Data Listing of the Bottom Materials Dredged and Cored from the Northern Philippine Sea

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Introduction

The Northern Philippine Sea has been intensely studied during the 1970's and in the early 1980's by Japanese marine geologists and geophysists mostly organized into or related to the Japanese Geodynamics Project. Above all, particular attention has been given to remnant arcs developed in the northwestern area of the sea, represented by the Kyushu-Palau Ridge and the Daito Ridge Group comprising Amami Plateau, Daito Ridge, and Oki-Daito Ridge. Special effort has been made to obtain geological data in order to discuss in detail the geohistory and geotectonics of these ridges, relying also on the geophysical data gained through the many Japanese GDP cruises, some R/V Hakuho-Maru KH cruises of the Ocean Research Institute, the University of Tokyo, and a R/V Hakurei-Maru GH cruise of the Geological Survey of Japan. As a result, there have been accumulated many dredge data of the rocks and the bottom sediments from the remnant arcs and other topographic highs in the Northwestern Philippine Sea. Besides these, we have obtained some piston core data from the same region and some dreged-rock data from the Kinan Seamount Chain in the Shikoku Basin of the Northeastern Philippine Sea.

Many authors have discussed the geological development and other relevant aspects of the remnant arcs or of the entire Northern Philippine Sea, from the GDP data and the data of the deep-sea drilling cores (DSDP Leg. 31 and IPOD Leg. 58) in some sites in the area. It seems, however, that many problems remain to be investigated, particularly concerning the origin and evolution of the remnant arcs. In this connection, compilation of existing geological data should be helpful for further study. An article was published in 1977, which contained a list of rock samples and piston and gravity cores obtained from the Daito Ridge Group, the Kyushu-Palau Ridge, and nearby deep-sea basins by that time (MIZUNO *et al.*, 1977). Since then, many additional data have been accumulated through two GDP cruises and two R/V Hakuho-Maru KH cruises.

In this article, we will present a comprehensive list of the dredged rock samples from the topographic highs such as ridges (remnant arcs) and seamounts in the Northern Philippine Sea, together with some piston core data obtained from the area, relying on the data

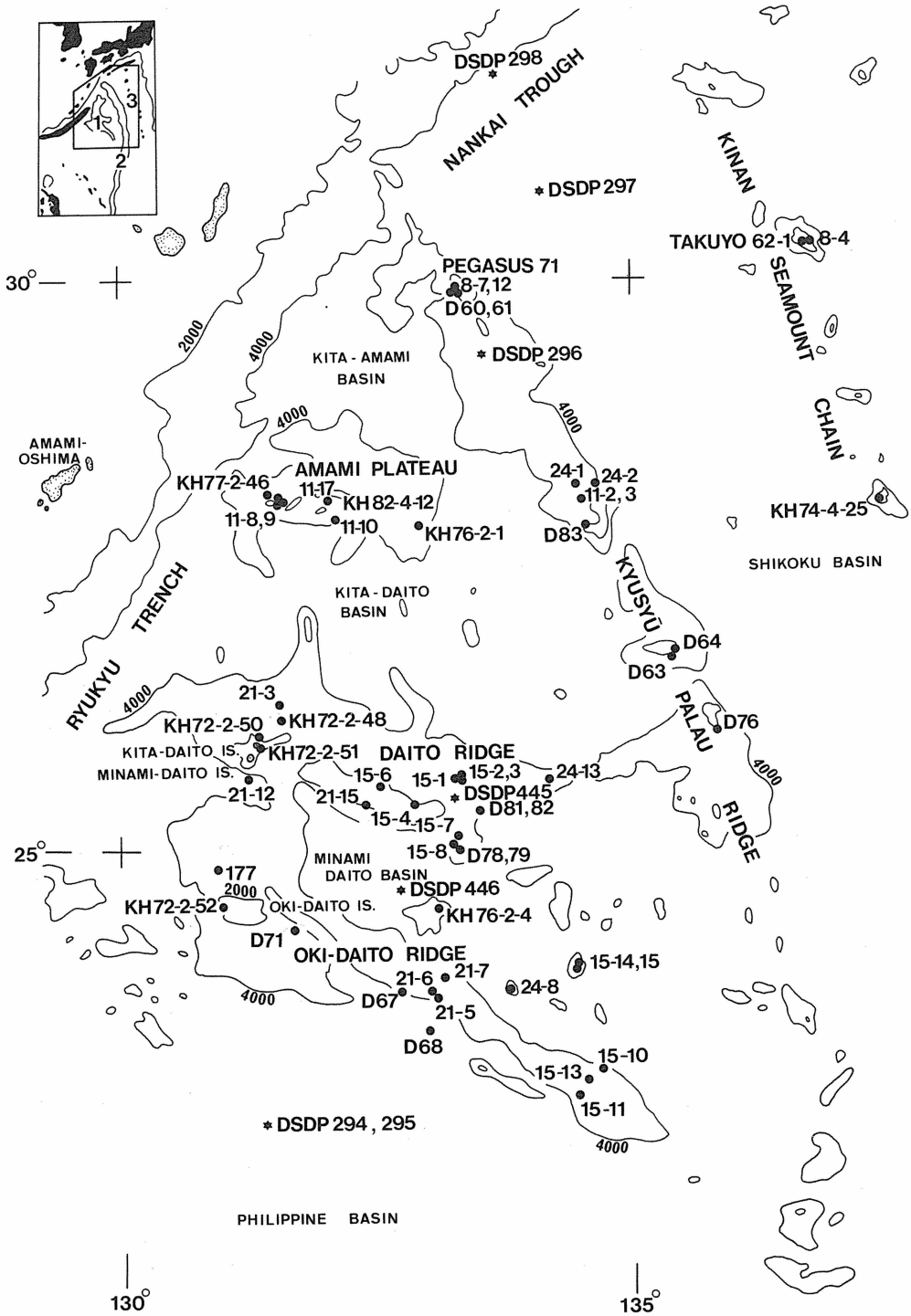

Fig. 1. Map showing the location of dredged rock samples together with DSDP sites in the Northwestern Philippine Sea.

