NATIONAL INSTITUTE OF POLAR RESEARCH

ANTARCTIC GEOLOGICAL MAP SERIES
SHEET 20 AKARUI POINT AND NAGA-IWA ROCK

Explanatory Text of Geological Map of Akarui Point and Naga-iwa Rock, Antarctica

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Explanatory Text of Geological Map of Akarui Point and Naga-iwa Rock, Antarctica

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1. Introduction

The Akarui Point is a bedrock exposure located at 68°27′S–68°29′S in latitude and 41°24′E–41°30′E in longitude, about 95 km northeast of Syowa Station, on the Prince Olav Coast. The bedrock exposure has an E-W width of 4 km and a N-S length of 3.7 km. The highest point is 115.2 m above sea level in the central part of the exposured area. Several ponds with meltwater appear in the summer season, and patterned grounds are distributed widely (Plate 1a).

Geological survey of the Akarui Point was carried out for the first time by K. YANAI of the 15th Japanese Antarctic Research Expedition (JARE-15) in February 1975. It was completed by K. KIZAKI and K. SHIRAISHI of JARE-21 in 1980.

The Naga-iwa Rock is a small ice-free area situated about 5 km northeast of the Akarui Point. It extends perpendicular to the coastal line as a wedge-shaped outcrop with a length of 2 km and a width of less than 1 km (Plate 1b). Geological survey of this area was carried out by K. SHIRAISHI of JARE-21 in 1980.

Geodetic survey of the Akarui Point was performed in 1975, 1977, 1979 and 1980. The topographical maps "Akarui Point: western part", "Akarui Point: eastern part", and "Naga-iwa Rock" on a scale of 1:25000, compiled from the air photographs taken in 1981, were published in 1982.

2. General Geology and Petrography

2.1. General geology

The Akarui point and Naga-iwa Rock are bounded by the Antarctic Sea on the north and northwest, and are covered by the continental ice on the southeast. The other small sides of these bedrock exposures are bounded by glaciers of various scales. Another small ice-free area is separated from the main area of the Akarui Point and an ice cliff showing a typical shear moraine is observed between the ice-free areas (Plate 2).

The basement rocks exposed in these areas are classified into the following types based on their petrographical characteristics.

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1. Garnet-biotite gneiss (Gg)
   1.1. Kyanite-bearing sillimanite-garnet-biotite gneiss
   1.2. Garnet-biotite gneiss
2. Biotite-hornblende gneiss (Gb)
   2.1. Biotite-hornblende gneiss
   2.2. Granodioritic migmatite
3. Hornblende-biotite gneiss (granitic migmatite) (Gbh)
4. Pyroxene gneiss (Gp)
5. Metabasites (Am and Mb)
   5.1. Amphibolite
   5.2. Ultrabasic granulite
6. Granite (Gr) and pegmatite (Pg)

The Akarui Point is underlain mainly by garnet-biotite, biotite-hornblende, and hornblende-biotite gneisses. Part of the biotite-hornblende gneiss and hornblende-biotite gneiss show a migmatitic mode of occurrence in the field, and gradually change to each other. Subordinate amount of metabasites are associated with these rocks as concordant thin layers and blocks. The occurrence of ultrabasic granulite is characteristic of the Akarui Point. Some ultrabasic rock containing a small amount of sapphirine of bulder shape occurs in the metabasites (Plate 3a). The compositional layerings as well as the mineral foliation strike NW-SE and dip towards NE or NW, showing anticlinal and synclinal structures in the western part of the bedrock exposure (Plate 3b). Small masses (mostly dikes) of granite and pegmatite occur throughout the area.

The Naga-iwa Rock is underlain mainly by well-layered garnet-biotite and biotite-hornblende gneisses. Thin layers of pyroxene gneiss and amphibolite are intercalated with these gneisses. In addition, two pyroxene-bearing metabasite occurs as a concordant lensoid body in garnet-biotite gneiss. The compositional layerings as well as mineral foliation strike NW-SE and dip steeply towards NE or NW. Tight intrafolial folds are often observed in the gneisses. Granite and pegmatite intrude extensively into the gneisses as small discordant masses. Gray to pinkish crystals of K-feldspar in the pegmatite are as long as 20 cm.

