

X. SURFACE SEDIMENT CHARACTERISTICS AND SEDIMENTOLOGY OFF TOKAI REGION

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Introduction

Marine sediments record geological events, such as environments, earthquakes and river floods. Around the Izu Peninsula, the collision of the Izu-Bonin arc has resulted in rapid uplift at the fringe of the collision zone and has provided large amount of terrigenous materials to the ocean through the steeply sloping rivers. Supplied materials have been transported to the deep-sea environments because of the narrow shelves and steep slopes. Particulate and dissolved terrigenous materials influenced marine organisms and changed primary productivity in the surface water. On the other hand, periodically occurred large earthquakes along the Nankai and Suruga Troughs emphasize the down-slope transportation by the gravitational movements. There is a possibility that the occurrences of large earthquakes have been recorded as gravity flow deposits such as turbidites and submarine debris flow deposits. Thus, it is very important to understand modern sedimentation in such high supply and tectonically active area.

To understand the modern sedimentation in this area, around 300 surface sediment samples were collected during the GH97 and GA97 cruises. Here, we shall describe the characteristics of surface sediment distribution off Tokai region followed by description of the mode of gravity flow deposits.

Materials and Methods

Total of 261 surface sediment samples were collected from shelf to trough areas off Tokai region by Kinoshita-type grab sampler during the cruises of GH97 (April-May, 1997) of R/V Hakurei-Marun and GA97 (July-August, 1997) of Asia-Marun by the Geological Survey of Japan (Fig. X-1 and Table X-1). Also, ten gravity core samples and a multiple core sample were obtained during the cruise of GH97. Most sediment core samples were collected from the slopes, slope basins and trough floors. Sea bottom photographs were taken at the same locations of grab sampling, but clear photographs were obtained only at 112 locations.

The collected sediment samples were visually described for grain size, grain composition, color, sedimentary structures, and occurrence of gravity flow deposits and tephras. Additional information on bottom materials and small bedforms were obtained from sea bottom photography. To understand the bulk density profiles of core samples, gamma-ray attenuation was measured.

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Keywords: surface sediment, turbidite, bulk density, tephra, off Tokai region

