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SHEET 25 BOTNNESET

Explanatory Text of Geological Map of Botnneset, Antarctica

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1. Introduction

Botnneset (69°38′–69°53′S, 37°00′–38°00′E) is a mainly ice-covered area along the "bottom" of Lützow-Holm Bay. The bedrock is exposed as small ice-free areas mostly less than 1km in length. The geological survey of the areas, Kumihimo Rock, Vesthovde-naka Rocks, a part of Vesthovde-nisi Rocks, Austhovde-minami Rocks and Nesholmen, was carried out by H. ANDO and M. YOSHIDA of the tenth Japanese Antarctic Research Expedition (JARE-10) in 1969 (YOSHIDA and ANDO, 1971). YOSHIDA (1975) interpreted the tectonic and metamorphic sequence of the region on the basis of the above survey. K. SHIRAISHI of JARE-25 surveyed Innhovde, Vesthovde-higasi Rocks, Vesthovde-naka Rocks and Austhovde in January 1984.

In 1975, the geomorphological survey of Austhovde was done by K. MORIWAKI of JARE-15 (MORIWAKI, 1976). The geodetic survey was conducted by the Geographical Survey Institute (GSI) in 1969 and 1975, and was completed in 1984. The Botnneset region appears in six topographic maps of Vesthovde, Såta and Kiska, Innhovde, Veslestabben, Nesbrekka and Austhovde on a scale of 1:25000 which were published by GSI in 1985. Nesholmen is not included in the present issue because the topographic map is not available.

2. Geology

2.1. General

The ice-free areas in the Botnneset region are generally flat in geomorphology, and some are exposed on coastal precipice slopes (Plate 1). Small amounts of morainic boulders are scattered on the rock surface. Glacial striae and glacial grooves are well preserved in many places except Vesthovde (Plate 2a). General trend of the glacial striae is NW-SE in Austhovde (MORIWAKI, 1976) and N-S in Innhovde and Kumihimo Rock. NW-SE glacial striae are also reported from Nesholmen, east of the present region (YOSHIDA, 1975). Patterned grounds are found in Austhovde-minami Rocks. In Vesthovde-naka Rocks and Austhovde-kita Rocks, round holes which are 10 to 20cm in diameter and several centimeters in depth are observed (Plate 2c). YOSHIDA (1975) interpreted that these holes were formed by sea-water action before these areas were uplifted. On the other hand, MORIWAKI (1976) indicated the differential weathering origin of these holes because the glacially scoured surface is locally preserved.

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The basement rocks of the present region consist of various high-grade metamorphic rocks with minor amounts of granite and pegmatite. Trends and dips of planar structures (banding and foliation) of the metamorphic rocks are various from place to place. In general the trends of foliations seem to be parallel to the coastal line. Among the conspicuous structures are distinct shear fractures and minor faults trending N-S to NW-SE in the central part of the region. These fractures are accompanied by granitic pegmatite intrusions.

The metamorphic rocks are composed mainly of pelitic to semipelitic and intermediate gneisses with subordinate amounts of basic to ultrabasic, calcareous and silicious rocks. The basement rocks exposed in the Botnneset region are classified as follows for mapping units:

1) Pyroxene-hornblende gneiss (Gp)
2) Biotite-hornblende gneiss (Gbh)
3) Biotite gneiss (Gb)
4) Garnet-biotite gneiss (Ggb)
5) Quartzite and siliceous garnet gneiss (Q)
6) Amphibolites and mafic to ultramafic granulites (Mb)
7) Marble and skarn (Ls)
8) Gneissose granite (Gr)
9) Metamorphosed mafic dike rocks (Dm)
10) Pegmatites (P)

In the following sections, outline of geology in each ice-free area investigated will be described.

2.2. *Kumihimo Rock*

Kumihimo Rock, located at the northwestern point of Fletta Bay, is a small exposure of about 100×300 m. The area consists mainly of mesocratic pyroxene-hornblende gneiss and quartzofeldspathic biotite gneiss with thin bands of two-pyroxene biotite granulite. The general structure is monoclinic toward SE with an eastward gentle mineral lineation. A granitic pegmatite concordantly intrudes the gneisses.

2.3. *Innhovde*

Innhovde, the largest ice-free area in the present region, has dimensions of 0.75× 3.0 km, extending NW-SE (Plate 1a). Basement rocks of the area are composed mainly of pyroxene-hornblende gneiss and biotite-hornblende gneiss with subordinate amounts of garnet-biotite gneiss, mafic to ultramafic granulite and amphibolite. Gneissose granite concordantly intrudes the above rocks. The structural trend of the metamorphic rocks is uniformly NW-SE, corresponding to the long dimension of the rock exposure, and dips moderately toward NE. Intrafolial folds shown by basic schlierens and layers are found in some places (Plate 3a).

2.4. *Vesthovde*

Vesthovde consists of three outcrops, Vesthovde-higasi Rocks, Vesthovde-naka Rocks and Vesthovde-nisi Rocks, separated 1.5 km apart from each other (Plate 1b).

All outcrops are almost flat and smoothly continue to the ice sheet. The surface of exposures is strongly weathered and no glacial striae are found.

Basement rocks are composed mainly of the alternation of mafic-rich and quartzofeldspathic garnet-biotite gneisses with minor amounts of quartzofeldspathic biotite-hornblende gneiss, marble, skarn, mafic to ultramafic granulite and amphibolite (Plate 4a). Gneissose granite subconcordantly intrudes the above rocks (Plate 3c). General trend of foliation is N-S to NE-SW and dips uniformly SE. Mineral lineations on the dominant foliation plunge gently toward E to SE. It is conspicuous that minor faults and shear planes trending NW-SE are widespread in the area. The faults show mostly left-lateral slip, and granitic pegmatite generally intrudes along the faults and shear planes (Plate 3b). Mylonitic gneisses and augen gneisses often accompany the faults. Mineral lineations near the faults plunge moderately toward N to NW.

2.5. *Austhovde*

Austhovde consists of three outcrops, Austhovde-kita Rocks, Austhovde-naka Rocks and Austhovde-minami Rocks (Plate 1c). Each outcrop is about 1.0 km in length, stretching conformably along the general trend of the foliation. The foliation trends E-W and dips S in the north and trends N-S and dips W in the south where mineral lineations plunge gently toward W. Therefore, it is possible to infer a megascopic gentle folding structure in this area. Austhovde-minami Rocks, is composed of the alternation of pyroxene-hornblende gneiss, silicious garnet gneiss, quartzite, garnet-biotite gneiss, biotite gneiss and marble (Plates 5b and 5c). A few thin layers of skarn also occur. Such a set of siliceous and calcareous formations is similar to that in the Skallen area in the Lützow-Holm Bay region. In Austhovde-kita Rocks and Austhovde-naka Rocks, the biotite gneiss and garnet-biotite gneiss are predominant, alternating with the biotite-hornblende gneiss and the biotite amphibolite. Layers of gneissose granite concordantly intrude the gneisses widely in these outcrops.