2.2. *Petrography*

The most important petrographical feature of the bedrock exposures is the occurrence of ultrabasic granulite, pyroxene gneiss, and two pyroxene-bearing metabasite. Orthopyroxene is a main constituent mineral in these rocks, but it does not occur in the other rock types. Thus, orthopyroxene sporadically occurs in the bedrock exposures, suggesting that these areas are situated at the transition from the amphibolite-facies region of the northeastern part of the Prince Olav Coast to the granulite-facies region of the Sôya Coast (HIROI *et al.*, 1983a, b; SHIRAISHI *et al.*, 1984).

The occurrence of metastable kyanite with abundant stable sillimanite in garnet-biotite gneiss is also significant, because it indicates that the regional metamorphism was of the kyanite-sillimanite type (HIROI *et al.*, 1983b).

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

2.2.1. Garnet-biotite gneiss

(1) Kyanite-bearing sillimanite-garnet-biotite gneiss

This is a medium-grained rock containing abundant garnet porphyroblasts. Sillimanite is easily distinguished with the naked eye. The constituent minerals are kyanite, sillimanite, garnet, biotite plagioclase, K-feldspar, quartz, opaque minerals, apatite and zircon. Small amounts of secondary muscovite and chlorite are also present. Kyanite occurs only in a small amount as subhedral to anhedral inclusions in garnet and plagioclase (Plate 4a). Sillimanite occurs far more abundant than kyanite does, and is in direct contact with most minerals present. Thus, it is safely concluded that kyanite is a metastable relic formed at an earlier stage of prograde recrystallization of the rock during the same regional metamorphism (HIROI *et al.*, 1983a).

(2) Garnet-biotite gneiss

This is a fine- to medium-grained rock with granoblastic to lepidoblastic texture. This rock is sometimes characterized by brownish green plagioclase which is common in pyroxene gneiss of the granulite facies. It gradually changes to biotite-hornblende gneiss. The constituent minerals are garnet, biotite, plagioclase, quartz, opaque minerals, apatite and zircon. K-feldspar is an additional phase in some cases. Garnet usually occurs as porphyroblasts, and sometimes shows a replacement texture by the mixture of biotite and plagioclase.

2.2.2. Biotite-hornblende gneiss

(1) Biotite-hornblende gneiss

This is a fine- to medium-grained rock with granoblastic texture. It is sometimes characterized by brownish green plagioclase like the case of pyroxene gneiss. The constituent minerals are biotite, hornblende, plagioclase, quartz, opaque minerals, apatite and zircon. Garnet and sphene are also present in some cases. Hornblende shows pleochroism with X'=pale yellow and Z'=green to brownish green. Plagioclase is antiperthitic in some cases.

(2) Granodioritic migmatite

This rock ranges from the heterogeneous mixture of amphibolitic blocks+granitic material to a more homogeneous but banded rock. The constituent minerals are biotite, hornblende, plagioclase, K-feldspar, quartz, opaque minerals, apatite and zircon. Sphene is sometimes an additional phase. Secondary chlorite is also present in a small amount. This migmatitic rock is characterized by the occurrence of K-feldspar.

2.2.3. Hornblende-biotite gneiss (granitic migmatite)

This is a fine-grained leucocratic rock with schlieren. This rock gradually changes to biotite-hornblende granodioritic migmatite. The constituent minerals are hornblende, biotite, plagioclase, K-feldspar, quartz, opaque minerals, apatite and zircon. Secondary chlorite and muscovite are also present in small amounts. This rock is richer in K-feldspar and quartz and poorer in mafic minerals than the biotite-hornblende granodioritic migmatite.

2.2.4. Pyroxene gneiss

This is a medium-grained rock with granoblastic texture. It shows compositional

Table 1. Chemical analyses of rocks from Akarui Point and Naga-iwa Rock.