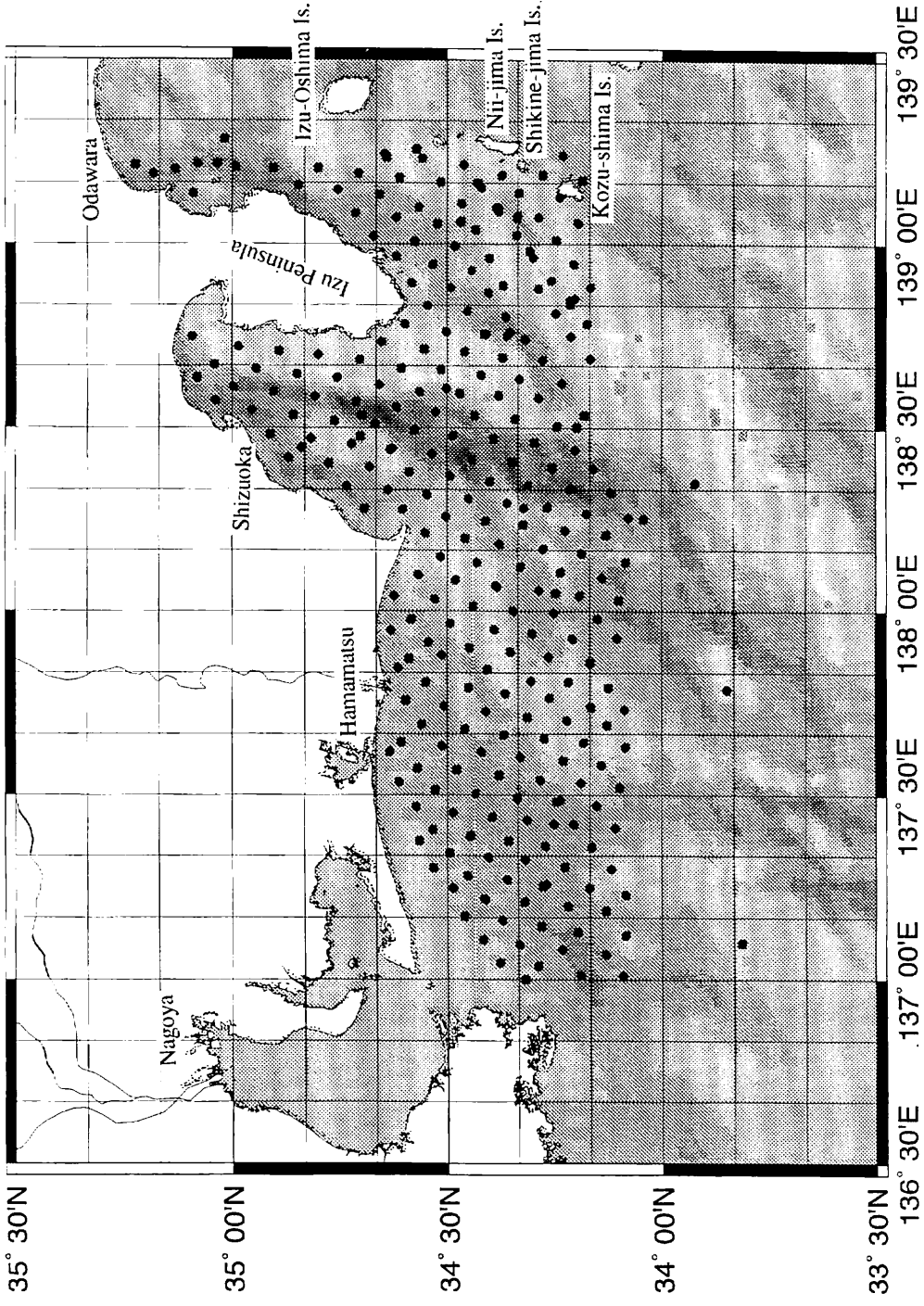


Fig. X-1 Sampling locations shown as dots.

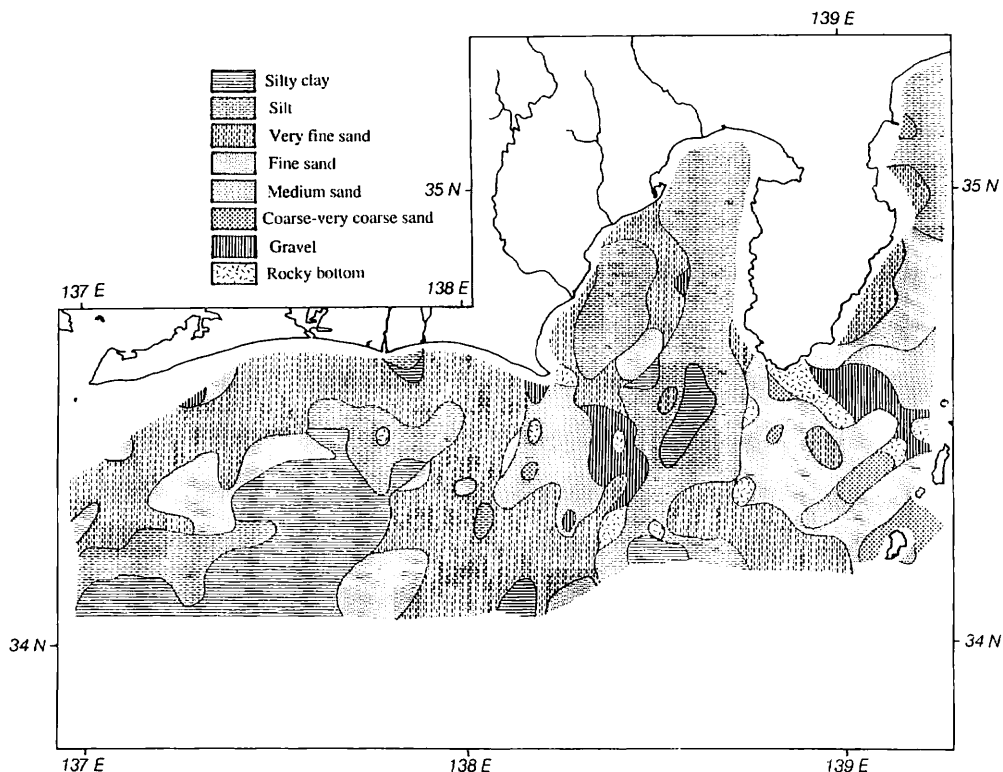


Fig. X-2 Spatial distribution of bottom materials.

