VII. BOTTOM SEDIMENTS IN THE GH78-1 AREA

Seizo Nakao and Taisuke Suzuki

Method

31 sediment samples were obtained from the survey area with Okean-70 grab sampler or box sampler, and 1 sample with deep sea camera in its frame pipe. Those samples were treated in the same process as those in the previous cruise, GH77-1 (NAKAO, 1979).

Composition of the coarse fraction and the types of sediment

Natural property and composition of the coarse fraction (>63 micron) settled in the sedimentation tube were described in the previous report (NAKAO, 1979).

The following types of sediments, two of which, i.e. (6) and (7) are newly defined in this report, are identified;

(1) deep sea clay: coarse fraction <10%, or 10–30% and non-biogenic (consists largely of "mineral" and silicified radiolarian remains),
(2) siliceous clay: coarse fraction 10–30%, radiolarian,
(3) calcareous-siliceous clay: coarse fraction 10–30%, foraminiferal-radiolarian,
(4) siliceous ooze: coarse fraction >30%, radiolarian,
(5) calcareous ooze: coarse fraction >30%, foraminiferal,
(6) calcareous-siliceous ooze: coarse fraction >30%, foraminiferal-radiolarian, and
(7) zeolitic mud: coarse fraction >30%, zeolitic.

Distribution of surface sediment

Fig. VII-1 shows distribution of the surface sediments classified into seven types mentioned in the preceding section. The southern half of the area is characterized by the distribution of biogenic sadiments, on the other hand the northern half by non-biogenic ones.

The coarse fraction consists almost exclusively of foraminiferal remains at the station 1075 (water depth, 4,028 m), and foraminiferal-radiolarian at St. 1070 (WD 4,947 m) as shown in Fig. VII-2(h). Maximum water depth where foraminiferal remains are found in the coarse fraction of the surface sediment is 5,250 m (St. 1067).

The main zone of siliceous clay (St. 1059) is continuous from the east adjacent area, GH77-1. Siliceous ooze, the coarse fraction of which consists dominantly of stained radiolarian remains, is distributed in the borderland between siliceous clay and deep sea clay, in the same manner as the case in GH77-1 (St. 731 and 732). In other words, the change of the coarse fraction ratio is not concordant with the change of water depth. This fact suggests some sorting effect which can concentrate radiolarian remains in the sediment.

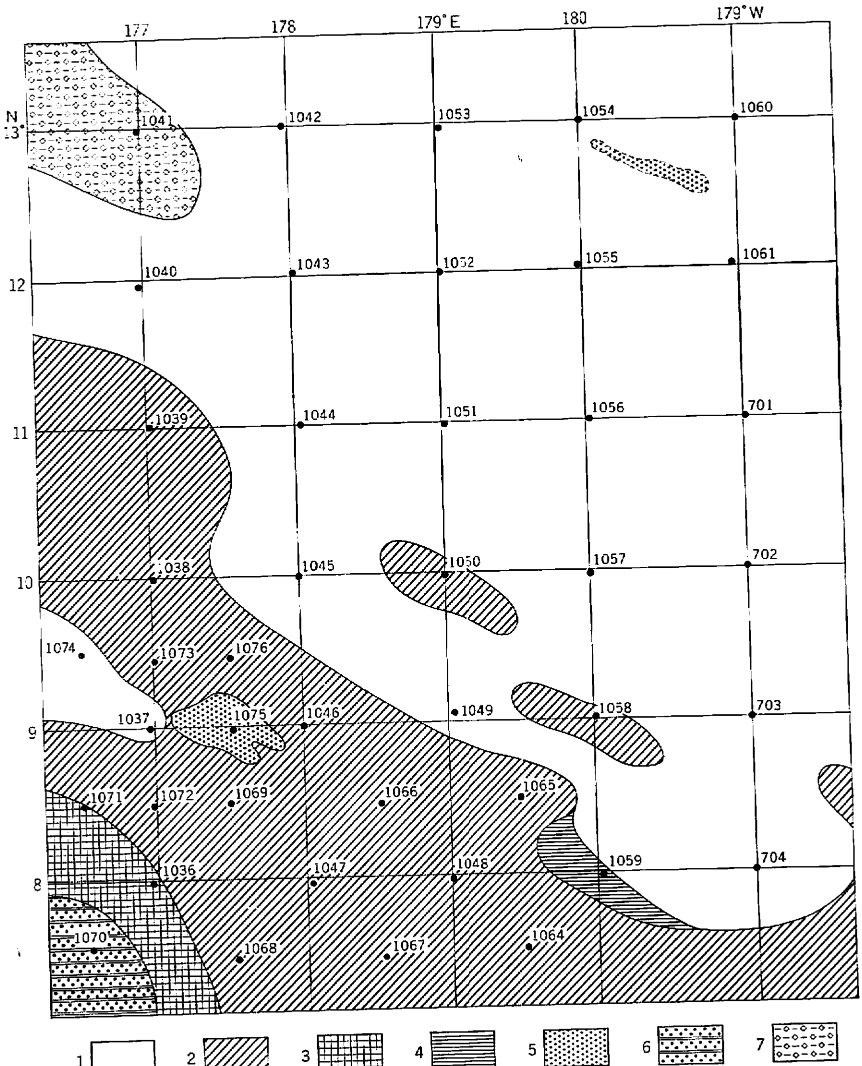
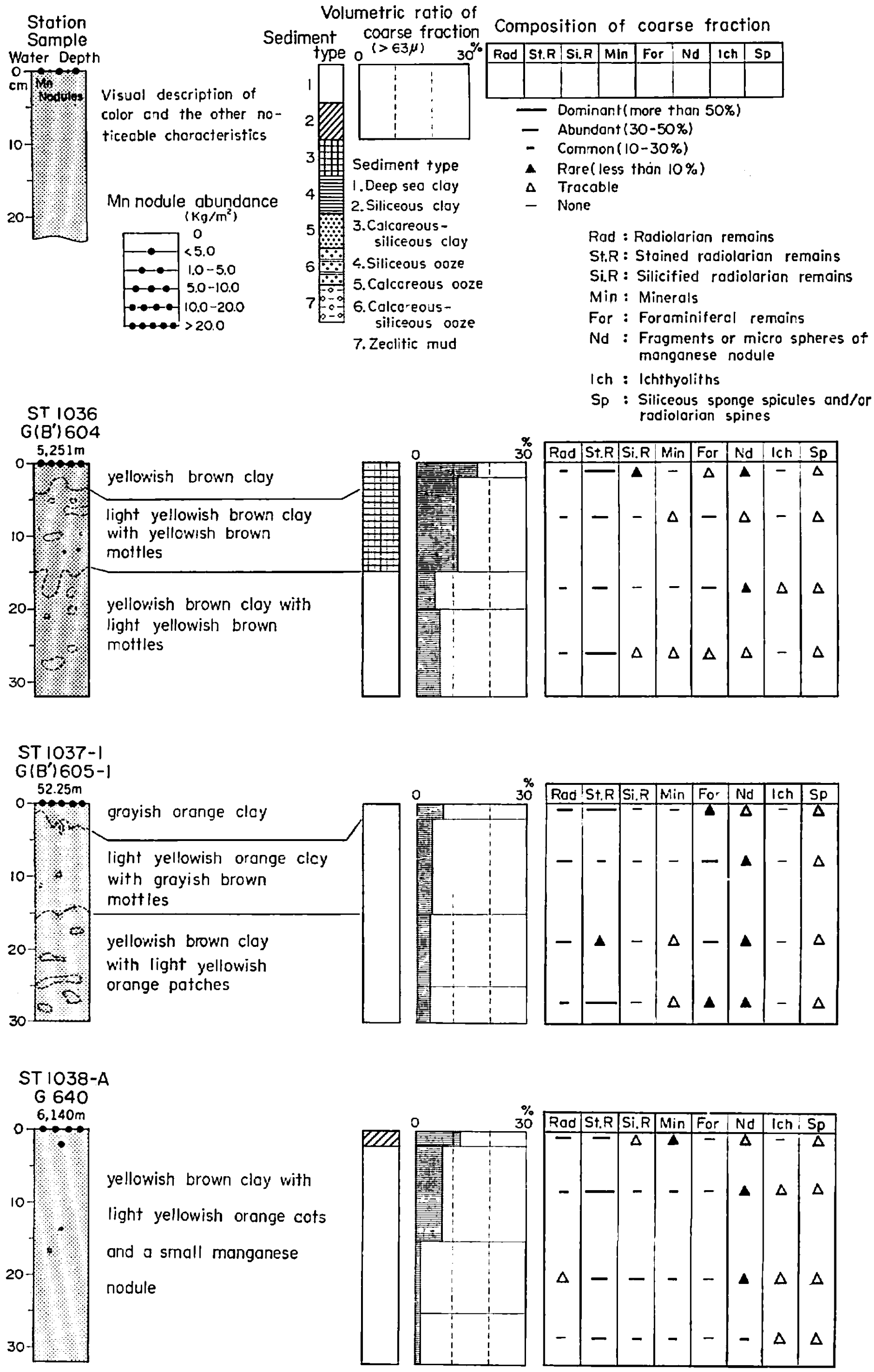


Fig. VII-1 Distribution of the surface sediments. 1. Deep sea clay, 2. Siliceous clay, 3. Calcareous-siliceous clay, 4. Siliceous ooze, 5. Calcareous ooze, 6. Calcareous-siliceous ooze, 7. Zeolitic mud.

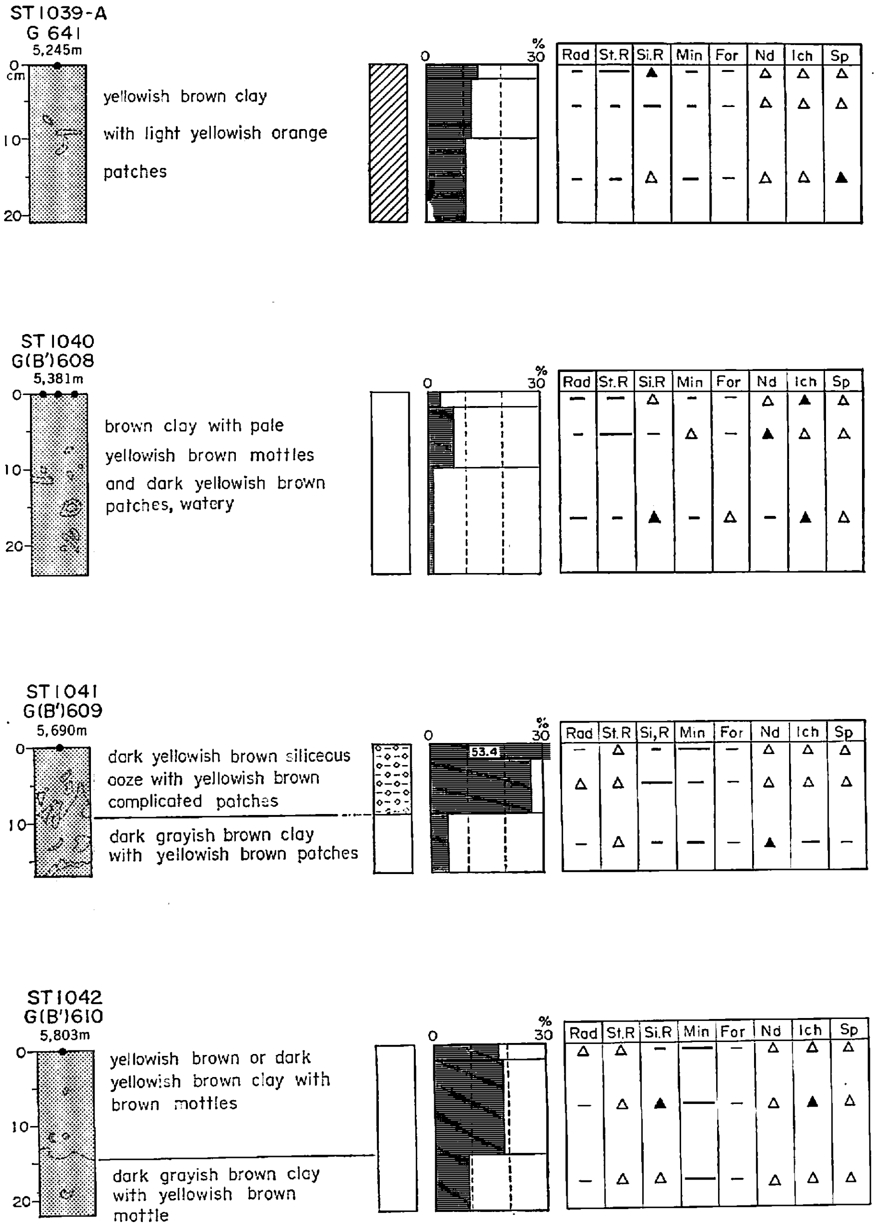
Deep sea clay is extensively distributed. However, it is very important to point out that more than 30% of the coarse fraction of deep sea clay consists of radiolarian (including the stained) remains, at about half the number of those stations (Fig. VII-3 (a) and (b)). At the remaining stations, the coarse fraction of deep sea clay consists of dominant zeolite (phillipsite) grains and abundant or common silicified radiolarian remains, in general.