3. Petrography

Representative bulk chemical compositions of the rocks are presented in Table 1.

3.1. *Pyroxene-hornblende gneiss*

This rock occurs in Innhovde, Austhovde-minami Rocks and Kumihimo Rock. The surface of this rock is usually stained reddish brown due to weathering. This is a medium- to coarse-grained rock with a distinct foliation defined by mafic minerals. Felsic minerals are characteristically dark grey in color. The consituent minerals are clinopyroxene, orthopyroxene, hornblende, biotite, K-feldspar, plagioclase and quartz (Plate 6a). Accessory minerals are apatite, opaque minerals and zircon. Clinopyrpoxene is minor in amount. K-feldspar and plagioclase show perthitic and antiperthitic structures, respectively.

3.2. *Biotite-hornblende-gneiss*

Biotite-hornblende gneiss is a common rock type in Innhovde and locally occurs in Vesthovde and Austhovde. The gneissose granite intrudes concordantly, resulting in

Table 1. Chemical analyses

Sp. No.	1	2	3	4	5	6	7	8	9
SiO_2	76.09	72.96	71.54	63.56	60.03	59.99	69.12	66.61	58.86
TiO_2	0.11	0.23	0.50	0.88	1.22	1.06	0.60	0.66	1.07
Al_2O_3	13.01	13.95	13.75	15.98	19.10	17.11	14.16	15.36	16.10
Fe_2O_3	0.33	0.48	0.52	1.34	1.10	1.82	2.42	1.42	2.37
FeO	0.25	1.47	3.24	5.45	6.79	6.48	1.77	2.45	4.88
MnO	0.01	0.02	0.09	0.09	0.13	0.10	0.07	0.07	0.10
MgO	0.27	0.83	0.77	2.90	1.92	3.88	1.06	1.40	3.77
CaO	0.44	0.95	1.41	2.01	3.02	3.41	2.82	3.06	6.14
Na_2O	1.67	1.70	2.64	3.51	4.16	2.94	3.11	3.63	3.11
K_2O	6.56	6.03	4.89	3.01	1.02	2.18	4.11	4.48	2.62
H_2O (+)	0.49	0.66	0.32	0.67	0.75	0.72	0.37	0.30	0.50
H_2O (−)	0.24	0.28	0.02	0.07	0.22	0.03	0.02	0.11	0.10
P_2O_5	0.02	0.05	0.07	0.19	0.05	0.24	0.16	0.17	0.22
Total	99.49	99.61	99.76	99.66	99.51	99.96	99.76	99.72	99.84
Q	39.97	35.97	31.28	20.06	18.28	18.11	28.04	19.47	11.58
C	2.41	3.02	1.72	3.75	5.78	4.29	—	—	—
or	38.77	35.64	28.90	17.79	6.03	12.88	24.29	26.48	15.48
ab	14.13	14.39	22.34	29.70	35.20	24.88	26.32	30.72	26.32
an	2.05	4.39	6.54	8.73	14.66	15.35	12.54	12.39	22.23
ne	—	—	—	—	—	—	—	—	—
di wo	—	—	—	—	—	—	0.17	0.70	2.84
di en	—	—	—	—	—	—	0.13	0.40	1.70
di fs	—	—	—	—	—	—	0.02	0.27	0.98
hy en	0.67	2.07	1.92	7.22	4.78	9.66	2.51	3.09	7.69
hy fs	0.02	1.96	4.86	7.61	9.79	8.83	0.37	2.09	4.44
ol fo	—	—	—	—	—	—	—	—	—
ol fa	—	—	—	—	—	—	—	—	—
mt	0.48	0.70	0.75	1.94	1.60	2.64	3.51	2.06	3.44
il	0.21	0.44	0.95	1.67	2.32	2.01	1.14	1.25	2.03
ap	0.05	0.12	0.16	0.44	0.12	0.56	0.37	0.39	0.51
Analyst	H	H	J	J	H	J	J	J	J

No. 1. A69012802 Quartzofeldspathic biotite gneiss (Austhovde-minami Rocks) (Gb)
2. A69012803 Quartzofeldspathic garnet-biotite gneiss (Austhovde-minami Rocks) (Ggb)
3. 84011807 Quartzofeldspathic garnet-biotite gneiss (Vesthovde-higasi Rocks) (Ggb)
4. 84012212 Garnet-biotite gneiss (Austhovde-naka Rocks) (Ggb)
5. Y69012931a Garnet-biotite gneiss (Vesthovde-naka Rocks) (Ggb)
6. 84011304 Spinel-bearing garnet-biotite gneiss (Innhovde) (Ggb)
7. 84011317 Hornblende-biotite gneiss (Innhovde) (Gbh)
8. 84011310 Orthopyroxene-hornblende-biotite gneiss (Innhovde) (Gp)
9. 84011303 Two-pyroxene-hornblende-biotite gneiss (Innhovde) (Gp)
10. Y69012931b Two-pyroxene-biotite granulite (Vesthovde-naka Rocks) (Mb)
11. 84011307K Olivine-bearing hornblende pyroxenite (Innhovde) (Mb)
12. 84011203 Orthopyroxene-biotite amphibolite (Innhovde) (Mb)
13. 84011307J Olivine-bearing two-pyroxene hornblendite (Innhovde) (Mb)

of rocks from the Botnneset.