Spatial distribution of surface sediments

Spatial distribution of bottom materials is shown in Fig. X-2 on the basis of on board visual description. In general, very fine sand is distributed on the shelves and silty or clayey sediments on the slopes and basin or trough floors. Wide and deeper distribution of very fine sand is found on the topographic high from the Omaezaki Spar to Daini-Tenryu Knoll. From under thin cover of the sandy sediments, semiconsolidated muddy sediments or sedimentary rocks were collected. Some of them contain old microfossils (Tanaka, 1999).

Sandy and gravelly sediments are distributed in a strait between the Izu Peninsula and Nii-jima, Shikine-jima and Kozu-shima Island (Fig. X-2). Basement rocks occur in the northern part and the topographic highs in the strait. Well-sorted sandy sediments with low mud content occur in the strait. Ripples are also found on sea bottom by bottom photography (Fig. X-3). These sediment and bedform characteristics show the influence of bottom currents. Strong bottom currents have resulted in restricted bottom organisms attached to the gravel and rocks, such as sponge, calcareous algae and sea anemone. Therefore, sediments contain high amounts of sponge spicules. Near Nii-jima, Shikine-jima and Kozu-shima Islands, volcanogenic materials including volcanic glass shards are main component of the sediments.

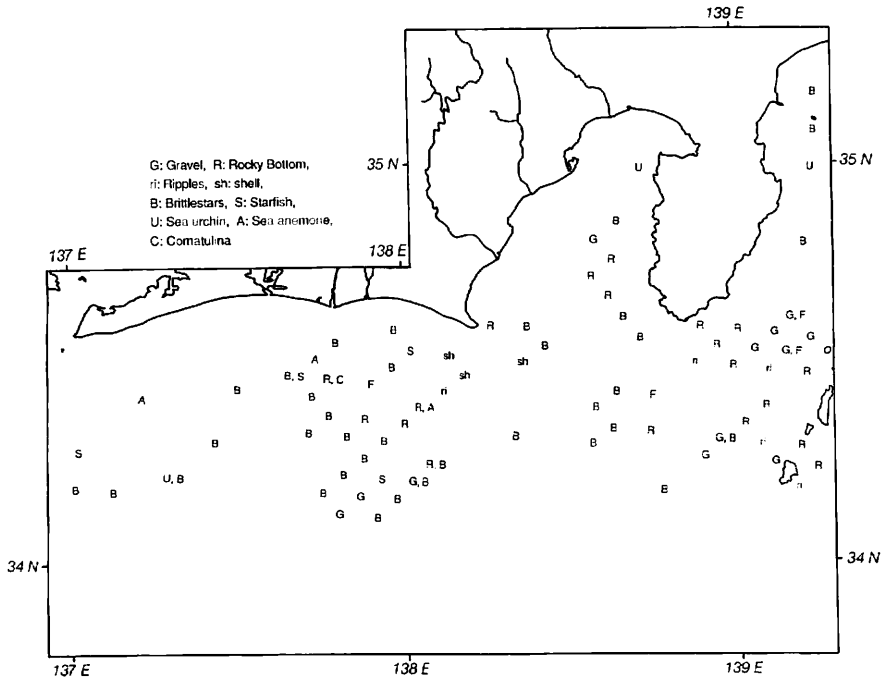


Fig. X-3 Sea bottom features observed by sea bottom photography.

