NATIONAL INSTITUTE OF POLAR RESEARCH

ANTARCTIC GEOLOGICAL MAP SERIES
SHEET 11 CAPE HINODE

Explanatory Text of Geological Map of Cape Hinode, Antarctica

Keizo YANAI and Terumi ISHIKAWA

NATIONAL INSTITUTE OF POLAR RESEARCH

TOKYO, MARCH 1978

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

Fig. 1a. Aerial photograph of the western part of Cape Hinode. JARE Antarctic ai1 photo 6AV II-2, No. 971.

Fig. 1b. Aerial photograph of the eastern part of Cape Hinode. JARE Antarctic air photo 6AV II-2, No. 019.

Fig. 2. Oblique air photograph of the central part of Cape Hinode. Meoto Rocks ana sea in the foreground, viewed from north west to southeast (continental ice sheet).

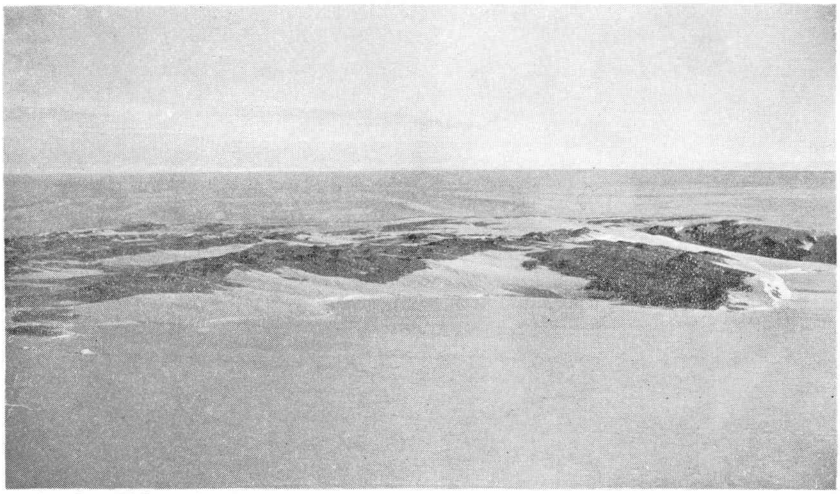

Fig. 3. Oblique air photograph showing Otome Point on the right and Meoto Rocks on the left, viewed from northwest to southeast (continental ice sheet).

Fig. 4. Amphibolite (black) is intruded discordantly by granite dikes (white) in the southern part.

Fig. 5. Anorthositic gneiss, coarse-grained due to granitization.

Fig. 6. Typical anorthositic gneiss is dark-colored due to violet grayish colored plagioclase.

Fig. 7. Hornblende gneiss, produced by reaction along the boundary of a pegmatite dike.

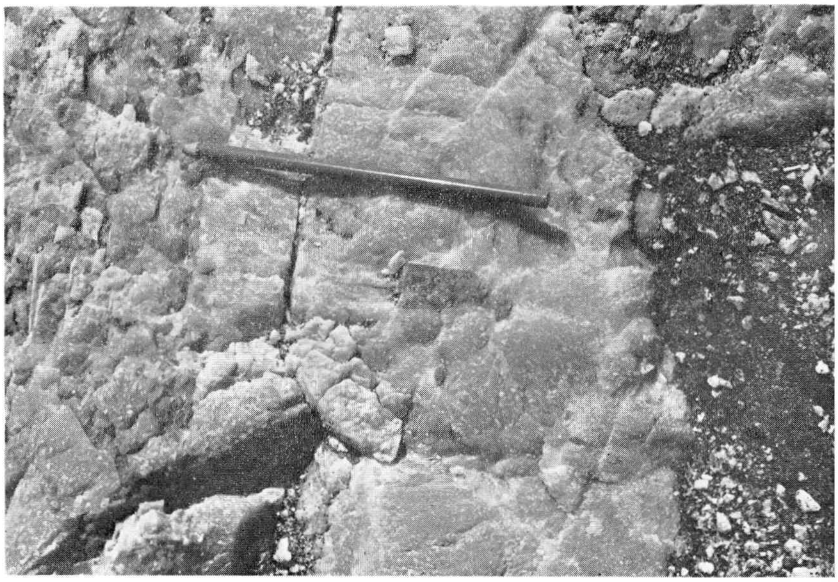

Fig. 8. Potassium feldspar containing beryl crystals in a pegmatite dike at the north-eastern end of the mapped area.

