Nomenclature and Classification of the Basement Metamorphic and Plutonic Rocks around the Lützow-Holm Bay Region, East Antarctica

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東南極リュツォ・ホルム湾周辺地域の基盤変成・深成岩類の命名と分類

加　納　　隆*

要旨: リュツォ・ホルム湾周辺に散在する露岩地域相互の対比を行い，東南極基盤岩の地質学的総合の基礎資料を与えることを目的として，変成岩類・深成岩類の分類・命名規準の標準化を試みた．主に日本隊の地質関係者の報文中に使用されている用語に関し，用語法とその岩石学的意味について考察を加えた．

岩石学的用語は，岩質・岩相・構造・地質体区分（層序区分）・テクトジェネシス，の5つのカテゴリーに分類できる．元来岩石はこれら諸側面を内包しており，命名に際しては，野外における産状や特徴をなるべく直感できるような，岩相名＋構造名を用いることが望ましい．またあわせて各用語の使用規準の概要を示した．

分類・命名に関しては，なお多くの議論があり，記載の不備や混乱もあるが，本論では主として岩質に基づいて，当地域の変成岩・深成岩類を 13 種類に大別し，各岩石の産状や岩石学的性質を総括的に述べた．

Abstract: The report discusses the usages and terminology of petrological terms used in the previous papers concerning the basement metamorphic and plutonic rocks around the Lützow-Holm Bay region, East Antarctica. The terms are classified into the following categories: (1) Lithology (mainly based on chemical composition of rocks), (2) Lithofacies, (3) Structure, (4) Megascopic litho-stratigraphic classification and (5) Tectogenesis. The report points out the general views on terminology in practical use for standardizing the nomenclature and classification of basement rocks.

The metamorphic and plutonic rocks in the region will be classified into the following 13 types, although several problems still remain, and petrological properties of each rock-type are described.

(1) Ultrabasic to basic rocks consisting mainly of olivines.
(2) Ultrabasic to basic rocks consisting mainly of pyroxenes ...〈Pyroxenite〉.
(3) Ultrabasic to basic rocks consisting mainly of amphiboles.....〈Amphibolite〉.
(4) Other ultrabasic to basic rocks.
(5) Basic to intermediate rocks including amphiboles as major mafic minerals....〈Hornblende gneiss〉.

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(6) Intermediate rocks including orthopyroxene and clinopyroxene as major mafic minerals....〈Two-pyroxene gneiss〉.
(7) Pelitic to psammitic rocks including biotite as major mafic mineral.... ....〈Biotite gneiss, etc.〉.
(8) Leucocratic or acidic rocks associated with other metamorphic rocks.
(9) Calcareous rocks.
(10) Quartzite.
(11) Plutonic or metamorphic rocks with syenitic or charnockitic compositions.
(12) Plutonic or metamorphic rocks with granitic or migmatitic appearances.
(13) Plutonic rocks with granitic or granodioritic compositions.

1. Introduction

In recent years, geological and petrological informations about the basement metamorphic and plutonic rocks in East Antarctica have been accumulated. More than twenty geologists joined the Japanese Antarctic Research Expedition (JARE-1 ~ -22) and have investigated the areas including Shinnan Iwa in the east, Yamato Mountains in the south and Bergica Mountains in the west. It is projected to extend the areas further to the East Queen Maud Land and the Enderby Land.

However, areal expansion and increasing number of geologists seem to cause some confusions in the nomenclature and classification of basement rocks, since the special fields and viewpoints of geologists are diverse. Moreover, the exposures of rocks are isolated in the continental ice sheet, just like the small islands in the ocean.

From 1979 to 1980, the meetings for standardizing the nomenclature and classification of metamorphic and plutonic rocks in the investigated areas have been held to establish the regional correlation of the geology around Lützow-Holm Bay.

The report discusses the usages and terminology of geological and petrological terms which have been dealt with in the previous papers, and presents basic data on the classification and correlation of metamorphic and plutonic rocks in East Antarctica, although several controversial problems have remained unsettled at the meetings.

2. Petrological Terms and Their Usages

2.1. Petrological terms used in the previous papers

The rock-names used as the geological and petrological titles in the previous papers and geological maps are as follows:

TATSUMI and KIKUCHI (Nankyoku Shiryô (Antarct. Rec.), **8**, 1959)
〈Ongul Islands, Langhovde, Skalvsnes, Skallen〉
(1) Hornblende-pyroxene dioritic gneiss
(2) Marble and quartzite

(3) Basic bands
(4) Pyralspite-biotite granodioritic gneiss
(5) Biotite granitic gneiss and granite
(6) Pegmatite

Geological map

(1) Granitic gneiss and granite
(2) Granodioritic gneiss
(3) Dioritic gneiss
(4) Basic metamorphic rock
(5) Marble
(6) Quartzite and siliceous beds

KIZAKI (Nankyoku Shiryô (Antarct. Rec.), **14**, 1962)

〈East Ongul Island〉

(1) Pegmatite
(2) Porphyroid
(3) Amphibolite
(4) Hornblende gneiss
(5) Garnet gneiss
(6) Charnockitic gneiss
(7) Granite

BANNO, TATSUMI, KUNO and KATSURA (JARE Sci. Rep., Ser. C, **1**, 1964)

〈Lützow-Holm Bay〉

(1) Ultrabasic and basic granulites
(2) Pyroxene gneiss
(3) Garnet gneiss
(4) Marble
(5) Quartzite

KIZAKI (JARE Sci. Rep., Ser. C, **2**, 1964)

〈East Ongul Island〉

(1) Metabasite
  a. Pyroxenite
  b. Pyroxene amphibolite
  c. Garnet-bearing pyroxene amphibolite
(2) Marble and quartzite
(3) Pyroxene gneiss
(4) Hornblende gneiss
(5) Garnet gneiss
(6) Granitic gneiss and granite
(7) Feldspathic bands
(8) Pegmatite

KIZAKI (JARE Sci. Rep., Ser. C, **3**, 1965)

〈Yamato Mountains〉

Petrography

(1) Pyroxene gneiss
(2) Pyroxene syenite

(3) Migmatitic gneiss and biotite granite
(4) Granitic gneiss
(5) Microcline granite
(6) Metabasite
(7) Microcline pegmatite

Geological map

(1) Granitic gneiss (Microcline granite)
(2) Migmatitic gneiss (Biotite granite)
(3) Porphyritic pyroxene syenite
(4) Pyroxene syenite
(5) Pyroxene gneiss
(6) Metabasite
  a. Basic granulite
  b. Pyroxene amphibolite
  c. Biotite amphibolite

SUWA (13th Inter. Geol. Congress, **4**, 1968)

〈Lützow-Holmbukta〉

(1) Ultrabasic and basic granulites
(2) Pyroxene gneiss
(3) Garnet gneiss
(4) Metasomatic pyroxene gneiss derived from pelitic gneiss
(5) Garnet-free pelitic gneiss intercalated in quartzite
(6) Marble
(7) Quartzite
(8) Granite
(9) Pegmatite

YOSHIDA and ANDO (Nankyoku Shiryô (Antarct. Rec.), **39**, 1971)

〈Lützow-Holm Bay〉

(1) Siliceous gneiss
(2) Alternation of basic and acid gneisses
(3) Basic granulite and amphibolite
(4) Granitic siliceous gneiss
(5) Gneissose granodiorite
(6) Hypersthene-bearing gneissose granodiorite
(7) Siliceous microdioritic gneiss
(8) Biotite gneiss
(9) Granitized biotite gneiss
(10) Biotite gneissose granite and hornblende gneissose granite
(11) Garnet-bearing gneissose granite
(12) Pink potash-feldspar gneissose granite

〈Yamato Mountains〉

(1) Biotite gneiss
(2) Amphibolite
(3) Basic granulite
(4) Biotite gneissose granite

(5) Hornblende gneissose granite
(6) Syenite
(7) Leucocratic syenite
(8) Pink potash-feldspar gneissose granite
(9) Micro biotite granite

SHIRAISHI, WATANABE and KIZAKI (Nankyoku Shiryô (Antarct. Rec.), **45**, 1972).

〈Sandercock Nunataks〉

(1) Hornblende-biotite gneiss
(2) Hypersthene-garnet gneiss
(3) Garnet gneiss
(4) Hypersthene-hornblende gneiss
(5) Pegmatite
(6) Aplite
(7) Metabasite

YANAI, KIZAKI, TATSUMI and KIKUCHI (Antarct. Geol. Map Ser., Sheet 1, 1974a)

〈East Ongul Island〉

(1) Metabasite
  a. Pyroxene amphibolite
  b. Pyroxenite
  c. Garnet-bearing pyroxene amphibolite
  d. Hornblende eclogite
  e. Hornblendite
  f. Anorthosite
(2) Pyroxene gneiss
  a. Basic enderbitic pyroxene gneiss
  b. Charnockitic pyroxene gneiss
  c. Garnet-bearing enderbitic pyroxene gneiss
(3) Hornblende gneiss
  a. Hornblende gneiss
  b. Scapolite-bearing hornblende gneiss
(4) Garnet gneiss
(5) Feldspathic band
(6) Hornblende-biotite gneissose granite
  a. Hornblende granite
  b. Garnet-bearing hornblende granite
  c. Biotite granite

YANAI, TATSUMI and KIKUCHI (Antarct. Geol. Map Ser., Sheet 2, 1974b)

〈West Ongul Island〉

(1) Metabasite
  a. Hornblende eclogite
  b. Hornblendite
  c. Pyroxenite
(2) Amphibolite
(3) Pyroxene gneiss
(4) Hornblende gneiss

(5) Garnet-biotite gneiss
(6) Porphyroblastic gneiss
(7) Garnet gneiss
(8) Feldspathic gneiss
(9) Garnet-bearing granitic gneiss
(10) Hornblende-biotite gneissose granite
(11) Microcline granite
(12) Pegmatite

YANAI, TATSUMI, KIKUCHI and ISHIKAWA (Antarct. Geol. Map Ser., Sheet 3, 1975a)
〈Teöya〉
(1) Pyroxene gneiss
(2) Garnet-biotite gneiss
(3) Porphyroblastic gneiss
(4) Hornblende gneiss
(5) Metabasite
(6) Garnet-bearing granitic gneiss

YANAI, TATSUMI and KIKUCHI (Antarct. Geol. Map Ser., Sheet 4, 1975b)
〈Ongulkalven Island〉
(1) Garnet-biotite gneiss
(2) Pyroxene gneiss
(3) Porphyroblastic gneiss
(4) Hornblende gneiss
(5) Garnet-bearing granitic gneiss
(6) Metabasite

SHIRAISHI (Nankyoku Shiryô (Antarct. Rec.), **53**, 1975)
〈Minami-Yamato Nunataks〉
(1) Hornblende-biotite gneiss
(2) Granitic gneiss
(3) Metabasite
(4) Granitic dyke and pegmatite

YOSHIDA (Mem. Natl Inst. Polar Res., Ser. C, **8**, 1975)
〈Botnneset〉
Petrography
(1) Metabasite
  a. Pyroxene metabasite
  b. Hornblende metabasite
(2) Paragneiss
  a. Basic gneiss
  b. Acid gneiss
  c. Quartz-feldspathic biotite gneiss
  d. Quartz-feldspathic garnet gneiss
(3) Brown gneissose granodiorite
(4) Hornblende-biotite microgranite
(5) White gneissose granodiorite
(6) Pink gneissose granite

(7) Pegmatite

Geological map

(1) Metabasite
(2) Acid gneiss
(3) Basic gneiss
(4) Quartz-feldspathic gneiss
(5) Acid brown gneiss
(6) Brown gneissose granodiorite
(7) White gneissose granodiorite
(8) Pink gneissose granite
(9) Granitic pegmatite
(10) Quartz-feldspathic biotite brown gneiss
(11) Brown augen gneiss
(12) Potash-feldspar porphyritic brown gneissose granodiorite
(13) Siliceous gneiss
(14) Brown gneiss
(15) Quartz-feldspathic gneiss
(16) Quartz-feldspathic garnet gneiss
(17) Brown to white granodioritic gneiss
(18) Porphyritic white gneissose granodiorite
(19) Hornblende-biotite microgranite
(20) Brown gneissose granodiorite with porphyritic potash-feldspar

ISHIKAWA (Mem. Natl Inst. Polar Res., Ser. C, **9**, 1976)

