X. BOTTOM SEDIMENTS

Masafumi Arita

Investigation method and sedimentary facies identification

From the survey area 27 samples of bottom sediments were obtained by means of an Ocean-70 grab, together with 7 samples by piston corer and 2 samples by a freefall corer.

The samples obtained with the Ocean grab were treated by the following process: 1) picking up manganese nodules from the surface of sediment in the grab, 2) scooping up surficial sediments of 300 cc in volume for compositional analysis, and 3) sampling two or three columns of 30–40 cm length by PVC cylinders with inside diameters of 120 mm and 60 mm.

All the piston and freefall cores and the columns from the Ocean grab were examined by visual observation and soft X-ray photography for observation of invisible internal sedimentary structures, and were divided into 10 cm length segments for compositional analysis. The compositional analysis was done on segments every 50 cm depth for the piston and free fall cores and throughout the columns of the grab samples. The segments were sifted under water through a sieve of 74 microns after the measurement of the total wet volume. The volume of coarse fractions, the residues on sieve, was measured by means of the tube which was designed by the author (Fig. X-1) and their volume ratio to the bulk samples were calculated.

In the sedimentation tube some layers of coarse fractions were generally clearly defined with respect to each other, resulting from the difference of settling velocity of their constituent materials. Generally, the layers consist of three color bands, brown, white, and pale brown- pale gray, in asending order, which are mostly characterized by mineral fraction, foraminifera, and radiolaria, respectively.

The coarse fractions of each color band were observed under binocular microscope for determination of their detailed composition.

Based on the results obtained, sedimentary facies of each sample were named according to the following classification of pelagic sediments.

Organic residues in bulk sample	Sedimentary facies type
0–10%	Deep sea clay
10–30%	Calcareous clay, siliceous clay, or calcareous-siliceous clay
more than 30%	Calcareous ooze, siliceous ooze, or calcareous-siliceous ooze

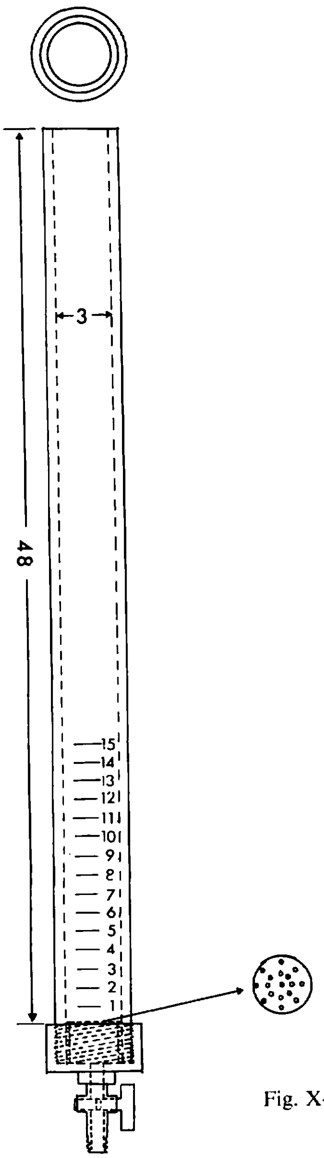


Fig. X-1 The sedimentation tube used in compositional analysis.

In the result, the sedimentary facies of the survey area are classified into the following five types; calcareous ooze, calcareous-siliceous clay, siliceous ooze, siliceous clay, and deep sea clay. They consist of coarse fractions of eight elements and finer materials than 74 microns dia. : the former consists of 1) fragments of diatom, 2) fresh radiolaria, 3) brown stained radiolaria, 4) silicified radiolaria, 5) shark's scale, 6) foraminifera, 7) fraction of agate?, and 8) manganese micronodule.

Among those, the *shark's scale* was tentatively named for *triangle ichthyoliths* for convenience of the following descriptions, and the shark's scale and the radiolaria are preliminary studied by M. ARITA and A. MIZUNO in Chap. XIII of this report.

Horizontal distribution of surficial sediments

Fig. X-2 provides, together with sampling positions, an areal distribution of surficial sedimentary facies type concerned only with the top 3 cm thick layer.

Calcareous ooze is distributed around the seamounts of the northeastern survey area. The volume of the coarse fraction is more than 30 % of the bulk sediment and it consists of planktonic foraminifera and its fragments. From a topographic viewpoint, it is most likely that the calcareous ooze is also distributed in the southwestern seamount district, although we have no data because of some troubles during sampling.

Calcareous-siliceous clay has a coarse fraction composed of foraminifera and radiolaria. The distribution has not been confirmed within the top 3 cm layer in the present

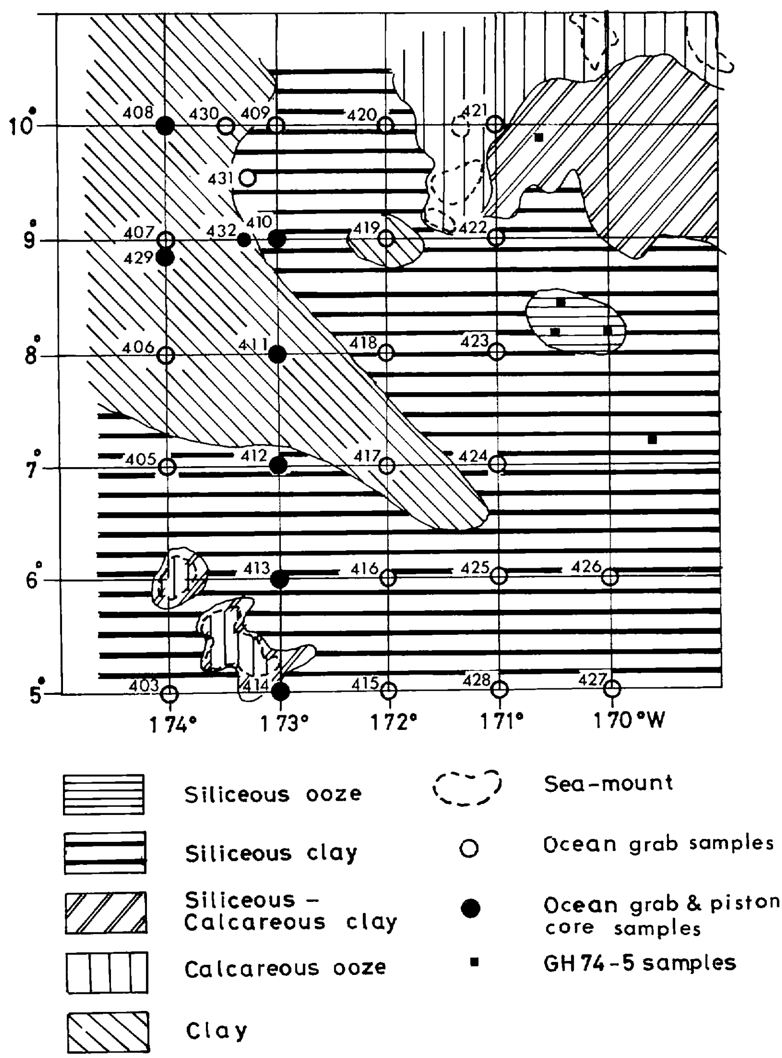


Fig. X-2 Distribution map of surficial sediments in GH76-1 area.

area, but it is presumably developed at the surface between the foot of the seamounts and the basin bottom at 5000 m, considering that sediments of the same type are widely distributed in the boundary area between calcareous ooze and siliceous clay as a transitional facies in the eastern adjoining GH74–5 area (ARITA, 1975).

The coarse fraction of *deep sea clay* is chiefly composed of brownish stained radiolaria and silicified radiolaria. Sediments of this type are widely distributed in the northwestern area, thinning southeastwards and wedging out beneath the veneer of siliceous clay in the southeastern part.

Siliceous clay has the coarse fraction mainly composed of fresh radiolaria of Quaternary age. Siliceous clay is widely developed in the southeastern part of the survey area as a surficial sediment of 20–30 cm thick.

Vertical sequence in grab samples

The results of observations and compositional analyses on the columnar samples from the Ocean-70 grab, which have thickness of 30–40 cm in general, are illustrated in Fig. X-3, together with those of measurements of magnetization and physical properties.

The following five types of vertical sequence of sedimentary facies are discriminated throughout the survey area, and they are shown in Fig. X-4.