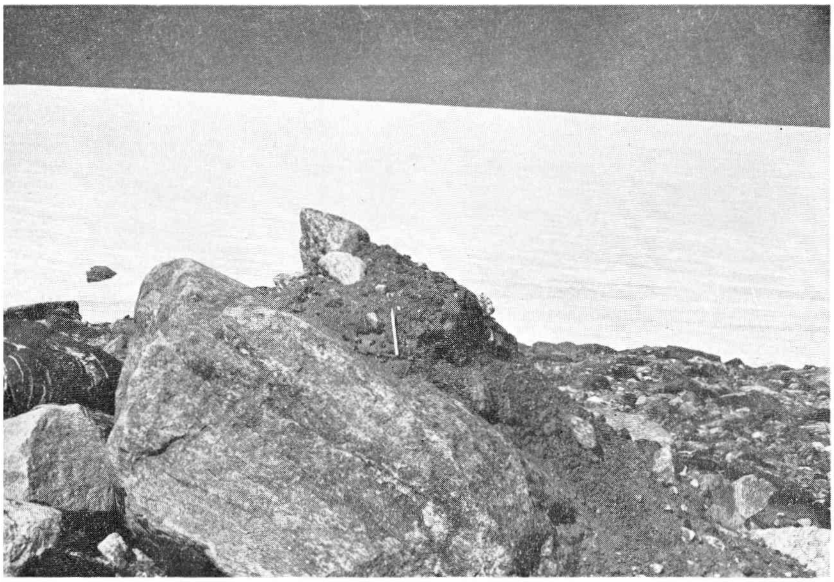

Fig. 9. Glacial deposit, occurring as a poorly sorted mixture along the margin of the continental ice.

Fig. 10. Stone circles on the moraine.

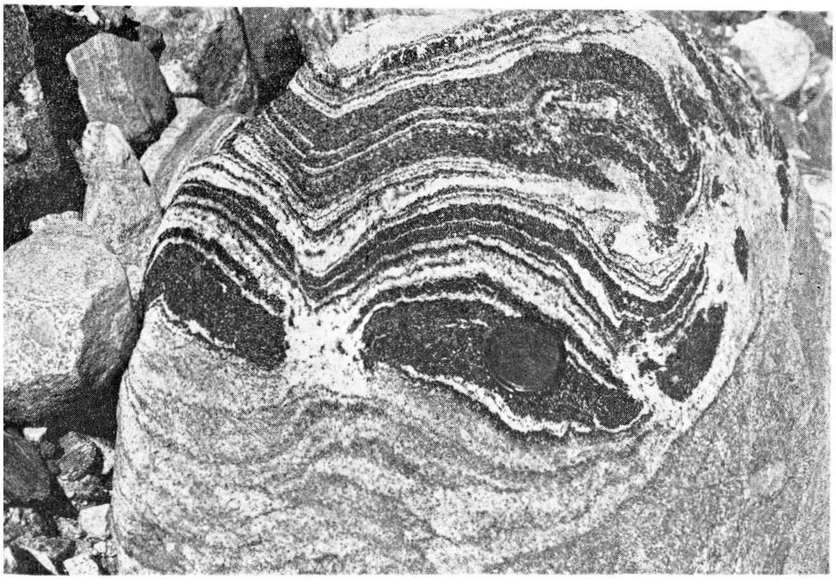

Fig. 11. Migmatite gneiss in the moraine.

Explanatory Text of Geological Map of Cape Hinode, Antarctica

Keizo YANAI* and Terumi ISHIKAWA**

The map available was 1 : 250,000 Prince Olav Coast published in 1963. Field scientists used also for field work aerial photographs which were produced to a scale of approximately 1 : 25,500 by the 6th Japanese Antarctic Research Expedition (JARE-6). In the 1973-74 summer season a makeshift map of topography drawn to a scale of 1 : 25,000 was also used.

The Cape Hinode is a large ice-free area situated between Syowa Station and Molodezhnaya Station (USSR). This area is bounded by Antarctic Sea on the north and west, and is covered with continental bare ice on the southeastern margin; the highest point is about 200 m above the sea level near the continental ice (Figs. 2 and 3). It seems that the area previously was covered with ice sheet all over, because many glacial features remain on the ice-free surface. In the summer season, many lakes and ponds filled with melt water appear in the lower part of the area, and melt water from the continental ice forms small stream and falls.

An anorthositic gneiss is well exposed in the main part of the area. Other gneissose rocks, which are generally exposed in the Lützow-Holm Bay area, and amphibolite penetrated by granitic intrusions are also exposed to a lesser extent. Glacial morainic rocks are scattered in the greater part of the area.

The geological map of the Cape Hinode was compiled by K. YANAI.