There is presumable distribution of calcareous ooze near the northeast corner



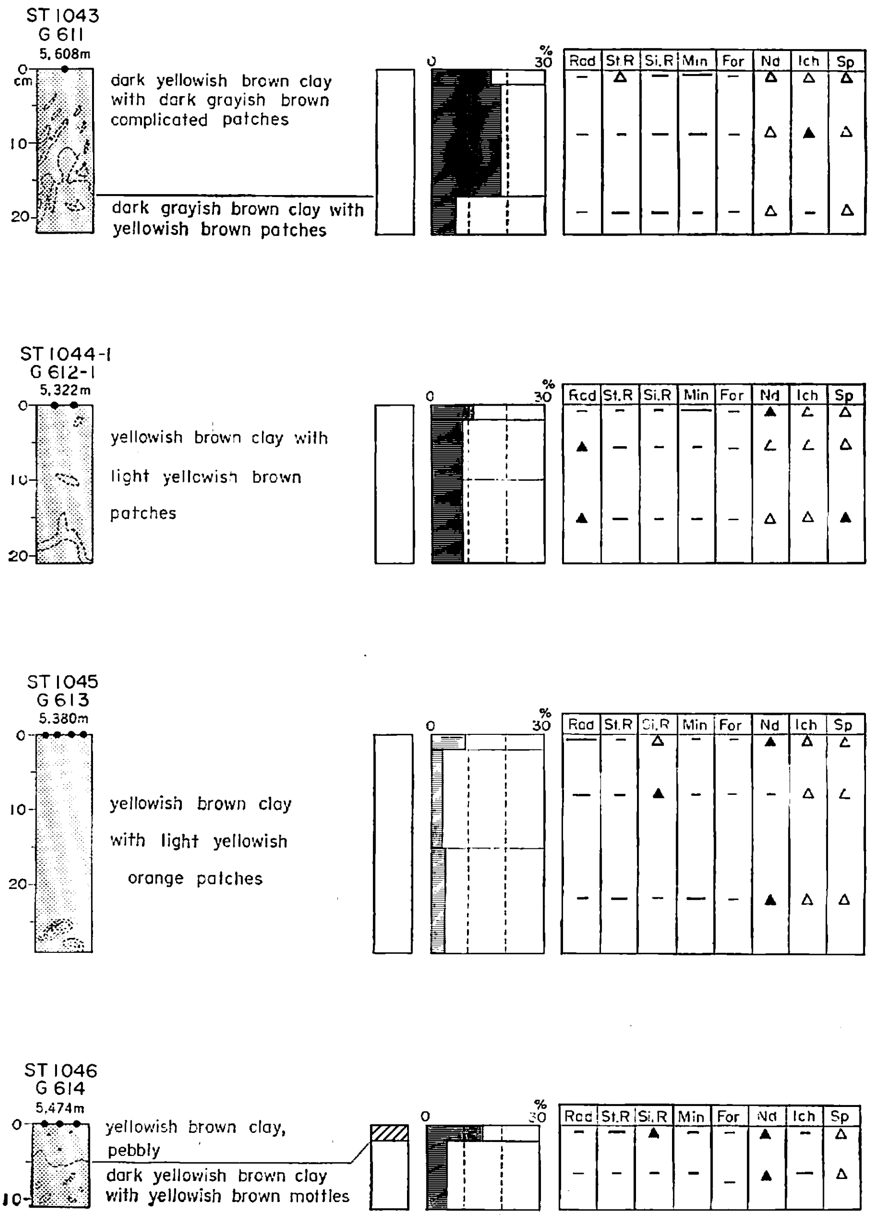
(a)

Fig. VII-2 (a–h) Description of the samples from Okean-70 or box sampler.

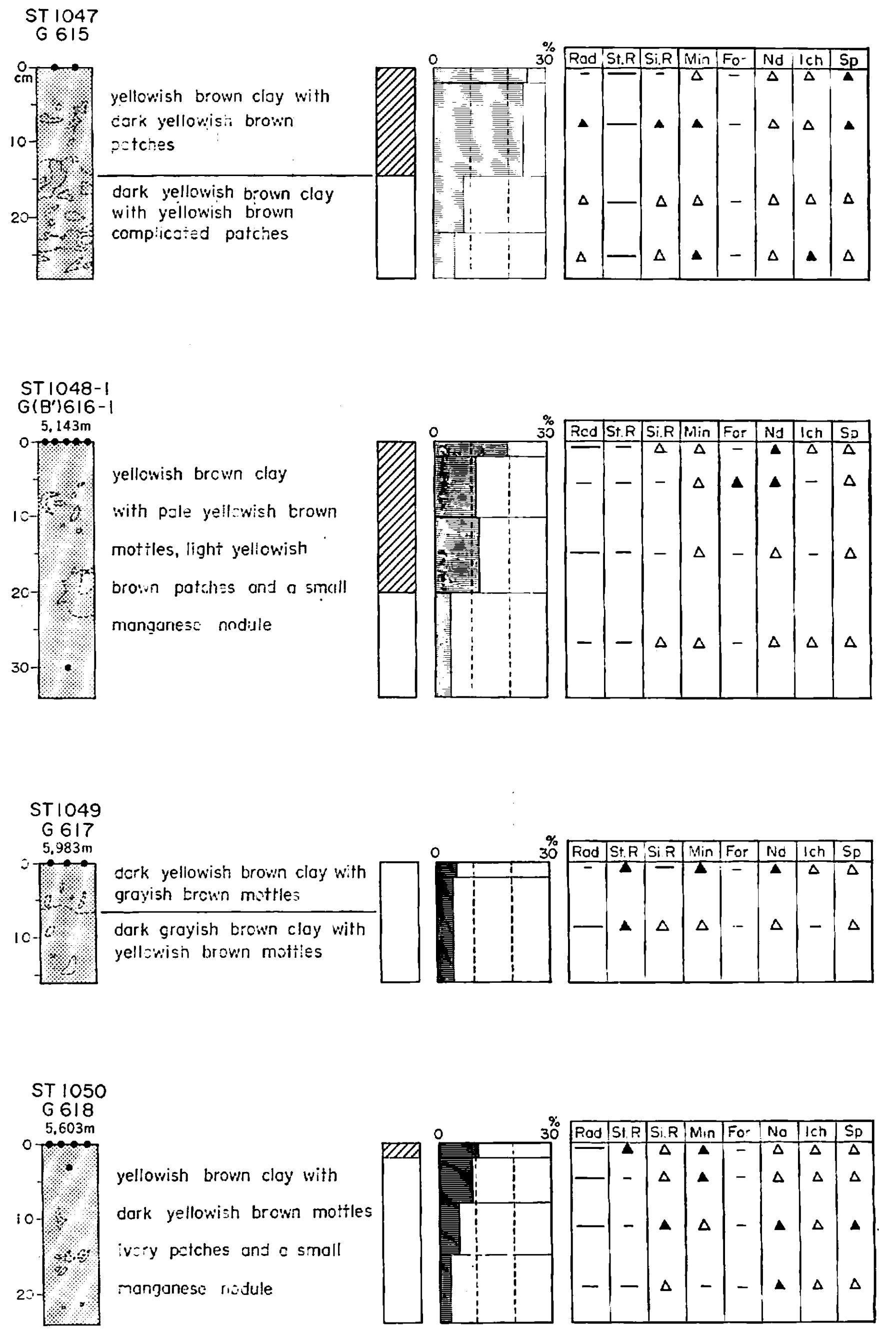


ST1039-A
G 641
5,245m
0
cm
10
20
yellowish brown clay
with light yellowish orange
patches
0
%
30
Rad
St.R
Si.R
Min
For
Nd
Ich
Sp
ST1040
G(B')608
5,381m
0
10
20
brown clay with pale
yellowish brown mottles
and dark yellowish brown
patches, watery
ST1041
G(B')609
5,690m
0
10
dark yellowish brown siliceous
ooze with yellowish brown
complicated patches
dark grayish brown clay
with yellowish brown patches
53.4
ST1042
G(B')610
5,803m
0
10
20
yellowish brown or dark
yellowish brown clay with
brown mottles
dark grayish brown clay
with yellowish brown
mottle

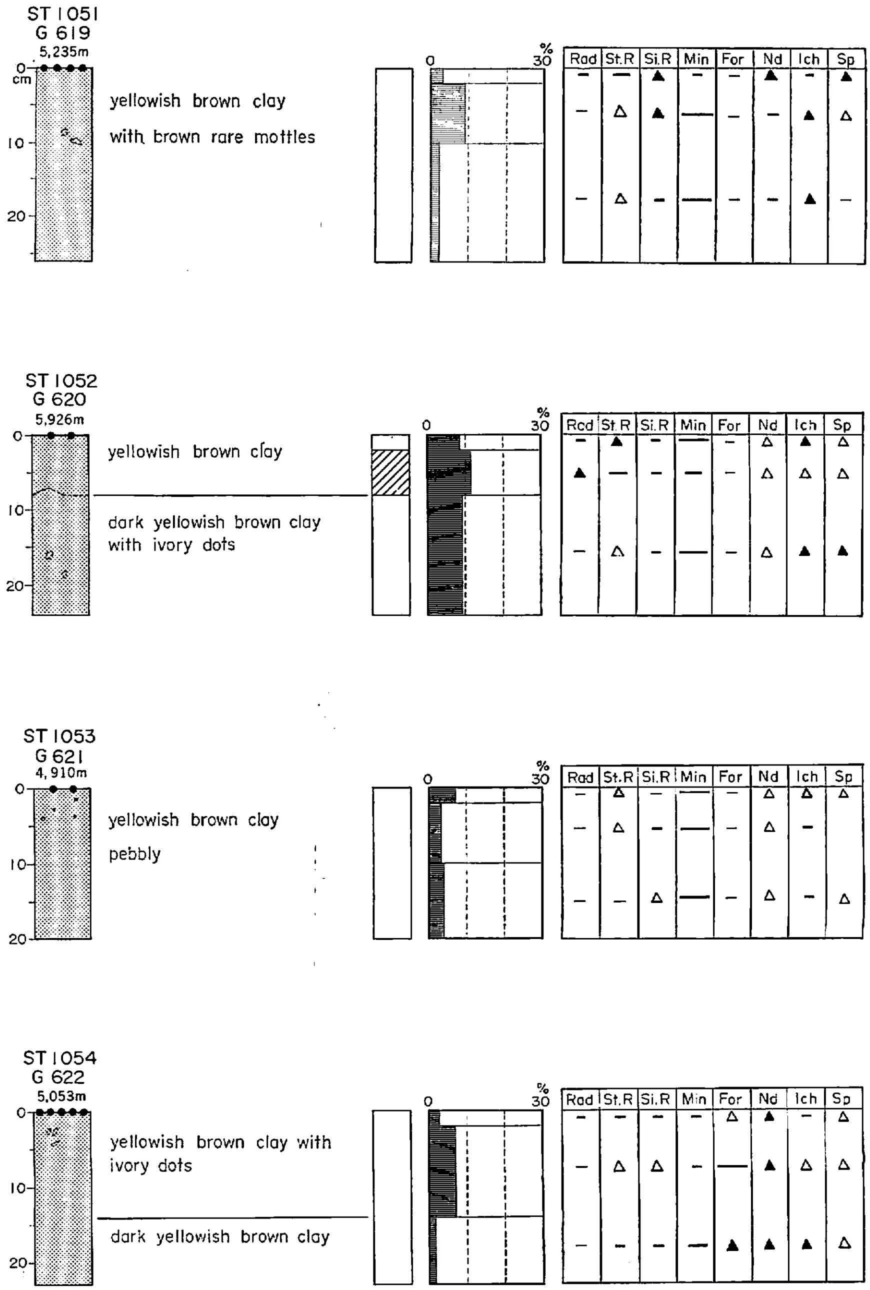
(b)