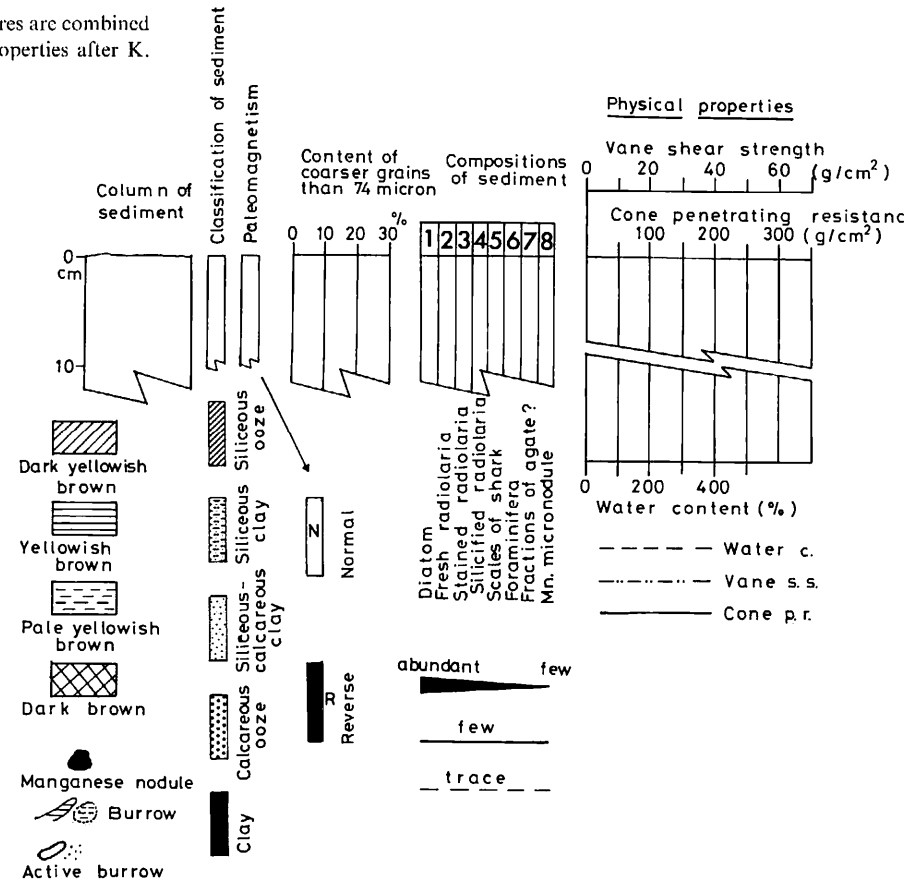
Type I is wholly composed of deep sea clay, and is observed at Sts. 406–408, 411, 417, 419, and 430, all of which are located in the distribution area of surficial deep sea clay. The vertical sequence generally shows dark yellowish brown to brown in color, and includes numerous burrows of benthonic organisms. The coarse fraction is generally less than 10 % in the surficial part of each column, tending to decrease downwards. It consists of fresh radiolaria, stained or silicified radiolaria, shark's scale, rarely dissolved benthonic foraminifera in part (*Siphonodosaria* type), and possible fragments of agate. Fresh radiolaria mainly occur in the upper part and some of other components show a tendency of downward increase in abundance.

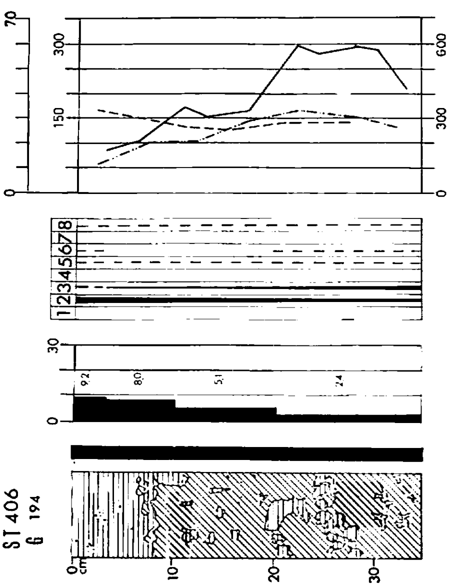
Type II consists of a combination of siliceous clay and deep sea clay, the latter of which is usually covered by siliceous clay of approximately 10–20 cm thick. It is observed at Sts. 403, 409, 410, 413, 416, 418, 420, 423, 425–427, and 431. The boundary between the two facies generally corresponds to a color change. The siliceous clay is yellowish brown with a composition of fragmentary diatom and fresh radiolaria, whereas the deep sea clay is yellowish brown to dark brown and consists of stained or silicified radiolaria. As typically shown in the sequences at Sts. 409, 418, 426, etc., the fresh radiolaria and fragmentary diatom predominant in the coarse fractions of the siliceous clay tend to become scarce or absent in those of the deep sea clay which are characterized by a general increase of stained or silicified radiolaria. Numerous burrows are observed in the deep sea clay part. They appear in some cases to penetrate downwards from the base of the siliceous clay part, as the burrows are filled with sediments which have the same color as the overlying siliceous clay. Thus it is suggested that the Quaternary siliceous clay might unconformably overlie the Tertiary deep sea clay and that many fresh radiolaria contained in the deep sea clay could have been carried down from siliceous clay by burrowing of benthonic organisms.

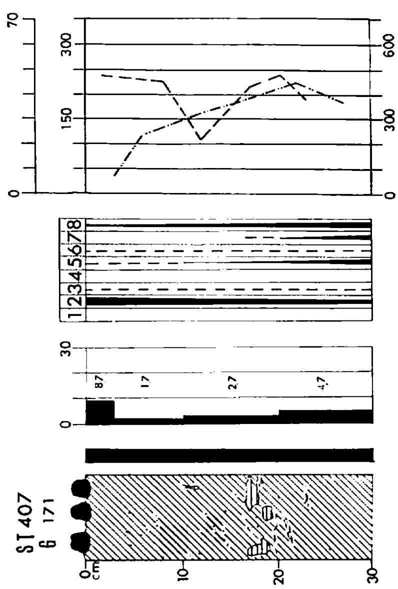
In *type III*, siliceous clay covers calcareous-siliceous clay within the column. This type

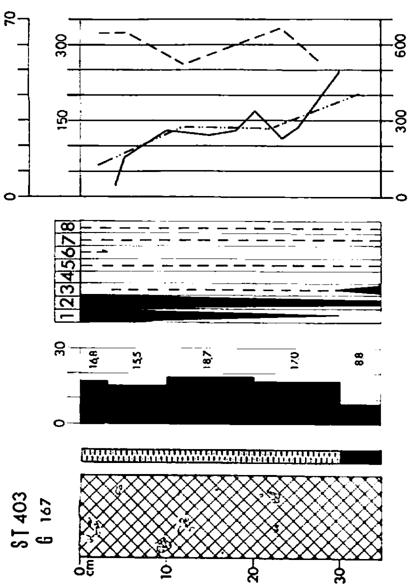
Fig. X-3 Results of compositional analyses of Ocean grab samples. All the figures are combined with the data on paleomagnetism after T. JOSHIMA and physical properties after K. TSURUSAKI and T. HIROTA (also see Chap. XI and XII)

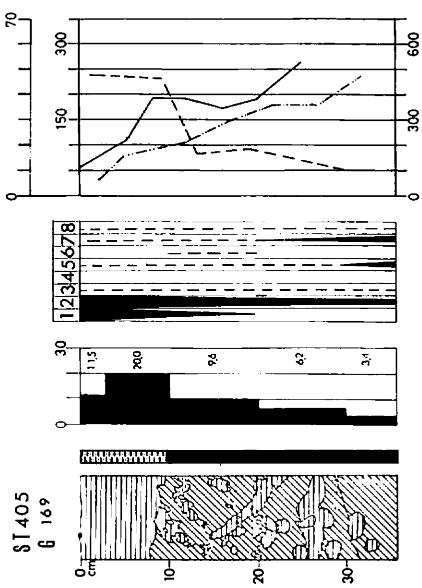
St. 402	04–57.9N,	173–56.3W;	depth,5660m	Type II
St. 405	06–58.2N,	174–00.8W;	depth,5600m	Type III
St. 406A	08–00.0N,	173–59.0W;	depth,5990m	Type I
St. 407	09–00.4N,	174–00.7W;	depth,5910m	Type I
St. 408	10–00.7N,	173–59.7W;	depth,5830m	Type I
St. 409	10–00.0N,	173 01.3W;	depth,5810m	Type II
St. 410	08 58.9N,	173–00.1W;	depth,5890m	Type II
St. 411	07–58.2N,	172–59.8W;	depth,5880m	Type I
St. 412	06–59.7N,	172–59.8W;	depth,5950m	Type IV
St. 413	06 00.7N,	172–59.5W;	depth,5820m	Type II
St. 414A	05–00.1N,	173–00.7W;	depth,5280m	Type III
St. 415	05–00.0N,	171–58.7W;	depth,5580m	Type IV
St. 416	06–01.5N,	171–59.5W;	depth,5780m	Type II
St. 417	07–01.4N,	171–59.7W;	depth,5660m	Type I
St. 418	07–59.6N,	172–00.3W;	depth,5600m	Type II
St. 419	09–00.7N,	172–00.6W;	depth,5510m	Type I
St. 420	09 59.1N,	172–00.9W;	depth.5670m	Type II
St. 421	09–59.3N,	171–01.0W;	depth,4385m	Type V
St. 422	08–55.3N,	170–59.7W;	depth,5110m	Type III
St. 423	07–59.1N,	170–59.9W;	depth,5450m	Type II
St. 424	07–01.1N,	171–00.1W;	depth,5790m	Type IV
St. 425	06–01.1N,	171–01.1W;	depth,5530m	Type II
St. 426	06–00.2N,	169–59.6W;	depth,5430m	Type II
St. 427	04–59.1N,	170–01.9W;	depth,5640m	Type II
St. 428	04–59.2N,	171 01.1W;	depth,5640m	Type IV
St. 430	09–59.6N,	173–29.9W;	depth,5850m	Type I
St. 431	09–28.8N,	173–29.9W;	depth,5880m	Type II