1. Introduction and General Information

Cape Hinode, 160 km northeast of Syowa Station in East Antarctica, is situated between 68°08′S and 68°12′S latitudes and 42°36′E and 42°46′E longitudes. This region was mapped for the first time by the Geographical Survey Institute, Japan, in 1963. The map of 1 : 250,000 Prince Olav Coast, which includes the Cape Hinode area, was compiled on the basis of vertical and oblique air photographs taken in 1957, 1959 and 1962 (Figs. 1a and 1b) and controlled by astronomical stations established by JARE-1, -4, -5 and -6. A detailed topographic map of the Cape Hinode area on the scale of 1 : 25,000 was published in 1975 by the Geographical Survey Institute, Japan.

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

** Mitsui Kinzoku Engineering Co., Ltd., 1, 2-chome, Nihonbashi-Muromachi, Chuo-ku, Tokyo 103.

The geology of the Cape Hinode area was surveyed for the first time by T. ISHIKAWA in January, 1972 (JARE-13). K. YANAI visited the area for further geological studies during December 1973 and January 1974 (JARE-15).

Other scientific observations carried out in this area were as follows: a geomorphological surveys by Y. YOSHIDA in 1968 and by K. MORIWAKI in 1972 and 1973-74, a biological and limnological survey by H. TOMINAGA in 1968 and by M. AOYANAGI, K. KOBAYASHI and S. KARASAWA in 1972 and 1973-74, a geochemical survey by M. SANO in 1973-74, a glaciological survey by H. NARITA in 1972, and measurements of astro-control points and gravity values by Y. KIMURA in 1972.

2. General Geology of Cape Hinode

2.1. General geology

Geology of the Cape Hinode area is considerably different from that of the nearly Lützow-Holm Bay region. The Cape Hinode area, for example, is characterized by anorthositic gneiss and garnet-bearing anorthositic gniess which is seen only rarely in the Lützow-Holm Bay region. Subordinate rock types are garnet gneiss, hornblende gneiss, amphibolite gneiss, granites, and metabasites. Completely absent from the Cape Hinode area are the pyroxene gneiss, porphyroblastic gneiss, and marble found outcropping prominently in the Lützow-Holm Bay region. Age determinations, and detailed petrological and chemical studies remain to be made in the future.

2.2. Petrography

The rocks exposed in this area are classified into the following units on the basis of their mode of occurrence and petrographic features.

(1) Metabasites (Bm)
(2) Amphibolite (Amp)
(3) Anorthositic gneiss (Gan)
(4) Garnet-bearing anorthositic gneiss (Gga)
(5) Hornblende gneiss (Gh)
(6) Garnet biotite gneiss (Ggb)
(7) Garnet-bearing granitic gneiss (Ggg)
(8) Amphibolite dike (Amd)
(9) Granite (Gr)
(10) Pegmatite (Pg)
(11) Unconsolidated sediments (At)

2.2.1. Metabasites (Bm)

Metabasites show two modes of occurrence. Those found northwest of Maigo Peak are roughly equidimensional bodies of ultrabasic metamorphic rocks ranging from a few centimeters to about 1 m in diameter included within hornblende gneiss. The other mode is as thin layers and lenses of basic metamorphic rocks within anorthositic gneiss and garnet gneiss, occurring at Kikko Terrace and in central part of the area.

The former type consists of medium- to fine-grained non-oriented crystals. These rocks are reddish gray to reddish brown in color, and composed of garnet, pyroxene and plagioclase. The latter is fine-grained, weakly foliated, gray to dark gray in color, and composed principally of biotite and quartz, with minor hornblende and plagioclase, and generally no garnet. The gray color is due to the large quantity of biotite, which shows yellow to brown pleochroism and contains zircon inclusions. The hornblende displays green to pale brown pleochroism. A small fraction of the less abundant plagioclase shows distinct twin crystals. The quartz content ranges from 30 to 40 modal percent. The quartz crystals are clear, with a weak wavy extinction. Accessories are mainly apatite, with some zircon and opaque minerals. Secondary minerals are chlorite and sericite, which occur as subhedral to anhedral grains.

2. 2. 2. Amphibolite (Amp)

This rock is distributed in the southern part and at the southwest end of this area. The rock is markedly foliated due to parallel orientation of mafic minerals and thin layers of salic minerals. It is fine- to medium-grained in texture, and black in hand specimen. The leucocratic parallel layers are partially folded. The rock is concordant with garnet-bearing anorthositic gneiss and garnet gneiss, but is intruded discordantly by granite (Fig. 4).