Locality No.		Akarui Point 1	2	3	4	5	6	7	8
SiO_2		40.02	40.78	41.43	41.98	43.67	46.10	46.65	56.43
TiO_2		0.19	0.09	0.18	1.58	0.21	1.57	2.18	1.09
Al_2O_3		8.09	21.86	19.58	9.46	7.20	15.82	11.45	14.94
Fe_2O_3		3.20	2.36	2.69	2.92	2.81	4.11	4.20	3.35
FeO		7.85	2.99	3.80	4.39	4.97	8.41	8.29	5.87
MnO		0.17	0.09	0.11	0.11	0.14	0.24	0.23	0.17
MgO		32.25	14.27	19.26	21.72	25.72	6.98	7.75	4.83
CaO		3.70	8.00	8.67	10.25	8.46	9.79	7.45	8.00
Na_2O		0.78	1.45	1.45	1.69	1.19	3.50	1.76	3.37
K_2O		0.15	4.10	0.25	0.31	0.59	1.17	3.88	0.96
H_2O (+)		3.44	3.38	1.86	3.67	4.39	1.91	3.37	1.03
H_2O (−)		0.13	0.22	0.08	0.06	0.17	0.16	0.19	0.08
P_2O_5		0.04	0.06	0.05	1.23	0.06	0.24	2.19	0.17
Total		100.01	99.65	99.41	99.32	99.58	100.00	99.59	100.29
ppm									
F		156	1920	106	908	606	763	4030	500
Cr		2060	854	878	767	3020	120	403	—
Q		–	–	–	–	–	–	–	9.72
Or		0.89	–	1.48	1.83	3.49	6.91	22.93	5.67
Ab		6.60	–	8.31	10.47	7.81	20.86	14.89	28.52
An		18.09	39.30	41.69	17.31	12.56	24.00	11.88	22.80
Ne		–	6.65	2.15	2.07	1.23	4.74	–	–
Lc		–	15.68	–	–	–	–	–	–
C		0.01	0.63	1.28	–	–	–	–	–
Di	Wo	–	–	–	10.65	12.12	9.60	4.50	6.59
	En	–	–	–	8.80	9.70	5.79	2.90	4.03
	Fs	–	–	–	0.53	1.02	3.30	1.29	2.19
Hy	En	1.12	–	–	–	–	–	13.01	8.00
	Fs	0.16	–	–	–	–	–	5.78	4.34
Ol	Fo	55.50	24.91	33.62	31.74	38.10	8.13	2.37	–
	Fa	8.97	2.75	3.60	2.10	4.40	5.10	1.16	–
Mt		4.64	3.42	3.90	4.23	4.07	5.96	6.09	4.86
Il		0.36	0.17	0.34	3.00	0.40	2.98	4.14	2.07
Hm		–	–	–	–	–	–	–	–
Ap		0.09	0.14	0.12	2.85	0.14	0.56	5.07	0.39

No. 1. 801263 Olivine-bearing ultrabasic granulite
2. 801274 Plagioclase-bearing ultrabasic granulite
3. 801275 Ultrabasic granulite
4. 801258 Olivine-bearing ultrabasic granulite
5. 801259 Olivine-bearing ultrabasic granulite
6. 801257 Biotite-bearing clinopyroxene amphibolite
7. 801252 Biotite amphibolite
8. 801264 Biotite-hornblende gneiss

Table 1. Continued.

Locality	Akarui Point					Naga-iwa Rock	
No.	9	10	11	12	13	14	15
SiO_2	58.88	60.04	69.21	69.47	69.95	51.34	58.25
TiO_2	1.20	1.11	0.57	0.49	0.56	0.31	1.13
Al_2O_3	16.30	15.54	14.30	14.52	14.37	4.79	17.63
Fe_2O_3	4.51	2.47	1.72	2.04	1.93	2.31	1.40
FeO	4.46	4.10	1.37	2.16	1.24	7.81	6.58
MnO	0.17	0.13	0.06	0.17	0.07	0.26	0.29
MgO	2.71	1.98	0.71	1.51	0.66	19.98	2.03
CaO	3.56	4.24	1.88	1.29	1.82	9.42	5.06
Na_2O	4.02	3.82	3.52	5.45	3.76	0.63	4.57
K_2O	2.29	3.00	4.71	1.75	4.63	0.70	1.11
$H_2O(+)$	0.93	2.45	1.04	0.68	0.35	1.88	0.95
$H_2O(-)$	0.19	0.15	0.13	0.11	0.02	0.21	0.19
P_2O_5	0.37	0.43	0.20	0.10	0.18	tr.	0.51
Total	99.59	99.46	99.42	99.74	99.54	99.64	99.70
ppm							
F	1170	1260	629	454	779	–	–
Cr	–	–	–	–	–	–	–
Q	14.83	14.14	26.07	25.52	25.98	–	10.62
Or	13.53	17.73	27.83	10.34	27.36	4.14	6.56
Ab	34.02	32.32	29.79	46.12	31.82	5.33	38.67
An	15.24	16.39	8.02	5.75	7.85	8.17	21.77
Ne	–	–	–	–	–	–	–
Lc	–	–	–	–	–	–	–
C	1.62	–	0.47	1.55	0.29	–	0.93
Di Wo	–	0.76	–	–	–	16.10	–
Di En	–	0.41	–	–	–	11.70	–
Di Fs	–	0.33	–	–	–	2.92	–
Hy En	6.75	4.52	1.77	3.76	1.64	31.62	5.05
Hy Fs	2.80	3.57	0.27	1.79	–	7.88	9.60
Ol Fo	–	–	–	–	–	4.52	–
Ol Fa	–	–	–	–	–	1.24	–
Mt	6.54	3.58	2.49	2.96	2.60	3.35	2.03
Il	2.28	2.11	1.08	0.93	1.06	0.59	2.15
Hm	–	–	–	–	0.14	–	–
Ap	0.86	1.00	0.46	0.23	0.42	–	1.18