〈Lützow-Holm Bay〉

(1) Pyroxene gneiss
(2) Pyroxene syenite
(3) Marble and quartzite
(4) Metabasite
(5) Biotite gneiss
(6) Garnet gneiss
(7) Hornblende gneiss
(8) Migmatite gneiss
(9) Granitic gneiss
(10) Biotite or microcline granite
(11) Pegmatite

Geological map

(1) Pegmatite
(2) Hornblende-biotite granite
(3) Garnet-bearing granitic gneiss
(4) Garnet gneiss
(5) Porphyroblastic gneiss
(6) Garnet-biotite gneiss
(7) Hornblende gneiss
(8) Pyroxene gneiss
(9) Metabasite

(10) Microcline granite
(11) Pegmatite
(12) Hornblende-biotite gneissose granite
(13) Garnet-bearing gneiss

ISHIKAWA, TATSUMI, KIZAKI, YANAI, YOSHIDA, M., ANDO, KIKUCHI, YOSHIDA, Y. and MATSUMOTO (Antarct. Geol. Map Ser., Sheet 5, 1976)

〈Langhovde〉

(1) Metabasite
(2) Pyroxene gneiss
(3) Hornblende gneiss
(4) Garnet-biotite gneiss
(5) Porphyroblastic gneiss
(6) Garnet gneiss
(7) Garnet-bearing granitic gneiss
(8) Pegmatite
(9) Microcline granite

YOSHIDA, M., YOSHIDA, Y., ANDO, ISHIKAWA and TATSUMI (Antarct. Geol. Map Ser., Sheet 9, 1976)

〈Skallen〉

(1) Paragneiss
  a. Quartz-feldspathic gneiss
  b. Siliceous gneiss
  c. Garnet-biotite gneiss
  d. Porphyroblastic biotite-plagioclase rock
(2) Concordant metabasite
  a. Pyroxene metabasite
  b. Hornblende metabasite
  c. Garnet metabasite
(3) Quartzite
(4) Marble
  a. Pure marble
  b. Marbles with scattered coloured minerals
(5) Skarn and allied rocks
  a. Pyroxene rock
  b. Phlogopite rock
(6) Garnet gneissose granite
(7) Charnockite
  a. Brown gneissose granodiorite
  b. Brown gneiss
(8) Pink granite
(9) Minor intrusives
  a. Discordant metabasite
  b. Brown microgranite
  c. Pegmatite

ISHIKAWA, YANAI, MATSUMOTO, KIZAKI, KOJIMA, TATSUMI, KIKUCHI and YOSHIDA (Antarct. Geol. Map Ser., Sheets 6 and 7, 1977)

〈Skarvsnes〉

(1) Metabasite
(2) Pyroxene gneiss
(3) Hornblende gneiss
(4) Marble
(5) Garnet-biotite gneiss
(6) Porphyroblastic gneiss
(7) Garnet gneiss
(8) Migmatitic gneiss
(9) Garnet-bearing granitic gneiss
(10) Gneissose microcline granite
(11) Pegmatite

ISHIKAWA (Antarct. Geol. Map Ser., Sheet 10, 1977)

〈Padda Island〉

(1) Garnet-biotite gneiss
(2) Hornblende gneiss
(3) Pyroxene gneiss
(4) Garnet-bearing granitic gneiss

YOSHIDA (Mem. Natl Inst. Polar Res., Ser. C, **11**, 1977)

〈Skallen〉

(1) Skallen group
  a. Marble
  b. Skarn
  c. Feldspathic garnet gneiss
  d. Siliceous gneiss
  e. Metabasite
  f. Charnockite
  g. Paragneiss
  h. Charnockitic garnet granite mass
  i. Brown gneiss
(2) Plutonic rocks
  a. Garnet granite
  b. Charnockite
  c. Pink granite
(3) Minor intrusives
  a. Discordant metabasite
  b. Biotite microgranite
  c. Pegmatite

Geological map

(1) Paragneiss
(2) Metabasite
(3) Brown gneiss
(4) Marble
(5) Skarn
(6) Pegmatite

(7) Garnet gneissose granite
(8) Pink granite
(9) Charnockite
(10) Discordant metabasite

SHIRAISHI (Mem. Natl Inst. Polar Res., Ser. C, **12**, 1977)

〈Yamato Mountains〉

(1) Syenite gneiss group
  a. Two-pyroxene syenite gneiss
  b. Clinopyroxene syenite gneiss
  c. Clinopyroxene quartz syenite gneiss
(2) Granite gneiss group
  a. Granite gneiss
    a-1. Nebulitic gneiss
    a-2. Schlieren gneiss
    a-3. Banded gneiss
  b. Migmatite gneiss
    b-1. Biotite granite
    b-2. Two-pyroxene biotite plagioclase gneiss
  c. Aplitic granite
(3) Metabasite
  a. Biotite granulite
  b. Pyroxene amphibolite
(4) Acid dyke

YANAI and YOSHIDA (Antarct. Geol. Map Ser., Sheet 11, 1978)

〈Cape Hinode〉

(1) Metabasite
(2) Amphibolite
(3) Anorthositic gneiss
(4) Garnet-bearing anorthositic gneiss
(5) Hornblende gneiss
(6) Garnet-biotite gneiss
(7) Garnet-bearing granitic gneiss
(8) Amphibolite dyke
(9) Granite
(10) Pegmatite

SHIRAISHI, KIZAKI, YOSHIDA and MATSUMOTO (Antarct. Geol. Map Ser., Sheet 27, 1978)

〈Mt. Fukushima〉

(1) Metabasite
  a. Concordant metabasite layer
  b. Concordant agmatitic metabasite
  c. Discordant migmatitic metabasite
(2) Quartz syenite gneiss
(3) Pink granite gneiss
(4) Migmatite gneiss
(5) Aplitic granite

(6) Acid dyke

YOSHIDA (J. Geosci., Osaka City Univ., **21**, 1978)

〈Lützow-Holmbukta〉

(1) Paragneiss and allied rocks
   a. Biotite gneiss
   b. Garnet gneiss
   c. Garnet-biotite gneiss
   d. Sillimanite-garnet gneiss
   e. Hornblende gneiss
   f. Metabasite
   g. Quartzite
   h. Marble
(2) Charnockitic rock
   a. Charnockitic plutonite
   b. Charnockitic gneiss
   c. Charnockitic pegmatite

NAKAI, KANO, YOSHIKURA, ISHIKAWA and YANAI (Antarct. Geol. Map Ser., Sheet 8, 1979a)

〈Kjuka〉

(1) Charnockitic gneiss
(2) Garnet-bearing quartz-feldspathic gneiss
(3) Metabasite
(4) Pegmatite

〈Telen〉

(1) Garnet-biotite gneiss
(2) Garnet-bearing leucocratic gneiss
(3) Garnet-bearing quartz-feldspathic gneiss
(4) Clinopyroxene gneiss
(5) Charnockitic gneiss
(6) Two-pyroxene gneiss
(7) Quartzite

SUZUKI and MORIWAKI (Antarct. Geol. Map Ser., Sheet 21, 1979)

〈Cape Omega〉

(1) Hornblende gneiss
(2) Clinopyroxene gneiss
(3) Biotite gneiss
(4) Garnet-biotite gneiss
(5) Metabasite
   a. Eclogitic rock
   b. Clinopyroxene amphibolite
   c. Biotite amphibolite
(6) Pink granite
(7) Pegmatite

YOSHIDA (J. Geosci., Osaka City Univ., **22**, 1979)

〈Lützow-Holmbukta〉

(1) Paragneiss and granitic rock

a. Garnet gneiss
b. Garnet-sillimanite gneiss
c. Garnet-biotite gneiss
d. Biotite gneiss
e. Muscovite-bearing gneiss
f. Staurolite-bearing gneiss

Granitic rock

g. Garnet gneissose granite
h. Pink granite

(2) Charnockitic rock
a. Charnockitic gneiss
b. Charnockitic plutonite
c. Charnockitic pegmatite

(3) Metabasite
a. Pyroxene metabasite
b. Hornblende metabasite
c. Garnet-biotite metabasite

(4) Meta-ultrabasite
a. Pyroxenite
b. Hornblendite
c. Eclogite

(5) Carbonaceous rock
a. Marble
b. Marble with scattered coloured minerals
c. Skarn

Table 1

(1) Charnockite
a. Charnockite
b. Enderbite
c. Syenite
d. Norite

(2) Paragneiss
a. Staurolite-sillimanite gneiss
b. Muscovite-garnet-biotite gneiss
c. Biotite gneiss
d. Garnet-biotite gneiss
e. Garnet gneiss
f. Garnet-biotite banded gneiss
g. Garnet or garnet-free pelitic gneiss

(3) Granite and pegmatite
a. Granite
b. Scapolite-plagioclase pegmatite
c. Pink granite
d. Pegmatitic granite
e. Biotite granite

(4) Metabasite
  a. Clinopyroxene-rich seam in basic gneiss
  b. Xenolithic block in pink granite
  c. Metabasite
  d. Amphibolite
  e. Basic granulite
  f. Discordant pyroxene metabasite
(5) Meta-ultrabasite
  a. Concordant clinopyroxene-garnet rock
  b. Pyroxenite
  c. Orthopyroxenite
  d. Hornblendite
  e. Hornblende eclogite
  f. Hornblende pyroxenite
  g. Basic granulite
  h. Amphibolite
  i. Ultrabasic granulite
  j. Meta-ultrabasite
(6) Hornblende gneiss
(7) Marble

MATSUMOTO, YOSHIDA and YANAI (Mem. Natl Inst. Polar Res., Spec. Issue, **14**, 1979)
〈Langhovde and Skarvsnes〉
(1) Metabasites
(2) Charnockitic rocks
(3) Hornblende gneiss
(4) Marble
(5) Garnet-biotite gneiss
(6) Porphyroblastic gneiss
(7) Garnet gneiss
(8) Migmatitic gneiss
(9) Garnet-bearing granitic gneiss
(10) Microcline granite and gneissose microcline granite
(11) Pegmatite

NAKAI, KANO and YOSHIKURA (Ditto, 1979b)
〈Cape Ryûgû〉
(1) Pegmatite, aplite and granite
(2) Hornblende gneiss
(3) Amphibolite
(4) Augen gneiss
(5) Crystalline limestone
(6) Leucocratic biotite gneiss
(7) Siliceous gneiss
(8) Garnet-biotite gneiss
(9) Fine-grained melanocratic biotite-hornblende gneiss
(10) Folded biotite gneiss

(11) Biotite gneiss

〈Oku-iwa Rock〉

(1) Biotite gneiss
(2) Migmatitic biotite-hornblende gneiss
(3) Leucocratic biotite gneiss
(4) Pink granite, aplite and pegmatite

〈Telen〉

(1) Biotite amphibolite
(2) Quartzite
(3) Garnet-bearing quartzose gneiss
(4) Charnockitic gneiss
(5) Clinopyroxene gneiss
(6) Leucocratic garnet-bearing gneiss
(7) Melanocratic hornblende-biotite gneiss
(8) Garnet-biotite gneiss

SUZUKI (Ditto, 1979)

〈Cape Omega〉

Metamorphic rocks

(1) Hornblende gneiss
(2) Clinopyroxene gneiss
(3) Biotite gneiss
(4) Garnet-biotite gneiss
(5) Metabasite

Plutonic rocks

(1) Gneissose granite
(2) Pink granite
(3) Pegmatite

KANISAWA, ONUKI and YANAI (Ditto, 1979a)

(1) Metabasites
  a. Biotite-hornblende eclogite 〈East Ongul Island〉
  b. Hornblende eclogite 〈West Ongul Island〉
  c. Biotite-garnet amphibolite 〈West Ongul Island〉
  d. Biotite-orthopyroxene-hornblende-plagioclase rock 〈East Ongul Island〉
  e. Orthopyroxene hornblendite 〈Langhovde〉
  f. Pyroxenite 〈East Ongul Island〉
(2) Charnockite
  g. Orthopyroxene-biotite-hornblende gneiss 〈West Ongul Island〉
(3) Paragneisses
  h. Biotite-hornblende gneiss 〈West Ongul Island〉
  i. Biotite-garnet gneiss 〈Ongulkalven Island〉
  j. Garnet-biotite gneiss 〈Langhovde, West Ongul Island〉
  k. Biotite gneiss 〈West Ongul Island〉

KANISAWA, YANAI and ISHIKAWA (Ditto, 1979b)

〈Cape Hinode〉

(1) Biotite amphibolite

(2) Clinopyroxene-bearing biotite amphibolite
(3) Biotite-hornblende gneiss
(4) Sillimanite-biotite-garnet gneiss
(5) Biotite gneiss
(6) Garnet-biotite gneiss
(7) Biotite granodiorite
(8) Hedenbergite-garnet-plagioclase rock

NAKAI, KANO and YOSHIKURA (Antarct. Geol. Map Ser., Sheet 15, 1980)

〈Cape Ryûgû〉

(1) Garnet-biotite gneiss
  a. Garnet-biotite gneiss
  b. Staurolite-bearing sillimanite-garnet-biotite gneiss
(2) Leucocratic muscovite-bearing biotite gneiss
(3) Hornblende-bearing biotite gneiss
  a. Hornblende-biotite gneiss
  b. Biotite gneiss
(4) Leucocratic hornblende-biotite gneiss
(5) Amphibolite and fine-grained biotite-hornblende gneiss
  a. Amphibolite
  b. Fine-grained biotite-hornblende gneiss
(6) Coarse-grained hornblende gneiss
(7) Epidote-clinopyroxene-hornblende gneiss
(8) Clinopyroxene gneiss
  a. Fine-grained clinopyroxene gneiss
  b. Diopside-bearing pegmatoid
  c. Coarse-grained clinopyroxene gneiss
(9) Garnet-clinopyroxene rock
(10) Crystalline limestone
(11) Augen gneiss
(12) Pegmatite
(13) Aplite

NAKAI, KANO and YOSHIKURA (Antarct. Geol. Map Ser., Sheet 22, 1981)

〈Oku-iwa Rock〉

(1) Biotite gneiss
(2) Migmatitic biotite-hornblende gneiss
  a. Amphibolite
  b. Biotite-hornblende gneiss
  c. Dioritic rock
(3) Leucocratic biotite gneiss
(4) Pink granite

2.2. The usages of petrological terms

This chapter considers the usages of petrological terms.