10	11	12	13	14	15	16	17	18	19	20
54.59	49.21	48.89	48.37	47.95	47.68	47.14	44.38	39.58	73.50	67.98
1.39	0.40	1.42	0.37	1.43	0.62	1.36	1.50	0.73	0.19	0.42
15.54	7.24	15.72	7.42	7.03	4.74	16.92	14.64	7.15	14.20	17.27
2.06	2.35	3.46	2.48	2.69	8.83	3.93	4.32	10.57	0.73	0.74
9.26	3.17	7.05	3.37	9.80	6.53	7.65	9.70	11.89	0.66	1.65
0.16	0.11	0.16	0.11	0.16	0.21	0.19	0.21	0.31	0.01	0.01
6.59	19.40	7.44	18.92	18.59	25.47	5.89	10.34	23.50	0.33	0.89
4.82	15.42	9.39	17.72	9.20	2.35	9.94	8.48	4.09	0.90	3.26
2.36	1.12	3.67	0.98	1.21	0.27	2.94	2.25	1.18	2.25	4.41
1.21	0.74	1.22	0.77	0.74	1.94	1.07	2.27	0.19	6.02	1.58
1.17	0.77	1.07	0.98	0.97	1.00	1.41	1.37	0.59	0.57	0.84
0.36	0.06	0.14	0.07	0.09	0.10	0.08	0.10	0.14	0.16	0.27
0.13	—	0.29	0.01	0.14	0.27	0.20	0.20	0.07	0.07	0.29
99.64	99.99	99.92	99.56*	100.00	100.01	99.83**	99.96	99.99	99.59	99.61
10.39	—	—	—	—	—	—	—	—	35.01	27.99
1.90	—	—	—	—	—	—	—	—	2.51	3.07
7.15	4.37	7.21	4.55	4.37	11.47	6.32	13.42	1.12	35.58	9.34
19.97	6.18	27.91	4.06	10.24	2.29	24.88	10.91	9.99	19.04	37.32
23.06	12.54	22.82	13.57	11.57	5.99	29.81	23.14	13.65	4.01	14.28
—	1.79	1.71	2.29	—	—	—	4.40	—	—	—
—	26.71	9.13	26.87	13.85	1.63	7.60	7.36	2.58	—	—
—	21.90	5.93	21.90	9.77	1.34	4.49	4.70	1.92	—	—
—	1.55	2.57	1.73	2.89	0.09	2.73	2.18	0.41	—	—
16.41	—	—	—	14.63	47.55	1.73	—	10.74	0.82	2.22
13.30	—	—	—	4.33	3.04	1.05	—	2.29	0.31	1.74
—	18.52	8.83	17.68	15.35	10.20	5.93	15.10	32.15	—	—
—	1.45	4.22	1.54	5.01	0.72	3.96	7.71	7.55	—	—
2.99	3.41	5.02	3.60	3.90	12.80	5.70	6.26	15.32	1.06	1.07
2.64	0.76	2.70	0.70	2.72	1.18	2.58	2.85	1.39	0.36	0.80
0.30	—	0.67	0.02	0.32	0.63	0.46	0.46	0.16	0.16	0.67
H	K	J	J	K	K	J	J	K	H	H

14. 84011813 Hornblende pyroxenite (Vesthovde) (Mb)
15. 84011306 Hornblende-biotite pyroxenite (Innhovde) (Mb)
16. 84012205 Biotite amphibolite (Austhovde-naka Rocks) (Mb)
17. 84012005 Orthopyroxene-biotite amphibolite (Vesthovde-higasi Rocks) (Mb)
18. 84012006 Spinel-hornblende-orthopyroxene periodotite (Vesthovde) (Mb)
19. A69013806 Pink K-feldspar gneissose biotite granite (Austhovde-minami Rocks) (Gr)
20. Y69012934 Granitic pegmatite (Vesthovde-naka Rocks) (P)

Analyst J: Japan Chemical Analysis Center
H: J. HIRABAYASHI (YOSHIDA, 1975)
K: S. KANISAWA (HIROI *et al.*, 1986)

* Trace amount of Cr is detected.
** including 1.11% CO_2.

the stromatic migmatite structure. There are many varieties in appearance due to the modal amounts of mafic and felsic minerals. The biotite-hornblende gneiss is generally medium- to coarse-grained, although K-feldspar porphyroblasts up to 3 cm long are not uncommon (Plate 6b). The banding structure shown by alternation of felsic and mafic layers of a few to several centimeters wide is generally distinct. The constituent minerals are biotite, hornblende, antiperthitic plagioclase, perthitic K-feldspar and quartz. Accessory minerals are apatite, zircon and opaque minerals. Scapolite is rarely found.

3.3. *Biotite gneiss*

Biotite gneiss is mainly exposed in Austhovde. This is a fine- to coarse-grained rock with lepidoblastic to granoblastic texture. This rock is generally quartzofeldspathic and thin biotite-rich layers make a distinct banded structure. The constituent minerals are biotite, plagioclase, perthitic K-feldspar and quartz with minor amounts of zircon, apatite and opaque minerals. In Vesthovde, mylonitic biotite gneiss occurs.

3.4. *Garnet-biotite gneiss*

Garnet-biotite gneiss is widely exposed in the present region. This rock varies from melanocratic to leucocratic according to the modal amounts of biotite, garnet, or both. The alternation of melanocratic and leucocratic varieties is on a scale of a few to a few tens centimeters, representing a distinct banded structure (Plates 3b and 4a). This is a fine- to coarse-grained rock with granoblastic to porphyroblastic textures. The constituent minerals are garnet, biotite, K-feldspar, plagioclase, quartz and accessory zircon, apatite, rutile and opaque minerals. Green spinel is rarely included in garnet porphyroblasts which reach up to 1 cm in diameter (Plate 6c).

3.5. *Quartzite and siliceous garnet gneiss*

These rocks occur only in Austhovde-minami Rocks. They occur as narrow bands of a few to ten meters wide (Plate 5b). It is characteristic that these rocks are intimately accompanied by marble and quartzofeldspathic biotite gneiss. Quartzite is composed mainly of quartz with minor amounts of garnet, biotite and opaque mineral. Siliceous garnet gneiss is composed mainly of quartz, plagioclase, garnet and K-feldspar with minor biotite and opaque minerals. Garnet reaches up to 7 mm in diameter.

3.6. *Amphibolites and mafic to ultramafic granulites*

Mafic to ultramafic granulites are composed of pyroxene-biotite granulite, eclogite, pyroxenite and peridotite. There are two modes of occurrence of these rocks. One is concordant layers, ribbons of several centimeters to a few tens meters wide among the gneisses. The pinch and swell, and boudinage structures are observed in places. Amphibolite and pyroxene-biotite granulite generally occur in this mode, alternating with the quartzofeldspathic and intermediate gneisses. The other mode of occurrence isolated lensoid or round blocks (Plate 5a). The size of such blocks varies from the order of centimeters to several meters. Some blocks have zoned structures in contact with the surrounding gneisses, suggesting the metasomatic reaction (HIROI *et al.*, 1986). Ultramafic granulites occur mainly as the isolated blocks. The mode of occurrence in the field and bulk chemical compositions of these isolated blocks suggest that these rocks were derived from various parts of layered gabbro and were tectonically fractured and emplaced in the sedimentary rocks (HIROI *et al.*, 1986).