No. 9. 801254 Biotite-hornblende gneiss
10. 8012510 Biotite-hornblende gneiss
11. 801253 Hornblende-biotite gneiss
12. 801261 Garnet-biotite gneiss
13. 801262 Hornblende-biotite gneiss
14. 80N-2 Two pyroxene-bearing amphibolite
15. 80N-16 Garnet-hornblende-bearing pyroxene gneiss

Analyst: Nos. 1–13 S. KANISAWA
Nos. 14 and 15 H. ONUKI (SHIRAISHI *et al.*, 1984)

layering from a garnet-bearing and hornblende-free part to a garnet-free and hornblende-bearing part. The constituent minerals are orthopyroxene, biotite, plagioclase, quartz, opaque minerals, apatite and zircon with garnet and/or hornblende. Orthopyroxene usually occurs as subhedral to anhedral grains, and is in direct contact with most minerals present. It sometimes includes hornblende. Garnet usually occurs as inclusions in plagioclase, but it is sometimes in direct contact with other minerals.

2.2.5. Metabasites

(1) Amphibolite

Ordinary amphibolite is a weakly foliated medium-grained rock. The constituent minerals of such ordinary amphibolite are clinopyroxene, hornblende, biotite, plagioclase, quartz, opaque minerals, apatite and zircon. Secondary tremolite, chlorite and calcite are usually present in small amounts.

Extraordinary amphibolite (Sp. 80N-2) is found as a lensoid body within garnet-biotite gneiss in the Naga-iwa Rock. The constituent minerals of the rock are orthopyroxene, clinopyroxene, tremolite, biotite, plagioclase, K-feldspar, quartz, opaque minerals, apatite and zircon. Secondary cummingtonite and magnesite are also present. The amounts of plagioclase K-feldspar and quartz are very small. This rock is extremely poor in Al_2O_3 and has a high $MgO/(MgO+FeO)$ ratio, and is similar to pyroxenite in the granulite-facies area both in bulk chemical composition and field occurrence.

(2) Ultrabasic granulite

This is a melanocratic fine- to medium-grained massive to weakly foliated rock. The constituent minerals are orthopyroxene, spinel, hornblende, biotite and apatite with plagioclase, clinopyroxene, olivine, and/or garnet. Olivine and plagioclase do not coexist. Garnet is always mantled by the symplektitic intergrowth of orthopyroxene, plagioclase, and spinel, and does not coexist with clinopyroxene. A small amount of sapphirine is present in some cases. Secondary talc and cummingtonite are also present in some cases.