ST 1043
G 611
5,608m
0
cm
10
20
dark yellowish brown clay with dark grayish brown complicated patches
dark grayish brown clay with yellowish brown patches
0
%
30
Rad
St.R
Si.R
Min
For
Nd
Ich
Sp
ST 1044-I
G 612-I
5,322m
yellowish brown clay with light yellowish brown patches
ST 1045
G 613
5,380m
yellowish brown clay with light yellowish orange patches
ST 1046
G 614
5,474m
yellowish brown clay, pebbly
dark yellowish brown clay with yellowish brown mottles

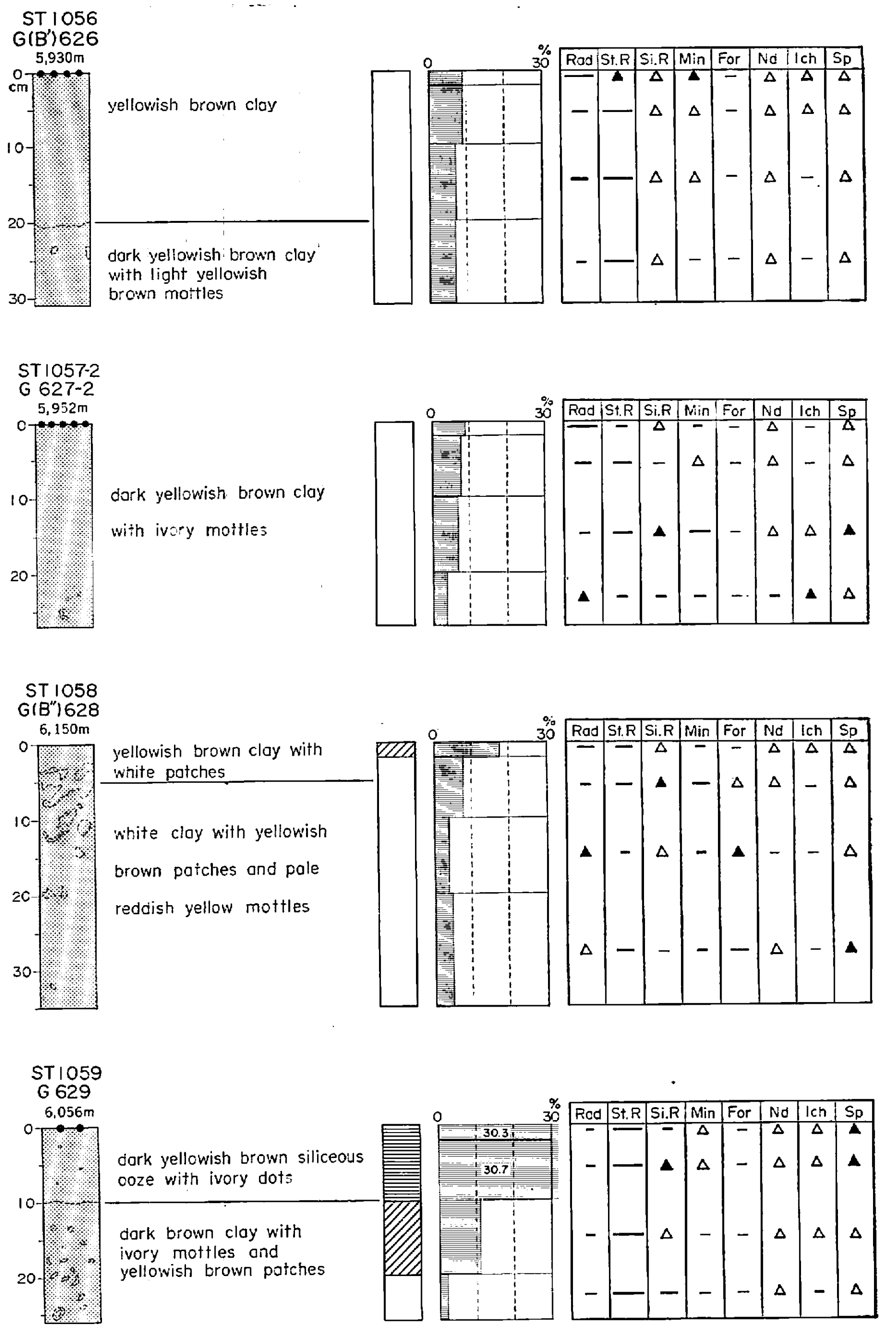
(c)


ST 1047
G 615
0
cm
10
20
yellowish brown clay with dark yellowish brown patches
dark yellowish brown clay with yellowish brown complicated patches
0
%
30
Rad
St.R
Si.R
Min
For
Nd
Ich
Sp
ST 1048-1
G(B')616-1
5,143m
0
10
20
30
yellowish brown clay with pale yellowish brown mottles, light yellowish brown patches and a small manganese nodule
ST 1049
G 617
5,983m
0
10
dark yellowish brown clay with grayish brown mottles
dark grayish brown clay with yellowish brown mottles
ST 1050
G 618
5,603m
0
10
20
yellowish brown clay with dark yellowish brown mottles ivory patches and a small manganese nodule

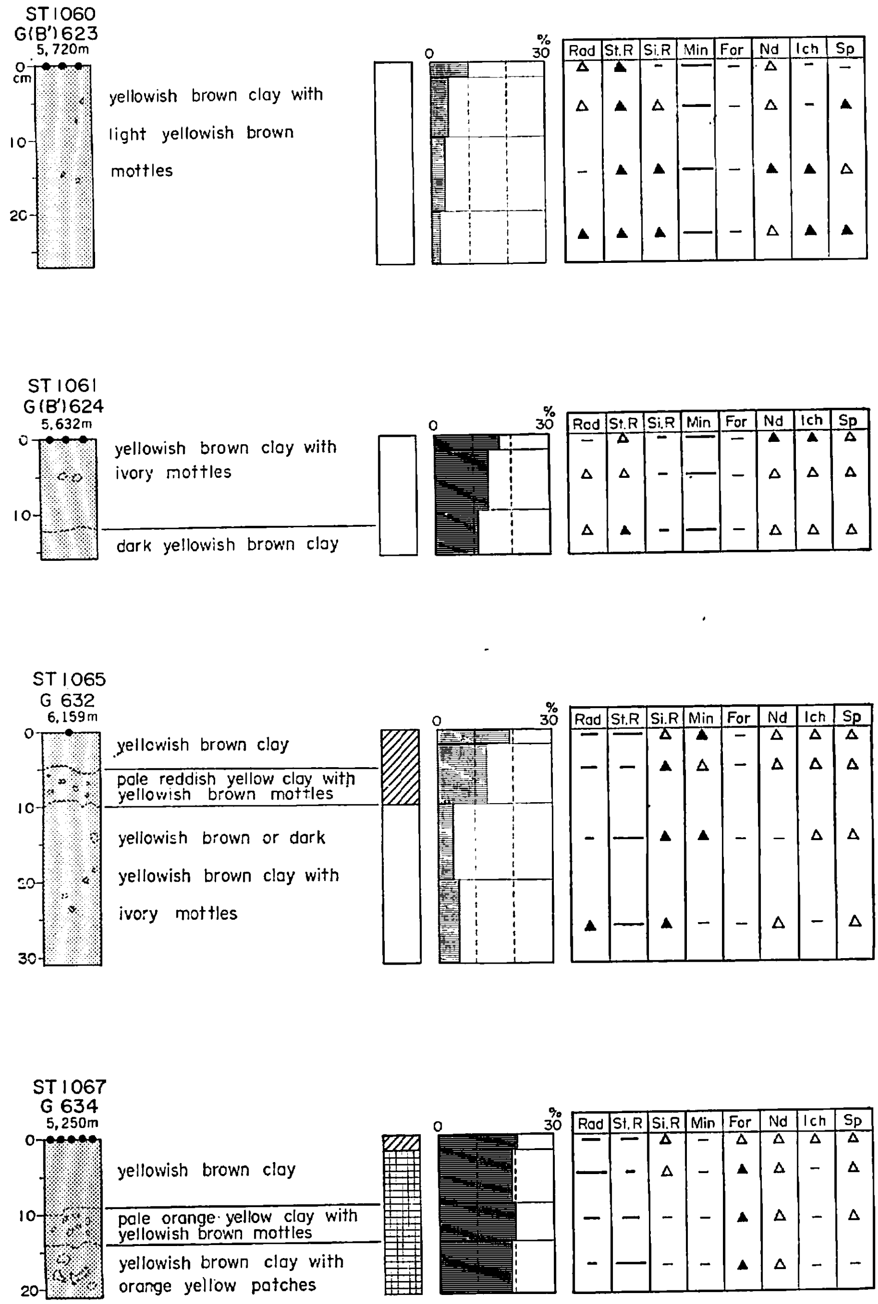
(d)


ST 1051
G 619
5,235m
cm
yellowish brown clay
with brown rare mottles
ST 1052
G 620
5,926m
yellowish brown clay
dark yellowish brown clay
with ivory dots
ST 1053
G 621
4,910m
yellowish brown clay
pebbly
ST 1054
G 622
5,053m
yellowish brown clay with
ivory dots
dark yellowish brown clay
0
10
20
%
30
Rad
St.R
Si.R
Min
For
Nd
Ich
Sp

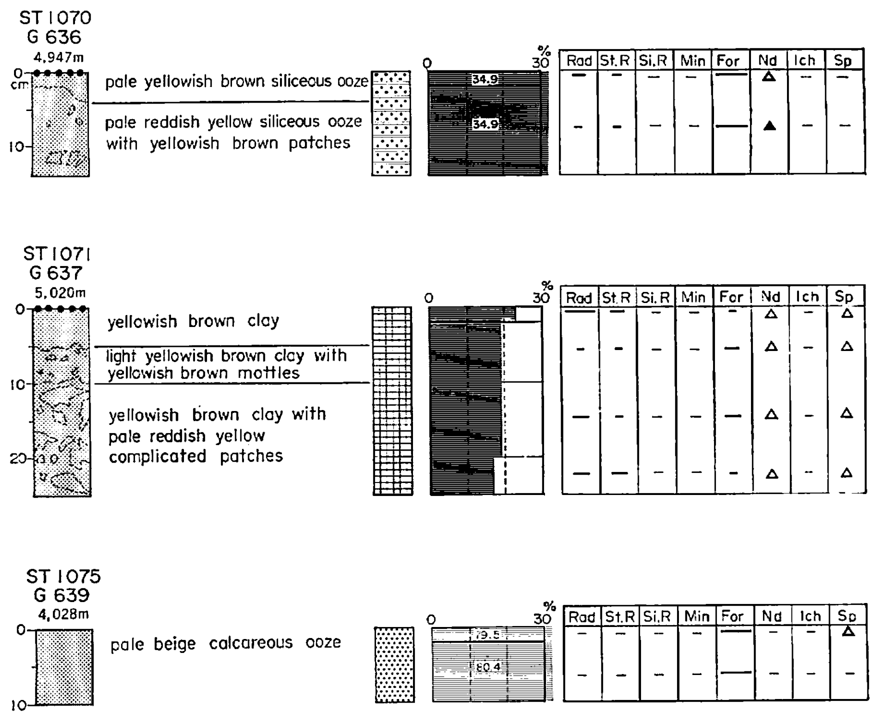
(e)