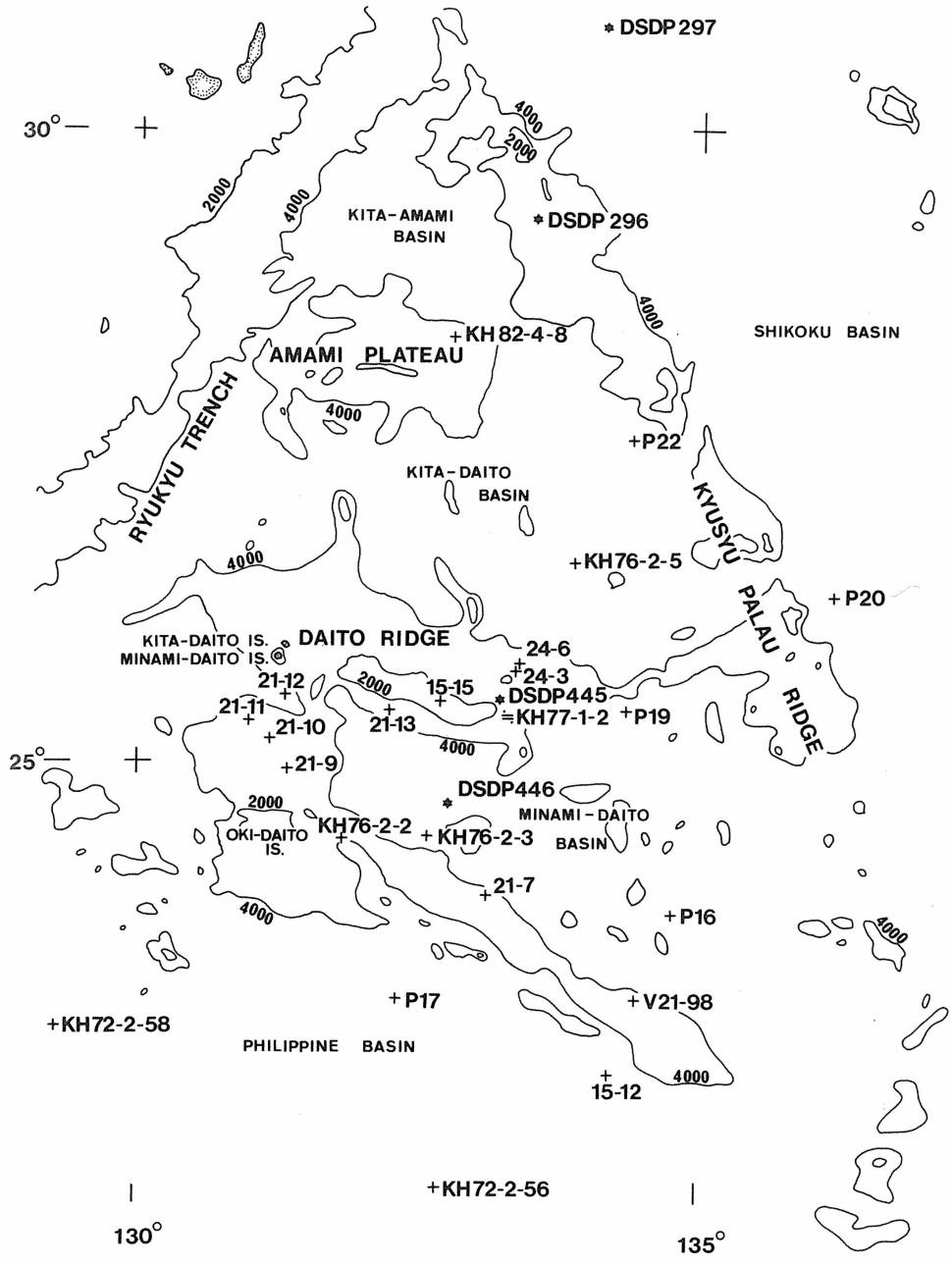

Fig. 2. Map showing piston and gravity coring in the Northwestern Philippine Sea.

published up to now (Fig. 1, Fig. 2).

Dredge hauls from the Daito Ridge Group

Dredge hauls from the Daito Ridge Group are classified into the following five groups including various rocks of unknown ages from many sites (Table 1).

Pre-Middle Eocene basement rocks

Pre-Middle Eocene basement rocks consist of acidic plutonic rocks, basaltic and andesitic volcanic and volcaniclastic rocks, clastic rocks (arkosic wacke, fine-grained sandstone, etc.), metamorphic rocks, and ultramafic rocks. The evidenced basement rocks are tonalite (GDP-11-17; ca. 75 m.y. K-Ar age for hornblende) and basalt (GDP-11-9; ca. 82—85 m.y. K-Ar age), both from the Amami Plateau.

A metamorphic rock represented by hornblende schist from the Daito Ridge (GH74-7-183) has K-Ar age of ca. 49 m.y. Thermally metamorphosed tremolite schist and peridotite occurred also as clasts in conglomerate of unknown age at the same site. It seems that the basement rocks of the Daito Ridge suffered two phases of metamorphism, namely the high pressure–low temperature metamorphism of an older age, and the thermal metamorphism of a younger age. The former must have been in the pre-Eocene time (possibly pre-Cenozoic). The latter most probably corresponds to the above mentioned K-Ar age (TOKUYAMA *et al.*, 1980). Some volcanic rocks from the Daito Ridge suffered thermal metamorphism also (GDP-15-1), and the Middle Eocene conglomerate in Site 445 of DSDP suffered metamorphism as well (MILLS, 1980). These data reveal that the Middle Eocene thermal metamorphism was extensive in the Daito Ridge.

Moreover, Deep-Sea drilling elucidated the presence of clasts of reef limestone of Barremian to Maestrichtian comprising *Orbitolina* and basalt of 59 m.y. ^{40}Ar-^{39}Ar age in the Middle Eocene conglomerate beds in Site 445, which are thought to have been derived from the Daito Ridge (MILLS, 1980; OZIMA *et al.*, 1980).