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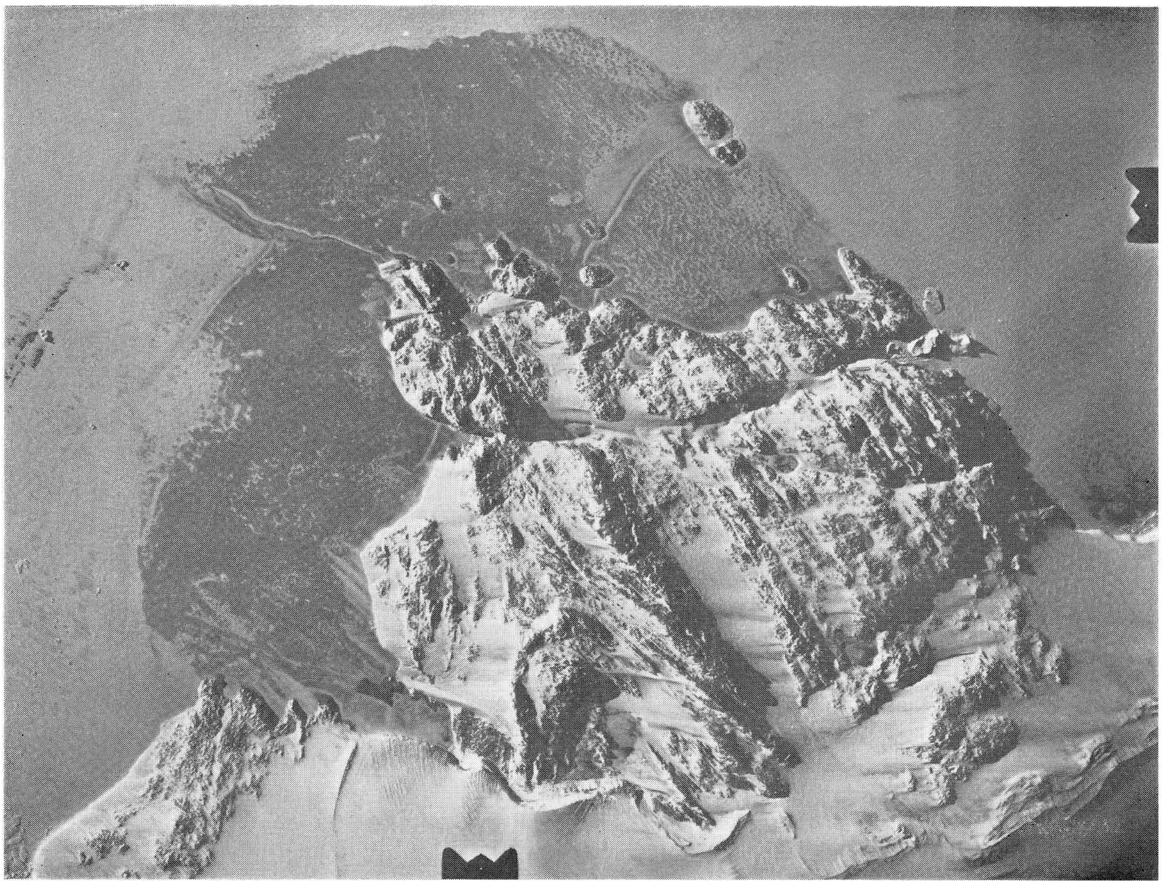
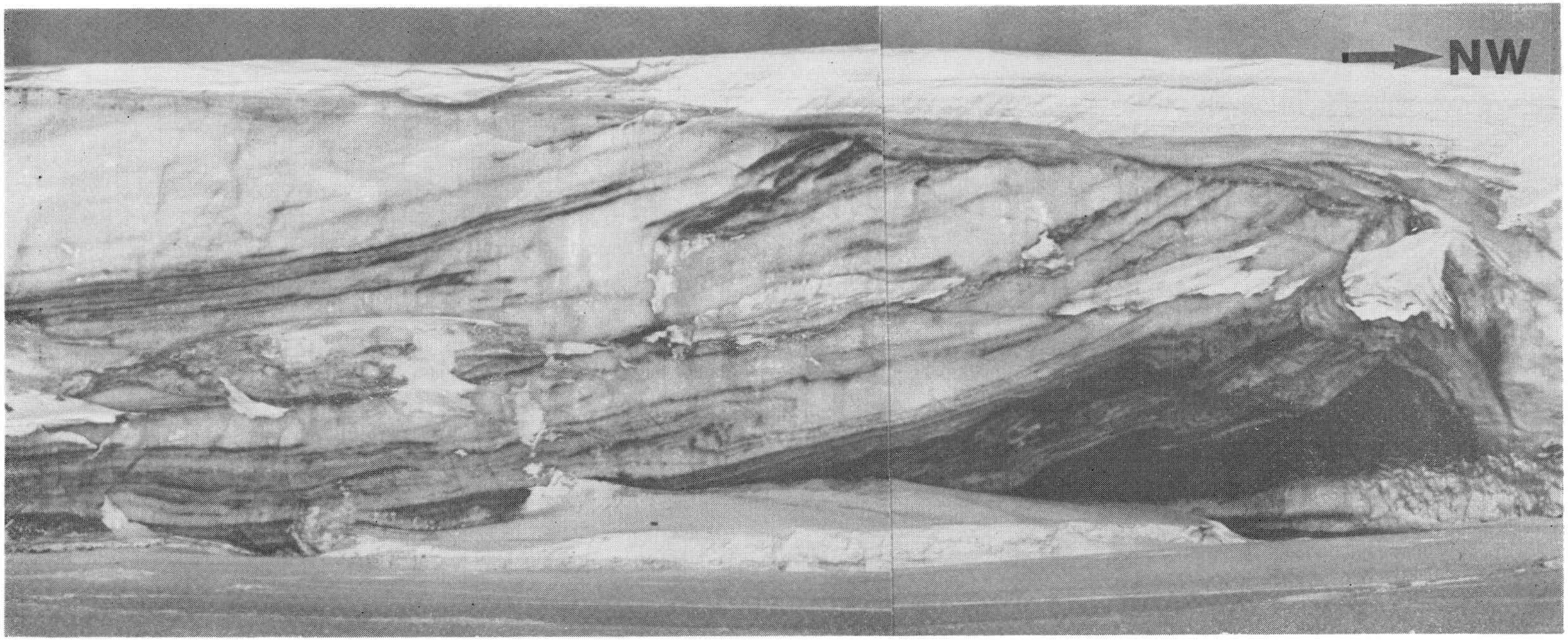
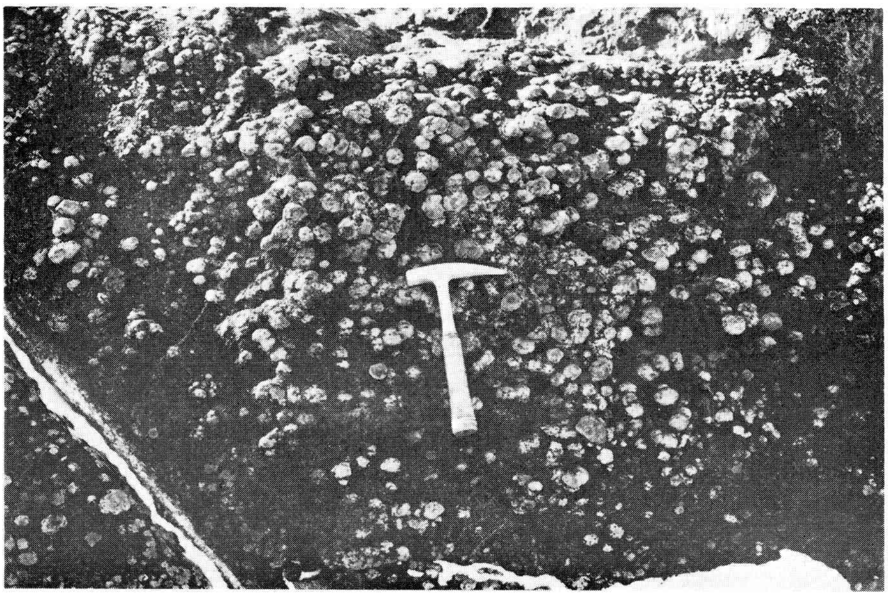