ST 1056
G(B')626
5,930m
cm
yellowish brown clay
dark yellowish brown clay
with light yellowish
brown mottles
%
Rad
St.R
Si.R
Min
For
Nd
Ich
Sp
ST 1057-2
G 627-2
5,952m
dark yellowish brown clay
with ivory mottles
ST 1058
G(B")628
6,150m
yellowish brown clay with
white patches
white clay with yellowish
brown patches and pale
reddish yellow mottles
ST 1059
G 629
6,056m
dark yellowish brown siliceous
ooze with ivory dots
dark brown clay with
ivory mottles and
yellowish brown patches
30.3
30.7

(f)


ST 1060
G(B')623
5,720m
yellowish brown clay with light yellowish brown mottles
ST 1061
G(B')624
5,632m
yellowish brown clay with ivory mottles
dark yellowish brown clay
ST 1065
G 632
6,159m
yellowish brown clay
pale reddish yellow clay with yellowish brown mottles
yellowish brown or dark yellowish brown clay with ivory mottles
ST 1067
G 634
5,250m
yellowish brown clay
pale orange-yellow clay with yellowish brown mottles
yellowish brown clay with orange yellow patches
Rad St.R Si.R Min For Nd Ich Sp
0 % 30
cm

(G)


ST 1070
G 636
4,947m
0
cm
10
pale yellowish brown siliceous ooze
pale reddish yellow siliceous ooze
with yellowish brown patches
0
%
30
34.9
34.9
Rad
St.R
Si.R
Min
For
Nd
Ich
Sp
ST 1071
G 637
5,020m
0
10
20
yellowish brown clay
light yellowish brown clay with
yellowish brown mottles
yellowish brown clay with
pale reddish yellow
complicated patches
0
%
30
Rad
St.R
Si.R
Min
For
Nd
Ich
Sp
ST 1075
G 639
4,028m
0
10
pale beige calcareous ooze
0
%
30
79.5
80.4
Rad
St.R
Si.R
Min
For
Nd
Ich
Sp

(h)

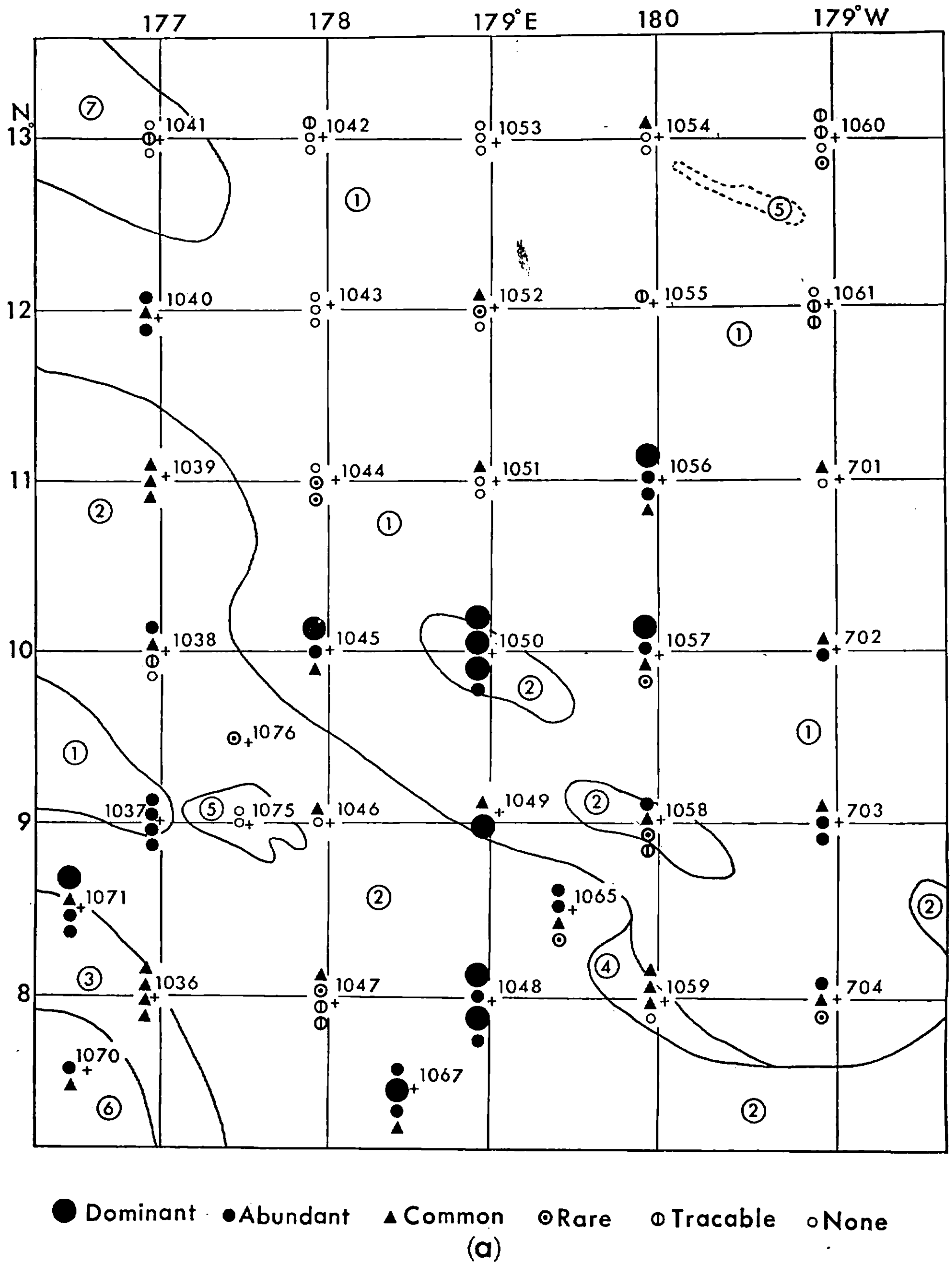
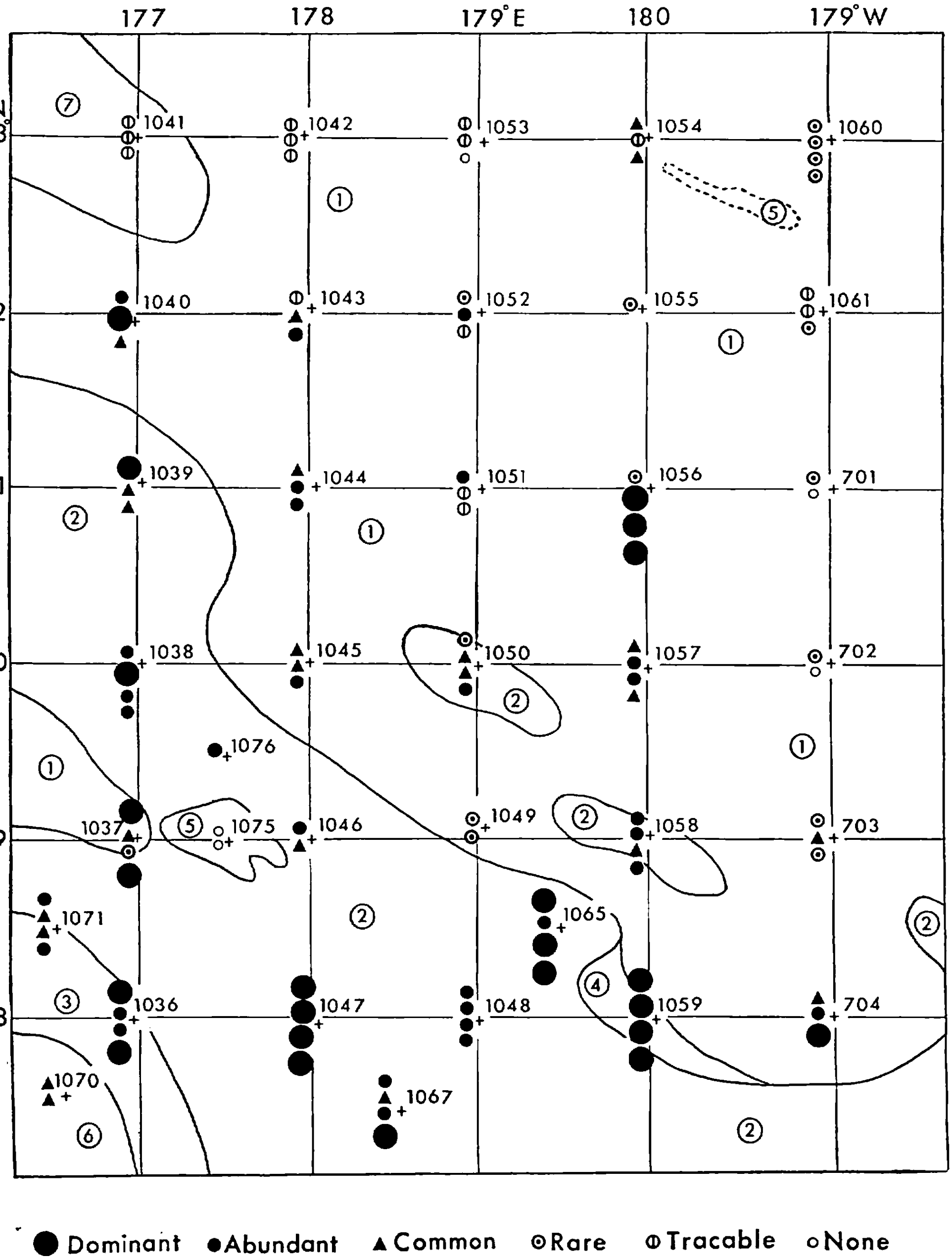
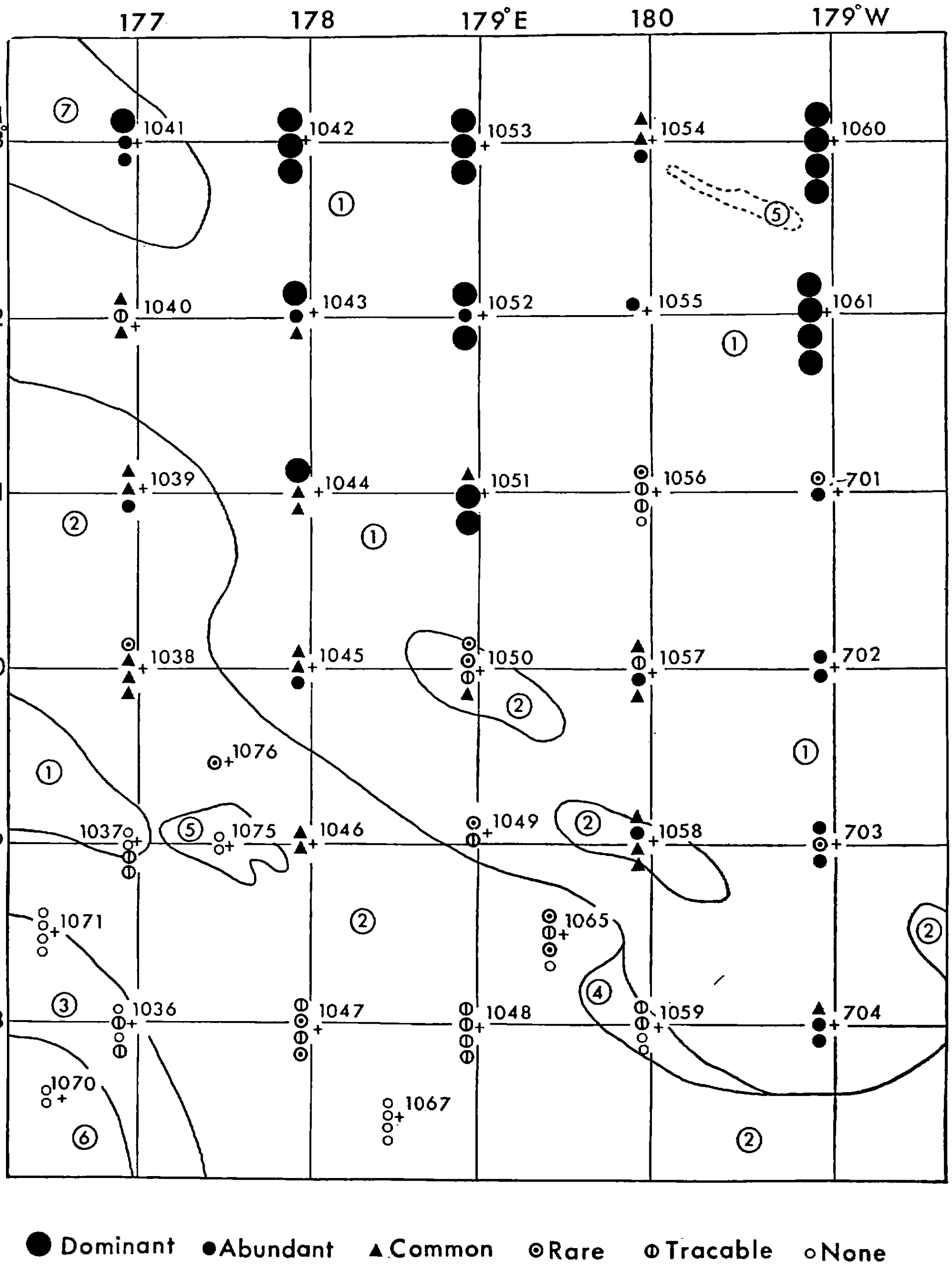