3.6.1. Amphibolite

This is a fine- to medium-grained rock with lepidoblastic to granoblastic textures. The constituent minerals are essentially biotite, hornblende and plagioclase with or without quartz. Orthopyroxene, clinopyroxene, or both are commonly contained in various amounts. Accessory minerals are apatite and opaque minerals.

3.6.2. Pyroxene-biotite granulite

This is a melanocratic fine- to medium-grained rock with granoblastic to lepidoblastic texture. There are two varieties of mineral assemblages in this rock. Garnet-orthopyroxene-biotite-plagioclase-quartz-opaque mineral with minor green spinel, apatite and zircon (Plate 7a), and orthopyroxene-clinopyroxene-biotite-plagioclase with or without quartz. The formar assemblage occurs as thin garnetiferous layers in the garnet-biotite gneiss (Plate 3a). The latter one is common in the hornblende-biotite gneiss and pyroxene-biotite gneiss. Minor amounts of hornblende, apatite and zircon are contained.

3.6.3. Orthopyroxene eclogite

This is a medium-grained rock with garnet porphyroblasts. The constituent minerals are garnet, orthopyroxene, clinopyroxene, plagioclase, and minor hornblende, biotite, quartz and opaque minerals. Garnet porphyroblasts are usually surrounded by symplectitic coronas which consist of amoeba-like orthopyroxene and plagioclase (Plate 7b). In some cases, a tiny grain of garnet is found in the center of such aggregate of orthopyroxene and plagioclase, indicating a complete replacement (Plate 7c). Quartz and biotite occur only as inclusions in garnet.

3.6.4. Spinel-hornblende-orthopyroxene periodotite

This is a medium- to coarse-grained rock with a granoblastic poligonal texture (Plate 8a). The constituent minerals are green spinel, hornblende, olivine and opaque minerals.

3.6.5. Hornblende pyroxenite

This is a medium-grained rock with a granoblastic poligonal texture (Plate 8b). The constituent minerals are orthopyroxene, clinopyroxene, hornblende and opaque minerals with or without biotite and olivine. This rock grades into two-pyroxene hornblendite due to the modal ratio of the hornblende and pyroxenes.

3.7. Marble and skarn

Marble and skarn are found in Austhovde-minami Rocks and Vesthovde-higasi Rocks. A pure marble layer of 10–20 m wide occurs in Austhovde-minami Rocks (Plate 5c). Impure marble layers associated with skarn zones are found in Vesthovde-higasi Rocks and Austhovde-minami Rocks. The impure marble and skarn contain calcite, dolomite, grossular garnet, clinopyroxene, tremolite, scapolite, plagioclase, phlogopite, K-feldspar and quartz (Plate 9a).

3.8. Gneissose granite

It is peculiar that gneissose granite occurs in many places in the Botnneset region.

The gneissosity of the granite is not always concordant with that of the host gneisses. The boundary between the gneissose granite and the host gneisses in generally obscured and shows migmatitic structures, suggesting partial melting or high temperature condition of the host gneisses during the emplacement of the gneissose granite. This rock is medium-grained, composed of K-feldspar, plagioclase, quartz and a small amount of biotite. It contains garnet in some places.

3.9. Metamorphosed mafic dike rocks

Metamorphosed mafic dike rocks are found in Innhovde, Vesthovde-higasi Rocks and Austhovde-naka Rocks. These dikes discordantly intrude the surrounding gneisses. Two modes of occurrence are observed. The foliation of the rock in Innhovde and Vesthovde is parallel to the trend of the dike intrusion, whereas that in Austhovde is parallel to that of the host gneisses (Plates 4b and 4c). These are melanocratic medium-grained rocks in both cases. The constituent minerals are as follows.

a. clinopyroxene-biotite-K-feldspar-quartz-apatite-opaque minerals(s) (Innhovde)
b. biotite-hornblende-K-feldspar-plagioclase-quartz-apatite-opaque mineral(s)-sphene (Austhovde)

K-feldspar is a dominant felsic mineral in both cases.

3.10. Pegmatites

Two kinds of pegmatites are observed; pink granitic pegmatite and hornblende pegmatite. Pink granitic pegmatites occurs sporadically in the whole region, whereas the hornblende pegmatite intrudes the biotite hornblende gneiss and pyroxene hornblende gneiss in Innhovde. The constituent minerals in both rock types are biotite, hornblende, K-feldspar (microline), plagioclase, quartz and magnetite. Hornblende in the hornblende pegmatite reaches up to 4 cm long.

4. Geologic Structure

Planar structures (banding and foliation) trend generally E-W and dip gently to moderately south, although they are highly variable. Most of mineral lineations are gentle, inclined either west or east. Some north to northwestery mineral lineations with moderate plunge angle, however, develop associated with the NNW-SSE foliations and the N-S shear zones and faults. These N-S shear zones and faults are associated with mylonites and pegmatite intrusions in some places.

YOSHIDA (1975) interpreted that the fundamental structure of the Botnneset region is composed of the earlier assymmetric linear folds with their near-horizontal axes trending E-W and the later open folds and faults trending nearly N-S. The linear fold structure is well documented in Nesholmen which lies outside and eastward of the present region.