a. Aerial photograph of the Akarui Point, Prince Olav Coast. JARE Antarctic air photo.

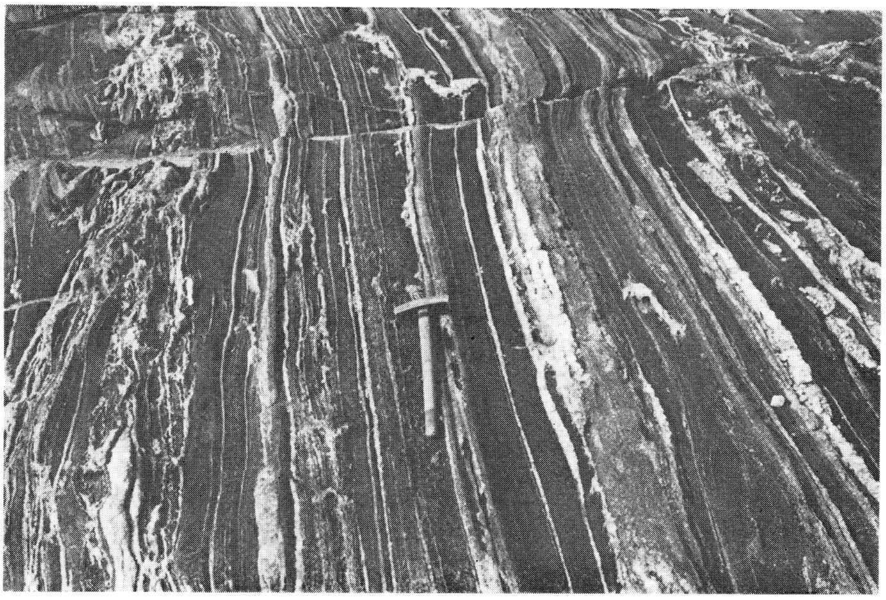
b. Aerial photograph of the Naga-iwa Rock, Prince Olav Coast, JARE Antarctic air photo.