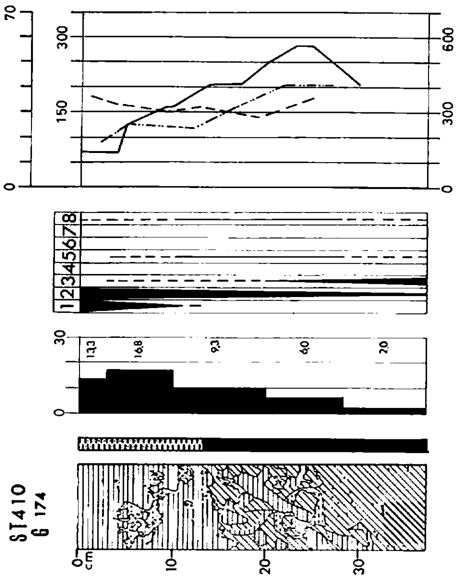


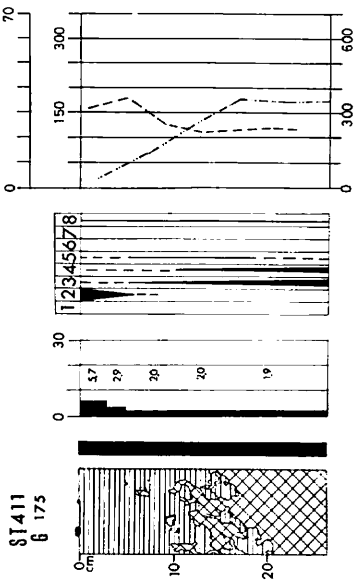

ST 406
G 194
0 cm
10
20
30
9,2
8,0
5,1
2,4
1 2 3 4 5 6 7 8
0
150
300
70
600

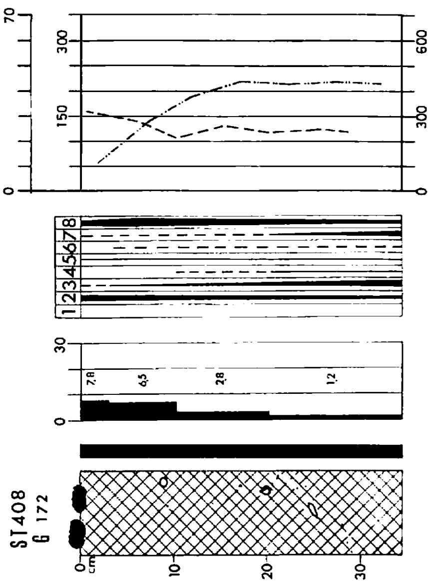

ST 407
G 171
0 cm
10
20
30
8,7
1,7
2,7
4,7
1 2 3 4 5 6 7 8
0
150
300
70
600

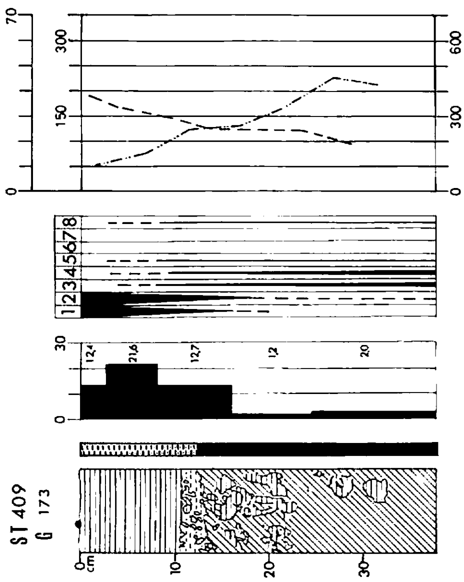

ST 403
G 167
0 cm
10
20
30
14,8
15,5
18,7
17,0
8,8
1 2 3 4 5 6 7 8
0
150
300
70
600

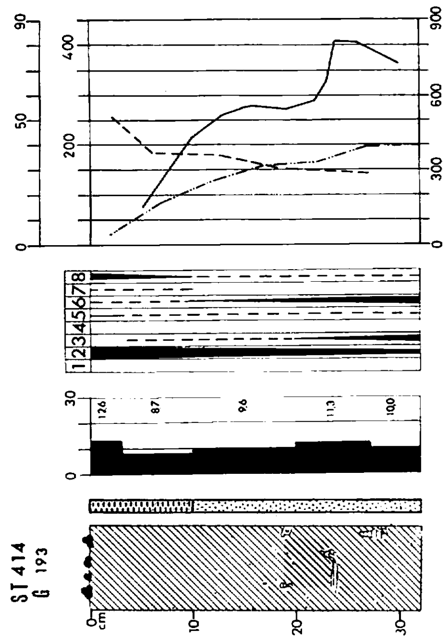

ST 405
G 169
0 cm
10
20
30
11,5
20,0
9,6
6,2
3,4
1 2 3 4 5 6 7 8
0
150
300
70
600

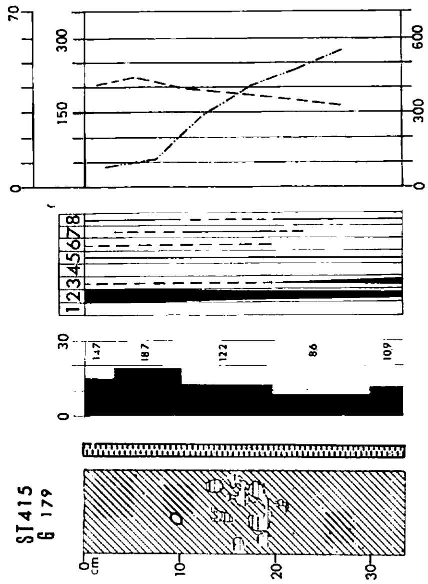

ST410
G 174
0
150
300
70
600
1 2 3 4 5 6 7 8
30
13,3
16,8
9,3
6,0
2,0
cm
10
20
30


ST411
G 175
0
150
300
70
600
1 2 3 4 5 6 7 8
30
5,7
2,9
2,0
2,0
1,9
cm
10
20


ST408
G 172
0
150
300
70
600
1 2 3 4 5 6 7 8
30
7,8
6,5
2,8
1,2
cm
10
20
30


ST 409
G 173
0
150
300
70
600
1 2 3 4 5 6 7 8
30
12,4
21,6
12,7
1,2
2,0
cm
10
20
30


ST 414
G 193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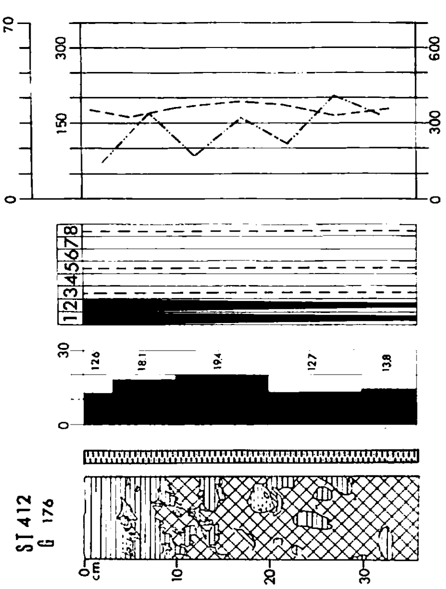
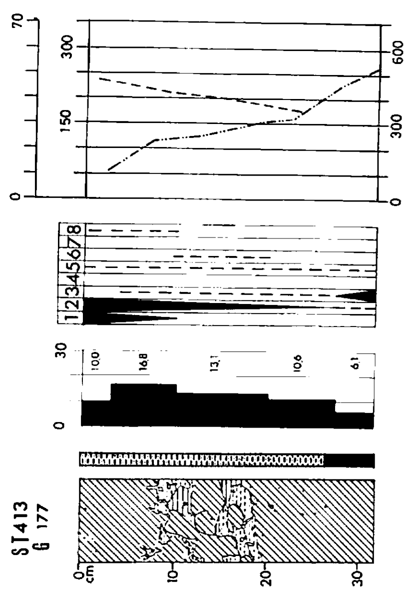
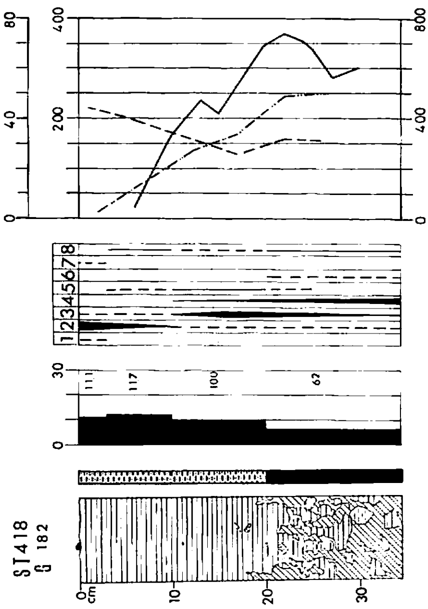
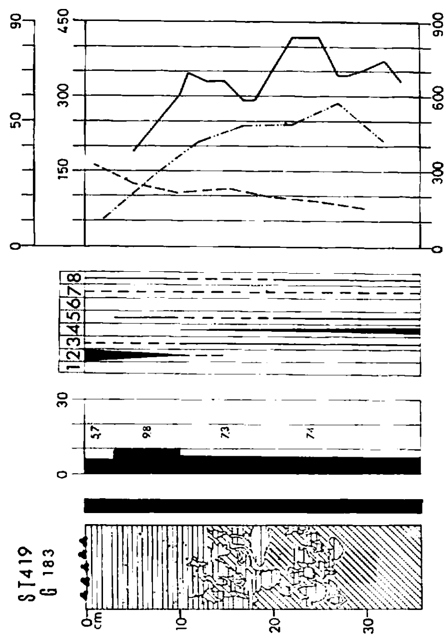
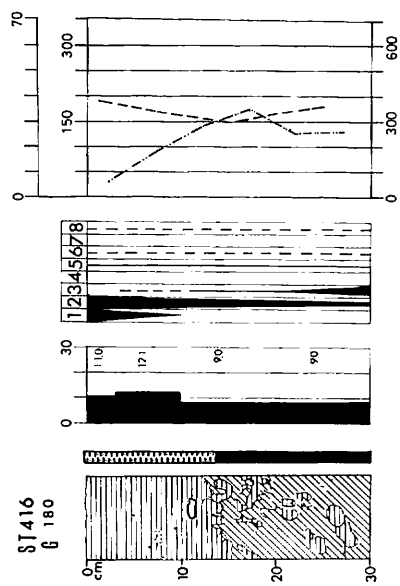
G 179