In a general sense, metamorphic rocks, especially polymetamorphic rocks, have

various properties acquired at the different stages of formation during the long geologic episodes. So, there will occur the cases where different names are used for the same rock-type according to the viewpoint taken by each geologist.

The petrological terms in the previous papers will be classified into the following categories.

(i) The terms based mainly on the chemical properties of rocks——Lithology or lithological terms——

〈Example〉

·Ultrabasic.....meta-ultrabasite.
·Basic.....metabasite, basic gneiss.
·Intermediate.
·Acidic.....acid gneiss.
·Pelitic.
·Aluminous.
·Psammitic.
·Siliceous.....siliceous gneiss.
Others.

These terms based mainly on the bulk-chemistry of rocks may suggest the original petrochemical properties of metamorphic rocks. It seems that the original lithofacies and structural properties of highly metamorphosed rocks almost disappeared and the original compositions are more or less modified by the metamorphism or metasomatism. The lithological properties cannot be always corresponding to the exact compositions of original rocks. Roughly speaking, however, it is a fact that many examples show close correspondence of the bulk-chemistry of original rocks with that of metamorphics, if the rock-units are chosen carefully enough for estimation.

The classification based on the lithological terms is available for establishing the litho-stratigraphy of metamorphic terrain.

(ii) Lithofacies and lithofacies terms.

〈Example〉

⊙Grain size.....coarse-grained, fine-grained, etc.
⊙Mineral assemblages.....garnet-sillimanite-biotite gneiss, etc.
⊙Texture.....porphyroid, granulite, porphyroblastic gneiss, etc.
⊙Colour.....brown gneiss, white gneiss.
Others.

These terms represent the physical properties of rocks based on the form of rock-forming minerals, mineral association and microscopic dimensional orientation of mineral aggregations. These properties are acquired during the metamorphism and suggest the metamorphic conditions. In practice, lithofacies terms are used most

widely in the nomenclature of metamorphic rocks.

(iii) Structure and structural terms.

〈Example〉

⊙Planar structure.....S-tectonite (not in use).

·Gneissosity.....gneiss, gneissose granite.

·Schistosity.....schist.

·Equi-dimensional.....granulite, hornfels.

·Compositional bandings.....banded gneiss, alternation of ~gneiss and ~gneiss.

⊙Linear structure.

·Lineation.....B-tectonite (not in use).

⊙Folding.....R-tectonite (not in use), folded biotite gneiss.

⊙Migmatite structure.....nebulitic gneiss, schlieren gneiss, banded gneiss, etc.

These terms represent the mesoscopic or megascopic properties of rock-specimens or outcrops based on the dimensional preferred orientation of minerals or mineral aggregations. These properties are also acquired during the metamorphism and deformation and suggest the dynamics of metamorphism. The terms are useful for compiling tectonic maps.

(iv) Megascopic litho-stratigraphic classifications in the scale of geological map.

〈Example〉

Skallen group, etc.

(v) Tectogenesis

〈Example〉

Charnockitic plutonite, ~gneiss, ~schist, etc.

These categories are not completely independent but more or less affected each other. For example, the mineral compositions and resultant colour of rocks (colour index) depend largely on the chemical composition of original rocks. Mesoscopic structural features are caused by the development of preferred orientation of minerals, and migmatite structure is also closely related to tectogenesis. (On the other hand, chemical composition is a purely lithological term and grain size is a purely lithofacies term.)

Tectogenesis is a term of wide comprehension including all the processes of formation of rock-bodies and geological structure. And the usage of gneiss, schist or other tectonic terms should be decided not only from the mesoscopic preferred orientation, grain size and/or chemical composition of rock-specimens, but also from general considerations of the geological situations of rock-bodies in the region.

As given in Chapter 2.1., numerous terms including different bases of terminology

have appeared in descriptions and several names belonging to entirely different categories have been used in the same area. Moreover, some terms seem to be unsuitable for use.

The term "metabasite" is most controversial. We cannot realize any other characteristics than that the rock is basic and metamorphics from it. Once a rock type is named metabasite from the viewpoint of lithology, a similar usage is applied to other rocks by calling them "meta-pelite", "meta-psammite" or "meta-intermediate rocks" instead of garnet-biotite gneiss, biotite gneiss or hornblende gneiss etc.

On the other hand, there seems to be less confusions of terminology in plutonic rocks than in the metamorphics, since the plutonic names involve lithological, lithofacies and structural meanings. For example, the term "granite" simultaneously suggests the rock's granitic chemical compositions, biotite-bearing quartz-feldspathic mineral assemblages, granite texture and plutonic occurrences.

3. Terminology and Nomenclature

Divergent views on the terminology and nomenclature would be difficult to reach a complete agreement, in spite of the discussions at the meetings. The chapter suggests just a general guide-line for more practical description.

3.1. Metamorphic rocks

(1) Do not use too much genetical terms in description. The terms and their usages which are not popular among common geologists are also unsuitable.

(2) Do not mix the terms belonging to different categories in the same area so far as possible.

(3) Too much simplified terms including only one or two characteristics are not desirable.

e.g. Brown gneiss, Leucocratic gneiss, etc.
Metabasite, Basic gneiss, Acid gneiss, Siliceous gneiss, etc.
Porphyroblastic gneiss, etc.
Nebulitic gneiss, Schlieren gneiss, Banded gneiss, etc.

(4) Plutonic terms are not suitable for metamorphic rocks, *e.g.* granodioritic gneiss, etc., except in the cases that the rocks are apparently plutonic origin, or in the cases where we do not understand whether the rocks are plutonic or metamorphic.

(5) In a general way, it is advisable to use the combination of lithofacies terms and structural terms so that the field-occurrences of rocks are clearly revealed.

e.g. Fine-grained leucocratic garnet-biotite gneiss
(grain size) (colour) (mineral assemblage)
←——lithofacies term——→←structural term→

(6) General usage of each term is as follows.

i. Chemical composition
Ultrabasic.....SiO_2<45% (in round numbers 40% ±)
Basic .....SiO_2 45~52% (in round numbers 50% ±)
Intermediate.....SiO_2 52~66% (in round numbers 60% ±)
Acidic .....SiO_2>66% (in round numbers 70% ±)

ii. Grain size
Fine-grained.....in round numbers ϕ<1 mm ±
Medium-grained .....in round numbers $\phi \fallingdotseq 5 \sim 3$ mm ±
Coarse-grained ..... in round numbers $\phi \fallingdotseq 5 \sim 10$ mm ±
Very coarse-grained ...in round numbers ϕ>10 mm

iii. Colour
Leucocratic.....colour index$\fallingdotseq$0~30%
Intermediate .....colour index$\fallingdotseq$30~60%
Melanocratic .....colour index$\fallingdotseq$60~100%
(Hypermelanic .....colour index$\fallingdotseq$90~100%)

iv. Mineral assemblage.....Use the characteristic minerals in the order of less amount, usually abridging feldspars and quartz for simplification.

v. Texture.....Write the most conspicuous minerals, *e.g.* Potash-feldspar porphyroblastic~gneiss.

vi. Migmatite structure.....Use the definitions of MEHNERT (1968) and his Fig. 1.

(7) Litho-stratigraphic classifications are based on the general lithological characteristics of rock-units using a place-name. When the petrological terms are used, the most characteristic or abundant rock-type is desirable.

3.2. Plutonic rocks

(1) Classification and nomenclature of plutonic rocks are generally based on I.U.G.S. (1973).

(2) It is hoped to use lithofacies and structural terms so that the natural occurrences of rocks are easily understood.
e.g. Fine-grained gneissose two-mica granite.

(3) When the rock-unit shows wide petrological variations, use the most frequent or characteristic type as the rock-name.

4. Classification of the East Antarctic Basement Rocks

This chapter represents the classification and petrographical properties of major rock-types, although several confusions and indistinctness still remain, and moreover the lack of detailed descriptions prevents complete classifications.

The rocks listed in Chapter 2.1. are classified into the following types, based mainly on their lithological characteristics, mineral compositions and colour index. Given in 4.1. to 4.10. are the rocks assumed to be metamorphics of sedimentary or igneous origin, those in 4.11. and 4.12. are the rocks which are unsettled whether metamorphic or plutonic, and those in 4.13. are plutonic rocks.

The symbol "?" indicates uncertainty of classification and "*" shows the rock which is assigned to more than two rock-types.

4.1. Ultrabasic to basic (hypermelanic to melanocratic) rocks consisting mainly of olivines

Not observed.

4.2. Ultrabasic to basic (hypermelanic to melanocratic) rocks consisting mainly of pyroxenes.....〈Pyroxenite〉

Ultrabasic to basic metamorphic rocks consisting mainly of pyroxenes are named pyroxenite. These rocks have been described under the following names in the previous papers.

Part of basic metamorphic rocks	(TATSUMI *et al.*, 1959)	Around Syowa Station
Part of ultrabasic and basic granulites (Two-pyroxenite)	(BANNO *et al.*, 1964)	Lützow-Holm Bay
Part of metabasite (Pyroxenite)	(KIZAKI, 1964)	East Ongul Island
? Part of metabasite (Basic granulite)	(KIZAKI, 1965)	Yamato Mountains
Part of ultrabasic and basic granulite	(SUWA, 1968)	Lützow-Holmbukta
Part of metabasite	(SHIRAISHI *et al.*, 1972)	Sandercock Nunataks
Part of metabasite (Pyroxenite)	(YANAI *et al.*, 1974a)	East Ongul Island
Part of metabasite (Pyroxenite)	(YANAI *et al.*, 1974b)	West Ongul Island
Part of metabasite (Hornblende pyroxenite)	(YANAI *et al.*, 1975a)	Teöya
? Part of metabasite (Pyroxene metabasite)	(SHIRAISHI, 1975)	Minami-Yamato Nunataks
Part of metabasite (Pyroxene metabasite)	(YOSHIDA, 1975)	Botnneset
Part of basic gneiss (Pyroxene metabasite)	(YOSHIDA, 1975)	Botnneset
? Part of metabasite	(ISHIKAWA, 1976)	Lützow-Holm Bay
? Part of metabasite	(ISHIKAWA *et al.*, 1976)	Langhovde
Part of concordant metabasite (Pyroxene metabasite)	(YOSHIDA *et al.*, 1976)	Skallen
? Part of discordant metabasite	(YOSHIDA *et al.*, 1976)	Skallen

? Part of metabasite	(ISHIKAWA *et al.*, 1977)	Skarvsnes
? Part of metabasite	(YOSHIDA, 1977)	Skallen
? Part of paragneiss	(YOSHIDA, 1977)	Skallen
Part of metabasite	(YOSHIDA, 1978)	Lützow-Holmbukta
Part of metabasite (Pyroxene metabasite)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of ultrametabasite (Pyroxenite)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of metabasite (Clinopyroxene-rich seam)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of metabasite (Discordant pyroxene metabasite)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of meta-ultrabasite (Pyroxenite)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of meta-ultrabasite (Orthopyroxenite)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of meta-ultrabasite (Hornblende pyroxenite)	(YOSHIDA, 1979)	Lützow-Holmbukta
? Part of metabasite	(MATSUMOTO *et al.*, 1979)	Langhovde and Skarvsnes
*?Part of metabasite (Clinopyroxenite)	(SUZUKI, 1979)	Cape Omega (see 4.9.3.)
Pyroxenite	(KANISAWA *et al.*, 1979a)	East Ongul Island

Pyroxenites are composed mainly of clinopyroxene and/or orthopyroxene with or without smaller amounts of plagioclase, hornblende, garnet and biotite. These are coarse- to medium-grained hypermelanic to melanocratic rocks showing deep green ~dark brown~black colour. These rocks have been usually described as a part of metabasites which occur as concordant sheets, discordant dykes and/or agmatitic breccia in the other gneisses.