Fig. VII-3 (a-d) Distribution of the major components in the coarse fraction (>63 μm). (a) Radiolarian remains, (b) Stained radiolarian remains, (c) Minerals and (d) Foraminiferal remains. Expression of abundance corresponds to that in Fig. VII-2, namely "Dominant" means the abundance of more than 50%, "Abundant" between 30 and 50% etc.

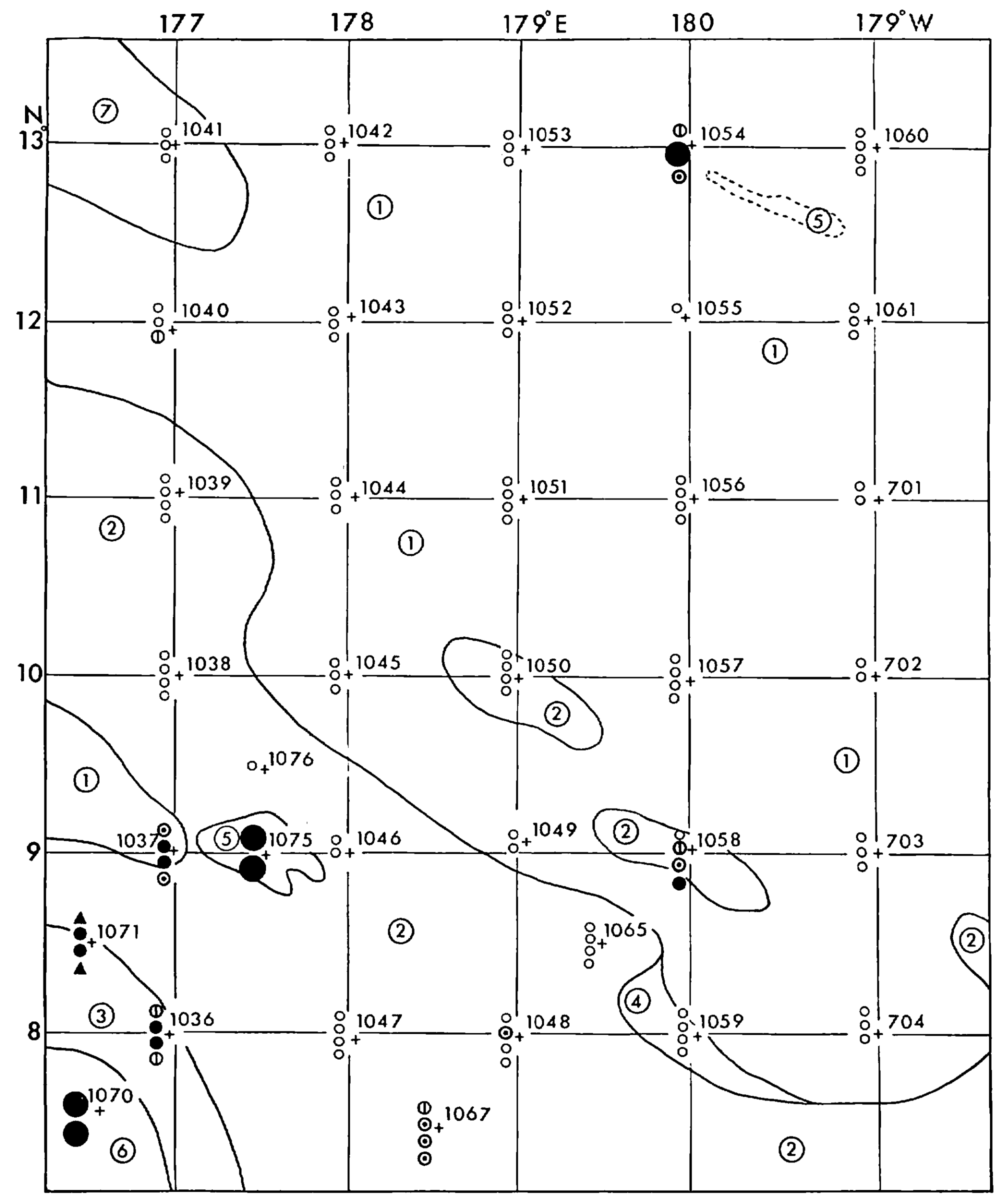

177
178
179°E
180
179°W
N
13°
12
11
10
9
8
1041
1042
1053
1054
1060
1040
1043
1052
1055
1061
1039
1044
1051
1056
701
1038
1045
1050
1057
702
1076
1037
1075
1046
1049
1058
703
1071
1065
1036
1047
1048
1059
704
1070
1067
● Dominant ●Abundant ▲Common ⊙Rare ⊕Tracable ○None

(b)



177
178
179°E
180
179°W
N
13°
12
11
10
9
8
1041
1042
1053
1054
1060
1040
1043
1052
1055
1061
1039
1044
1051
1056
701
1038
1045
1050
1057
702
1076
1037
1075
1046
1049
1058
703
1071
1065
1036
1047
1048
1059
704
1070
1067
Dominant
Abundant
Common
Rare
Tracable
None

(c)



Dominant ●Abundant ▲Common ⊙Rare ⦶Tracable ○None

(d)

of the survey area. This presumption is based upon dominant foraminiferal remains in the coarse fraction of the sample just beneath the surface from St. 1054 (Fig. VII-3 (d)) and topographic high shallower than 4,500 m.

Zeolitic mud from St. 1041 has the coarse fraction which consists of dominant (about 60%) zeolite (phillipsite) grains and common (almost 30%) silicified radiolarian remains. The coarse fraction ratio of that sample is up to 53.4%.

Sequence in sediment cores

Fig. VII-2 (a–h) shows vertical section, type of sediment, composition of the coarse fraction of the cores from Okean-70 or box sampler. Surface and vertical distribution of major components in the coarse fraction is shown in Fig. VII-3 (a–d), photographs of vertical section of the core samples in Fig. VII-4 (a–e) and Softex-radiographs of sliced core samples in Fig. VII-5 (a–f).

Mottle structure, which suggests bioturbation in the past, is more or less observed on the vertical sections of almost all cores. However, occurrence of abundant and large-scale mottle structure is restricted in the zone south of the parallel of latitude, 9°N.

The sediment with the coarse fraction of more than 10% is thin in general. Those have such fraction ratio throughout the whole core length are found at the stations, 1039 (core length: 20 cm), 1061 (16 cm), 1067 (21 cm), 1070 (14 cm), 1071 (25 cm) and 1075 (10 cm). Among those, however, only the two samples, i.e. those from St. 1039 and 1061 are free from foraminiferal remains in the coarse fraction. The sample from St. 1039 has the coarse fraction consisting of dominant (ca. 60%) stained radiolarian remains in the surface and abundant (ca. 45%) "mineral" in the bottom. And the coarse fraction of the sample from St. 1061 consists dominantly of zeolite grains.

Abrupt decreasing (to less than half of that in the uppermost or upper adjacent part) of the coarse fraction ratio is observed in about half the number of core samples. This phenomenon is common also in some samples, the coarse fractions of which consist largely of "mineral".

In some vertical sequences, temporary increasing of foraminiferal remains in the coarse fraction is observed (Fig. VII-3(d), St. 1036, 1037, 1048, 1054 and 1071). It cannot be clarified whether this increasing is caused by the oscilation of primary supply of calcareous material or rather rapid redistribution of pre-existent foraminiferal sediment.

Stratigraphy

Although concrete stratigraphic evidence has not been proved for this cruise, some presumption may be given through the petrographic comparison of the samples with those in the previous cruise, GH77-1, for which radiolarian biostratigraphy has been clarified for 8 samples including 3 long cores (SAKAI, private communication).

Compiled data of that radiolarian biostratigraphy, foraminiferal biostratigraphy (NATORI, private communication, in NAKAO, 1979) and the coarse fraction petrography suggest following criteria for presumption of geologic age of the samples.

1) The sample, coarse fraction of which consists fresh radiolarian remains as a major component, small amount of stained radiolarian remains, if any, and no silicified radiolarian remains, will be of Quaternary age. Volumetric ratio of the coarse fraction of such a sample usually exceeds several percent.
2) Calcareous and calcareous-siliceous sediments which are distributed at topographic highs in the area of GH77-1 are of Quaternary age.
3) Abrupt decreasing of the coarse fraction ratio mentioned above, in the sample with radiolarian and stained radiolarian remains in its coarse fraction, seems to appear around the boundary between Tertiary and Quaternary deposits.
4) Silicified radiolarian remains indicate older age, in general, but reworking and redistribution of those particles, and bioturbation of the sediments should be taken into account.
5) "Mineral" grains (mainly zeolite mineral) increase in the coarse fraction toward older age. And the sediment, in the coarse fraction of which "mineral" component is abundant or dominant, seems to be of Tertiary age. Considerations for reworking and redistribution of those, and bioturbation of the sediments are necessary, too.

According to the application of those criteria mentioned above, following presumptions on geologic age and stratigraphy of the sediment in this area (GH78-1) can be given.

1) The surface sediments, which are distributed in the zone south of the parallel of latitude 10°N, will be of Quaternary age, except at St. 1059 and 1076, where the sediments may be of Tertiary age. However, the thickness of the Quaternary sediment seems to be thinner than 20 cm in the case of non-calcareous sediment, because the sediment showing characteristics of Tertiary age underlies those Quaternary sediment in such a case.
2) In the northern half of the area, the sediments of possible Quaternary age are distributed at the stations 1051, 1052, 1054 and 1056. Other than those it seems Quaternary sediments are distributed on the surface of the stations 1039, 1040 and 1055.

As for the zeolite rich deep sea clay and the zeolitic mud in the northern half of the area, further study is necessary to presume the geologic age of those. KASTNER and STONECIPHER (1978) point out that phillipsite predominates in volcanogenic and clayey sediments (sedimentation rates of $< 5\ m/10^6$ years) of Recent to Eocene age, that it starts to form at the sediment-water interface and that the most common precursor is volcanic (basaltic) material, in particular basaltic glass and palagonite.