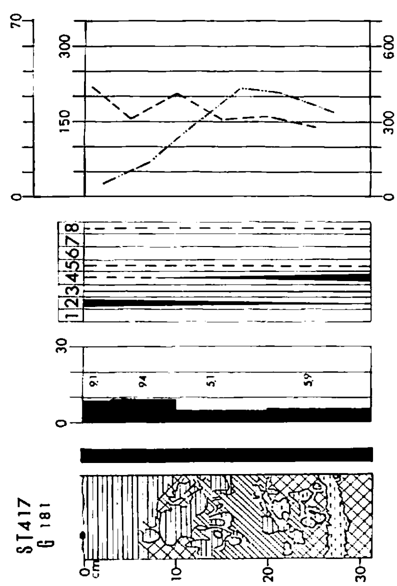

ST 412
G 176

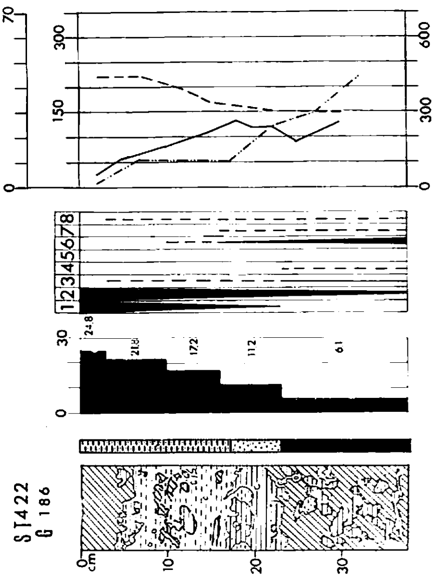

ST 413
G 177


ST418
G 182


ST419
G 183


ST416
G 180


ST417
G 181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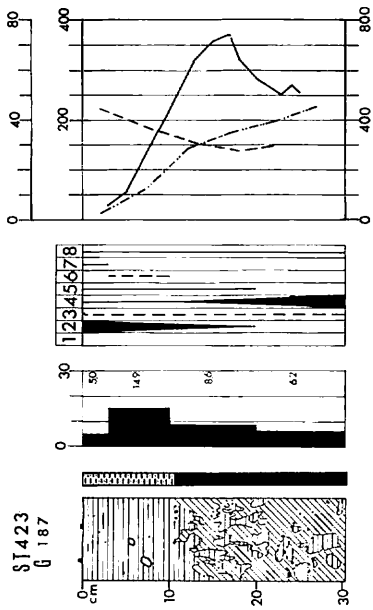
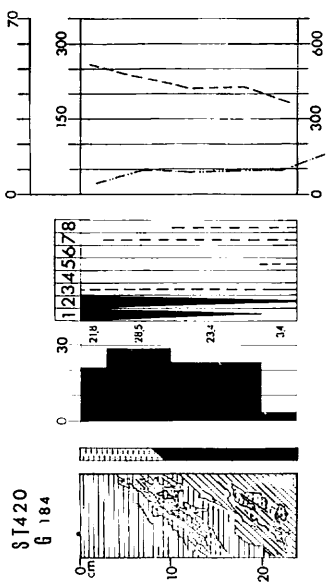
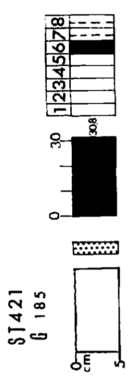
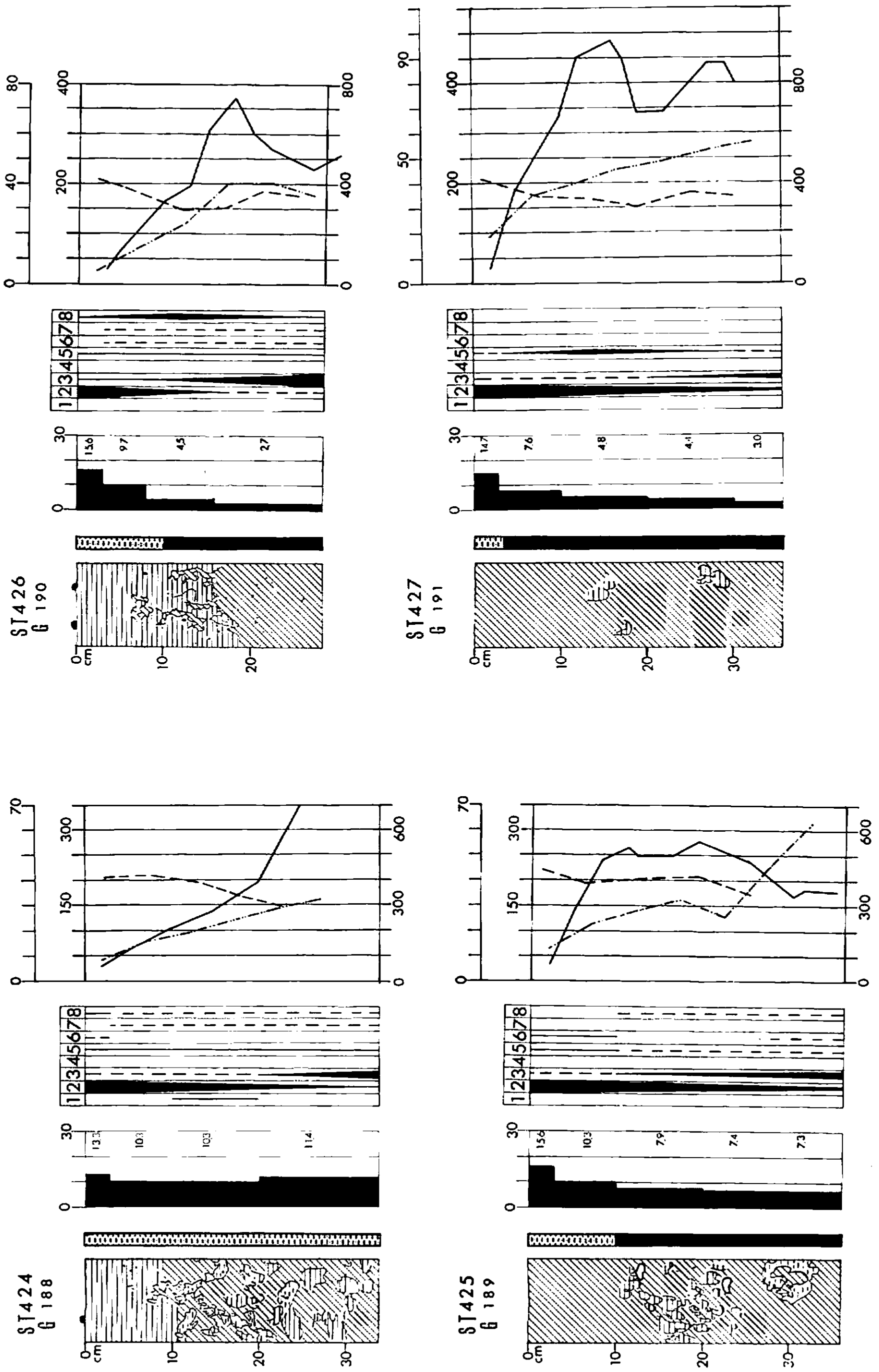
G 186