4.3. Ultrabasic to basic (hypermelanic to melanocratic) rocks consisting mainly of amphiboles.....〈Amphibolite〉

Ultrabasic to basic metamorphic rocks consisting mainly of amphiboles are named amphibolite. These rocks have been described as metabasite, amphibolite, hornblendite, basic granulite, etc. in the previous papers.

Part of basic metamorphic rocks	(TATSUMI *et al.*, 1959)	Around Syowa Station
Amphibolite	(KIZAKI, 1962)	East Ongul Island
Part of ultrabasic and basic granulites	(BANNO *et al.*, 1964)	Lützow-Holm Bay
Part of metabasite (Pyroxene amphibolite)	(KIZAKI, 1964)	East Ongul Island
Part of metabasite (Garnet-bearing pyroxene amphibolite)	(KIZAKI, 1964)	East Ongul Island
Part of metabasite (Pyroxene amphibolite)	(KIZAKI, 1965)	Yamato Mountains
Part of metabasite (Biotite amphibolite)	(KIZAKI, 1965)	Yamato Mountains
Part of basic granulite and amphibolite	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
Amphibolite	(YOSHIDA *et al.*, 1971)	Yamato Mountains
? Basic granulite	(YOSHIDA *et al.*, 1971)	Yamato Mountains
Part of metabasite (Pyroxene amphibolite)	(YANAI *et al.*, 1974a)	East Ongul Island
Part of metabasite (Garnet-bearing pyroxene amphibolite)	(YANAI *et al.*, 1974a)	East Ongul Island

Part of metabasite (Hornblendite)	(YANAI *et al.*, 1974a)	East Ongul Island
Part of metabasite (Hornblendite)	(YANAI *et al.*, 1974b)	West Ongul Island
Amphibolite	(YANAI *et al.*, 1974b)	West Ongul Island
Part of metabasite (Pyroxene amphibolite)	(YANAI *et al.*, 1975a)	Teöya
Part of metabasite (Hornblende metabasite)	(YOSHIDA, 1975)	Botnneset
Part of metabasite	(ISHIKAWA, 1976)	Lützow-Holm Bay
? Part of metabasite	(ISHIKAWA *et al.*, 1976)	Langhovde
Part of concordant metabasite (Hornblende metabasite)	(YOSHIDA *et al.*, 1976)	Skallen
? Part of discordant metabasite	(YOSHIDA *et al.*, 1976)	Skallen
? Part of metabasite	(ISHIKAWA *et al.*, 1977)	Skarvsnes
Part of metabasite (Pyroxene amphibolite)	(SHIRAISHI, 1977)	Yamato Mountains
Amphibolite	(YANAI *et al.*, 1978)	Cape Hinode
Amphibolite dyke	(YANAI *et al.*, 1978)	Cape Hinode
Concordant agmatitic metabasite (Pyroxene amphibolite)	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima
? Concordant metabasite	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima
? Discordant migmatitic metabasite	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima
Part of metabasite	(YOSHIDA, 1978)	Lützow-Holmbukta
Part of metabasite	(NAKAI *et al.*, 1979a)	Kjuka
Two-pyroxene amphibolite	(NAKAI *et al.*, 1979a)	Telen
Part of metabasite (Clinopyroxene amphibolite)	(SUZUKI *et al.*, 1979)	Cape Omega
Part of metabasite (Biotite amphibolite)	(SUZUKI *et al.*, 1979)	Cape Omega
Part of metabasite (Hornblende metabasite)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of ultrametabasite (Hornblendite)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of ultrametabasite (Amphibolite)	(YOSHIDA, 1979)	Lützow-Holmbukta
? Part of metabasite	(MATSUMOTO *et al.*, 1979)	Langhovde and Skarvsnes
Amphibolite	(NAKAI *et al.*, 1979b)	Cape Ryûgû
Biotite amphibolite	(NAKAI *et al.*, 1979b)	Telen
Part of metabasite (Clinopyroxene amphibolite)	(SUZUKI, 1979)	Cape Omega
Part of metabasite (Biotite amphibolite)	(SUZUKI, 1979)	Cape Omega
Biotite-garnet amphibolite	(KANISAWA *et al.*, 1979a)	West Ongul Island
? Orthopyroxene hornblendite	(KANISAWA *et al.*, 1979a)	Langhovde
Biotite amphibolite	(KANISAWA *et al.*, 1979b)	Cape Hinode
Clinopyroxene-bearing biotite amphibolite	(KANISAWA *et al.*, 1979b)	Cape Hinode
Amphibolite	(NAKAI *et al.*, 1980)	Cape Ryûgû
Amphibolite	(NAKAI *et al.*, 1981)	Oku-iwa Rock

Amphibolites are composed mainly of hornblende and usually associated with clinopyroxene, orthopyroxene, plagioclase, biotite and garnet. According to the presence of minor mineral constituents, rocks are called pyroxene amphibolite, two-

pyroxene amphibolite, garnet amphibolite, etc. These are coarse- to fine-grained hypermelanic to melanoclatic rocks and have usually massive and occasionally foliated appearances. They occur as concordant sheets, broken sheets, discordant dykes and/or agmatitic breccia in the other gneisses.

4.4. Other ultrabasic to basic rocks

The rocks of ultrabasic to basic compositions except pyroxenites and amphibolites are classified into the following types.

4.4.1. Eclogites or eclogitic rocks

The rocks composed mainly of pyroxene and garnet have been called eclogite or eclogitic rock. Some of them are almost indistinguishable from skarns.

Part of metabasite (Hornblende eclogite)	(YANAI *et al.*, 1974a)	East Ongul Island
Part of metabasite (Hornblende eclogite)	(YANAI *et al.*, 1974b)	West Ongul Island
Part of metabasite (Garnet-pyroxene-plagioclase rock)	(YANAI *et al.*, 1978)	Cape Hinode
Part of metabasite (Eclogitic rock)	(SUZUKI *et al.*, 1979)	Cape Omega
Part of ultrametabasite (Eclogite)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of ultrametabasite (Hornblende eclogite)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of ultrametabasite (Concordant clinopyroxene-garnet rock)	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of metabasite (Eclogitic rock)	(SUZUKI, 1979)	Cape Omega
Biotite-hornblende eclogite	(KANISAWA *et al.*, 1979a)	East Ongul Island
Hornblende eclogite	(KANISAWA *et al.*, 1979a)	West Ongul Island

Eclogites or eclogitic rocks have been usually described as a part of metabasites, and their occurrences are rather restricted in a few areas; Ongul Islands and Cape Omega.

The rocks of Ongul Islands are composed of garnet, orthopyroxene, clinopyroxene, hornblende, phlogopite and plagioclase, and those of Cape Omega, garnet, clinopyroxene, plagioclase, scapolite and quartz. These are hypermelanic to melanocratic rocks with reddish to reddish-brown tint and usually massive appearances.

4.4.2. Anorthosite or anorthositic rocks

Part of metabasite	(YANAI *et al.*, 1974a)	East Ongul Island
*?Feldspathic band	(YANAI *et al.*, 1974a)	East Ongul Island (4.8.3.)
*?Feldspathic gneiss	(YANAI *et al.*, 1974b)	West Ongul Island (4.8.3.)
Anorthositic gneiss	(YANAI *et al.*, 1978)	Cape Hinode
Garnet-bearing anorthositic gneiss	(YANAI *et al.*, 1978)	Cape Hinode

Anorthosites or anorthositic rocks have been described as a part of metabasites in the previous papers. The rocks in East Ongul Island are leucocratic with milky colour, composed mainly of plagioclase ($An=50$) and associated with biotite. They

occur as small patches within the metabasite beds around Syowa Station. Anorthositic gneisses in Cape Hinode are medium- to coarse-grained weakly foliated rocks with dark to greyish violet colour, and are composed of plagioclase, quartz, hornblende, biotite and small amounts of garnet and potash-feldspar. The leucocratic bands of charnockitic rocks are sometimes anorthositic.

4.4.3. Other ultrabasic to basic rocks

Part of metabasite (Garnet-biotite-plagioclase rock)	(YANAI *et al.*, 1975b)	Ongulkalven Island
Part of concordant metabasite (Garnet metabasite)	(YOSHIDA *et al.*, 1976)	Skallen
Part of metabasite (Biotite granulite)	(SHIRAISHI, 1977)	Yamato Mountains
Part of metabasite (Biotite-quartz rock)	(YANAI *et al.*, 1978)	Cape Hinode
Part of metabasite (Garnet-biotite metabasite)	(YOSHIDA, 1979)	Lützow-Holmbukta
? Part of ultrametabasite (Basic granulite)	(YOSHIDA, 1979)	Lützow-Holmbukta
? Part of ultrametabasite (Ultrabasic granulite)	(YOSHIDA, 1979)	Lützow-Holmbukta
? Part of ultrametabasite (Meta-ultrabasite)	(YOSHIDA, 1979)	Lützow-Holmbukta

4.5. Basic to intermediate (melanocratic to intermediate) rocks including amphiboles as major mafic minerals……〈Hornblende gneiss〉

Basic to intermediate (partly acidic) metamorphic rocks including hornblende as major mafic constituent have been usually called hornblende gneisses.

Part of basic metamorphic rocks	(TATSUMI *et al.*, 1959)	Around Syowa Station
Hornblende gneiss	(KIZAKI, 1962)	East Ongul Island
Part of basic granulites	(BANNO *et al.*, 1964)	Lützow-Holm Bay
Hornblende gneiss	(KIZAKI, 1964)	East Ongul Island
? Part of metabasite (Basic granulite)	(KIZAKI, 1965)	Yamato Mountains
Part of basic granulite	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
Hypersthene hornblende gneiss	(SHIRAISHI *et al.*, 1972)	Sandercock Nunataks
Hornblende gneiss	(YANAI *et al.*, 1974a)	East Ongul Island
Scapolite-bearing hornblende gneiss	(YANAI *et al.*, 1974a)	East Ongul Island
Hornblende gneiss	(YANAI *et al.*, 1974b)	West Ongul Island
Hornblende gneiss	(YANAI *et al.*, 1975a)	Teöya
Hornblende gneiss	(YANAI *et al.*, 1975b)	Ongulkalven Island
Part of metabasite (Hornblende-biotite metabasite)	(SHIRAISHI, 1975)	Minami-Yamato Nunataks
Basic gneiss	(YOSHIDA, 1975)	Botnneset
? White gneissose granodiorites	(YOSHIDA, 1975)	Botnneset
? Porphyritic white gneissose granodiorites	(YOSHIDA, 1975)	Botnneset
Hornblende gneiss	(ISHIKAWA, 1976)	Lützow-Holm Bay
? Part of metabasite	(ISHIKAWA, 1976)	Lützow-Holm Bay