Middle Eocene Nummulites-bearing rocks

Middle Eocene *Nummulites*-bearing rocks (limestone and phosphorized limestone) and plenty of individual specimens of *Nummulites boninensis,* accompanied by *Astericyclina penuria* in some places, were collected from the topographic highs of the Amami Plateau, Daito Ridge, and Oki-Daito Ridge. This, together with seismic reflection data, suggests that Middle Eocene shallow marine calcareous deposits are widely distributed on the main topogaphic highs of the Daito Ridge Group, overlying the pre-Eocene rocks as infered above.

Oligocene calcareous semi-consolidated sediments

Pelagic semi-consolidated calcareous mudstone or chalk was collected from the Daito Ridge (GDP-24-13). It comprises calcareous nannofossils ranging from Middle to Late Oligocene.

Neogene semi-consolidated sediments

Pliocene carbonate rock (KH-76-2), mudstone of calcareous nannofossil bearing mudstone of Middle to Late Miocene (GDP-24-2) were collected from the Amami Plateau, and Early Pliocene calcareous mudstone with planktonic foraminifers (GH74-7-167) and semi-consolidated calcareous mud of Neogene were collected from the Oki-Daito Ridge and the Daito Ridge (GDP-21-15), respectively.

Rocks undated

Geologic ages of the other rocks have not yet been evidenced. The larger part belongs to volcanogenic rocks of basic to intermediate nature, with some exceptions of clastic rocks of siltstone, sandstone, and conglomerate. Phosphate and/or calcareous rocks from many places of the Ridge Group are of unknown age also.

Some parts of the volcanogenic rocks are inferred to be post-Eocene mainly from seismic reflection records of the sampling sites (Okuda *et al.*, 1976; RM GDP-21, 1977; Misawa *et al.*, this volume). Some tuffaceous sediments contain microfossils possibly of Eocene and Miocene (GDP-15-11, RM GDP-15, 1976; RM GDP-24, 1978; Shiki, 1979). Mizuno *et al.* (1979) postulated that most of the volcanic rocks of unknown age at least on the Daito Ridge may represent either Eocene or younger volcanic activity. However, there must also be older (Paleocene and Cretaceous) volcanogenic rocks among the rocks of unknown age throughout the entire Daito Ridge Group.

The conglomerate at GH 74-7-183 including clasts of metamorphic ultramafic, and volcanic rocks mentioned above was tentatively supposed to be Oligocene, overlying the *Nummulites*-bearing rocks (Mizuno *et al.*, 1975), although its stratigraphic situation and geologic age are still problematic.

At any rate, further studies of the precise geologic ages of the above-mentioned rocks should be made in future.

Dredge hauls from the Kyushu-Palau Ridge

Dredge hauls from the seamounts of Komahashi-Daini, Komahashi, Kita-Koho, and Minami-Koho are listed in Table 2. They contain acidic itrusive rocks, intermediate-basic volcanogenic rocks, limestones, semi-consolidated mudstone, etc.

Granodiorite from the Minami-Koho Seamount was dated ca 48.5 m.y. (K-Ar age; GH 74-7-175), and K-Ar age of tonalite from Komahashi-Daini (GDP-8-12, GH74-7-150-1) was ca 37.4—37.5 m.y. Limestone of Late Oligocene–Middle Miocene with benthic foraminifers of shallow-sea nature was found at Komahashi-Daini (GDP-8-7) and Komahashi (GDP-11-3). Accompanied by limestone, andesite and basalt were collected at Komahashi. Similar occurrence was discovered at another site at Komahashi, where augite basalt and hyaloclastic, tuff-breccia of basaltic andesite are associated with coral-bearing limestone (GH74-7-184). Such association may indicate that volcanogenic-calcareous sedimentary sequence of Oligocene-Miocene similar to that at DSDP Site 296 (29 20.4'N, 133 31.52'E, south of Komahashi-Daini; at a depth of 2920m) is rather widely distributed in the northern part of the Kyushu-Palau Ridge including the Komahashi-Daini and Komahashi Seamounts, but the calcareous sedimentary sequence is represented by near-

shore facies in the summit area of the seamounts instead of by pelagic facies in deeper area as in DSDP Site 296.

Younger sediments are known as Middle-Late Pliocene semi-consolidated mudstones (GDP-24-2).

Geological data are still too sparse and insufficient for discussing the detailed feature of the geologic evolution of the entire Kyushu-Palau Ridge. Further studies are required.

Dredge hauls from the Kinan Seamount Chain

Basalt or altered basaltic tuff, etc. was obtained from three seamounts of Hakuho, Daini-Kinan, and Kinan (Table 1). The data from the latter two seamounts are insufficient for discussing in detail the nature of the constituents, but those concerning the pillow basalt from the Hakuho Seamount (KH74-4-25) are enough to give the mineralogical and chemical characterization of the seamount. The petrochemical nature of the rock seems to resemble that of MORB but differs in higher content of K_2O (Tokuyama and Fujioka, 1976; Tokuyama, this volume).

Short cores from the Daito Ridge Group

About ten short gravity and piston cores (several tens centimeters long) from the topograpic highs have been obtained mainly through GDP cruises (Table 2). They mostly consist of calcareous or foraminiferal ooze, which seems to cover the top of the ridges as thin veneer. A hiatus of about 2 m.y. between the Late Pliocene and the Late Pleistocene was found in core GDP-11-15 (Amami Plateau) through micropaleotological studies (KONDA *et al.*, 1977). It is necessary to carry out further detailed studies on theother sites to confirm the geographical extent of the hiatus throughout the ridge group.

Piston cores from deep-sea basins

All the cores from the basin bottoms in the Daito Ridge Group Region, together with the northern margin of the Philippine Basin, consist mostly of brownish pelagic clay interbedded with volcanic ash layers (Table 2). The rate of the Recent sedimentation in the small basins in the Daito Region is much higher than that of the Philippine Basin.

Table 1. Dredge hauls from the Daito Ridge Group.

Remarks (common to Tables 1–5):

1) The listed data have already been published except for KH76-2 and GDP-24 cruises.
2) A pair of location (Latitude in N and Longitude in E) in the left columm implies a series of hit-bottom—leave bottom time.
3) In the column, (manganese nodule) means that dredged samples are coated with manganese layer and/or occur as a nucleus of manganese nodule.
4) In the right column, RM-GDP-8, RM-GDP-11, etc., stand for Research Members of the GDP-8 Cruise, Research Members of the GDP-11 Cruise, etc., respectively. (1985) # means report involved in this book.