Thus, the occurrence of phillipsite is not to be a criterion to distinguish the geologic age, Quaternary from Tertiary, of the sediment. However, phillipsite occurs with silicified radiolarian remains in this area, in general. Furthermore, phillipsite rich sediment underlies calcareous sediment which will be of Quaternary age at the station, 1054. Those facts lead us to the presumption that the phillipsite rich sediment in this area is not to be of Quaternary age.

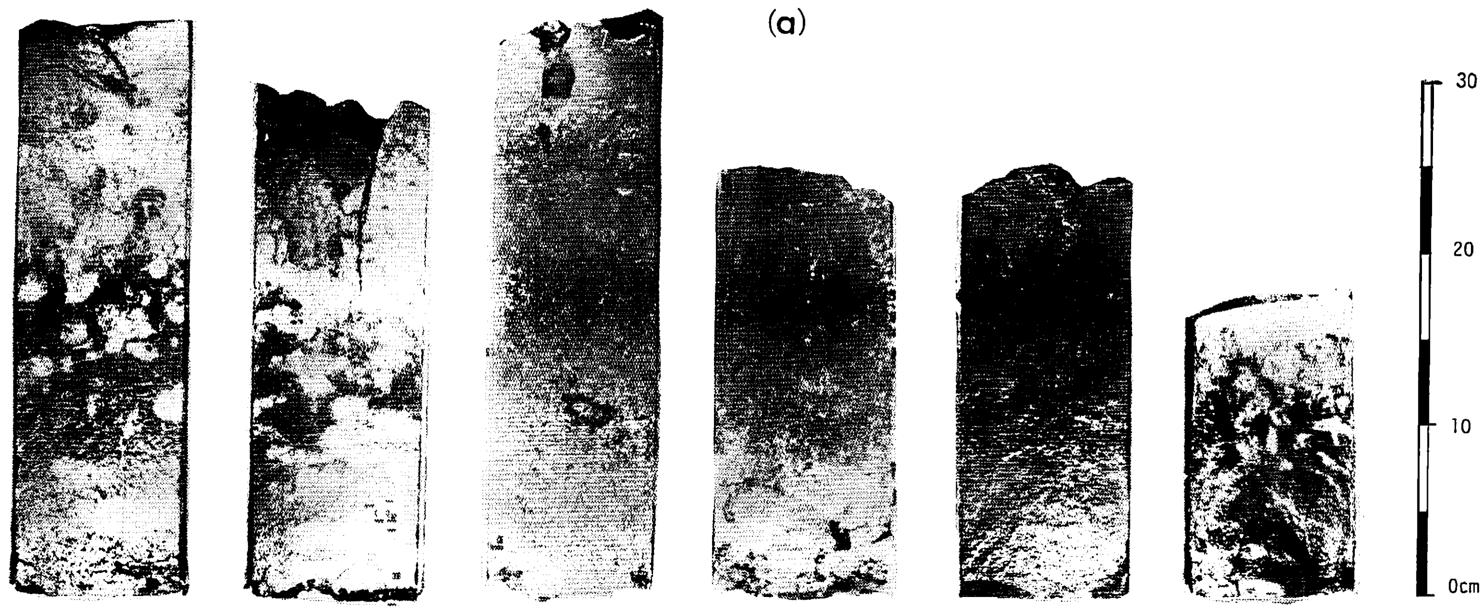
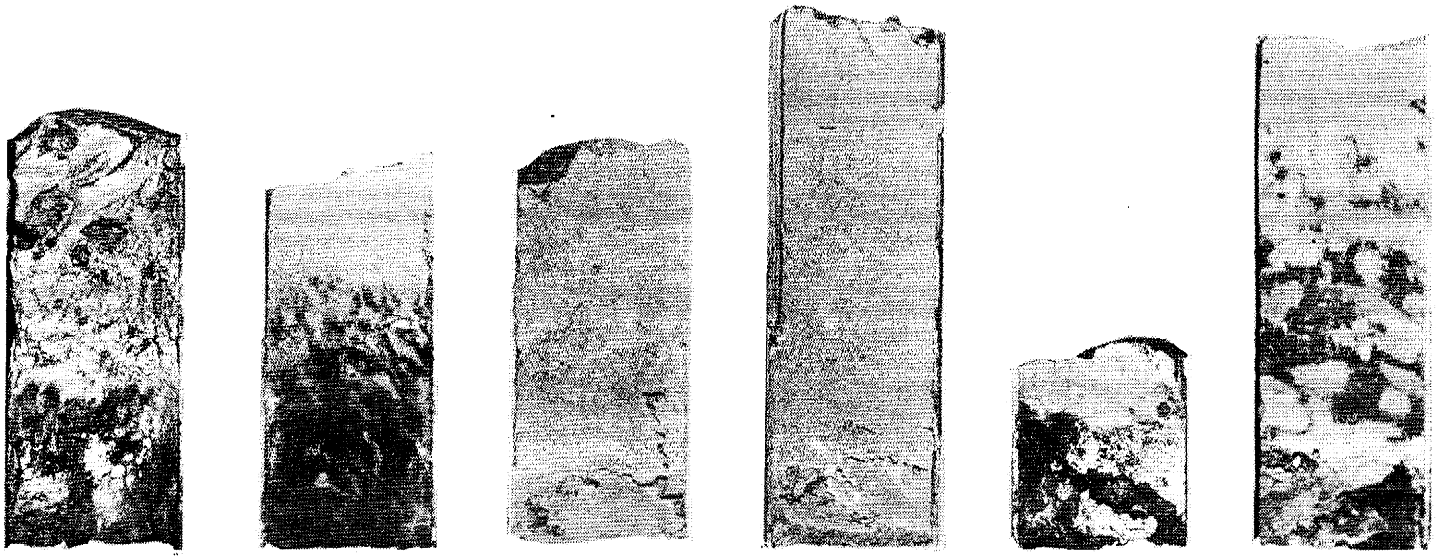


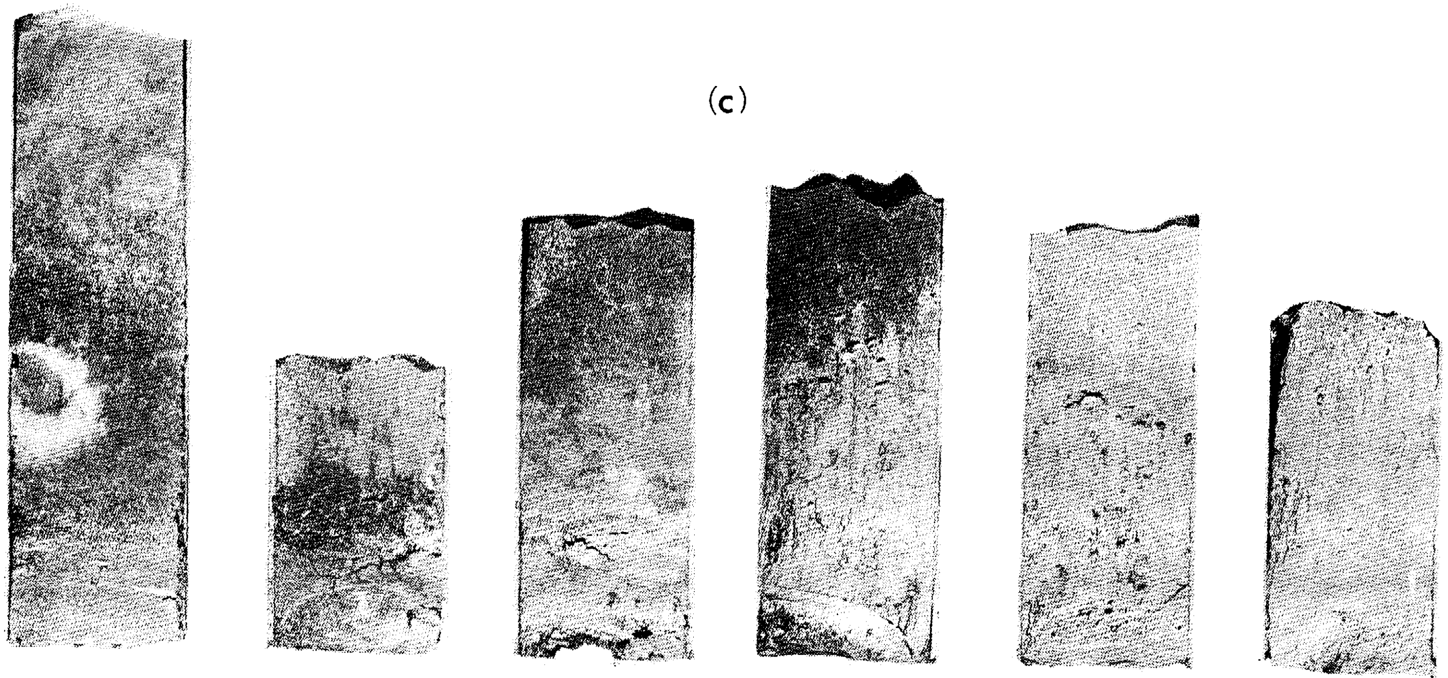
Fig. VII-4 (a-e) Photographs of vertical section of the core samples from Okean-70 or box sampler.

(b)



St.No.1042 G(B')610 | StNo.1043 G611 | St.No.1044-1 G612-1 | St.No.1045 G613 | St.No.1046 G614 | St.No.1047 G615

(c)