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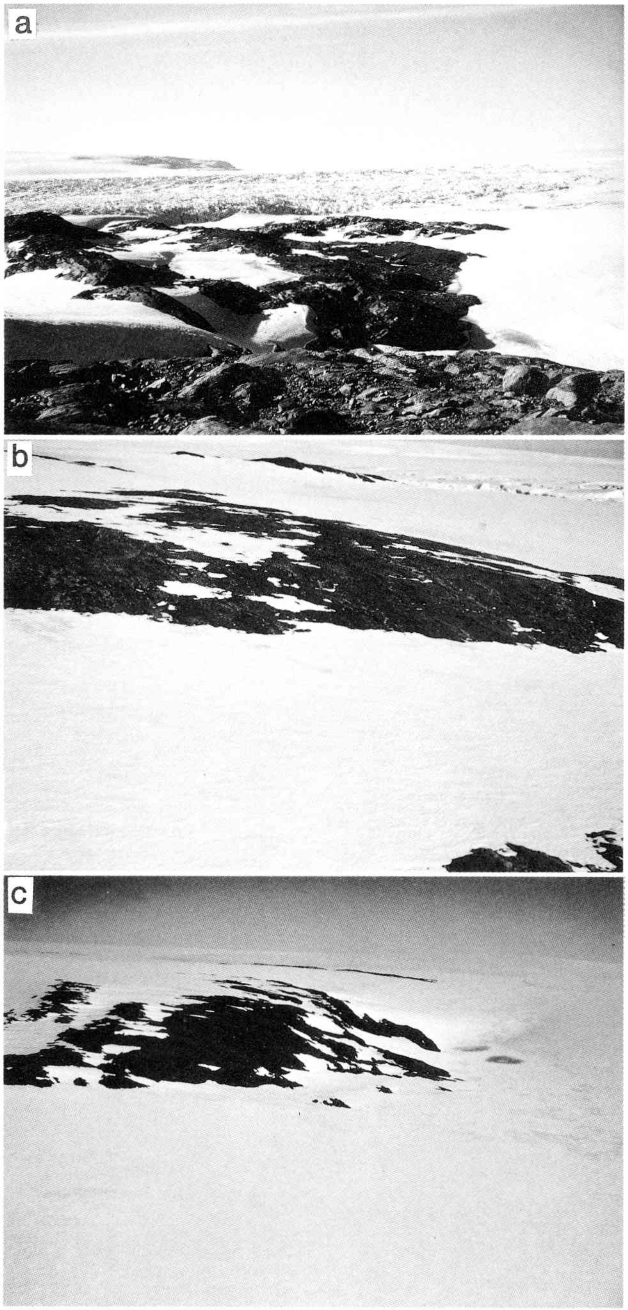
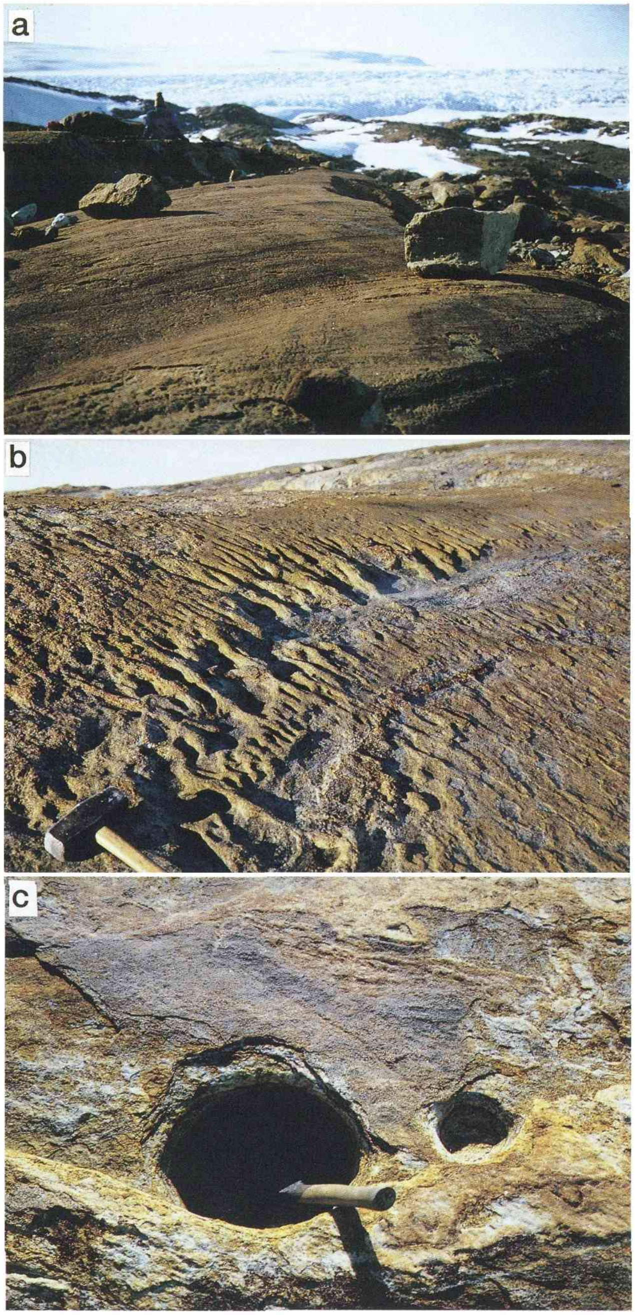
(*Received January 26, 1987*).

Plate 1



a: *Northern part of Innhovde, viewed from Peak 130.7.*
b: *Vesthovde-higasi Rocks, viewed from east.*
c: *Austhovde-minami Rocks, viewed from south.*

Plate 2

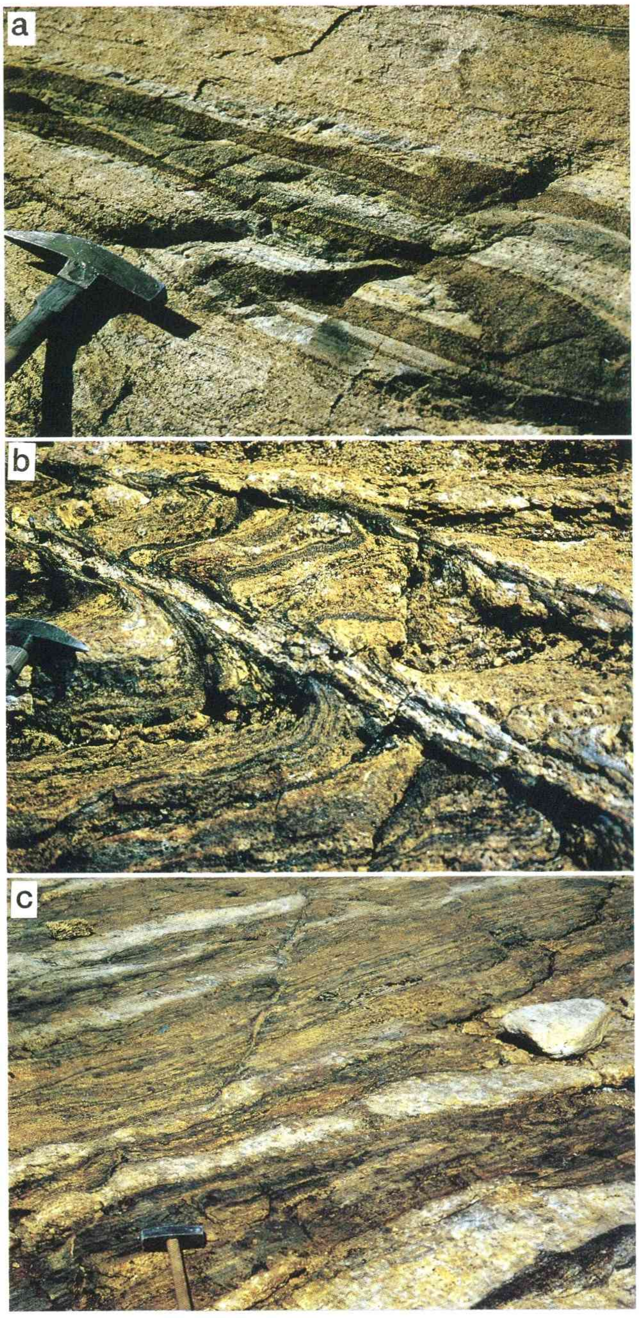


a: *Glacial striae and glacial grooves on the surface of pyroxene-hornblende gneiss. Morainic boulders are scattered on the glacially scoured surface.* (*Innhovde*)