ST423
G 187


ST420
G 184


ST421
G 185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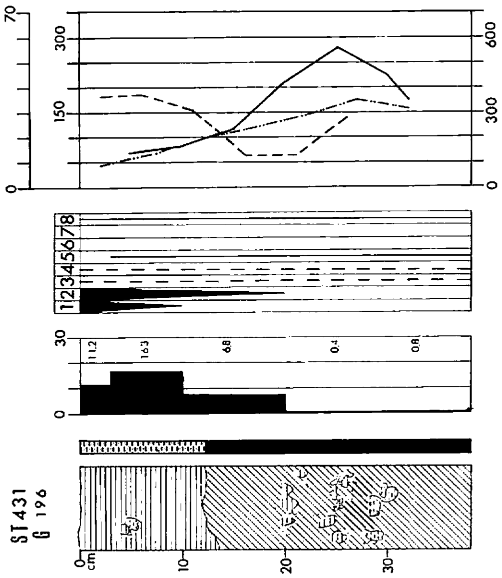
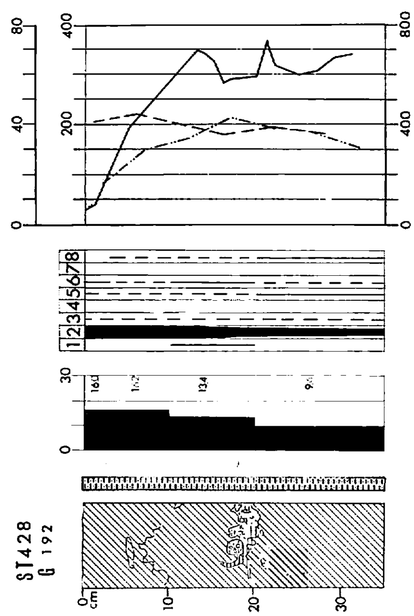
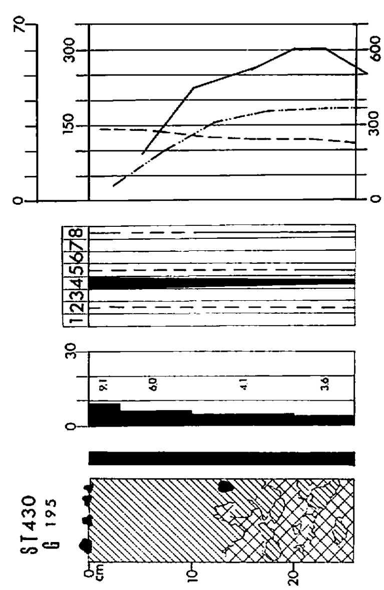
ST427 G 191
ST424 G 188
ST425 G 189


ST 431
G 196


ST 428
G 192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G 195

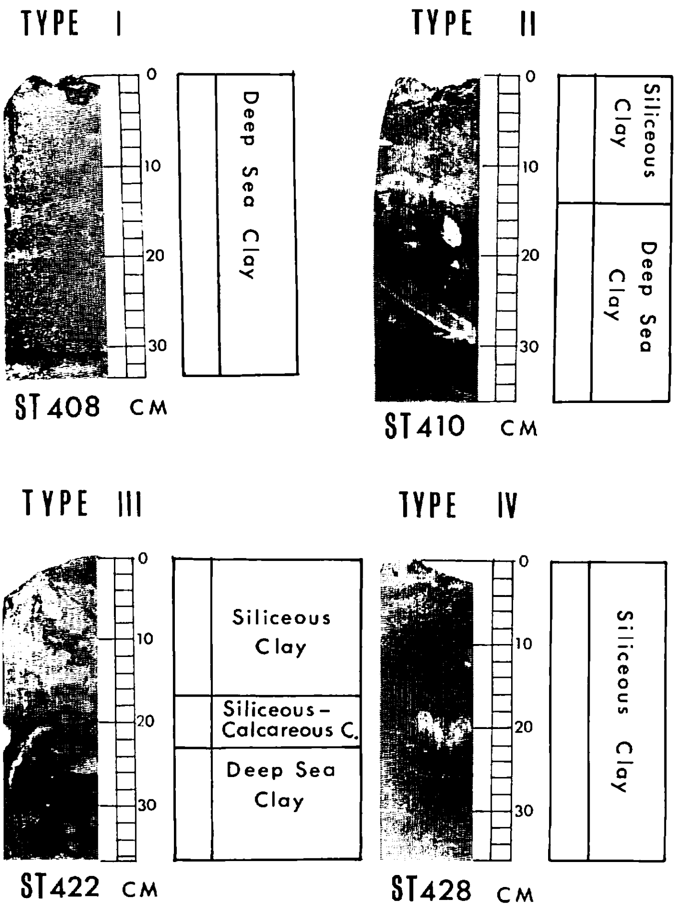


Fig. X-4 Sequence type of sample from grab.

is distributed at Sts. 414 and 422, which are located near seamounts. In the column of St. 414, fresh radiolaria and manganese micronodules predominate in surficial 10 cm and decrease in abundance downwards. The lower horizon is characterized by planktonic foraminifera and stained radiolaria in a 1:9 volume ratio respectively. At St. 422 the surficial 17 cm part consists of siliceous clay of which the coarse fraction is composed of fragmentary diatom and fresh radiolaria. The underlying horizon, 17–22 cm, consists of calcareous-siliceous clay, similar to St. 414. The lower part consists of deep sea clay. It is noteworthy that in this deep sea clay no diatom is found, but fresh radiolaria becomes less abundant, and stained, silicified radiolaria, and foraminifera occur more abundantly.

Type IV composed only of siliceous clay is observed at Sts. 412, 415, 424, and 428. In this type fresh radiolaria is predominant throughout the columns, but in some cases it decreases downwards with increasing amounts of stained radiolaria.

Type V was tentatively named, based upon the sequence of St. 421. It is composed only of calcareous ooze, of which coarse fractions without radiolaria, consist of planktonic foraminifera and its fragments.

Soft X-ray photographing was carried out of all the columns to observe their internal sedimentary structures. The pictures obtained show no particular structures such as lamination, definite boundary of different sedimentary facies, etc., except small manganese nodules and obscurely recognizable burrows, implying that they are composed of nearly homogeneous sediments.

Examinations on *chronology and stratigraphy of the sequence types* provide interesting results, although any definite conclusion is difficult to draw as yet, owing to lack of clear boundaries between different sedimentary facies and the parallel occurrence of younger and older forms of micro-animals such as radiolaria, shark's scale, and others.

Among the sequences, type II seems to be the most easy to interprete. As described before, in type II fresh radiolaria of Quaternary age, abundant in the upper part, decreases downwards and disappears in the lower part, while stained radiolaria, including some Miocene species, is abundant in the lower part and decreases upwards, becoming of a trace or very scarse. Their stratigraphic relation to each other is somewhat variable from column to column. In some columns represented by St. 413 their alternation is rather definite and its horizon corresponds to a facies boundary. On the other hand some columns show the parallel occurrence within some stratigraphic interval which includes the facies boundary, and other columns show no definite relation between them.

Because of the downward penetration of burrows from the base of the upper siliceous clay, it is probable that the siliceous clay is of Quaternary age, and the lower deep sea clay is Tertiary, including Early-Middle Miocene at least. The boundary implies a time hiatus, although the detailed chronology still remains unsolved. The indefinite relation, between fossil occurrences and facies boundary, could have been caused from bioturbation of vigorous benthonic activities of present and past as evidenced by the present observations and deep sea bottom pictures (see Chap. IX).

Carcharodon megalodon which are found on the surface of the type I sequence suggests that this type is of Middle Miocene age, although it includes Quaternary radiolaria. The presence of calcareous-siliceous clay of the lower part of type III suggests that the relationship between type V and type II, and IV is the lateral change of sedimentary facies of Quaternary age. Furthermore, the lack of radiolaria in type V may be attributed to the different living positions between planktonic foraminifera and radiolaria on the ocean column during sedimentation.

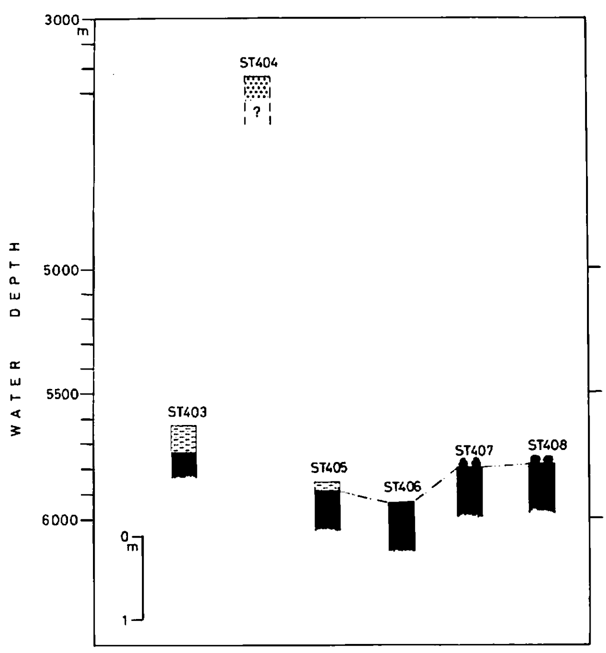
From the foregoing, the stratigraphic relation and sea bottom exposure of Tertiary sediments are somewhat similar to those of deep sea short cores reported by JOHNSON (*in* GREENSLATE *et al.*, 1973) and JOHNSON (1972) from the eastern equatorial Pacific and by JOHNSON *et al.*, (1970) from the central equatorial Pacific. Although there are some discrepancies in identification of the top horizon of the stratigraphic sequence of the short cores between the results of the present study and those of JOHNSON (*in* GREENSLATE *et al.*, 1973; 1972), it is most likely that Quaternary sediments unconformably cover Tertiary sediments as a thin veneer except for some particular cases, and that the latter is directly exposed on the sea bottom in places. In the GH76-1 area, the Quaternary sediments are represented by siliceous clay and calcareous ooze, and the Tertiary sediments by deep sea clay.