AMAMI PLATEAU

1)	GDP-11-8 28-03.0, 131-34.8- 28-03.8, 131-34.9 1580-1690	Andesite tuff and basalt: Phosphate and zeolite rock (manganese nodule)	SHIKI, TOKUOKA, *et al.* (1975); AOKI (1975); AOKI *et al.* (1975); AOKI *et al.* (1976); ISHIKAWA and AOKI (1978), AOKI and ISHIKAWA (1985) # ; TOKUYAMA (1985) # ; MUSASHINO and SHIKI (1985) # : volcanogenic rocks; biotite bearing hornblende andesite tuff, clinopyroxene (orthopyroxene or olivine pseudomorph) bearing andesite, biotite-clinopyroxene-hornblende bearing andesite tuff, glassy andesitic tuff, basalt and clinopyroxene andesite tuff.
2)	GDP-11-9 28-04.0, 131-37.8 1350-1410	*Nummulites boninensis, Asterocyclina penuria, Paraster nummuliticus*? – bearing limestone; Olivine basalt andesite tuff, phosphate and zeolite rock (manganese nodule)	RM-GDP-11; SHIKI, TOKUOKA, *et al.* (1975); KONDA (1975); KONDA *et al.* (1975); KONDA *et al.* (1977); AOKI *et al.* (1976); ISHIKAWA and AOKI (1978), AOKI and ISHIKAWA (1985) # ; TOKUYAMA (1985) # ; MUSASHINO and SHIKI (1985) # : Middle Eocene type larger foraminiferas are collected from foraminiferal sand, which includes the Eocene arenaceous foraminiferas of *Ammodiscus ariakensis* and *Ammodiscoides* cfr. *hanzawai*; Volcanogenic rocks Orthopyroxene-clinopyroxene andesite tuff, olivine (pseudomorph)-clinopyroxene basalt, hornblende-orthopyroxene bearing glassy andesite tuff, etc.; augite-olivine-bearing basalt has the K-Ar age of 85.1 ± 2.1 and 82.4 ± 2 m.y., and $^{87}Sr/^{86}Sr$ ratio of 0.7038 ± 4 and 0.7030 ± 2.
3)	GDP-11-10 27-55.5, 132-0.50 –27-55.0, 132-05.9 2140–2250	Augite-olivine basalt (manganese nodule)	SHIKI, TOKUOKA, *et al.* (1975); AOKI (1975); AOKI *et al.* (1975); AOKI and ISHIKAWA (1985) #
4)	GDP-11-17 28-05.0, 132-01.4– 28-05.9, 132-01.8 1800-2110	Plutonic rocks: augite gabbro, biotite-hornblende tonalite, and biotite-hornblende granodiorite (manganese nodule) Volcanic rocks: augite basalt, hornblende-augite-olivine basalt, oxyhornblende andesite, and hornblende-clinopyroxene-olivine (pseudomorph) basalt (manganese nodule)	SHIKI, TOKUOKA, *et al.*(1975); AOKI (1975); SUWA and AOKI (1975); AOKI *et al.* (1975); AOKI *et al.* (1976); ISHIKAWA and AOKI (1978); AOKI and ISHIKAWA (1985) # ; TOKUYAMA (1985) # ; MUSASHINO and SHIKI (1985) # : all kinds of pluotonic rocks belong to single rock series; tonalite has the K-Ar ages of 69.5 ± 2.0 as to the bulk rock and 75.1 ± 2.4 m.y. as to hornblende contained and is considered to be older than 75.1 m.y.; also it has $^{87}Sr/^{86}Sr$ ratio of 0.7032 ± and K/Rb ratio of 1110, which shows somewhat different nature of the rock as compared with granite and granodiorite generally distributed in the Japanese Islands; the occurrence of oxyhornblende andesite implies that a part of the volcanism, at least, occurred under

			terrestrial environment, though the age is uncertain.
5)	KH72-2(=GDP-3)-46 28-05.9, 131-38.0– 28-05.9, 131-38.6 2470-3000	Augite-hypers thene andesite (manganese nodule)	ISHIBASHI (1975): Detailed data not available
6)	KH76-2-1 27-51.0, 132-58.6– 27-51.5, 132-59.1 2740-3000	Altered carbonate rock? (manganese nodule), Pliocene carbonate rock, and augite and hypersthene-bearing hornblende dacite	KONISHI *et al.* (1983): Anbular pebbles of trondhjemite and rounded pebbles of andesite (?) from a conglomeratic substratum on which a thick crust has grown.
7)	KH-82-4-12 28-08.3, 132-07.3– 28-07.6, 132-07.1 2030-1910	Trondhjemite, basalt (?), calcareous siltstone, and calcareous sandstone (manganese nodule)	
DAITO RIDGE			
1)	GDP-15-1 25-39.5, 133-18.0– 25-38.5, 133-17.3 2720-2840	Metamorphic rocks: black schist and acidic igneous rock suffered thermal metamorphism Plutonic rocks: hornblende-biotite granodiorite, gabbro Volcanic and volcaniclastic rocks: clinopyroxene andesite, two pyroxene andesite, altered andesite Other igneous rocks: altered dolerite Clastic rocks: arkosic wacke, fine-grained sandstone, tuffaceous calcareous sandstone, radiolaria bearing fine-grained tuffaceous claystone	RM-GDP-15 (1976); ISHIKAWA and AOKI (1978); AOKI and ISHIKAWA (1985)#: rocks were obtained as small angular pebbles of less than 1 cm dia., which may have been reworked from their bed rocks; a part of the clastic rocks might be the original rock of the metamorphic rock and intruded by the intrusive rocks.
2)	GDP-15-2 25-40.9, 133-22.7– 25-41.0, 133-22.1 2490-2505	Clinopyroxene andesite, two pyroxene andesites, olivine basalt, biotite-green hornblende andesite tuff	RM-GDP-15 (1976); ISHIKAWA and AOKI (1978); AOKI and ISHIKAWA (1985)#; MUSASHINO and SHIKI (1985)#
3)	GDP-15-3 25-41.3, 133-20.3– 25-40.4, 133-20.2 2375-2450	Plutonic rock: gabbro Volcanic and volcanoclastic rocks: clinopyroxene-hornblende andesite, clinopyroxene andesite, andesitic tuff breccia Phosphate and zeolite rock (manganese nodule)	RM-GDP-15 (1976); ISHIKAWA and AOKI (1978); AOKI and ISHIKAWA (1985)#; MUSASHINO and SHIKI (1985)#