b: *Weathered surface of gneissose granite.* (*Austhovde-kita Rocks*)

c: *Round holes on the weathered surface of garnet-biotite gneiss.* (*Vesthovde-naka Rocks*)

Plate 3

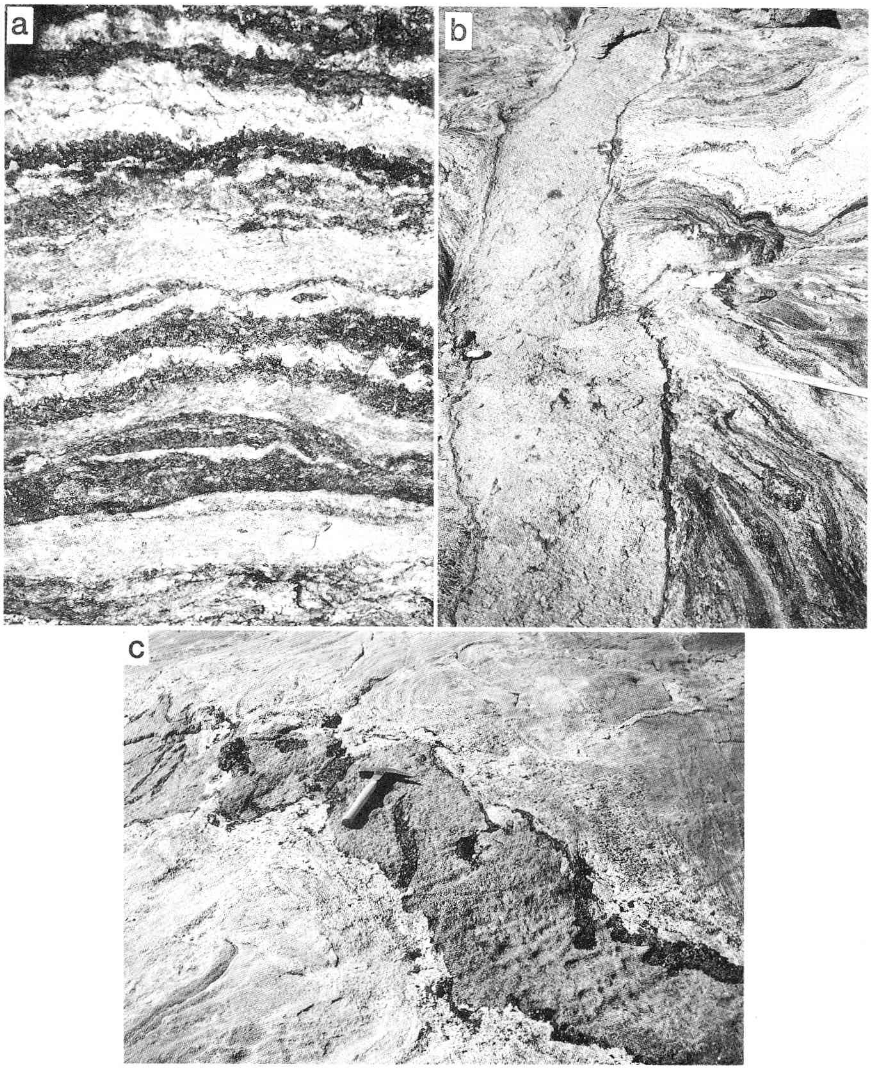


a: Intensely folded biotite-orthopyroxene-garnet granulite intercalated with garnet-biotite gneiss. (Innhovde)

b: Shear planes accompanied by granitic pegmatite in garnet-biotite gneiss. (Vesthovde-higasi Rocks)

c: Gneissose granite concordantly intruding garnet-biotite gneiss. Note the obscured boundary between them. (Vesthovde-higasi Rocks)