Hornblende gneiss	(ISHIKAWA *et al.*, 1976)	Langhovde
? Part of metabasite	(ISHIKAWA *et al.*, 1976)	Langhovde
? Part of discordant metabasite	(YOSHIDA *et al.*, 1976)	Skallen
Hornblende gneiss	(ISHIKAWA *et al.*, 1977)	Skarvsnes
? Part of metabasite	(ISHIKAWA *et al.*, 1977)	Skarvsnes
Hornblende gneiss	(ISHIKAWA, 1977)	Padda Island
? Part of paragneiss	(YOSHIDA, 1977)	Skallen
? Part of metabasite	(YOSHIDA, 1977)	Skallen
Hornblende gneiss	(YANAI *et al.*, 1978)	Cape Hinode
Hornblende gneiss	(YOSHIDA, 1978)	Lützow-Holmbukta
? Part of metabasite	(YOSHIDA, 1978)	Lützow-Holmbukta
Hornblende gneiss	(SUZUKI *et al.*, 1979)	Cape Omega
Part of metabasite	(NAKAI *et al.*, 1979a)	Kjuka
Part of metabasite	(YOSHIDA, 1979)	Lützow-Holmbukta
Part of metabasite (Xenolithic block in pink granite)	(YOSHIDA, 1979)	Lützow-Holmbukta
? Part of basic granulite	(YOSHIDA, 1979)	Lützow-Holmbukta
Hornblende gneiss	(MATSUMOTO *et al.*, 1979)	Langhovde, Skarvsnes, Byvågåsane
Hornblende gneiss	(NAKAI *et al.*, 1979b)	Cape Ryûgû
Fine-grained melanocratic biotite-hornblende gneiss	(NAKAI *et al.*, 1979b)	Cape Ryûgû
Migmatitic biotite-hornblende gneiss	(NAKAI *et al.*, 1979b)	Oku-iwa Rock
Hornblende gneiss	(SUZUKI, 1979)	Cape Omega
Biotite-orthopyroxene-hornblende-plagioclase rock	(KANISAWA *et al.*, 1979a)	East Ongul Island
Orthopyroxene-biotite-hornblende gneiss	(KANISAWA *et al.*, 1979a)	West Ongul Island
Biotite-hornblende gneiss	(KANISAWA *et al.*, 1979a)	West Ongul Island
Coarse-grained hornblende gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû
* Epidote-clinopyroxene-hornblende gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû (4.9.2.)
Migmatitic biotite-hornblende gneiss	(NAKAI *et al.*, 1981)	Oku-iwa Rock
Biotite-hornblende gneiss	(NAKAI *et al.*, 1981)	Oku-iwa Rock
* Dioritic rock	(NAKAI *et al.*, 1981)	Oku-iwa Rock (4.12.1.)

Hornblende gneisses are medium- to coarse-grained and melanoclatic to intermediate rocks with strong or weak gneissosity and with or without compositional banding. Rocks are composed mainly of hornblende, biotite, plagioclase, potash-feldspar, quartz and occasionally associated with small amounts of clinopyroxene, orthopyroxene, garnet and scapolite. According to the presence of minor mineral constituents, rocks are named pyroxene-hornblende gneiss, scapolite-bearing hornblende gneiss, biotite-hornblende gneiss, etc. Hornblende gneisses sometimes occur as granitized or retrograded derivatives from the pyroxene gneisses or charnockitic gneisses.

4.6. Intermediate rocks (partly pelitic or psammitic) including orthopyroxene and clinopyroxene as major mafic minerals.....〈Two-pyroxene gneiss〉

Intermediate rocks or partly acidic or pelitic to psammitic rocks including orthopyroxene and clinopyroxene are named two-pyroxene gneisses. These rocks have been usually called pyroxene gneiss, charnockitic gneiss, enderbitic gneiss, dioritic gneiss and brown gneiss.

Hornblende-pyroxene dioritic gneiss	(TATSUMI *et al.*, 1959)	Around Syowa Station
Dioritic gneiss	(TATSUMI *et al.*, 1959)	Around Syowa Station
Charnockitic gneiss	(KIZAKI, 1962)	East Ongul Island
Pyroxene gneiss	(BANNO *et al.*, 1964)	Lützow-Holm Bay
Pyroxene gneiss	(KIZAKI, 1964)	Lützow-Holm Bay
Pyroxene gneiss	(KIZAKI, 1965)	Yamato Mountains
Pyroxene gneiss	(SUWA, 1968)	Lützow-Holmbukta
Hypersthene-garnet gneiss	(SHIRAISHI *et al.*, 1972)	Sandercock Nunataks
Pyroxene gneiss (Basic enderbitic pyroxene gneiss)	(YANAI *et al.*, 1974a)	East Ongul Island
Pyroxene gneiss (Charnockitic pyroxene gneiss)	(YANAI *et al.*, 1974a)	East Ongul Island
Pyroxene gneiss (Garnet-bearing enderbitic pyroxene gneiss)	(YANAI *et al.*, 1974a)	East Ongul Island
Pyroxene gneiss	(YANAI *et al.*, 1974b)	West Ongul Island
Pyroxene gneiss	(YANAI *et al.*, 1975a)	Teöya
Pyroxene gneiss	(YANAI *et al.*, 1975b)	Ongulkalven Island
Acid brown gneiss	(YOSHIDA, 1975)	Botnneset
Quartz-feldspathic biotite brown gneiss	(YOSHIDA, 1975)	Botnneset
Brown augen gneiss	(YOSHIDA, 1975)	Botnneset
Brown gneiss	(YOSHIDA, 1975)	Botnneset
Brown to white granodioritic gneiss	(YOSHIDA, 1975)	Botnneset
Pyroxene gneiss	(ISHIKAWA, 1976)	Lützow-Holm Bay
Pyroxene gneiss	(ISHIKAWA *et al.*, 1976)	Langhovde
Part of charnockites (Brown gneiss)	(YOSHIDA *et al.*, 1976)	Skallen
Pyroxene gneiss	(ISHIKAWA *et al.*, 1977)	Skarvsnes
Pyroxene gneiss	(ISHIKAWA, 1977)	Padda Island
Brown gneiss	(YOSHIDA, 1977)	Skallen
* Syenite gneiss group (Two pyroxene syenite gneiss)	(SHIRAISHI, 1977)	Yamato Mountains (4.11.1.)
* Syenite gneiss group (Clinopyroxene syenite gneiss)	(SHIRAISHI, 1977)	Yamato Mountains (4.11.1.)
* Syenite gneiss group (Clinopyroxene quartz syenite gneiss)	(SHIRAISHI, 1977)	Yamato Mountains (4.11.1.)
Part of migmatite gneiss (Two-pyroxene biotite-plagioclase gneiss)	(SHIRAISHI, 1977)	Yamato Mountains
* Quartz syenite gneiss	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima (4.11.1.)

Part of charnockitic rocks (Charnockitic gneiss)	(YOSHIDA, 1978)	Lützow-Holmbukta
Charnockitic gneiss	(NAKAI *et al.*, 1979a)	Kjuka and Telen
Part of charnockitic rocks	(YOSHIDA, 1979)	Lützow-Holmbukta
? Part of charnockitic rocks	(MATSUMOTO *et al.*, 1979)	Langhovde, Skarvsnes
Charnockitic gneiss	(NAKAI *et al.*, 1979b)	Telen

Two-pyroxene gneisses are composed of clinopyroxene, orthopyroxene, plagioclase, potash-feldspar, quartz and associated with biotite, hornblende, garnet and opaque minerals. The rocks are fine- to coarse-grained and usually show foliated appearances. These are dark grey to dark greyish green or dark brown in colour due to the presence of dark-coloured quartz and feldspars.

4.7. Pelitic to psammitic (intermediate to leucocratic) rocks including biotite as major mafic mineral.....〈Biotite gneiss, etc.〉

Intermediate to leucocratic rocks with pelitic to psammitic compositions are as follows.

Pyralspite-biotite granodioritic gneiss	(TATSUMI *et al.*, 1959)	Around Syowa Station
? Granodioritic gneiss	(TATSUMI *et al.*, 1959)	Around Syowa Station
Garnet-free pelitic gneiss	(SUWA, 1968)	Lützow-Holmbukta
? Metasomatic pyroxene gneiss derived from pelitic gneiss	(SUWA, 1968)	Lützow-Holmbukta
Biotite gneiss	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
Granitized biotite gneiss	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
Biotite gneiss	(YOSHIDA *et al.*, 1971)	Yamato Mountains
Hornblende-biotite gneiss	(SHIRAISHI *et al.*, 1972)	Sandercock Nunataks
Garnet-biotite gneiss	(YANAI *et al.*, 1974b)	West Ongul Island
Porphyroblastic gneiss	(YANAI *et al.*, 1974b)	West Ongul Island
Garnet-biotite gneiss	(YANAI *et al.*, 1975a)	Teöya
Porphyroblastic gneiss	(YANAI *et al.*, 1975a)	Teöya
Garnet-biotite gneiss	(YANAI *et al.*, 1975b)	Ongulkalven Island
Porphyroblastic gneiss	(YANAI *et al.*, 1975b)	Ongulkalven Island
Hornblende-biotite gneiss	(SHIRAISHI, 1975)	Minami-Yamato Nunataks
Quartz-feldspathic biotite gneiss	(YOSHIDA, 1975)	Botnneset
Biotite gneiss	(ISHIKAWA, 1976)	Lützow-Holm Bay
Porphyroblastic gneiss	(ISHIKAWA, 1976)	Lützow-Holm Bay
Garnet-biotite gneiss	(ISHIKAWA, 1976)	Lützow-Holm Bay
Garnet-biotite gneiss	(ISHIKAWA *et al.*, 1976)	Langhovde
Porphyroblastic gneiss	(ISHIKAWA *et al.*, 1976)	Langhovde
Garnet-biotite gneiss	(YOSHIDA *et al.*, 1976)	Skallen
Porphyroblastic biotite-plagioclase rock	(YOSHIDA *et al.*, 1976)	Skallen
Garnet-biotite gneiss	(ISHIKAWA *et al.*, 1977)	Skarvsnes
Porphyroblastic gneiss	(ISHIKAWA *et al.*, 1977)	Skarvsnes
Garnet-biotite gneiss	(ISHIKAWA, 1977)	Padda Island

Garnet-biotite gneiss	(YANAI *et al.*, 1978)	Cape Hinode
Biotite gneiss	(YOSHIDA, 1978)	Lützow-Holmbukta
Garnet-biotite gneiss	(YOSHIDA, 1978)	Lützow-Holmbukta
Sillimanite-garnet gneiss	(YOSHIDA, 1978)	Lützow-Holmbukta
Garnet-biotite gneiss	(NAKAI *et al.*, 1979a)	Telen
Biotite gneiss	(SUZUKI *et al.*, 1979)	Cape Omega
Garnet-biotite gneiss	(SUZUKI *et al.*, 1979)	Cape Omega
Garnet-sillimanite gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta
Garnet-biotite gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta
Biotite gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta
Muscovite-bearing gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta
Staurolite-bearing gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta
Staurolite-sillimanite gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta
Muscovite-garnet-biotite gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta
Garnet-biotite banded gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta
Garnet or garnet-free pelitic gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta
Garnet-biotite gneiss	(MATSUMOTO *et al.*, 1979)	Langhovde, Skarvsnes
Porphyroblastic gneiss	(MATSUMOTO *et al.*, 1979)	Hamnenabben, Byvågåsane, Breidvågnipa, Skarvsnes
Leucocratic biotite gneiss	(NAKAI *et al.*, 1979b)	Cape Ryûgû
Leucocratic biotite gneiss	(NAKAI *et al.*, 1979b)	Oku-iwa Rock
Folded biotite gneiss	(NAKAI *et al.*, 1979b)	Cape Ryûgû
Biotite gneiss	(NAKAI *et al.*, 1979b)	Cape Ryûgû
Biotite gneiss	(NAKAI *et al.*, 1979b)	Oku-iwa Rock
Melanocratic hornblende-biotite gneiss	(NAKAI *et al.*, 1979b)	Telen
Garnet-biotite gneiss	(NAKAI *et al.*, 1979b)	Telen
Garnet-biotite gneiss	(SUZUKI, 1979)	Cape Omega
Biotite gneiss	(SUZUKI, 1979)	Cape Omega
Garnet-biotite gneiss	(KANISAWA *et al.*, 1979a)	Langhovde, West Ongul Island
Biotite gneiss	(KANISAWA *et al.*, 1979a)	West Ongul Island
Sillimanite-biotite-garnet gneiss	(KANISAWA *et al.*, 1979b)	Cape Hinode
Biotite gneiss	(KANISAWA *et al.*, 1979b)	Cape Hinode
Garnet-biotite gneiss	(KANISAWA *et al.*, 1979b)	Cape Hinode
Garnet-biotite gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû
Staurolite-bearing sillimanite-garnet-biotite gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû
Hornblende-bearing biotite gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû
Hornblende-biotite gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû
Biotite gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû
Leucocratic hornblende-biotite gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû
Biotite gneiss	(NAKAI *et al.*, 1981)	Oku-iwa Rock
Leucocratic biotite gneiss	(NAKAI *et al.*, 1981)	Oku-iwa Rock

Pelitic to psammitic metamorphic rocks including biotite as major mafic constituent are subdivided into the following types.