4)	GDP-15-4 25-27.8, 132-53.1 25-27.9, 132-53.2 1160-1245	*Nummulites*-bearing limestone, manganese-coated zeolitic mudstone, and individual specimens of larger foraminifer	RM-GDP-15 (1976); ISHIKAWA and AOKI (1978); AOKI and ISHIKAWA (1985)#; MUSASHINO and SHIKI (1985)#: the individual specimens of larger foraminifer are considered to have been derived from *Nummulites*-bearing limestone. They contain *Nummulites boninensis, Discocyclina* 2 spp., and *Asterocyclina* sp.
5)	GDP-15-6 25-32.7, 132-32.9– 25-32.7, 132-32.7 1770-1785	*Nummulites boninensis*	RM-GDP-15 (1976): *Nummulites* occurs as an individual specimen of megalospheric form, associated with *Discocyclina* sp.
6)	GDP-15-7 25-16.2, 133-14.5 25-16.5, 133-15.1 2190-2580	*Nummulites* boninensis, Discocyclina sp., Asterocyclina sp., green schist, dolerite, tuff, and phosphate	RM-GDP-15 (1976); ISHIKAWA and AOKI (1978); AOKI and ISHIKAWA (1985)#; MUSASHINO and SHIKI (1985)#: the rocks, together with fossils, were obtained from foraminiferal sand of the upper Pliocene-Holocene; *Nummulites* is represented by many specimens of megalospheric form and one specimen of microspheric form.
7)	GDP-15-8 25-12.1, 133-10.5– 25-12.2, 133-10.6 3200-3400	Zeolite rock	RM-GDP-15 (1976); ISHIKAWA and AOKI (1978); MUSASHINO and SHIKI (1985)#
8)	GDP-21-3 26-18.9, 131-30.3– 26-18.3, 131-30.5 2575-3060	Altered basalt fragment catched in phosphate rock (manganese nodule)	RM-GDP-21 (1977)
9)	GDP-21-12 25-34.2, 131-19.2 4425	Phosphate rock? (manganese nodule)	RM-GDP-21 (1977): caught at the bottom of corer.
10)	GDP-21-15 25-27.0, 132-19.2– 25-27.1, 132-18.5 2918-3029	Semi-consolidated calcareous mud, and small manganese nodules	RM-GDP-21 (1977); MUSASHINO and SHIKI (1985)#
11)	GDP-24-13 25-41.1, 134-10.5– 25-39.7, 134-09.8 2010-2550	Oligocene chalk	RM-GDP-24 (1978); MUSASHINO and SHIKI (1985)#: comprising calcareous nannofossils ranging from the Middle to Late Oligocene (*Cocolithus eopelagicus, Discoaster deflandrei,* etc.) and planktonic *foraminifers* of the Late Oligocene (*Globigerina augulisuturalis,* etc.)
12)	GH74-7-179 (D78)– 25-03.8, 133-18.8 25-04.0, 133-19.0 2720-2770	Siltstone (manganese nodule)	MIZUNO, NOHARA, *et al.* (1975): detailed data not available.

13)	GH74-7-180 (D79) 25-02.5, 133-20.5– 25-02.5, 133-20.4 1690	Tuffaceous rock and altered andesite (manganese nodule)	MIZUNO, NOHARA, *et al.* (1975); MIZUNO, OKUDA, *et al.* (1975): detailed data not available.
14)	GH74-7-183 (D82) 2-23.0, 133-32.0– 25-23.4, 133-31.7 1820-1800	Metamorphic rocks: hornblende schist, tremolite schist, diopside-chlorite schist Ultramafic rock peridotite Conglomerate with schist pebbles (manganese nodule)	MIZUNO, NOHARA, *et al.* (1975); MIZUNO, OKUDA, *et al.* (1975); YUASA and WATANABE (1977); TOKUYAMA (1980): the rocks were collected from the acoustic basement: Mineralogical data of the metamorphic rocks suggest that there were two metamorphic events. The older one was intermediate to high-pressure metamorphism, and the younger was contact metamorphism, and the younger was contact metamorphism by a Paleocene magmatic event. The K–Ar age of the schist, 49±3.7 m.y., may indicate the second metamorphic event. The conglomerate contains angular-subangular pebbles of tremolite schist and serpentinite, and a minor amount of basalte pebble, besides volcanogenic plagioclase grains.
15)	KH72-2(=GDP-3)-48 26-11.6, 131-33.3– 26-11.7, 131-32.0 3029-2838	Pyroxene andesite	ISHIBASHI (1975): detailed data not available
16)	KH72-2(=GDP-3)-50 25-59.4, 131-21.4– 25-59.1, 131-21.0 1491-1863	Hornblende andesite	ISHIBASHI (1975): detailed data not available
17)	KH72-2(=GDP-3)-51 25-56.9, 131-21.4– 25-57.2, 131-20.8 1270-502	Pyroxene andesite tuff and tuff-breccia, and (?) dacite	ISHIBASHI (1975): detailed data not available
18)	KH-77-1 25-23.7, 133-05.2– 25-24.1, 133-06.4 1400	Micro-manganese nodules	FUJIOKA *et al.* (1980)

OKI-DAITO RIDGE

1)	GDP-15-10 23-03.3, 134-45.5– 23-03.1, 134-45.3 2210-2560	*Nummulites boninensis* and other larger foraminiferas	RM-GDP-15 (1976): *Nummulites boninensis* is represented by megalospheric form; the other larger foraminiferas are *Discocyclina* sp. and *Asterocyclina* 3 spp.
2)	GDP-15-11 22-47.5, 134-28.7– 22-47.9, 134-30.5 2880-3700	Zeolite rock, phosphate rock, calcareous rock, clinopyroxene basalt, pumice, taffaceous sandstone (manganese nodule)	RM-GDP-15 (1976): AOKI and ISHIKAWA (1985)#: possible *Lacazinella* sp. of Eocene was obtained from a rock; a tuffaceous rock contains Middle Miocene Radiolaria, *Cyrtocapella terapera* and others (S. SUGANO, personal communication).