Ice cliff showing a typical shear moraine at the end of the continental ice sheet.

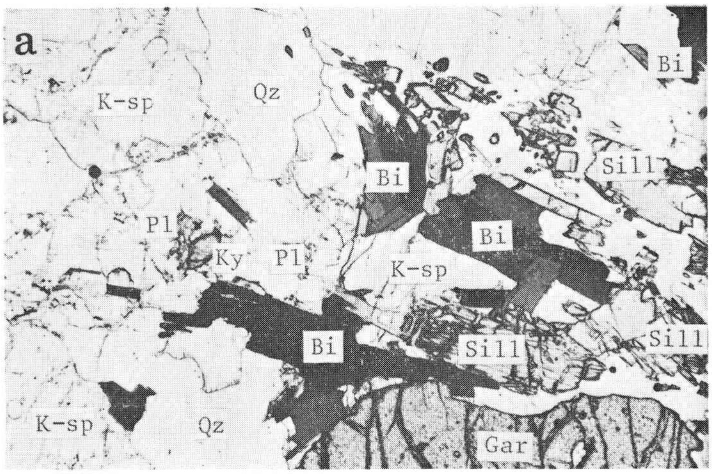


a. A bulder-shaped appearance of ultrabasic rock in metabasites in the Akarui Point.

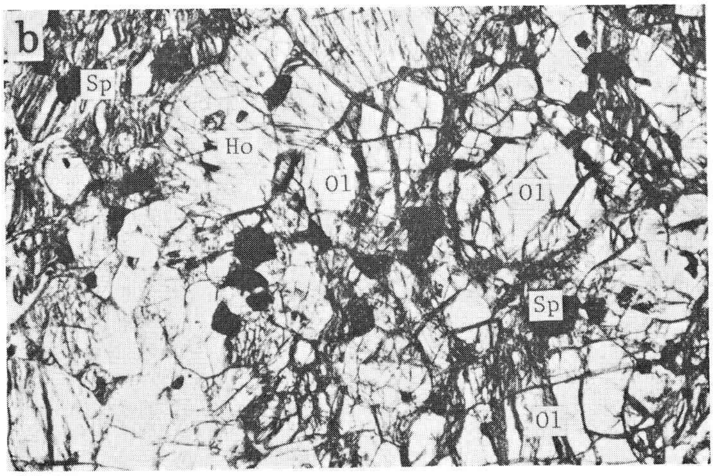


b. Well-developed compositional layering of biotite-hornblende gneiss in the Akarui Point.

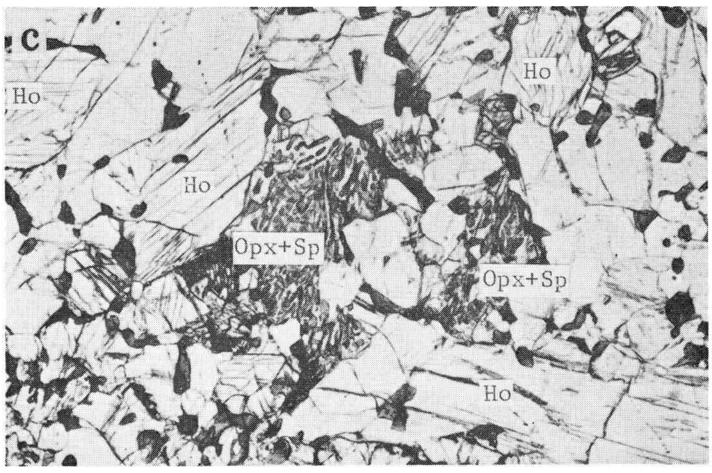
Plate 4



a. An occurrence of relic-like kyanite and stable sillimanite in garnet-biotite gneiss, Akarui Point (Sp. 75020605). Sill; sillimanite, Ky; kyanite, Gar; garnet, Bi; biotite, Pl; plagioclase, K-sp; K-feldspar, Qz; quartz.