4.7.1. Aluminous rocks with characteristic mineral assemblenges

These are called garnet-biotite gneiss, sillimanite-biotite-garnet gneiss or staurolite-bearing sillimanite-garnet-biotite gneiss, etc., according to the mineral assemblages. The rocks are composed mainly of plagioclase, quartz, biotite, garnet and occasionally associated with potash-feldspar, sillimanite, muscovite and staurolite.* Usually, these are rich in Al_2O_3 and Fe_2O_3.

4.7.2. Pelitic to psammitic gneiss.....〈Biotite gneiss〉

These are the most common rock-types around Lützow-Holm Bay, and named biotite gneiss. The rocks are fine- to coarse-grained and foliated, having compositional bandings. These are composed of plagioclase, quartz, potash-feldspar, biotite, opaque minerals (magnetite) and occasionally associated with garnet and hornblende.

4.7.3. Potash-feldspar porphyroblastic biotite gneiss

Porphyroblastic equivalents having large potash-feldspar porphyroblasts have been called porphyroblastic gneiss, however, as in Chapter 3.1. (3), the rocks will be named potash-feldspar porphyroblastic biotite gneiss.

4.8. Leucocratic or acidic rocks associated with other metamorphic rocks

The rocks with leucocratic or acidic appearances associated with other metamorphic rocks seem to be subdivided into several types, but there are confusions and indistinctness among them, because of the lack of detailed descriptions. Besides, some of them are undistinguishable from each other and from the granitic rocks of Chapter 4.12.

4.8.1. Leucocratic rocks including garnet as major mafic mineral.....〈Garnet gneiss〉

Garnet gneiss	(KIZAKI, 1962)	East Ongul Island
Garnet gneiss	(BANNO *et al.*, 1964)	Lützow-Holm Bay
Garnet gneiss	(KIZAKI, 1964)	Lützow-Holm Bay
Garnet gneiss	(SUWA, 1968)	Lützow-Holm Bay
Garnet gneiss	(SHIRAISHI *et al.*, 1972)	Sandercock Nunataks
Garnet gneiss	(YANAI *et al.*, 1974a)	East Ongul Island
Garnet gneiss	(YANAI *et al.*, 1974b)	West Ongul Island
Garnet gneiss	(ISHIKAWA, 1976)	Lützow-Holm Bay
Garnet gneiss	(ISHIKAWA *et al.*, 1976)	Langhovde
Garnet gneiss	(ISHIKAWA *et al.*, 1977)	Skarvsnes
? Feldspathic garnet gneiss	(YOSHIDA, 1977)	Skallen
Garnet gneiss	(YOSHIDA, 1978)	Lützow-Holmbukta
Garnet-bearing leucocratic gneiss	(NAKAI *et al.*, 1979a)	Telen
Garnet gneiss	(YOSHIDA, 1979)	Lützow-Holmbukta

* Kyanite has been found from Sinnan Rocks, Cape Ryûgû, Akebono Rock, Cape Hinode, Niban Rock and Tenmondai Rock, cordierite and corundum, from Sinnan Rocks, and andalusite, also from Cape Hinode and Tenmondai Rock (by recent personal communication from Yoshikuni HIROI).

Garnet gneiss	(MATSUMOTO *et al.*, 1979)	Langhovde, Skarvsnes, Byvågåsane
Leucocratic garnet-bearing gneiss	(NAKAI *et al.*, 1979b)	Telen
? Biotite-garnet gneiss	(KANISAWA *et al.*, 1979a)	Ongulkalven Island

Leucocratic rocks including garnet as major mafic mineral have been usually called garnet gneiss.

These are fine- to medium-grained leucocratic rocks and have usually massive appearances and white colour. The rocks are composed mainly of quartz, plagioclase, potash-feldspar and small amounts of granular garnet with reddish to pinkish tint, biotite and opaque minerals. These rocks occur as white-coloured concordant layers in the other pelitic to psammitic gneisses.

4.8.2. Leucocratic or acidic rocks including small amounts of garnet and biotite as mafic minerals

*? Garnet-bearing granitic gneiss	(YANAI *et al.*, 1975b)	Ongulkalven Island (4.8.3., 4.12.1.)
Garnet-bearing granitic gneiss	(ISHIKAWA, 1976)	Lützow-Holm Bay
Garnet-bearing granitic gneiss	(ISHIKAWA *et al.*, 1976)	Langhovde
Garnet-bearing granitic gneiss	(ISHIKAWA *et al.*, 1977)	Skarvsnes
*? Garnet-bearing granitic gneiss	(ISHIKAWA, 1977)	Padda Island (4.8.3., 4.12.1.)
Garnet-bearing granitic gneiss	(YANAI *et al.*, 1978)	Cape Hinode
Garnet-bearing quartz-feldspathic gneiss	(NAKAI *et al.*, 1979a)	Kjuka
Garnet-bearing quartz-feldspathic gneiss	(NAKAI *et al.*, 1979a)	Telen
Garnet-bearing granitic gneiss	(MATSUMOTO *et al.*, 1979)	Langhovde, Skarvsnes, Breidvågnipa
Garnet-bearing quartzose gneiss	(NAKAI *et al.*, 1979b)	Telen

These are usually fine- to medium-grained and weakly foliated rocks with distinct reddish or pinkish colour due to large amounts of potash-feldspar, and sometimes have compositional bandings consisting of thick quartz-feldspathic bands and thin biotite-bearing bands. The rocks are composed mainly of potash-feldspar, quartz, plagioclase and small amounts of biotite, garnet and opaque minerals.

The name granitic gneiss is not desirable. Some of them are undistinguishable from other leucocratic or acidic rocks (4.8.3.) and from granitic rocks (4.12.1.).

4.8.3. Other leucocratic or acidic rocks

* Feldspathic band	(KIZAKI, 1964)	Lützow-Holm Bay (4.13.1.)
Siliceous gneiss	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
Acid gneiss	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
* Granitic siliceous gneiss	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay (4.12.1.)
* Siliceous microdioritic gneiss	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay (4.12.1.)
*? Feldspathic band	(YANAI *et al.*, 1974a)	East Ongul Island (4.4.2.)
*? Feldspathic gneiss	(YANAI *et al.*, 1974b)	West Ongul Island (4.4.2.)
*? Garnet-bearing granitic gneiss	(YANAI *et al.*, 1975b)	Ongulkalven Island (4.8.2., 4.12.1.)

	Quartz-feldspathic gneiss	(YOSHIDA *et al.*, 1976)	Skallen
	Siliceous gneiss	(YOSHIDA *et al.*, 1976)	Skallen
*?	Garnet-bearing granitic gneiss	(ISHIKAWA, 1977)	Padda Island (4.8.2.)
	Siliceous gneiss	(YOSHIDA, 1977)	Skallen
	Siliceous gneiss	(NAKAI *et al.*, 1979b)	Cape Ryûgû
	Leucocratic muscovite-bearing biotite gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû

These are usually coarse-grained rocks occurring as leucocratic bands or pools in the other gneisses and have granitic appearances. The rocks are composed of plagioclase, quartz and potash-feldspar with or without biotite, muscovite and garnet (feldspathic gneiss, only plagioclase).

The rocks called granitic gneiss, siliceous gneiss, leucocratic gneiss, acid gneiss and some of the garnet-bearing granitic gneiss seem to belong to approximately the same rock-type, but details are not clear and some of them are undistinguishable from the rocks of 4.8.1., 4.8.2. and 4.12.1.

4.9. Calcareous rocks

4.9.1. Marble or crystalline limestone

Marble	(TATSUMI *et al.*, 1959)	Around Syowa Station
Marble	(BANNO *et al.*, 1964)	Lützow-Holm Bay
Marble	(KIZAKI, 1964)	East Ongul Island
Marble	(SUWA, 1968)	Lützow-Holmbukta
Marble	(ISHIKAWA, 1976)	Lützow-Holm Bay
Pure marble	(YOSHIDA *et al.*, 1976)	Skallen
Marble with scattered coloured minerals	(YOSHIDA *et al.*, 1976)	Skallen
Marble	(ISHIKAWA *et al.*, 1977)	Skarvsnes
Marble	(YOSHIDA, 1977)	Skallen
Marble	(YOSHIDA, 1978)	Lützow-Holmbukta
Marble	(YOSHIDA, 1979)	Lützow-Holmbukta
Marbles with scattered coloured minerals	(YOSHIDA, 1979)	Lützow-Holmbukta
Marble	(MATSUMOTO *et al.*, 1979)	Breidvågnipa
Crystalline limestone	(NAKAI *et al.*, 1979a)	Cape Ryûgû
Crystalline limestone	(NAKAI *et al.*, 1979b)	Cape Ryûgû

Pure marbles are coarse-grained white-coloured massive rocks composed mostly of calcite, occasionally small amounts of phologopite, spinel and graphite.

Impure marbles are also composed mainly of calcite and associated with forsterite, phlogopite, dolomite, graphite, spinel, clinopyroxene, amphibole and serpentine.

4.9.2. Melanocratic rocks associated with marbles.....〈Skarn〉

	Pyroxene rocks	(YOSHIDA *et al.*, 1976)	Skallen
	Phlogopite rocks	(YOSHIDA *et al.*, 1976)	Skallen
?	Skarn	(YOSHIDA, 1979)	Lützow-Holmbukta

? Skarn	(YOSHIDA, 1979)	Skallen
Hedenbergite-garnet-plagioclase rock	(KANISAWA *et al.*, 1979b)	Cape Hinode
* Epidote-clinopyroxene-hornblende-gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû (4.5.)
Garnet-clinopyroxene rock	(NAKAI *et al.*, 1980)	Cape Ryûgû

Pyroxene rocks occur as small veins or dykes in the marble-skarn zone at Skallen. These are coarse-grained, green to black in colour, and composed mostly of diopside with small amounts of biotite, amphibole, scapolite and plagioclase.

Phlogopite rocks occur as irregular blocks in the marble-skarn zone at Skallen. These are coarse-grained massive rocks consisting of phlogopite, scapolite, amphibole and clinopyroxene.

Impure marbles containing large amounts of magnesian minerals, some eclogitic rocks and scapolite-bearing rocks are also assumed to be skarn and allied rocks.

CaO-rich melanocratic rocks consisting of hedenbergite-garnet, epidote-clinopyroxene-hornblende and garnet-clinopyroxene seem to be skarn and allied rocks.

4.9.3. Clinopyroxene gneiss

Clinopyroxene gneiss	(NAKAI *et al.*, 1979a)	Telen
Clinopyroxene gneiss	(SUZUKI *et al.*, 1979)	Cape Omega
Clinopyroxene gneiss	(NAKAI *et al.*, 1979b)	Telen
Clinopyroxene gneiss	(SUZUKI, 1979)	Cape Omega
*?Part of metabasite (Clinopyroxene gneiss)	(SUZUKI, 1979)	Cape Omega (4.2.)
Fine-grained clinopyroxene gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû
Diopside-bearing pegmatoid	(NAKAI *et al.*, 1980)	Cape Ryûgû
Coarse-grained clinopyroxene gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû

Clinopyroxene gneiss with calcareous compositions have been reported only from Telen, Cape Omega and Cape Ryûgû. Most of them are fine-grained melanocratic to intermediate and massive rocks with deep green colour, and occur as concordant layers among the other gneisses. The rocks are composed of diopsidic to salitic clinopyroxene, quartz, plagioclase with or without amphibole, biotite, potash-feldspar, sphene, calcite and scapolite.

The coarse-grained equivalents are found at Cape Ryûgû, and diopside-bearing pegmatoids occur as small and irregular veins or pools in fine-grained clinopyroxene gneiss.

4.10. Quartzite

Quartzite	(TATSUMI *et al.*, 1959)	Around Syowa Station
Quartzite	(BANNO *et al.*, 1964)	Lützow-Holm Bay
Quartzite	(KIZAKI, 1964)	East Ongul Island
Quartzite	(SUWA, 1968)	Lützow-Holmbukta
Quartzite	(ISHIKAWA, 1976)	Lützow-Holm Bay
Quartzite	(YOSHIDA *et al.*, 1976)	Skallen

Quartzite	(YOSHIDA, 1978)	Lützow-Holmbukta
Quartzite	(NAKAI *et al.*, 1979)	Telen

Quartzites are light-coloured massive to weakly foliated rocks which occur as concordant layers, about 2～3 m to over 10 m in thickness, in the pelitic to psammitic gneisses. These are composed mostly of quartz with small amounts of potash-feldspar, plagioclase and biotite.