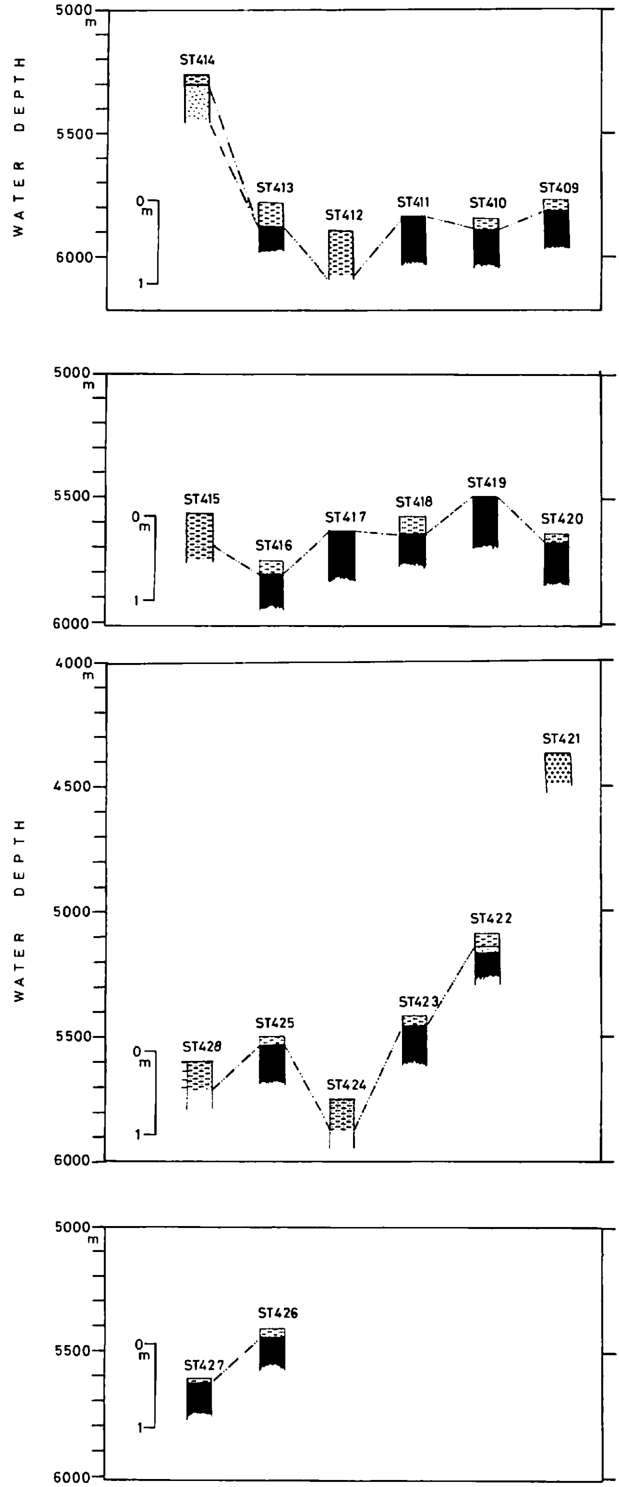
It has been suggested (JOHNSON *et al.*, 1970; JOHNSON, 1972; HOLLISTER *et al.*, 1974) that ocean floor erosion and sediment redistribution by bottom currents caused Tertiary sediment outcropping on the deep sea bottom. However, as pointed out by JOHNSON (1972) and ARITA (1977), the velocity of the ocean bottom current is too slow to erode sediment on the ocean floor. This investigation seems to suggest that the Tertiary deep sea clay outcrops in the GH76-1 area might have been caused by non-deposition of Quaternary sediments, rather than erosion, as also suggested by deep sea photography (Y. KINOSHITA, Chap. IX).

Fig. X-5 shows five profiles of stratigraphic sequences of the present area arranged in a north-south direction in relation to their water depth. Except for the calcareous ooze in the seamount area, there seems to be no particular relation between the sequence of sedimentary facies and water depth. However, siliceous-calcareous clay found in the lower or middle part of the type III sequence at Sts. 414 and 422 occurs in the vicinity of a seamount at a depth of 5280 m and 5170 m respectively. With such a depth of over 5000 m it is difficult to explain the accumulation of a siliceous-calcareous facies, because the CCD of the low latitude zone is generally considered to be between 4000 m and 5000 m (BERGER, 1971).

If this is accepted, one interpretation for the possible origin may be that the siliceous-calcareous facies could have been formed at a time of lower sea level possibly in Quaternary age, though the amount of lowering can not be exactly estimated. This interpretation may also give some accounts for general facies distribution of surficial sediments in the survey area and that during Quaternary time the siliceous clay was

Fig. X-5 Profiles of sedimentary sequence by grab samples. In each profile, columns are arranged in the way of south to north from left to right.





WATER DEPTH
5000 m
5500
6000
0 m
1
ST414
ST413
ST412
ST411
ST410
ST409
ST415
ST416
ST417
ST418
ST419
ST420
4000 m
4500
ST421
ST422
ST423
ST424
ST425
ST428
ST426
ST427

formed from planktonic radiolaria in the surface water stimulated by the presence of seamounts which were larger than present because of a lower sea level. The deep sea clay area may have been a non-depositional province, situated far away from the seamount areas.

Vertical sequence in piston and freefall cores

Piston cores were obtained at stations arranged along the meridians 173° and 174°W (Fig. X-2), and additional freefall cores were available at Sts. 414 and 432. The results of observations and compositional analyses are shown in Fig. X-6, and brief accounts are given in the following.

St. 414A-1 (P67): The piston core of 540 cm long is wholly occupied by deep sea clay except the uppermost 20 cm which is composed of siliceous clay with small manganese nodules at the top. The deep sea clay is interbedded with a phosphorite zone (Fig. X-7) at a depth of 250–280 cm, and has a different color in the horizons above and below this zone. Deep sea clay above the phosphorite zone is dark yellowish-brown, with 0.8–3.1% of coarse fraction mainly consisting of radiolaria. The clay below the phosphorite is pale yellowish brown, and is associated with numerous small burrows and a lesser amount of coarse fraction (decreasing to 0.3%), composed of shark's scale and manganese micronodule. According to the remanent magnetization measurement results (see Chap. XI) two magnetic reversals are recognized within the middle-lower part of the deep sea clay above the phosphorite zone. The sediments of these reversal parts are characterized by coarse fractions consisting of stained radiolaria and shark's scale. Fresh radiolaria occurs in the top of the core down to 60 cm, decreasing in abundance downwards. Mid-Tertiary type shark's scale and manganese micronodule are the main compositional element of the coarse fractions in the lower normaly magnetized part.

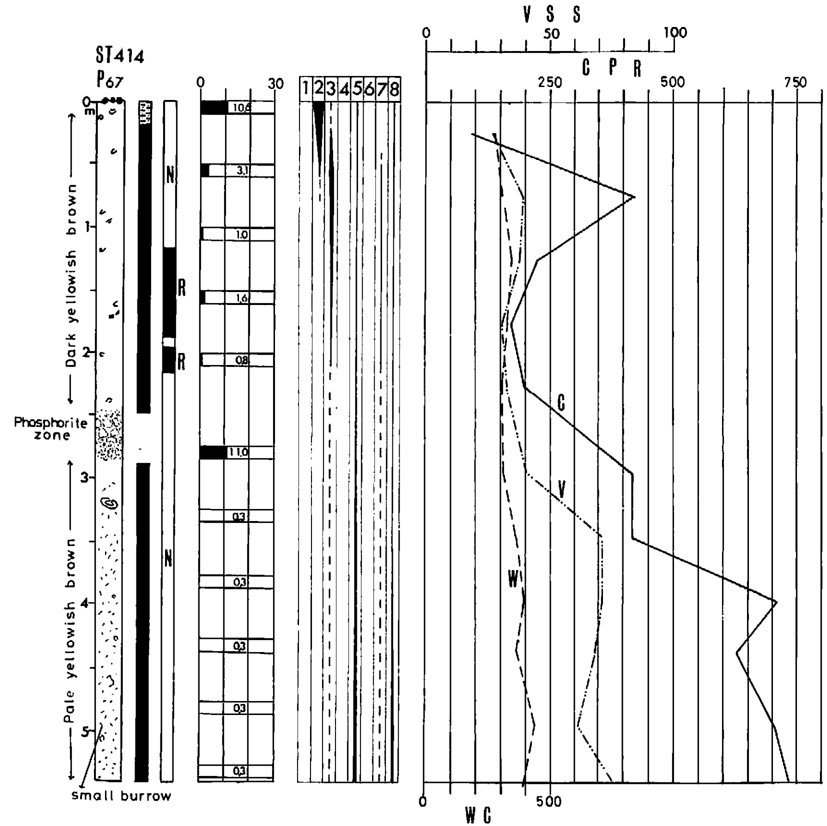
St. 414 (FC2): A 1 m long freefall core was obtained from a station about 3.8 km west from St. 414 A (see Fig. II-12). The core consists wholly of yellowish brown deep sea clay. In contrast to the preceding core, the coarse fraction amount to 25.3% in the surficial part and is more than 30% in the lower part. It is mainly composed of stained radiolaria and rare fresh radiolaria. The surficial part consists of siliceous clay while the lower part is a siliceous ooze. Some of predominant species of stained radiolaria are Miocene *Dorcadospyris dentata* and *Calocycletta costata*.