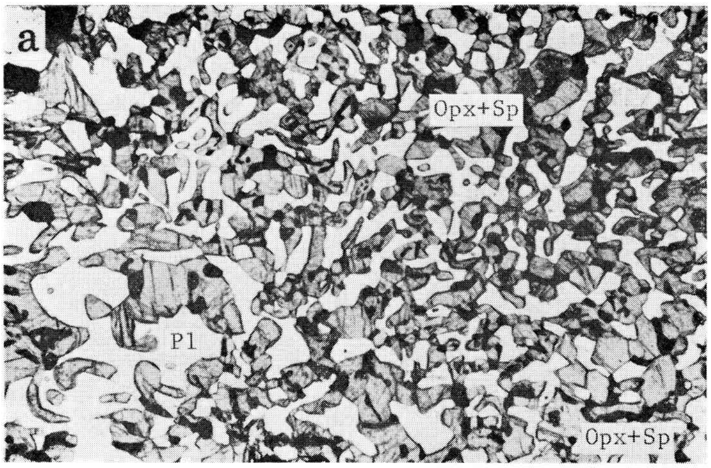


b. Olivine (Ol) rich-spinel (Sp)-hornblende (Ho) assemblage in ultrabasic granulite, Akarui Point (Sp. 801259).

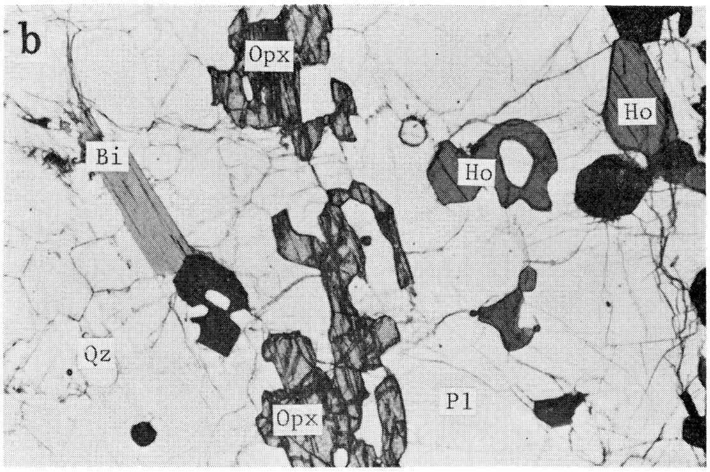


c. Symplektitic intergrowth of orthopyroxene-spinel assemblage in ultrabasic granulite, Akarui Point (Sp. 801275). Opx; orthopyroxene, Sp; spinel, Ho; hornblende.

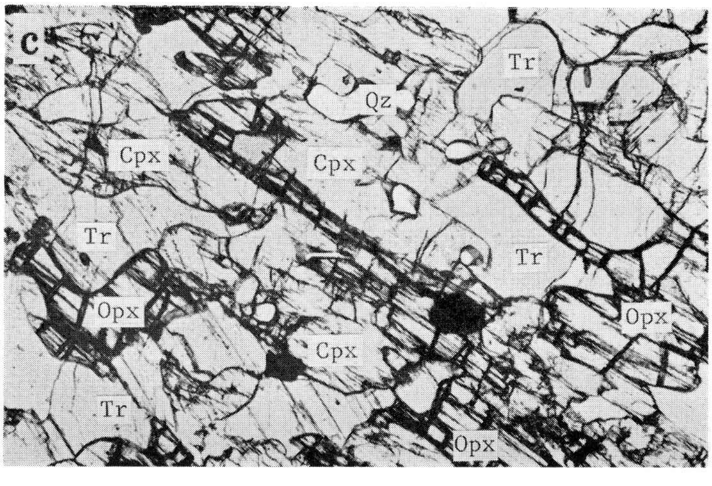
Plate 5



a. Symplektitic intergrowth of orthopyroxene (Opx)-spinel (Sp)-plagioclase (Pl) assemblage in ultrabasic granulite, Akarui Point (Sp. 75020613).



b. Orthopyroxene in pyroxene gneiss, Naga-iwa Rock (Sp. 80N-16) with 5 mm. Opx; orthopyroxene, Ho; hornblende, Bi; biotite, Pl; plagioclase.



c. An occurrences of orthopyroxene (Opx), clinopyroxene (Cpx) and tremolite (Tr) in two pyroxenes amphibolite, Naga-iwa Rock (Sp. 80N-2). Qz; quartz.

Antarctic Geological Map Series

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