4.11. Plutonic or metamorphic rocks with charnockitic or syenitic compositions

4.11.1. Syenitic rocks

Porphyritic pyroxene syenite	(KIZAKI, 1965)	Yamato Mountains
Pyroxene syenite	(KIZAKI, 1965)	Yamato Mountains
Syenite	(YOSHIDA *et al.*, 1971)	Yamato Mountains
Leucocratic syenite	(YOSHIDA *et al.*, 1971)	Yamato Mountains
? Pyroxene syenite	(ISHIKAWA, 1976)	Lützow-Holm Bay
* Syenite gneiss group (Two-pyroxene syenite gneiss)	(SHIRAISHI, 1977)	Yamato Mountains (4.6.)
* Syenite gneiss group (Clinopyroxene syenite gneiss)	(SHIRAISHI, 1977)	Yamato Mountains (4.6.)
* Syenite gneiss group (Clinopyroxene quartz syenite gneiss)	(SHIRAISHI, 1977)	Yamato Mountains (4.6.)
* Quartz syenite gneiss	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima (4.6.)
? Syenite	(YOSHIDA, 1979)	Lützow-Holmbukta

Syenitic rocks have been reported mainly from the Yamato Mountains, and those of the Lützow-Holm Bay region are not confirmed because of the lack of descriptions. Syenite gneiss group seems to correspond approximately to the two-pyroxene gneisses.

Syenitic rocks in the Yamato Mountains are usually coarse-grained massive or weakly foliated rocks composed of potash-feldspar, quartz, plagioclase, clinopyroxene, orthopyroxene, biotite, hornblende, sphene, apatite, zircon and opaque minerals and are subdivided into several types according to their mineral compositions. Gradational relations are commonly observed between the syenitic rocks and the granitic rocks and some parts of the syenitic rocks gradually transform into the granitic gneisses due to the later metamorphism or granitization.

4.11.2. Charnockitic rocks

Hypersthene-bearing gneissose granodiorite	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
? Gneissose granodiorite	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
Brown gneissose granodiorite	(YOSHIDA, 1975)	Botnneset
Potash-feldspar porphyroblastic brown gneissose granodiorite	(YOSHIDA, 1975)	Botnneset
? Part of charnockites (Brown gneissose granodiorite)	(YOSHIDA *et al.*, 1976)	Skallen

*?	Brown microgranite	(YOSHIDA *et al.*, 1976)	Skallen (4.13.1.)
	Charnockite	(YOSHIDA, 1977)	Skallen
	Charnockitic garnet granite mass	(YOSHIDA, 1977)	Skallen
	Part of charnockitic rocks (Charnockitic plutonite)	(YOSHIDA, 1978, 1979)	Lützow-Holmbukta
	Part of charnockitic rocks (Charnockitic pegmatite)	(YOSHIDA, 1978, 1979)	Lützow-Holmbukta
	Charnockite	(YOSHIDA, 1979)	Lützow-Holmbukta
	Enderbite	(YOSHIDA, 1979)	Lützow-Holmbukta

Petrographical features of the charnockites or charnockitic rocks are approximately similar to the two-pyroxene gneisses and the differences between them are not always distinct. YOSHIDA (1978) classified them into three types on the basis of the tectonic viewpoints.

Charnockites occur as the concordant layers or small stocks and veinlets in the other paragneisses. These are usually medium- to coarse-grained massive or weakly foliated rocks with dark grey, dark green and dark brown colour due to the presence of dark-coloured quartz and feldspars. The rocks are composed of plagioclase, quartz, potash-feldspar, clinopyroxene, orthopyroxene, biotite, hornblende, opaque minerals, with or without garnet, and are subdivided into several types according to their mineral compositions.

4.11.3. Noritic rocks

Norite	(YOSHIDA, 1978)	Ongul Islands

The name norite appeares only in Table 1 of YOSHIDA (1979), but the name is not used in the original articles (BANNO *et al.*, 1964 and SUWA, 1968). The rocks are composed mainly of orthopyroxene, biotite and hornblende.

4.12. Plutonic or metamorphic rocks with granitic or migmatitic appearances

4.12.1. Granitic gneiss or migmatitic gneiss

	Biotite granitic gneiss	(TATSUMI *et al.*, 1959)	Around Syowa Station
	Granitic gneiss	(TATSUMI *et al.*, 1959)	Around Syowa Station
*	Granitic gneiss (Microcline granite)	(KIZAKI, 1965)	Yamato Mountains (4.13.1.)
*	Migmatitic gneiss (Biotite granite)	(KIZAKI, 1965)	Yamato Mountains (4.13.1.)
*	Granitic siliceous gneiss	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay (4.8.3.)
*	Siliceous microdioritic gneiss	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay (4.8.3.)
?	Garnet-bearing granitic gneiss	(YANAI *et al.*, 1974b)	West Ongul Island
?	Garnet-bearing granitic gneiss	(YANAI *et al.*, 1975a)	Teöya
*?	Garnet-bearing granitic gneiss	(YANAI *et al.*, 1975b)	Ongulkalven Island (4.8.2.)
	Granitic gneiss	(SHIRAISHI, 1975)	Yamato Mountains
	Migmatite gneiss	(ISHIKAWA, 1976)	Lützow-Holm Bay
	Granitic gneiss	(ISHIKAWA, 1976)	Lützow-Holm Bay

	Migmatitic gneiss	(ISHIKAWA *et al.*, 1977)	Skarvsnes
*?	Garnet-bearing granitic gneiss	(ISHIKAWA, 1977)	Padda Island (4.8.2., 4.8.3.)
	Granitic gneiss (Nebulitic gneiss)	(SHIRAISHI, 1977)	Yamato Mountains
	Granitic gneiss (Schlieren gneiss)	(SHIRAISHI, 1977)	Yamato Mountains
	Granitic gneiss (Banded gneiss)	(SHIRAISHI, 1977)	Yamato Mountains
	Migmatite gneiss	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima
*	Pink granitic gneiss	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima (4.13.1.)
	Migmatitic gneiss	(MATSUMOTO *et al.*, 1979)	Breidvågnipa
(*	Dioritic rock	(NAKAI *et al.*, 1981)	Oku-iwa Rock (4.5.))

Granitic gneisses or migmatitic gneisses usually have granitic appearances in their chemical and mineral compositions, texture and occurrences. The petrographical differences between the granitic gneiss and the plutonic granites are not very distinct and some of them are undistinguishable from the rocks of 4.8.3. and 4.13.1.

These rocks are rather massive and some parts of them show gneissose, nebulitic, schlieren and banded structures. Massive granitic parts intrude or penetrate into the surrounding paragneisses. These are composed mainly of potash-feldspar, quartz, plagioclase and minor amounts of biotite.

Dioritic rocks in the Oku-iwa Rock region show the similar migmatitic appearances.

4.12.2. Augen gneiss

Augen gneiss	(NAKAI *et al.*, 1979b)	Cape Ryûgû
Augen gneiss	(NAKAI *et al.*, 1980)	Cape Ryûgû

Augen gneiss has been reported only from the Cape Ryûgû region. This is red to pinkish coloured coarse-grained foliated rock, and is characterized by augen-form porphyroblasts of potash-feldspars. The rock is composed mainly of potash-feldspar, quartz, plagioclase and minor amounts of biotite, hornblende, sphene, apatite and magnetite.

4.13. Plutonic rocks with granitic or granodioritic compositions

4.13.1. Granitic or granodioritic rocks

	Granite	(KIZAKI, 1962)	East Ongul Island
*	Feldspathic band	(KIZAKI, 1964)	Lützow-Holm Bay (4.8.3.)
*	Migmatitic gneiss (Biotite granite)	(KIZAKI, 1965)	Yamato Mountains (4.12.1.)
*	Granitic gneiss (Microcline granite)	(KIZAKI, 1965)	Yamato Mountains (4.12.1.)
	Microcline granite	(KIZAKI, 1965)	Yamato Mountains
	Granite	(SUWA, 1968)	Lützow-Holmbukta
	Biotite gneissose granite and hornblende gneissose granite	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
	Garnet-bearing gneissose granite	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay
	Pink potash-feldspar gneissose granite	(YOSHIDA *et al.*, 1971)	Lützow-Holm Bay and Yamato Mountains

	Micro-biotite granite	(YOSHIDA *et al.*, 1971)	Yamato Mountains
	Hornblende granite	(YANAI *et al.*, 1974a)	East Ongul Island
	Garnet-bearing hornblende granite	(YANAI *et al.*, 1974a)	East Ongul Island
	Biotite granite	(YANAI *et al.*, 1974a)	East Ongul Island
	Hornblende-biotite gneissose granite	(YANAI *et al.*, 1974b)	West Ongul Island
	Microcline granite	(YANAI *et al.*, 1974b)	West Ongul Island
	Hornblende-biotite microgranite	(YOSHIDA, 1975)	Botnneset
	Pink gneissose granite	(YOSHIDA, 1975)	Botnneset
	Biotite or microcline granite	(ISHIKAWA, 1976)	Lützow-Holm Bay
	Hornblende-biotite granite	(ISHIKAWA, 1976)	Lützow-Holm Bay
	Microcline granite	(ISHIKAWA, 1976)	Lützow-Holm Bay
	Hornblende-biotite gneissose granite	(ISHIKAWA, 1976)	Lützow-Holm Bay
	Microcline granite	(ISHIKAWA *et al.*, 1976)	Langhovde
	Garnet gneissose granite	(YOSHIDA *et al.*, 1976)	Skallen
	Pink granite	(YOSHIDA *et al.*, 1976)	Skallen
*?	Brown microgranite	(YOSHIDA *et al.*, 1976)	Skallen (4.11.2.)
	Gneissose microcline granite	(ISHIKAWA *et al.*, 1977)	Skarvsnes
	Garnet gneissose granite	(YOSHIDA, 1977)	Skallen
	Pink granite	(YOSHIDA, 1977)	Skallen
	Garnet granite	(YOSHIDA, 1977)	Skallen
	Biotite microgranite	(YOSHIDA, 1977)	Skallen
	Migmatite gneiss (Biotite granite)	(SHIRAISHI, 1977)	Yamato Mountains
	Aplitic granite	(SHIRAISHI, 1977)	Yamato Mountains
?	Acid dyke	(SHIRAISHI, 1977)	Yamato Mountains
	Granite	(YANAI *et al.*, 1978)	Cape Hinode
	Aplitic granite	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima
	Acid dyke	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima
*	Pink granite gneiss	(SHIRAISHI *et al.*, 1978)	Mt. Fukushima (4.12.1.)
	Gneissose granite	(SUZUKI *et al.*, 1979)	Cape Omega
	Pink granite	(SUZUKI *et al.*, 1979)	Cape Omega
	Garnet gneissose granite	(YOSHIDA, 1979)	Lützow-Holmbukta
	Pink granite	(YOSHIDA, 1979)	Lützow-Holmbukta
	Granite	(YOSHIDA, 1979)	Lützow-Holmbukta
	Pegmatitic granite	(YOSHIDA, 1979)	Lützow-Holmbukta
	Biotite granite	(YOSHIDA, 1979)	Lützow-Holmbukta
	Microcline granite	(MATSUMOTO *et al.*, 1979)	Langhovde
	Gneissose microcline granite	(MATSUMOTO *et al.*, 1979)	Breidvågnipa
	Granite	(NAKAI *et al.*, 1979b)	Cape Ryûgû
	Pink granite	(NAKAI *et al.*, 1979b)	Oku-iwa Rock
	Pink granite	(SUZUKI, 1979)	Cape Omega
	Gneissose granite	(SUZUKI, 1979)	Cape Omega
	Biotite granodiorite	(KANISAWA *et al.*, 1979b)	Cape Hinode
	Pink granite	(NAKAI *et al.*, 1981)	Oku-iwa Rock

Plutonic rocks having granitic to granodioritic compositions occur as rather minor

intrusives, dykes, veinlets and/or irregular pools in the metamorphic rocks. These are medium- to coarse-grained leucocratic rocks and are usually massive and occasionally foliated. The rocks are composed mainly of potash-feldspar, plagioclase, quartz, biotite and with or without garnet and hornblende, and are subdivided into several rock-types according to their mineral compositions. The most predominant rock-type among them is the massive granite with pink to red tint including abundant pink potash-feldspars. Aplites are the fine-grained equivalents of granites.