Constituent minerals of the amphibolite are hornblende, clinopyroxene, biotite, plagioclase and quartz. The rock is characterized by its major abundance of hornblende (30–40 percent) and the absence of garnet and potassium feldspar. Hornblende is euhedral to subhedral, shows green to yellow brown pleochroism, and commonly includes opaque minerals. Clinopyroxene is pleochroic from colorless to pale green and occurs in a small amount. Biotite shows deep brown to yellow brown pleochroism, and grades in abundance from miner to rare. Plagioclase abundant in the rock is euhedral to subhedral, and twinned on the albite to albite-Carlsbad laws. Quartz is anhedral and usually shows wavy extinction. Accessories are opaque minerals, zircon and apatite. Apatite is common.

2. 2. 3. Anorthositic gneiss (Gan)

Anorthositic gneiss is most widespread in the middle and eastern parts of this area. It is medium-grained, becoming coarser where granitized (Fig. 5). The rock has a generally granulitic texture with weak foliation due to parallel orientation of mafic and salic minerals. The latter are characteristically colored dark to pale or grayish violet (Fig. 6). Feldspar in the rock sometimes shows a milky color and weak schiller.

The anorthositic gneiss, showing a gradual transition to garnet-bearing anorthositic gneiss and hornblende gneiss, is composed of hornblende, biotite, plagioclase and quartz. Potassium feldspar and garnet are rarely present. Quartz and plagioclase are most common. Plagioclase occurs as subhedral grains twinned on the albite and pericline laws, and includes rare thin laths of potassium feldspar (antiperthite). Quartz occurs as anhedral grains filling the interstices between other minerals, and shows distinct wavy extinction. Biotite shows brown to yellow brown pleochroism. Hornblende shows green to pale brown pleochroism. Mafic minerals usually contain opaque minerals and zircon. Secondary alteration of the constituent minerals is very weak. Accessories are zircon, opaque minerals and apatite.

2. 2. 4. Garnet-bearing anorthositic gneiss (Gga)

This rock is distributed to the west of Otome Point. It is fine- to medium-grained, and similar in appearance to the above-mentioned anorthositic gneiss, but contains a very small amount of garnet and looks more leucocratic than the anorthositic gneiss. It sometimes has a pale violet color due to colored salic minerals, as described for the anorthositic gneiss. Weak foliation of the rock due to the orientation of mafic minerals can be recognized in the field.

The rock contains biotite, garnet, plagioclase and quartz, with occasional hornblende. Garnet occurs as small grains, aggregated with biotite. Thus, in both appearance and petrographic features this rock is similar to the anorthositic gneiss.

2. 2. 5. Hornblende gneiss (Gh)

Hornblende gneiss is found at Otome Point, from the middle part of the area to the northern part of Penguin Heights, and also to the north of Maigo Peak. The rock is found within the anorthositic gneiss along the boundary with pegmatite, and thus is a granitized equivalent of the anorthositic gneiss, with all major minerals occurring typically as anhedral grains. A similar phenomenon was recognized in the pyroxene gneiss of the Lützow-Holm Bay region.

The hornblende gneiss is medium-grained, light gray and pinkish gray, showing strong foliation and a granular texture. The rock is composed of biotite, hornblende, plagioclase and quartz, with pyroxene and potassium feldspar rarely present. The rock is characterized by the absence of garnet. Hornblende shows green to yellow brown pleochroism. Biotite shows brown to yellow brown pleochroism. Plagioclase is twinned on the albite and albite-Carlsbad laws. Quartz shows distinct wavy extinction. Accessories are apatite, zircon, muscovite and opaque minerals.

2. 2. 6. Garnet biotite gneiss (Ggb)

Garnet biotite gneiss occurs as thin layers within amphibolites in two outcrops in the southwestern part of this area. This gneiss is intruded concordantly by granitic rock and concordantly contacts amphibolite. It is mantled in many places by moraine deposits. It is characterized by relatively large porphyroblasts of garnet 0.5–1 cm in diameter. The gneiss is medium- to coarse-grained and has a distinct gneissose structure displayed by the layered concentration of biotite flakes.

Constituent minerals are garnet, biotite, sillimanite and quartz. Garnet is euhedral to subhedral, and includes large amounts of fine-grained quartz and biotite. Biotite shows reddish brown to brown pleochroism and includes zircon, apatite and opaque minerals. Sillimanite is colorless and commonly occurs as fibres, needles and long prismatic crystals. Quartz, occurring as relatively large crystals, shows a distinct wavy extinction. Accessories are apatite, zircon and opaque minerals.