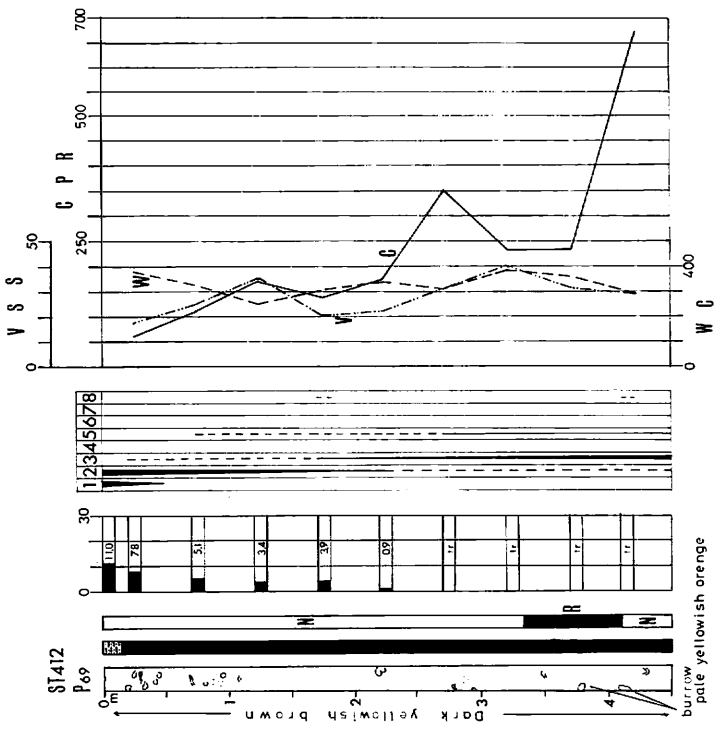
St. 413A (P68): This core is dark yellowish brown and is largely composed of deep sea clay except in the uppermost 20 cm which is represented by siliceous clay. The amount of the coarse fraction markedly decreases downward within the core. Diatom is confined to the uppermost 40 cm. fresh radiolaria ranges from the top to a depth of 220 cm, and stained radiolaria and shark's scale are rather abundant in the lower 50–100 cm of the core. Measurement of remanent magnetization shows that all the parts of core are normally magnetized.

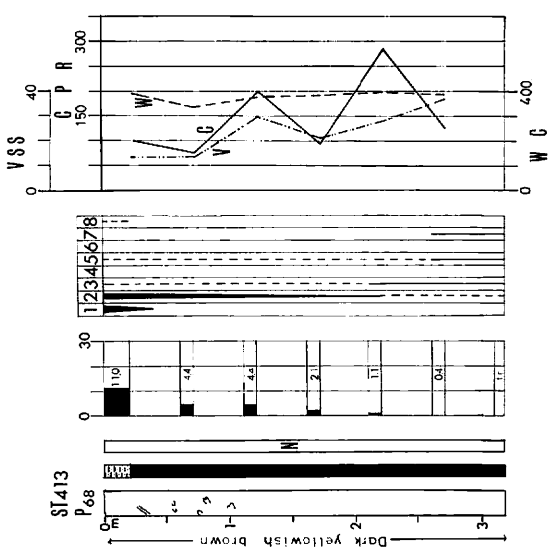
St. 412A (P69): This core, which is dark yellowish in color, is largely composed of deep sea clay except for 10 cm of siliceous clay at the top, similar to the preceding core. The amount of coarse fraction gradually decreases downwards, and is negligible below a depth of 25 cm. The varitation of coarse fraction components is similar to P69: fragmentary diatom and fresh radiolaria disappears at 30–40 cm and 220 cm depth respectively; stained radiolaria and shark's scale become rather abundant in the lower

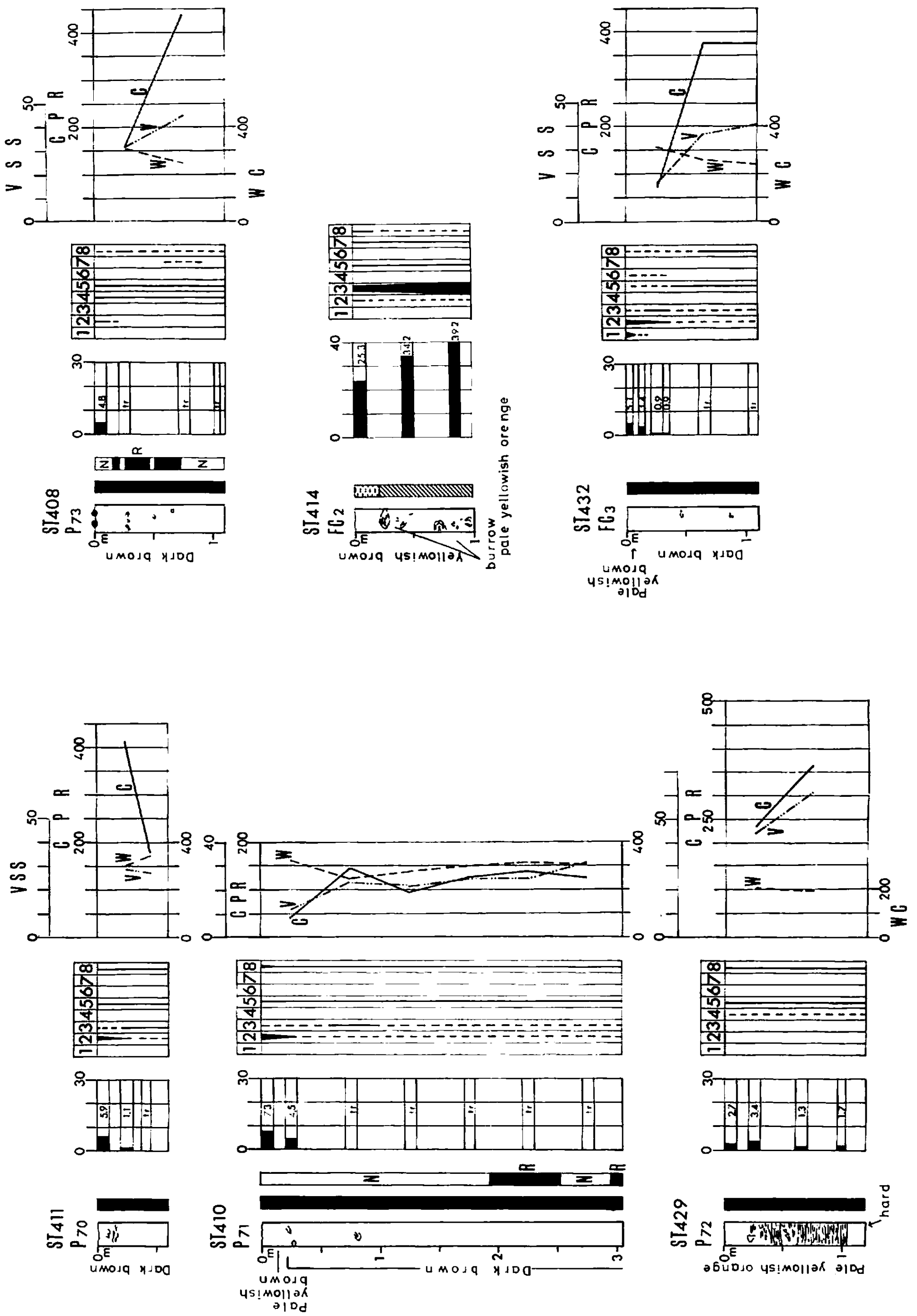
Fig. X-6 Analytical results of piston and free fall cores. All the figures are shown in the same way as Fig. X-3

St. 414A-1	04–59.4N,	172–58.3W;	depth,5380m
St. 413A	06–01.6N,	172–59.3W;	depth,5820m
St. 412A	06–59.8N,	172–59.0W;	depth,5920m
St. 411A	07–59.4N,	173–01.1W;	depth,5890m
St. 410A	08–59.2N,	173–01.0W;	depth,5860m
St. 429	08–51.4N,	174–00.4W;	depth,6310m
St. 408A	09–58.7N,	174–00.9W;	depth,5820m
St. 414	04–59.1N,	173–00.2W;	depth,5430m
St. 432	09–00.6N,	173–30.9W;	depth,5960m




ST412
P69
Dark yellowish brown
burrow
pale yellowish orenge
V S S
C P R
W C
N
R


ST413
P68
Dark yellowish brown
VSS
C P R
W C
N


ST408
P73
Dark brown
ST414
FC2
yellowish brown
burrow
pale yellowish orenge
ST432
FC3
Dark brown
Pale yellowish brown
ST411
P70
Dark brown
ST410
P71
Pale yellowish brown
Dark brown
ST429
P72
Pale yellowish orange
hard
V S S
C P R
W C

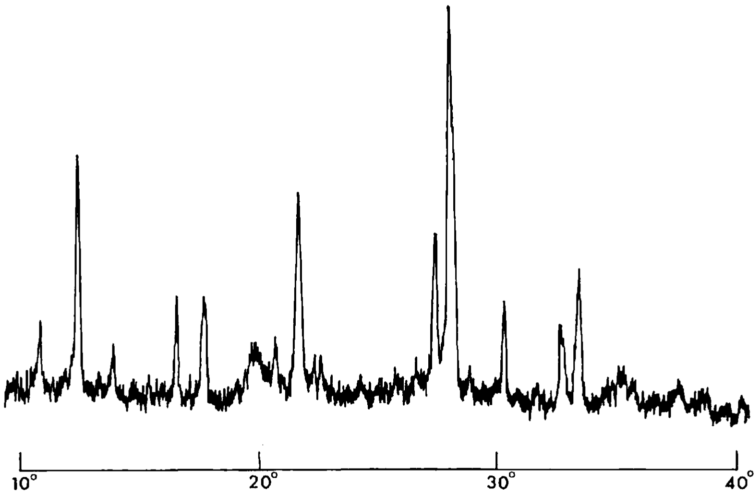


Fig. X-7 X-ray diffraction pattern of phosphorite observed in P 67.

half of the core. Remanent magnetization measurement shows the presence of a marked reversal in the lower part of the core.