4.13.2. Aplite

Aplite	(SHIRAISHI *et al.*, 1972)	Sandercock Nunataks
Aplite	(NAKAI *et al.*, 1979b)	Cape Ryûgû
Aplite	(NAKAI *et al.*, 1979b)	Oku-iwa Rock
Aplite	(NAKAI *et al.*, 1980)	Cape Ryûgû

These are fine-grained and massive granitic rocks with pink to red tints and occur as small veins or pools associated with granitic rocks.

4.13.3. Pegmatite

Pegmatite	(TATSUMI *et al.*, 1959)	Around Syowa Station
Pegmatite	(KIZAKI, 1962)	East Ongul Island
Pegmatite	(KIZAKI, 1964)	Lützow-Holm Bay
Microcline pegmatite	(KIZAKI, 1965)	Yamato Mountains
Pegmatite	(SUWA, 1968)	Lützow-Holmbukta
Pegmatite	(SHIRAISHI *et al.*, 1972)	Sandercock Nunataks
Pegmatite	(YANAI *et al.*, 1974a)	East Ongul Island
Pegmatite	(YANAI *et al.*, 1974b)	West Ongul Island
Pegmatite	(YOSHIDA, 1975)	Botnneset
Granite pegmatite	(YOSHIDA, 1975)	Botnneset
Pegmatite	(ISHIKAWA, 1976)	Lützow-Holm Bay
Pegmatite	(ISHIKAWA *et al.*, 1976)	Langhovde
Pegmatite	(YOSHIDA *et al.*, 1976)	Skallen
Pegmatite	(ISHIKAWA *et al.*, 1977)	Skarvsnes
Pegmatite	(YOSHIDA, 1977)	Skallen
Pegmatite	(YANAI *et al.*, 1978)	Cape Hinode
Pegmatite	(NAKAI *et al.*, 1979)	Kjuka
Pegmatite	(SUZUKI *et al.*, 1979)	Cape Omega
Scapolite-plagioclase pegmatite	(YOSHIDA, 1979)	Lützow-Holmbukta
Pegmatite	(MATSUMOTO *et al.*, 1979)	Langhovde, Breidvågnipa, Skarvsnes
Pegmatite	(NAKAI *et al.*, 1979b)	Cape Ryûgû, Oku-iwa Rock
Pegmatite	(SUZUKI, 1979)	Cape Omega
Pegmatite	(NAKAI *et al.*, 1980)	Cape Ryûgû

Pegmatites occur as small dykes, veinlets and irregular pools in the various metamorphic rocks associated with granitic or granodioritic rocks. These are very coarse-

grained massive rocks consisting of potash-feldspar, quartz, plagioclase, biotite and magnetite. There may occur two types of pegmatites; pink pegmatites and white pegmatites. The former is the most predominant and the latter occasionally includes euxenite.

5. Concluding Remarks

In general, classification or nomenclature is the artificial application of the logical standard to the natural systems which have rather continuous and complicated mutual relationships. Too much logical and rigid standard is often useless for understanding the real geological situations of rocks. Certain freedom within the petrological basis of terminology, resulting from the difference of viewpoint among geologists, will have to be allowed in classification and nomenclature. It would be sufficient for practical use if many geologists can recognize the general petrological and geological features of rocks in individual system of classification, even though some exceptions or irregularities might be involved.

A perfect classification will not be achieved before all the investigations are concluded.

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References

BANNO, S., TATSUMI, T., KUNO, H. and KATSURA, T. (1964): Mineralogy of granulite facies rocks in the area around Lützow-Holm Bay, Antarctica. JARE Sci. Rep., Ser. C, **1**, 1–12.

ISHIKAWA, T. (1976): Superimposed folding of the Precambrian metamorphic rocks of the Lützow-Holm Bay region, East Antarctica. Mem. Natl Inst. Polar Res., Ser. C, **9**, 1–41.

ISHIKAWA, T. (1977): Geological map of Padda Island, Antarctica. Antarct. Geol. Map. Ser., Sheet 10 (with explanatory text, 4 p.), Tokyo, Natl Inst. Polar Res.

ISHIKAWA, T., TATSUMI, T., KIZAKI, K., YANAI, K., YOSHIDA, M., ANDO, H., KIKUCHI, T., YOSHIDA, Y. and MATSUMOTO, Y. (1976): Geological map of Langhovde, Antarctica. Antarct. Geol. Map Ser., Sheet 5 (with explanatory text, 10 p.), Tokyo, Natl Inst. Polar Res.

ISHIKAWA, T., YANAI, K., MATSUMOTO, Y., KIZAKI, K., KOJIMA, S., TATSUMI, T., KIKUCHI, T. and YOSHIDA, M. (1977): Geological map of Skarvsnes, Antarctica. Antarct. Geol. Map Ser., Sheets 6 and 7 (with explanatory text, 10 p, 2 pls.), Tokyo, Natl Inst. Polar Res.

I. U. G. S. SUBCOMMISSION (1973): Plutonic rocks classification and nomenclature recommended by

the IUGS subcommission on the systematics of igneous rocks. Geotimes, **18**, 26–30.

KANISAWA, S., ONUKI, H. and YANAI, K. (1979a): Chemical characteristics of biotite and hornblende from metamorphic rocks around Lützow-Holmbukta, East Antarctica. Mem. Natl Inst. Polar Res., Spec. Issue, **14**, 153–163.

KANISAWA, S., YANAI, K. and ISHIKAWA, K. (1979b): Major element chemistry of metamorphic rocks of the Cape Hinode district, East Antarctica. Mem. Natl Inst. Polar Res., Spec. Issue, **14**, 164–171.

KIZAKI, K. (1962): Nankyoku Higashi-Ongul Tô no kôzôchishitsu oyobi ganseki, dai ichi-bu kôzôchishitsu (Structural geology and petrology of East Ongul Island, East Antarctica, part 1 structural geology). Nankyoku Shiryô (Antarct. Rec.), **14**, 1147–1155.

KIZAKI, K. (1964): Tectonics and petrography of the East Ongul Island, Lützow-Holm Bukt, Antarctica. JARE Sci. Rep., Ser. C, **2**, 1–24.

KIZAKI, K. (1965): Geology and petrography of the Yamato Sanmyaku, East Antarctica. JARE Sci. Rep., Ser. C, **3**, 1–27.

MATSUMOTO, Y., YOSHIDA, M. and YANAI, K. (1979): Geology and geologic structure of the Langhovde and Skarvsnes region, East Antarctica. Mem. Natl Inst. Polar Res., Spec. Issue, **14**, 106–120.

MEHNERT, K. R. (1968): Migmatites and the Origin of Granitic Rocks. Amsterdam, Elsevier, 392 p.

NAKAI, Y., KANO, T., YOSHIKURA, S., ISHIKAWA, T. and YANAI, K. (1979a): Geological map of Kjuka and Telen, Antarctica. Antarct. Geol. Map Ser., Sheet 8 (with explanatory text, 5 p.), Tokyo, Natl Inst. Polar Res.

NAKAI, Y., KANO, T. and YOSHIKURA, S. (1979b): Outline of geology of Cape Ryûgû, Oku-iwa Rock and Telen, East Antarctica. Mem. Natl Inst. Polar Res. Spec. Issue, **14**, 121–127.

NAKAI, Y., KANO, T. and YOSHIKURA, S. (1980): Geological map of Cape Ryûgû, Antarctica. Antarct. Geol. Map Ser., Sheet 15 (with explanatory text, 9 p, 2 pls.), Tokyo, Natl Inst. Polar Res.

NAKAI, Y., KANO, T. and YOSHIKURA, S. (1981): Geological map of Oku-iwa Rock, Antarctica. Antarct. Geol. Map Ser., Sheet 22 (with explanatory text, 4 p, 2 pls.), Tokyo, Natl Inst. Polar Res.

SHIRAISHI, K., WATANABE, O. and KIZAKI, K. (1972): Higashi-Nankyoku tairiku Endâbi rando no Sandâkokku Nunatâku-gun no chishitsu ni tsuite (Geology of the Sandercock Nunataks in Enderby Land, East Antarctica). Nankyoku Shiryô (Antarct. Rec.), **45**, 66–75.

SHIRAISHI, K. (1975): Geology of the West Yamato Nunataks, East Antarctica. Nankyoku Shiryô (Antarct. Rec.), **53**, 57–74.

SHIRAISHI, K. (1977): Geology and petrography of the Northern Yamato Mountains, East Antarctica. Mem. Natl Inst. Polar Res., Ser. C, **12**, 1–33.

SHIRAISHI, K., KIZAKI, K., YOSHIDA, M. and MATSUMOTO, Y. (1978): Geological map of Northern Yamato Mountains, (1) Mt. Fukushima, Antarctica. Antarct. Geol. Map Ser., Sheet 27 (with explanatory text, 7 p, 2 pls.), Tokyo, Natl Inst. Polar Res.

SUWA, K. (1968): Petrological studies on the metamorphic rocks from the Lützow-Holmbukta area, East Antarctica. XXIII Int. Geol. Congr., **4**, 171–187.

SUZUKI, M. (1979): Metamorphic and plutonic rocks in the Cape Omega area, East Antarctica. Mem. Natl Inst. Polar Res., Spec. Issue, **14**, 128–139.

SUZUKI, M. and MORIWAKI, K. (1979): Geological map of Cape Omega, Antarctica. Antarct. Geol. Map Ser., Sheet 21 (with explanatory text, 5 p, 2 pls.), Tokyo, Natl Inst. Polar Res.

TATSUMI, T. and KIKUCHI, T. (1959): Nankyoku Syowa Kiti fukin no chigakuteki kansatsu (sono 2) (Report of geomorphological and geological studies of the wintering team (1957–58) of the first

Japanese Antarctic Research Expedition, part 2). Nankyoku Shiryô (Antarct. Rec.), **8**, 443–463.

YANAI, K., KIZAKI, K., TATSUMI, T. and KIKUCHI, T. (1974a): Geological map of East Ongul Island, Antarctica. Antarct. Geol. Map Ser., Sheet 1 (with explanatory text, 13 p.), Tokyo, Natl Inst. Polar Res.

YANAI, K., TATSUMI, T. and KIKUCHI, T. (1974b): Geological map of West Ongul Island, Antarctica. Antarct. Geol. Map Ser., Sheet 2 (with explanatory text, 5 p.), Tokyo, Natl Inst. Polar Res.

YANAI, K., TATSUMI, T., KIKUCHI, T. and ISHIKAWA, T. (1975a): Geological map of Teöya, Antarctica. Antarct. Geol. Map Ser., Sheet 3 (with explanatory text, 3 p.), Tokyo, Natl Inst. Polar Res.

YANAI, K., TATSUMI, T. and KIKUCHI, T. (1975b): Geological map of Ongulkalven Island, Antarctica. Antarct. Geol. Map Ser., Sheet 4 (with explanatory text, 3 p.), Tokyo, Natl Inst. Polar Res.

YANAI, K. and ISHIKAWA, T. (1978): Geological map of Cape Hinode, Antarctica. Antarct. Geol. Map Ser., Sheet 11 (with explanatory text, 6 p, 4 pls.), Tokyo, Natl Inst. Polar Res.

YOSHIDA, M. (1975): Geology of the region around Botnneset, East Antarctica. Mem. Natl Inst. Polar Res., Ser. C, **8**, 1–43.

YOSHIDA, M. (1977): Geology of the Skallen region, Lützow-Holmbukta, East Antarctica. Mem. Natl Inst. Polar Res., Ser. C, **11**, 1–38.

YOSHIDA, M. (1978): Tectonics and petrology of charnockites around Lützow-Holmbukta, East Antarctica. J. Geosci., Osaka City Univ., **21** (Art. 6), 65–152.

YOSHIDA, M. (1979): Metamorphic conditions of the polymetamorphic Lützow-Holmbukta region, East Antarctica. J. Geosci., Osaka City Univ., **22** (Art. 4), 97–140.

YOSHIDA, M. and ANDO, H. (1971): Geological surveys in the vicinity of Lützow-Holm Bay and the Yamato Mountains, East Antarctica. Report No. 1 of the geology section of the 10th Japanese Antarctic Research Expedition. Nankyoku Shiryô (Antarct. Rec.), **39**, 46–54.

YOSHIDA, M., YOSHIDA, Y., ANDO, H., ISHIKAWA, T. and TATSUMI, T. (1976): Geological map of Skallen, Antarctica. Antarct. Geol. Map Ser., Sheet 9 (with explanatory text, 16 p, 2 pls.), Tokyo, Natl Inst. Polar Res.

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