St.No.1048-1 G(B')616-1

St.No.1049 G617

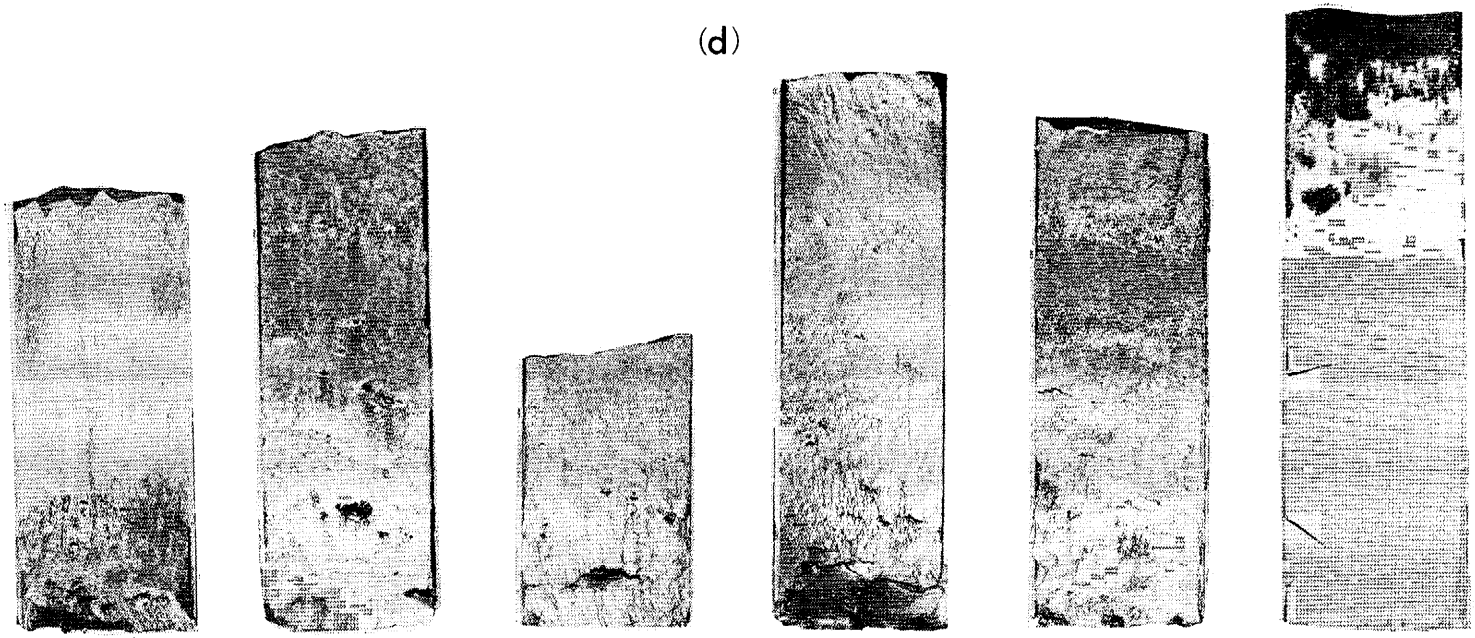
St.No.1050 G618

St.No.1051 G619

St.No.1052 G620

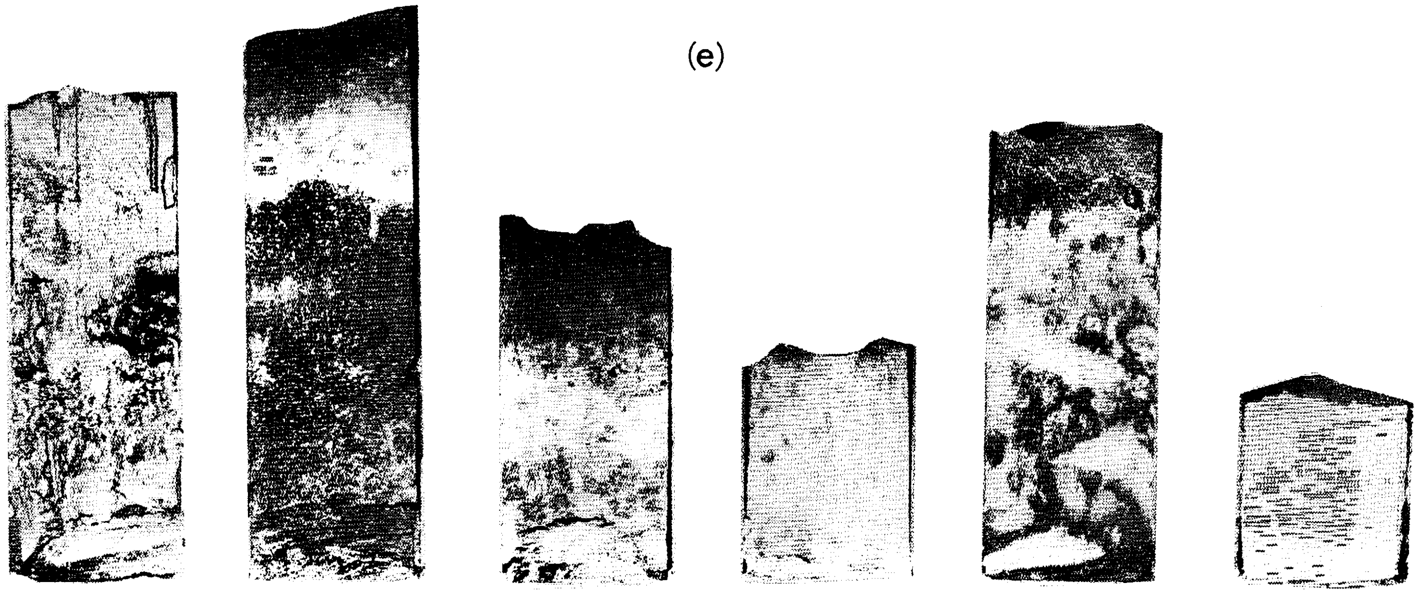
St.No.1053 G621

(d)



St.No.1054 G622 | St.No.1060 G(B')623 | St.No.1061 G(B')624 | St.No.1056 G(B')626 | St.No.1057-2 G627-2 | St.No.1058 G(B")628

(e)



St.No.1059 G629 | St.No.1065 G632 | St.No.1067 G634 | St.No.1070 G636 | St.No.1071 G637 | St.No.1075 G639

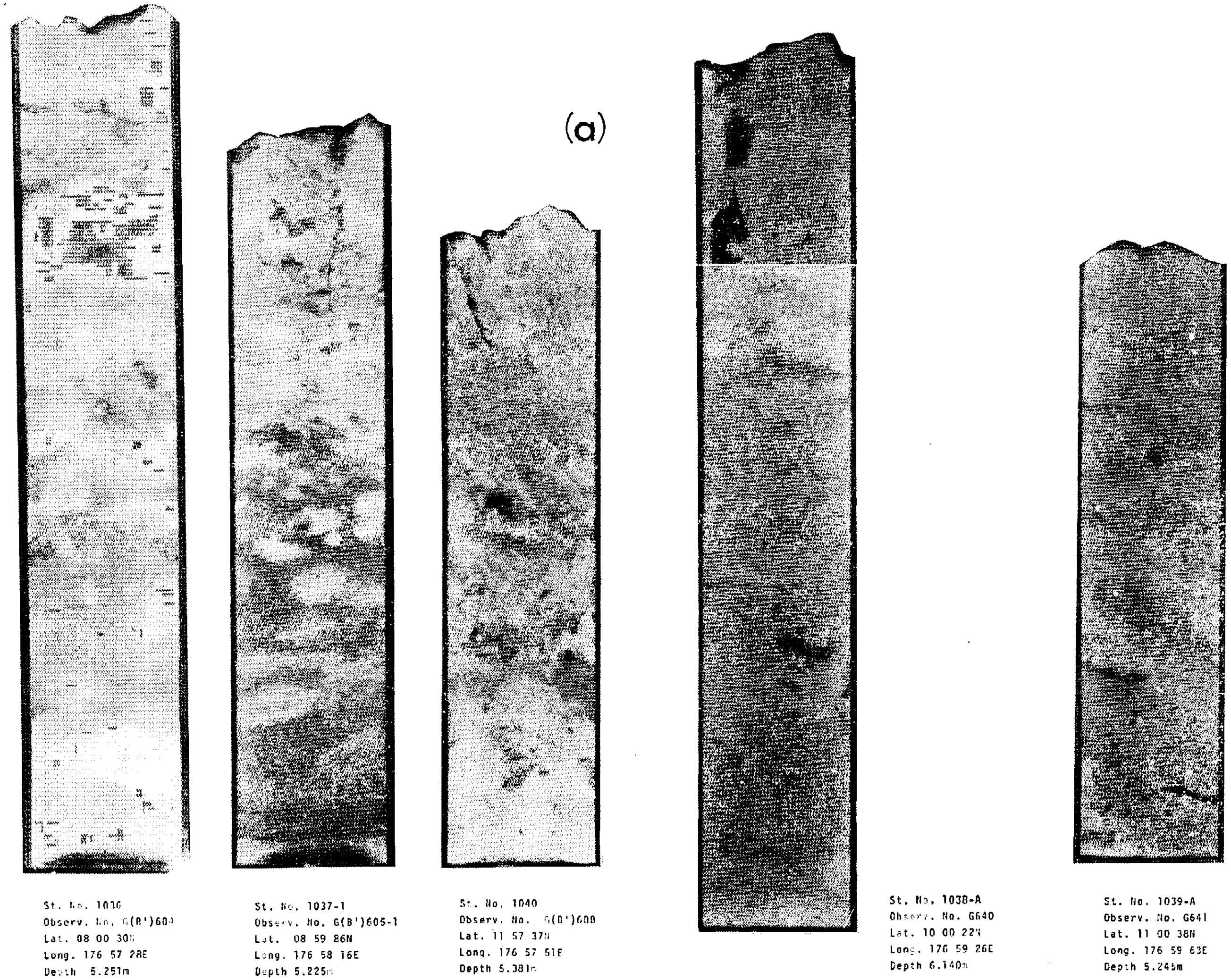
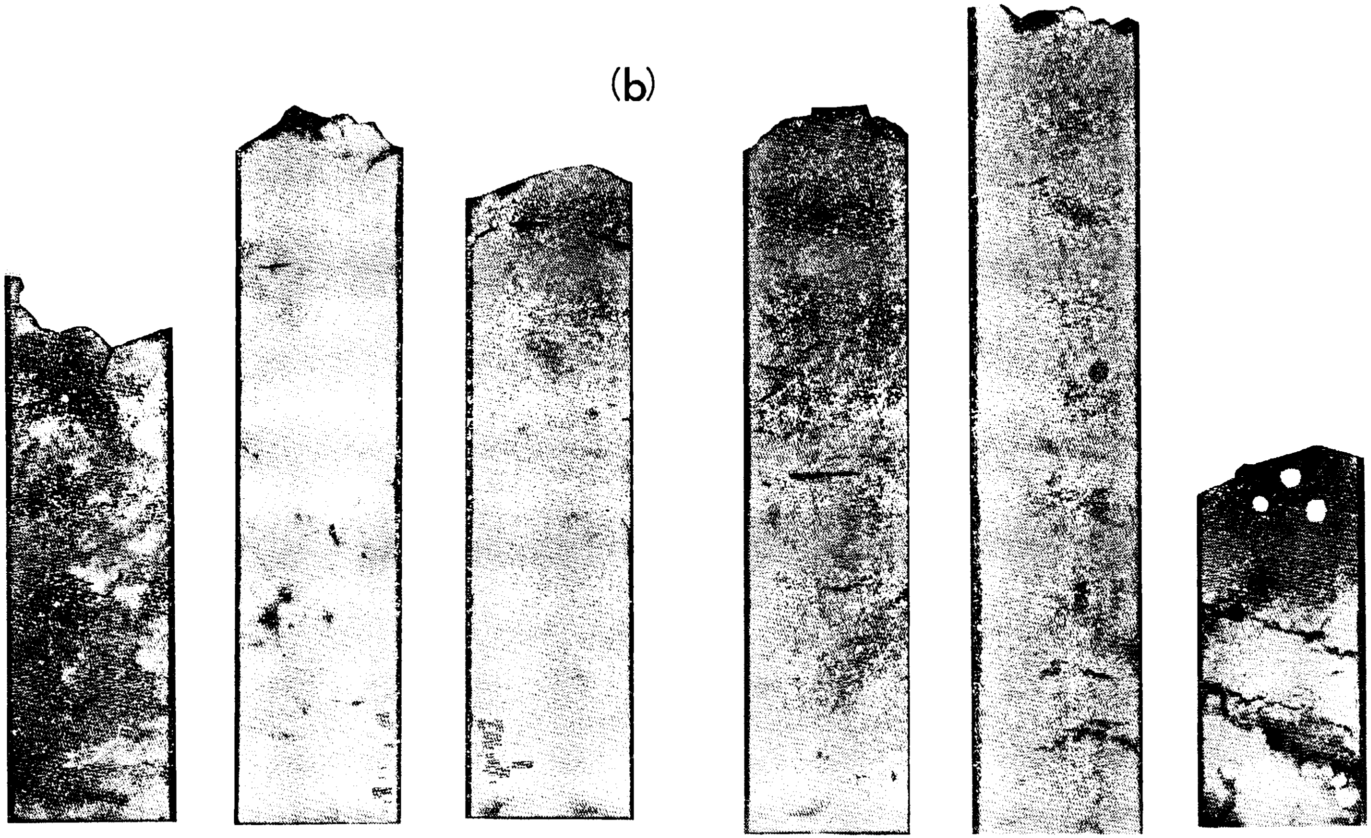


Fig. VII-5 (a-f) Softex-radiographs of sliced core samples from Okean-70 or box sampler.