Plate 4

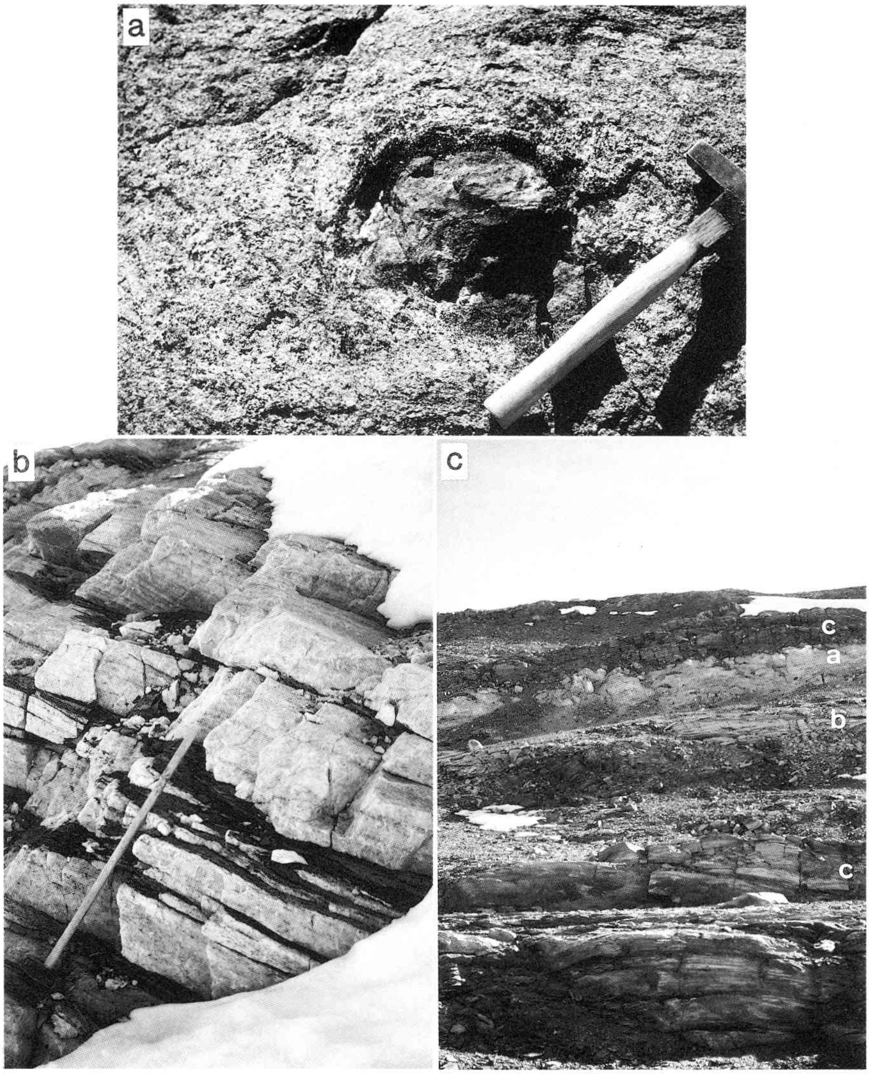


a: *Banded garnet-biotite gneiss. Alternation of garnet-dominant layers, biotite-dominant layers and quartzofeldspathic layers, ranges in width from a few to 20 cm.* (*Vesthovde-higasi Rocks*)

b: *A metamorphosed mafic dike which has foliation parallel to the direction of intrusion.* (*Visthovde-higasi Rocks*)

c: *A metamorphosed mafic dike, showing foliation parallel to that of the surrounding garnet-biotite gneiss.* (*Austhovde-naka Rocks*)

Plate 5

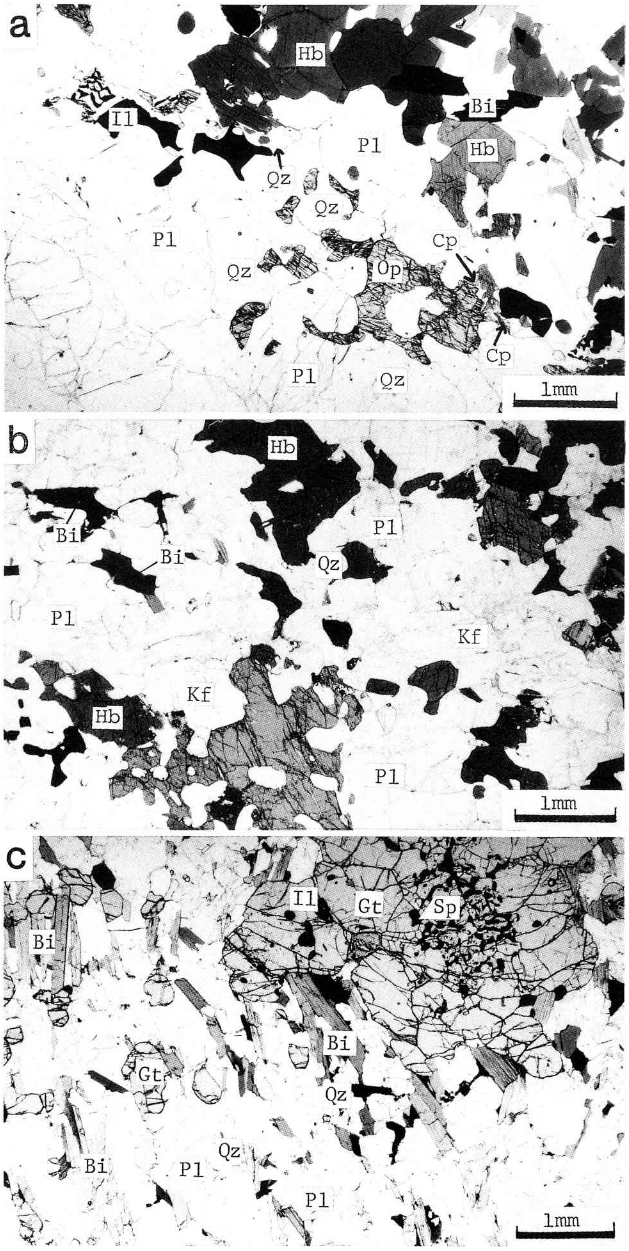


a: *A rounded block of ultramafic granulite (clinopyroxenite). A reaction crust is found in contact with the surrounding biotite-hornblende gneiss. (Innhovde)*

b: *Quartzite layers intercalating with thin biotite amphibolite layers. (Austhovde-minami Rocks)*

c: *A marble layer (a) of 10 to 20 m wide, alternating with siliceous garnet gneiss (b) and garnet-biotite gneiss (c). (Austhovde-minami Rocks)*