3)	GDP-15-13 22-58.0, 134-32.5– 22-58.7, 134-33.2 1940-1970	Phosphate rock, *Nummulites boninensis* and other larger foraminiferas	RM-GDP-15 (1976): *Nummulites boninensis* is represented by megalospheric form; the other larger foraminiferas are *Discocyclina* sp. and *Asterocyclina* 2 spp.
4)	GDP-21-5 23-45.0, 133-02.3– 23-45.2, 133-01.9 2730-2735	*Nummulites boniensis,* Dolerite, basalt, andesite, and tuff	RM-GDP-21 (1977); ISHIKAWA and AOKI (1978); Aoki and Ishikawa (1985)#; MUSASHINO and SHIKI (1985)#: olivine (pseudomorph)—clino—pyroxene basalt, olivine bearing basalt, altered basaltic tuff, two-pyroxene andesite, andesitic tuff, and zeolitic rock (manganese nodule); associated sediments (foram ooze) contain *Nummulitees* and *Discoastor* (Pliocene species).
5)	GDP-21-6 23-45.8, 133-02.0– 23-47.5, 133-00.9 1970-1980	Phosphate rock (and calcareous rock?) (manganese nodule)	RM-GDP-21 (1977); MUSASHINO and SHIKI (1985)#: Some of the rocks contain *Nummulites boninensis.*
6)	GH74-7-159 (D67) 23-48.1, 132-46.6– 23-48.5, 132-47.1 2290-2110	Phosphate rock? (manganese nodule)	MIZUNO, NOHARA, *et al.* (1975): detailed data are not available.
7)	GH74-7-160 (D68) 23-28.0, 133-03.0– 23-27.8, 133-02.3 2990+	Augite basalt and augite dolerite (manganese nodule)	MIZUNO, NOHARA *et al.* (1975); MIZUNO, OKUDA, *et al.* (1975): upper Miocene nannoplanktons are found in manganese crusts of the nodules (S. NISHIDA, personal communication); Detailed data of the igneous rocks are not available.
8)	GH74-7-167 (D71) 24-20.0, 131-42.2– 24-19.2, 131-41.5 2340-2330	*Nummulites*-bearing limestone. and calcareous mudstone	MIZUNO, NOHARA, *et al.* (1975); MIZUNO, OKUDA, *et al.* (1975); MIZUNO, KONDA *et al.* (1977); *Nummulites boninensis* (megalo- and microspheric forms), *Asterocyclina penuria*, and *Asterocyclina* sp. were abundantly found in limestone and as individual specimen; Eocene large *Venericardia* (“*Venericor*”) and gastropods were also collected; calcareous mudstone contains abundant planktonic foraminiferas indicating the Early Pliocene (N19) (*Globorotalia margaritae, G. multicamerata, G. crassula viola, Globoquadrina altispira*, etc.)
9)	KH72-2(=GDP-3)-52 24-29.5, 131-00.0– 24-29.3, 131-00.3 2496-2436	Pyroxene andesite	ISHIBASHI (1975): detailed data are not available.

Table 2. Dredge hauls from the seamounts in the Minami-Daito Basin.

1)	GDP-15-14 23-59.1, 134-30.0– 23-59.1, 134-30.0 2880-3020	Calcareous rock	RM-GDP-15 (1976): detailed data not available.
2)	GDP-15-15 23-59.6, 134-30.0– 24-00.1, 134-29.3 2640-3000	Phosphate rock and zeolitic mudstone and andesite (manganese nodule)	RM-GDP-15 (1976)
3)	GDP-24-8 23-50.1, 133-50.1– 23-50.1, 133-49.4 3280-3320	Altered tuff and tuffbreccia (manganese nodule)	RM-GDP-24 (1978)
4)	KH-76-2-4 24-31.5, 133-06.8– 24-31.9, 133-06.1 2600-2700	Calcareous or phosphotic rock (Upper Pliocene), and manganese nodule fragments	(unfinished)

Table 3. Dredge hauls from the Kyushu-Palau Ridge.

KOMAHASHI-DAINI SEAMOUNT			
1)	GDP-8-7 29-53.4, 133-20.2– 29-52.8, 133-20.1 975-1018	Limestone and phosphate rock (manganese nodule)	SHIKI, TOKUOKA, *et al.* (1975); SHIKI, AOKI, *et al.* (1974); KONDA *et al.* (1975); USUI *et al.* (1976); MUSASHINO and SHIKI (1985) #: the limestone contains *Orbulina universa, Amphistegina, Lepidocyclina, Miogypsinidae,* which indicate the Middle Miocene or younger age; the mineral and chemical compositions of ferro-manganese oxides coating the rocks are presented in USUI *et al.* (1976).
2)	GDP-8-12 29-55.6, 133-18.5– 29-55.0, 133-20.0 2250-2280	Plutonic rocks: Trondhjemite, biotite-hornblende tonalite, biotite granodiorite, quartz diorite, diorite porphyrite (manganese nodule) Volcanic rock: clinopyroxene andesite (manganese nodule) Other rocks: tuff, sandstone, zeolitic rock (manganese nodule)	RM-GDP-8 (1974); SHIKI, TOKUOKA, *et al.* (1975); SHIKI, AOKI, *et al.* (1974); SUWA and AOKI (1975); AOKI *et al.* (1975); AOKI *et al.* (1976), ISHIZAKA (1975); NISHIMURA (1975); SHIBATA and OKUDA (1975); USUI *et al.* (1976); HARADA and NISHIDA (1975); ISHIKAWA and AOKI (1978); AOKI and ISHIKAWA (1985) #; MUSASHINO and SHIKI (1985) #: the plutonic rocks obtained are characterized by consisting mainly of plagioclase and quartz, with few K-feldspar, and belong to single rock series; tonalite has 37.4±6.4 m.y. K-Ar age and 51 m.y. ±20% fission track age; a part of the rocks is characterized by high K/Rb (543, 1118) and low K/Na ratio; the mineral and chemical compositions and microfossils (nannoplankton, planktonic foraminifera, etc.) have been studied by Usui et al. (1976) and Harada and Nishida (1975), respectively.