(b)



St. No. 1041
Observ. No. G(B')609
Lat. 12 58 92N
Long. 177 00 13E
Depth 5.690m

St. No. 1042
Observ. No. G(B')G10
Lat. 12 59 93N
Long. 177 58 42E
Depth 5.803m

St. No. 1043
Observ. No. G611
Lat. 12 00 94N
Long. 178 00 00E
Depth 5.608m

St. No. 1044-1
Observ. No. G612-1
Lat. 11 00 38N
Long. 178 00 54E
Depth 5.322m

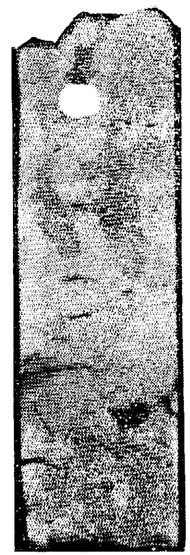
St. No. 1045
Observ. No. G613
Lat. 09 59 31N
Long. 178 00 56E
Depth 5.380m

St. No. 1046
Observ. No. G614
Lat. 09 01 02N
Long. 177 59 93E
Depth 5.474m

(c)

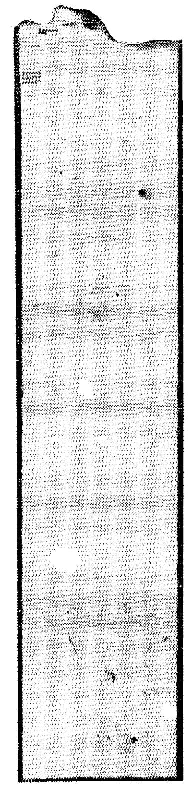
St.No. 1047
Observ. No. G615
Lat. 07 59 15N
Long. 178 01 67E
Depth 5.660m

St. No. 1048-1
Observ. No. G616-1
Lat. 07 59 72N
Long. 179 00 26E
Depth 5.143m



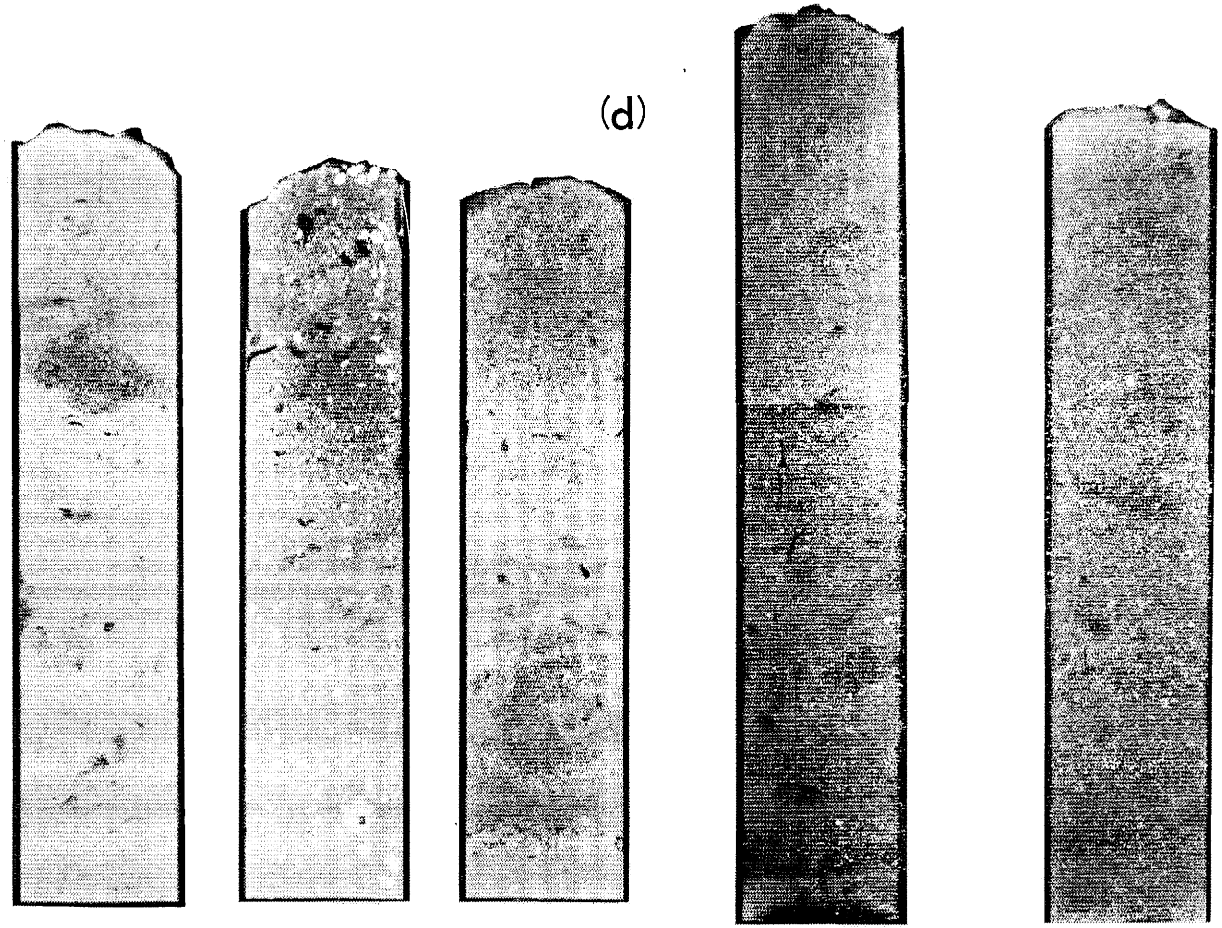
St.No. 1049
Observ. No. G617
Lat. 09 04 51N
Long. 179 02 38E
Depth 5.983m

St. No. 1050
Observ. No. G618
Lat. 09 59 65N
Long. 179 00 65E
Depth 5.603m



St. No. 1051
Observ. No. G619
Lat. 10 59 21N
Long. 179 01 10E
Depth 5.235m

(d)



St. No. 1052
Observ. No. G620
Lat. 12 00 27N
Long. 179 01 46E
Depth 5,926m

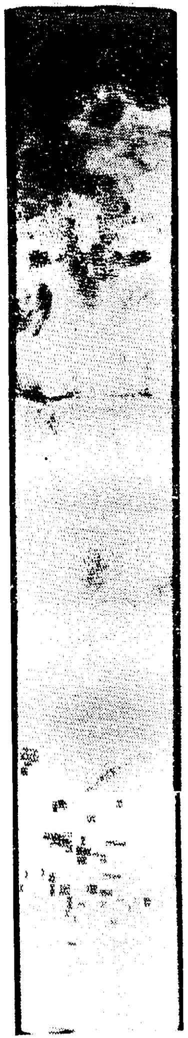
St. No. 1053
Observ. No. G621
Lat. 12 57 44N
Long. 179 01 19E
Depth 4910m

St. No. 1054
Observ. No. G622
Lat. 12 59 51N
Long. 179 59 92E
Depth 5,053m

St. No. 1056
Observ. No. G(B')626
Lat. 10 58 83N
Long. 179 58 62W
Depth 5,930m

St. No. 1057-2
Observ. No. G627-2
Lat. 09 59 36N
Long. 179 59 96W
Depth 5,952m

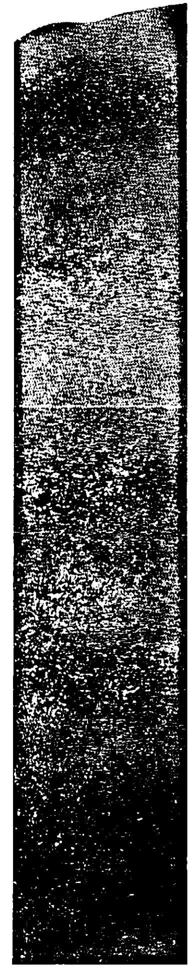
(e)



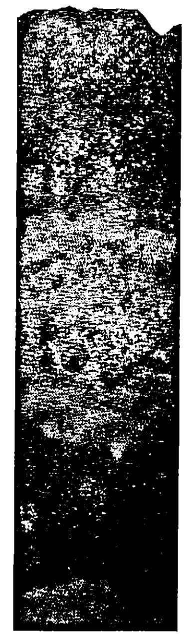
St. No. 1058
Observ. No. G(B")628
Lat. 09 01 08N
Long. 179 59 80W
Depth 6.150m

St. No. 1059
Observ. No. G629
Lat. 07 59 60N
Long. 179 59 41W
Depth 6.056m

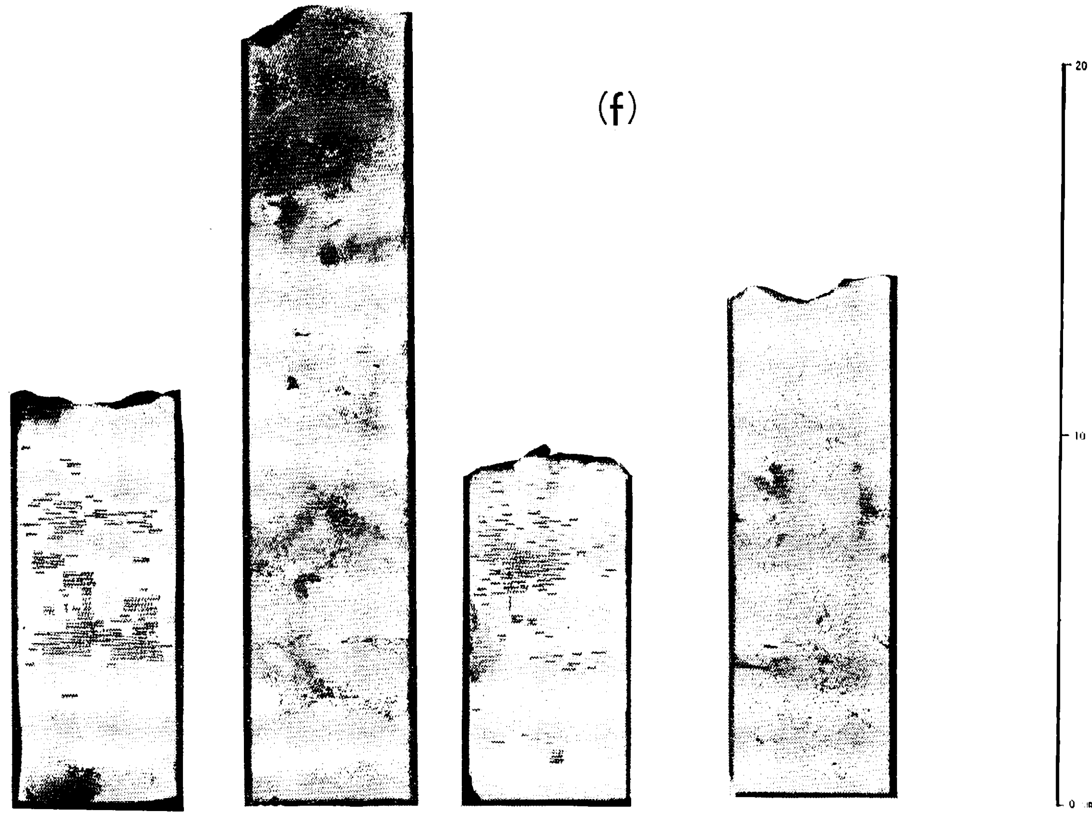
St. No. 1060
Observ. No. G(B')623
Lat. 12 59 08N
Long. 178 59 46W
Depth 5.720m



St. No. 1065
Observ. No. G632
Lat. 08 32 06N
Long. 179 28 51E
Depth 6.159m



St. No. 1067
Observ. No. G634
Lat. 07 29 11N
Long. 178 31 31E
Depth 5.250m



(f)

St. No. 1070
Observ. No. G636
Lat. 07 33 83N
Long. 176 32 97E
Depth 4,947m

St. No. 1071
Observ. No. G637
Lat. 08 30 50N
Long. 176 30 39E
Depth 5,020m

St. No. 1075
Observ. No. G639
Lat. 09 00 17N
Long. 177 30 09E
Depth 4,028m

St. No. 1061
Observ. No. G(B')624
Lat. 11 59 82N
Long. 179 02 60W
Depth 5,632m

Interrelation between distribution of manganese nodules and sediments

1) Manganese nodule is none or scarse on calcareous or siliceous ooze.

2) Manganese nodules occur abundantly (> 10 kg/m^2) only with sediment of possible Quaternary age.

3) The highest abundance (> 20 kg/m^2) of manganese nodules occur with the sediment, the coarse fraction of which is largely radiolarian or foraminiferal-radiolarian, except at the station 1054.

References

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