St. 411A (P70): This short core of about 60 cm long wholly consists of dark colored deep sea clay with a coarse fraction of less than 5.9%. Fresh radiolaria aboundant in the upper 20 cm noticeably decreases downwards. Shark's scale and manganese micronodule are observed throughout the core, while stained radiolaria is rather abundant in the horizon with few fresh radiolaria.

St. 410A (P71): This core is represented by dark brown deep sea clay and is similar to the preceeding one. The coarse fraction in the top 30 cm rarges from 7.3–4.5% and is mainly composed of fresh radiolaria, and decreases to traceable amounts in the lower horizons, which are largely composed of shark's scale and manganese micronodule, with a small amount of fresh radiolaria. Two magnetic reversals are recognized in the lower part of the core.

St. 429A (P72): This station is situated in the GH76-1 Trough bottom over 6000 m in depth. The core is composed of deep sea clay which is characterized by a well developed thin alternation of pale yellowish orange and black colored bands. The lowest part is well lithified. Throughout the core, the coarse fraction is composed of shark's scale and manganese micronodule. No radiolaria occurs. This composition suggests a possible correlation with the part below the phosphorite zone in the P67 core.

St. 408 (P73): The core is composed of dark brown deep sea clay, similar to P70. The coarse fraction content is 4.8% in the surficial part, being composed of fresh radiolaria, and the lower part is composed of a small amount of shark's scale and silicified radiolaria. Three magnetic reversals are recognized in the horizon below 17 cm.

St. 432 (FC3): This freefall core, about 1 m long, consists of deep sea clay with a coarse fraction of less than 5%. The coarse fraction consists of diatom in the top 10–20 cm; fresh and stained radiolaria are rather abundant in the top 40 cm and shark's scale increases in amount below 40 cm.

Soft X-ray photographing of all the cores did not reveal any sedimentary structures except in the core of St. 429 (P72). The P72 core is characterized by abundant thin layer alternation on the soft X-ray picture as also visually observed. If this core can be correlated with the lower part of P67 from the similarity of coarse fraction composition, the large difference of sedimentary structure of both the cores might have resulted from the difference of the sediment supplying process in that P72 was obtained from the trough bottom.

Geological ages for these cores show a time range from Middle Tertiary to Quaternary from preliminary biostratigraphic evidence (see Chap. XIII). However, interpretation of zonation of compositional elements in these cores is still a problem. Fig. X-8 shows the relation between summarized features of cores, sampling locations and bathymetric position. So far as the available profiles are concerned, siliceous clay in the area to the south of 7°N covers the deep sea clay as a veneer of 10–20 cm thick. In the area to the north of 8°N the underlying deep sea clay is directly exposed on the sea floor. As the components of the coarse fractions in the parts that are magnetically reversed are

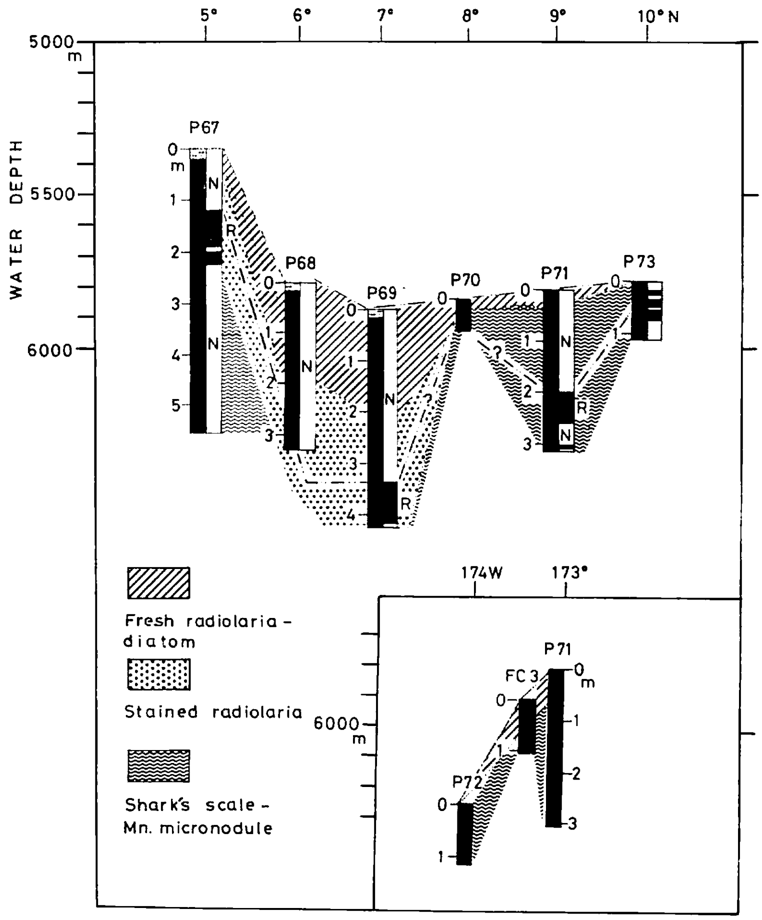


Fig. X-8 Profiles of sedimentary sequence by piston and free fall core samples.

constant among the different cores, this reversal can be regarded as a key which may suggest any geological time interval. Consequently, as shown in Fig. X-8, which is a N-S section along Long. 173°W, a sedimentary basin of Middle Tertiary age probably existed between the seamount areas.

Clay minerals

About eight samples from four cores were preliminarily investigated by S. Aoki, to study the effect of diagenesis. The clay fractions under 2 microns in size grade were collected by a sedimentation technique. The test specimens thus collected were heated or chemically treated and examined by means of X-ray diffraction. Results obtained have shown the presence of montmorillonite, chlorite, illite, kaolinite, and illite plus random mixed layer of illite-montmorillonite. Quartz and feldspar were identified in all the samples examined. Clinoptilolite was found in some samples. The clay mineral composition varies sample to sample. As shown in Fig. X-9, montmorillonite concentration in some samples increases downwards. It is considered that the presence of clinoptilolite and the downward increase of montmorillonite concentration in the cores may be the result of diagenesis.

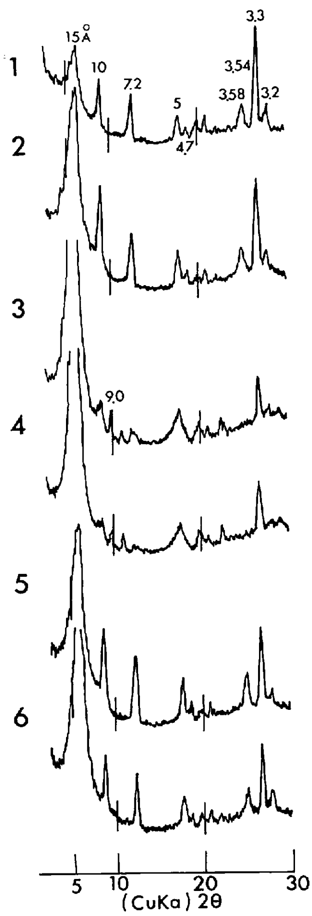


Fig. X-9 X-ray diffraction pattern of analyzed samples.
1; P71, depth, 50–60cm.
2; P71, depth, 250–260cm.
3; P72, depth, 20–30cm.
4; P72, depth, 90–100cm.
5; P73, depth, 10–20cm.
6; P73, depth, 90–100cm.

Summary

In the survey area, the distribution of surficial sedimentary facies were controlled by the presence of seamounts. These sedimentary facies are classified into calcareous ooze, calcareous-siliceous clay, and siliceous clay of Quaternary age, and deep sea clay of Middle Tertiary age. In the siliceous clay area, the relation between Quaternary and Middle Tertiary sediments is unconformable and Quaternary sediments of only 20 cm thickness cover the Middle Tertiary deposits. The deep sea clay area is considered to have been a non-depositional area in Quaternary time. Some zonation of compositional elements is generally recognized in the core samples, and the magnetic reversal in each of the cores is the key marker bed of Middle Tertiary age.

Acknowledgment

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