Plate 6

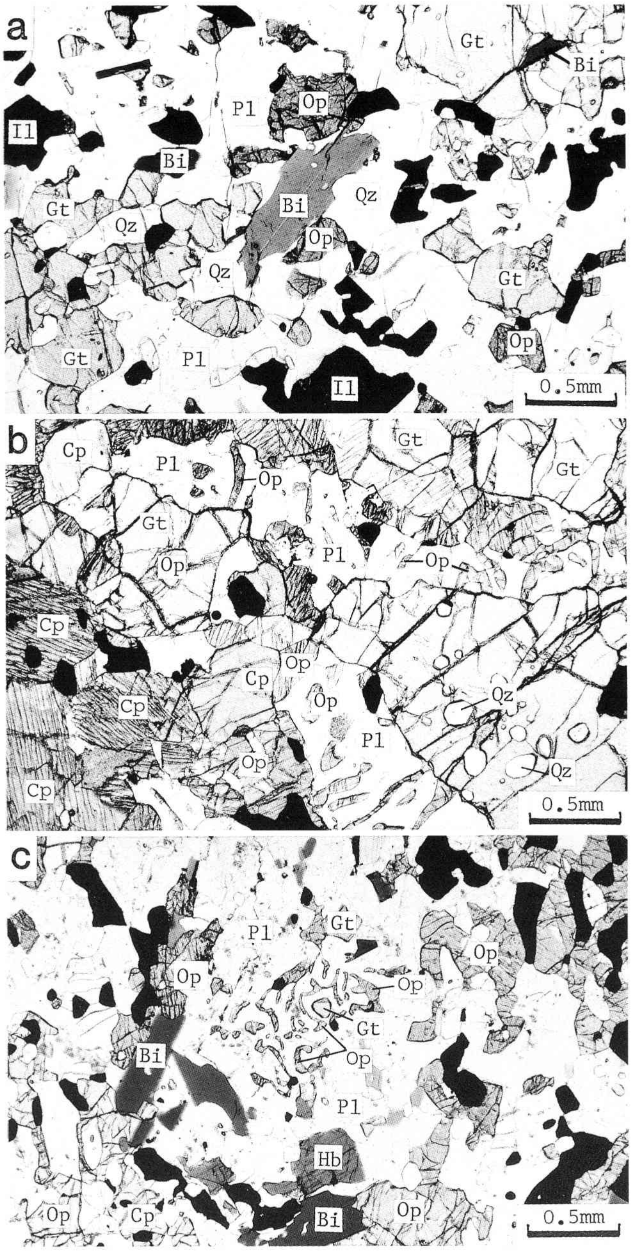


a: *A photomicrograph of pyroxene-hornblende gneiss* (*84011415*). (*Innhovde*). *Bi: biotite, Cp: clinopyroxene, Gt: garnet, Hb: hornblende, Il: ilmenite, Kf: K-feldspar, Ol: olivine, Op: orthopyroxene, Pl: plagioclase, Qz: quartz, Sc: scapolite, Sp: spinel, Sph: sphene. Mineral abbreviations are same in other plates.*

b: *A photomicrograph of biotite-hornblende gneiss* (*84011602*). (*Innhovde*)

c: *A photomicrograph of garnet-biotite gneiss. Spinel inclusions are found in a core part of garnet porphyroblast* (*84011304*). (*Innhovde*)

Plate 7



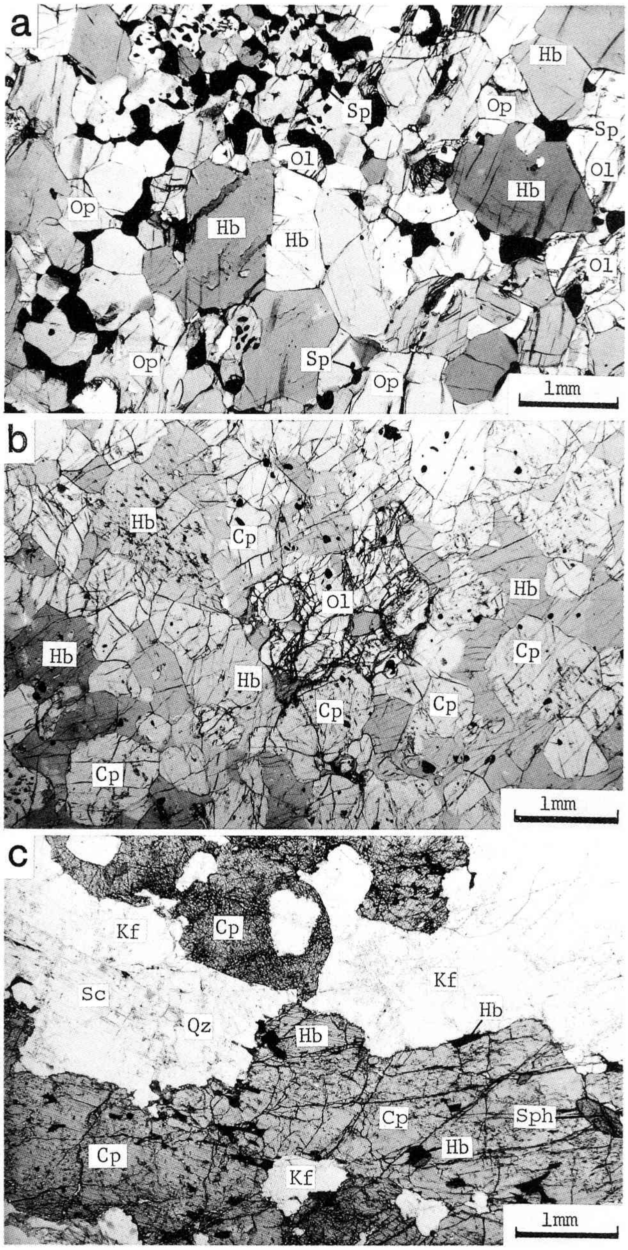
Photomicrographs of mafic to ultramafic granulites.

a: Biotite-orthopyroxene-garnet granulite (84011411). (Innhovde)

b: Orthopyroxene eclogite. Note quartz is included in garnet porphyroblasts (84012223). (Austhovde-minami Rocks).

c: ditto. A tiny garnet grain is centered in the amoeba-like intergrowth of orthopyroxene and plagioclase (84011305). (Innhovde)

Plate 8



a: *A photomicrographs of ultramafic granulites. Spinel-hornblende peridotite (84012006). (Vesthovde-higasi Rocks)*
b: *ditto. Olivine-hornblende pyroxenite (84011307). (Innhovde)*
c: *A photomicrograph of skarn (84012218). (Austhovde-minami Rocks)*

Antarctic Geological Map Series

Sheet 1	East Ongul Island	March 1974
Sheet 2	West Ongul Island	March 1974
Sheet 3	Teöya	March 1975
Sheet 4	Ongulkalven Island	March 1975
Sheet 5	Langhovde	March 1976
Sheet 6 & 7	Skarvsnes	March 1977
Sheet 8	Kjuka and Telen	March 1979
Sheet 9	Skallen	March 1976
Sheet 10	Padda Island	March 1977
Sheet 11	Cape Hinode	March 1978
Sheet 14	Sinnan Rocks	March 1983
Sheet 15	Cape Ryûgû	March 1980
Sheet 16	Akebono Rock	March 1986
Sheet 17	Niban Rock	March 1983
Sheet 18	Kasumi Rock	March 1984
Sheet 19	Tenmondai Rock	March 1985
Sheet 20	Akarui Point and Naga-iwa Rock	March 1984
Sheet 21	Cape Omega	March 1979
Sheet 22	Oku-iwa Rock	March 1981
Sheet 23	Honnör Oku-iwa Rock	March 1987
Sheet 24	Rundvågskollane and Rundvågshetta	March 1986
Sheet 25	Botnneset	March 1987
Sheet 26	Strandnibba	March 1985
Sheet 27(1)	Mt. Fukushima, Northern Yamato Mountains	March 1978
Sheet 28	Central Yamato Mountains, Massif B and Massif C	March 1982
Sheet 29	Belgica Mountains	March 1981