3)	GH74-7-150-1 (D60) 29-52.0, 133-17.0 29-52.0, 133-17.0 1040-1070	Biotite-hornblende tonalite (manganese nodule)	MIZUNO, NOHARA, *et al.* (1975); MIZUNO, OKUDA, *et al.* (1975); SHIBATA *et al.* (1977): tonalite is dated at 37.5±1.9 m.y. K–Ar age.
4)	GH74-7-150-2 (D61) 29-53.0, 133-19.5 29-53.0, 133-19.5 530+	Biotite-hornblende tonalite (manganese coated)	MIZUNO, NOHARA, *et al.* (1975); MIZUNO, OKUDA, *et al.* (1975)
5)	29°51.3, 133°19.0 900-1299	plagiogranite and andesite	OSTAPENKO and NARYJENYI (1976), (Japanes translation AOKI *et al.*, 1977): plagiogranite was thought to have K–Ar age of 14 m.y.

KOMAHASHI SEAMOUNT

1)	GDP-11-2 28-04.8, 134-39.8– 28-04.5, 134-39.8 535-560	Limestone? and dolerite (manganese nodule)	SHIKI, TOKUOKA, *et al.* (1975): detailed data not available
2)	GDP-11-3 28-05.5, 134-37.5– 28-05.5, 134-38.0 620-1350	Augite-olivine (pseudomorph)–andesite, olivine (pseudomorph) clinopyroxene basalt (manganese nodule) Limestone	SHIKI, TOKUOKA, *et al.* (1975); AOKI (1975); KONDA *et al.* (1975); AOKI *et al.* (1975); ISHIKAWA and AOKI (1978); AOKI and ISHIKAWA (1985)#: limestone contains the Late Oligocene-Middle Miocene fossils of *Miogypsina*, *Spiroclypeus*, and *Marginopora*?
3)	GDP-24-1 28-15.4, 134-32.5– 28-25.3, 134-32.5 2410-2460	Olivine (pseudomorph)–pyroxene basalt tuffbreccia, basaltic tuff, and sandy tuff. (manganese nodule)	(unfinished)
4)	GDP-24-2 28-13.1, 134-42.0– 28-13.6, 134-41.7 3440-3580	semi-consolidated mudstone	(unfinished): Middle—Late Pliocene
5)	GH74-7-184 (D83) 24-51.0, 134-34.7– 27-51.3, 134-34.0 2230-1540	Coral-bearing limestone, augite basalt, hyaloclastic tuff-breccia, tuff, and volcanic conglomerate	MIZUNO, NOHARA, *et al.* (1975); MIZUNO, OKUDA, *et al.* (1975): tuff-breccia and tuff are mainly of basic andesite; the rocks obtained can be correlated with the volcaniclastic rocks in the lower half of DSDP Hole 296.

KITA-KOHO SEAMOUNT

1)	GH74-7-153-1 (D63) 26-44.5, 135-24.6– 26-45.3, 135-25.0 520-345	Phosphate rock	MIZUNO, NOHARA, *et al.* (1975)
2)	GH74-7-153-2 (D64) 26-46.1, 135-27.2– 26-46.2, 135-27.0 430*-460**	Carbonate rock	MIZUNO, NOHARA, *et al.* (1975)

MINAMI-KOHO SEANOUNT			
1)	GH74-7-175 (D76) 26-06.0, 135-52.7– 26-05.0, 135-52.5 1100-980	Biotite-hornblende granodiorite (manganese nodule) titanaugite, basalt hornfels	MIZUNO, NOHARA, *et al.* (1975); MIZUNO, OKUDA, *et al.* (1975); MIZUNO *et al.* (1977): granodiorite includes many inclusions of hornblende-titano-augite basalt and has 48.5 ± 1.4 m.y. K-Ar age.

Table 4. Dredge hauls from the Kinan seamount Chain.

DAINI-KINAN SEAMOUNT			
1))	GDP-8-4 30-08.3, 136-51.5– 30-08.1, 136-43.5 770-980	Altered basaltic tuff	SHIKI, AOKI *et al.* (1974); SHIKI, TOKUOKA, *et al.* (1975)
KINAN SEAMOUNT			
1)	30-10.5, 136-42.5 750	Palagonite tuff	Dredged by RV Takuyo, Hydrographic Office, Japan, in 1962; Probably altered from calcareous rock. bryozoans, calcareous algae, molluscs etc. are contained.
HAKUHO SEAMOUNT			
1)	KH-74-4-25 28-01.0, 137-26.4– 28-01.2, 137-27.8 2790-2250	Pillow basalt	TOKUYAMA and FUJIOKA (1976): texture and chemical composition of various parts of the pillow were studied in detail.

Table 5. Data of the main piston and gravity cores obtained in the Northwestern Philippine Sea.

AMAMI PLATEAU			
1)	GDP-11-15 28-06.2, 131-35.2 1830	Gravity core, 50cm long; calcareous ooze	SHIKI, TOKUOKA, *et al.* (1975); KONDA (1975); NISHIMURA *et al.* (1977): calcareous nannoplankton, benthonic foraminiferas, and planktonic foraminiferas were studied in detail; their vertical distributions imply that the upper 15cm of the core belongs to the upper Pleistocene (NN20-21, N22-23) and the lower 35cm to the upper Pliocene, and a time hiatus of about 2 m.y. is present inbetween; faunal character of benthonic foraminiferas suggests an increase of water depth about 1000m during the late Pleistocene.

