISHIDA, T. (1981): Geological map of the Belgica Mountains, Antarctica. Antarct. Geol. Map Ser., Sheet **29** (with explanatory text, 7p.), Tokyo, Natl Inst. Polar Res.

PICCIOTTO, E., DEUTSCH, S. and PASTEELS, P. (1964): Isotopic ages from the Sør-Rondane Mountains, Dronning Maud Land. Antarctic Geology, ed. by R. J. ADIE. Amsterdam, North-Holland, 570–578.

SHIRAISHI, K. and KIZAKI, K. (1979): Yamato Sanmyaku no chishitsu (Geology of the Yamato Mountains). Gekkan Chikyû (The Earth Monthly), **1**(12), 928–937.

(*Received October 31, 1981*; *Revised manuscript received December 14, 1981*)