2.2.7. Garnet-bearing granitic gneiss (Ggg)

Garnet-bearing granitic gneiss occurs only in the northwest part of Maigo Peak as thin layers in the hornblende gneiss. It is uniformly fine- to medium-grained, granulitic in texture, with a gray color in hand specimen. The weak foliation of the gneiss is due to parallel orientation of biotite and colorless minerals in gray salic minerals. The rock is characterized by garnet, differing from the hornblende gneiss which lacks garnet, but in mode of occurrence it is similar to the latter. The relation between this gneiss and the hornblende gneiss is one of gradual transition.

Constituent minerals are garnet, biotite, plagioclase, perthite and quartz. Petrographic features of the gneiss are similar to those of the hornblende gneiss except for the garnet. Garnet is subhedral and shows colorless to pale yellowish pleochroism.

2.2.8. Amphibolite dike (Amd)

Amphibolite dikes are found intruded at two localities in this area: one is about 400 m south of Penguin Heights in the anorthositic gneiss, and the other is about 600 m northwest of Maigo Peak in the anorthositic gneiss, hornblende gneiss and garnet-bearing granitic gneiss. The dikes are small in scale, but petrographically they are amphibolite. The rock is characterized by relatively large crystals of porphyroblastic plagioclase, approximately 2 cm in diameter, showing dark to violet grayish color in fine-grained dark matrix.

Constituent minerals of the rock are hornblende, biotite, plagioclase, quartz and potassium feldspar. Quartz and potassium feldspar are small in quantity, but plagioclase, hornblende and biotite are found in large quantities. The dark gray color of the rock is due to the large proportion of mafic minerals and gray-colored plagioclase. Porphyroblasts are all plagioclase with broad zoned rims which become more albitic.

2.2.9. Granite (Gr)

The granite occurs as discordant dikes and sheets in the amphibolite of the southern part of the area (Fig. 4), and sometimes as concordant sheets in the garnet gneiss in the south-southwestern part. It is light gray in color, medium- to coarse-grained, and usually massive. It has a gneissose structure and is generally homogeneous.

The rock is composed of biotite, plagioclase, quartz and potassium feldspar. Plagioclase and quartz are large in quantity. Potassium feldspar is usually homogeneous with partially altered rims.

2.2.10. Pegmatite (Pg)

Pegmatite occurs as clear-cut veins and dikes in the medial part of this area. Straight dikes of pegmatite are about 1 m wide and 1 km long, trending N–S across the foliation of the basement rocks, paralleling joint patterns. Along the boundary of the pegmatite, hornblende gneiss occurs with a width of a few centimeters to 1 m (Fig. 7).

The pegmatite is pink-colored and composed of potassium feldspar (perthite) and pure quartz, with small amounts of plagioclase, biotite, magnetite and beryl (Fig. 8).

2. 2. 11. Unconsolidated sediments (At)

Abundant sediment accumulations occur in the lower part of the ice-free area, in the middle part, and along the margin of the continental ice in the south, but at higher elevations these materials are scattered. For the most part they are glacial deposits which accumulated around the continental ice and formed moraine banks. The deposits are poorly sorted mixtures of gravel, sand and silt (Fig. 9). Stone circles occur around the pond and on the moraines (Fig. 10). Most of the constituent rocks of the moraines are granites, migmatites and gneisses in abundance, and marble, skarn and thermally metamorphosed dolerite in small amounts (Fig. 11). The moraines, however, do not contain examples of the anorthositic gneiss which is well exposed in this area. Therefore, the anorthositic gneiss may not be abundantly distributed beneath the continental ice sheet.

3. Geological Structure

General strike of the foliation and fold axes is NW-SE and the dip of the foliation ranges from vertical to 40°. The half dome of the anticline is found between Otome Point and Penguin Heights. The dome dips steeply in this eastern limb but gently in its western and southern limbs. A syncline trending about N70°W is found in the southern part, dipping steeply on both sides.

Acknowledgment

We wish to thank Professor William A. CASSIDY, University of Pittsburgh, for his critical reading of the manuscript.

Antarctic Geological Map Series

Sheet	1	East Ongul Island	March 1974
Sheet	2	West Ongul Island	March 1974
Sheet	3	Teöya	March 1975
Sheet	4	Ongulkalven Island	March 1975
Sheet	5	Langhovde	March 1976
Sheet	6 & 7	Skarvsnes	March 1977
Sheet	9	Skallen	March 1976
Sheet	10	Padda Island	March 1977
Sheet	11	Cape Hinode	March 1978
Sheet	27 (1)	Mt. Fukushima, Northern Yamato Mountains	March 1978