KITA-DAITO BASIN

1)	GH74-7-185 (P22) 27-34.5, 134-24.5 4575	Piston core, 539cm long; clay; the upper half is tuffaceous, interbedded with volcanic ash layers	MIZUNO, NOHARA, *et al.* (1975); INOKUCHI and MIZUNO (1977): normally magnetized throughout the core; sedimentation rate (average), more than 7.8mm/1000 y.
2)	KH-76-2-5 26-35.0, 133-52.0 5150	Gravity core, 35cm long; reddish brown and orange clay with a few brownish black thin layer	

DAITO RIDGE

1)	GDP-15-5 25-30.7, 132-42.0 1720	Short gravity core; foraminiferal ooze	RM-GDP-15 (1976): calcareous nannoplankton remains contained show the Earliest Pleistocene.
2)	GDP-21-12 25-34.2, 131-19.2 4425	Piston core, 47.7cm long; pale yellowish orange clay and yellowish brown clay	RM-GDP-21 (1977): 0–7.5cm—pale yellowish orange clay, Holocene. 7.5–46cm—yellowish brown clay, calcareous fossils are rare. 46–47.7cm—pale yellowish orange clcareous ooze, lowest pleistocene or upper Pliocene. Derived fossils of older pliocene time are contaminated. 0–15cm—normally magnetized. 15–30cm—reversely magnetized. 30–47.5cm—normally magnetized.
3)	GDP-21-13 25-25.0, 132-17.1 3460	Gravity core, 51cm long; foraminiferal ooze	RM-GDP-21 (1977)
4)	GDP-24-3 25-46.4, 133-21.2 3230	Gravity core, 57cm long; calcareous ooze	(unpublished): Recent
5)	GDP-24-6 25-48.5, 133-22.3 3139	Piston core, 460cm long; lower half is disturbed by flow-in; calcareous	(unpublished): Recent in whole
6)	KH-77-1-2 25-31.3, 133-15.5 3400	Piston core, 882cm long; light brown silty clay, light brown clayey ooze, yellowish brown diatomaceous clay, light grayclay, etc.	FUJIOKA *et al.* (1980); in Preliminaly Report Hakuho Maru Cruise KH-77-1 (ed. NASU and KOBAYASHI): one thick (23cm) and three thin volcanic ash layers are interbedded.
7)	KH-82-4-St.8 28-23.1, 132-45.9 2630	Piston core, 754.5cm long; grayish yellow brown	Preliminary Report Hakuho Maru Cruise KH-82-4 (1983) (ed. K. KOBAYASHI): Three volcanic ash layer are interbedded

MINAMI-DAITO BASIN

1)	GH74-7-172 (P19) 25-160, 134-22.0 5290	Piston core 556cm long; the uppermost part is interbedded with a volcanic ash layer 1.5cm thick.	MIZUNO, NOHARA, *et al.* (1975); INOKUCHI and MIZUNO (1977): normally magnetized throughout the core; sedimentation rate is calculated as more than 8.1mm/1000 y.
2)	GH74-7-156 (P16) 23-47.0, 134-45.3 5100	Piston core 552cm long; the lower half is disturbed by flow-in; clay	MIZUNO, NOHARA, *et al.* (1975)
3)	KH-76-2-3 24-27.2, 132-35.4 4660	Piston core 960cm long; homogenous dark brown to light-brown silty clay	0–570cm—reddish or yellowish brown clay, 570–860cm; yellowish brown laminated clay, alternation of clay of yellowish orange and yellowish brown color. 860–992cm—disturbed by flow-in but seems to be the alternation as above. Largely tuffaceous as a whole. 42–48cm-light yellowish orange volcanic ash. 695–700cm—volcanic ash with pumice gravels. 705–722cm—compact volcanic ash. Tonouchi and Kobayashi (1980) ; 0–565cm—normally magnetized (Brunhes), 565–740cm—reversely magnetized, 740–820cm—normally magnetized (Jaramillo). age of bottom; 1.09 m.y. (from extrapolation); sedimentation rate (Brunhes epoch) is calculated as 8.3mm/1000 y.

OKI-DAITO RIDGE

1)	Lamont V21-98 23-06, 134-26 2134	Piston core, 517cm long; calcareous foraminiferal ooze	TAKAYAMA (1969); TAKAYAMA (1970); TAKAYAMA (1973); UJIIE (1975); UJIIE and MIURA (1975): detailed studies were made on nannoplankton and planktonic foraminifera fossils; the core ranges from the Uppermost Miocene (N18, the latest stage of the Gilbert Epoch) through the Quarternary; sedimentation rate (average) is 1.4mm/1000 y.
2)	GDP-21-7 23-58.0, 133-07.8 3100	Piston core, 47cm long; foraminiferal ooze	RM-GDP-21 (1977): microfossils from the bottom of the core show the Earliest Pleistocene. Derived fossils of Eocene and Miocene—Pliocene are found.
3)	GDP-21-9 24-58.8, 131-18.5 2535	Piston core, 34cm long; foraminiferal ooze	RM-GDP-21 (1977): Recent.
4)	GDP-21-10 25-14.0, 131-10.9 3020	Gravity core, 59cm long; foraminiferal ooze	RM-GDP-21 (1977): Pleistocene to Recent. Depositional environment deeper than 2000m is assumed on the bases of benthonic foraminiferal assemblage.

5)	GDP-21-11 25-22.5, 130-59.0 3317	Piston core, 45cm long; Calcareous ooze	RM-GDP-21 (1977): Recent. Depositional environment deeper than 2000m is assumed on the bases of benthonic foraminiferal assemblage
6)	KH-76-2-2 24-25.5, 131-48.9 2030	Piston core, 50cm long; Foraminiferal sand	

PHILIPPINE BASIN (northern margin)

1)	GDP-15-12 22-37.8, 134-13.5 5160	Piston core, 572cm long; clay	RM-GDP-15 (1976); 0-ca. 3.6m interval is normally magnetized.
2)	GH74-7-158 (P17) 23-06.5, 132-19.8 5550	Piston core, 556cm long; clay interbedded with thin layers of volcanic ash	MIZUNO, NOHARA, *et al.* (1975); INOKUCHI and MIZUNO (1977): 0–333cm—normally magnetized (Brunhes), 333–402cm—reversely magnetized, 402–446cm—normally magnetized (Jaramillo), 446–556cm—reversely magnetized; sedimentation rate (average) 48mm/1000 y.

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