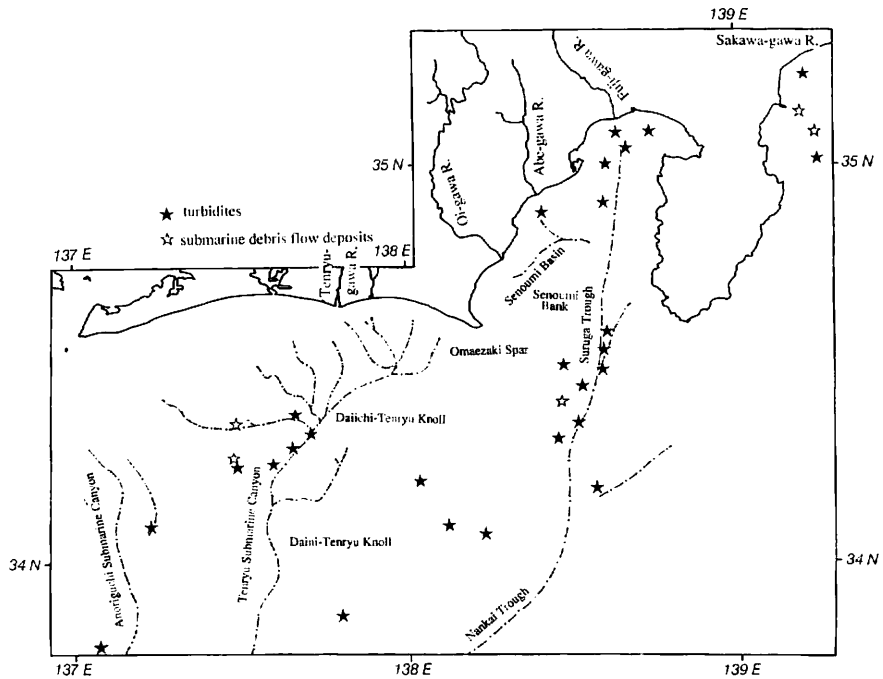


Fig. X-4 Spatial distribution of gravity flow deposits.

Sandy shelf sediments west of the Cape Omaezaki characteristically contain biotite. Relatively well-sorted sand with low mud content shows high wave and current energy on the shelf. Muddy sediments occur at the front of the mouth of Tenryu River indicating high supply of fine-grained materials from the river.

Gravity flow deposits were found widely in the study area (Fig. X-4). They distribute on the slope at the front of Sakawa-gawa, Fuji-gawa and Tenryu-gawa Rivers, and in the submarine canyons, troughs and basins. There are three turbidite layers in the uppermost 20-30 cm sediments of the Suruga Trough (Fig. X-5). They show normal grading (upward fining) and parallel and ripple lamination. Pebbles and cobbles were collected from the floor of the Tenryu Submarine Canyon. Soft-x radiographs indicate the occurrence of turbidite mud. Several turbidite layers are found in the sediment cores (Fig. X-6) collected from the east of the Izu Peninsula (GH97-301), at the front of Fuji-gawa River mouth (GH97-302), in the Kumano Trough, a forearc basin along the Nankai Trough (GH97-307) and in the small slope basins (GH97-306, -309, -310, and -311). These turbidite layers are easily detected by the bulk density profiling. Asymmetric density peaks are found in the profiles (Fig. X-7). Larger density indicates the coarser grain size and asymmetry indicates the normal grading of the turbidite layer. Turbidite layers occurred in the Suruga Trough and the Tenryu Submarine Canyon are coarser and thicker than those in the slope basins. Only a few turbidites are found in the upper part of core GH97-307. These turbidite layers are thin and finer grained. On the other hand in the lowest part, occurrence of turbidites with coarser sediments became higher.

The uppermost part of GH97-314 and pilot core of GH97-303 is composed of very loose (very high water content) diatomaceous ooze. There is no evidence, but it is possible that the diatomaceous ooze was missed when the grab sampler hit the bottom. Very high concentration of suspended materials in the bottom water judged from the bottom photography also suggested the diatomaceous ooze might be the sediments related to the spring bloom.

Sediment lithology and physical properties

Sediment bulk density changes according to sediment grain size (Ogawa and Matsumoto, 1978; Ikehara, 1989). That is, finer sediments have lower bulk density. Bulk density profiles show several peaks from the base line of 1.2-1.6 g/cm³ (Fig. X-7). Based on the bulk density differences between peaks and base line, grain size difference between turbidites and hemipelagic mud are larger at cores GH97-301, -306, -311 and -314 than at cores GH97-302, -307, -309 and -310. Especially at core GH97-302 collected from the upper slope off the mouth of Fuji-gawa River, bulk density profile shows many peaks, and relatively higher base line values (around 1.7 g/cm³) than values for hemipelagic mud in the other cores (1.2-1.6 g/cm³). The coarser hemipelagic mud might be deposited in relation to the material supply from the river.

Very low bulk density (around 1.1 g/cm³) was measured at the uppermost 20 cm of core GH97-314 (Fig. X-7). Sediments of this part is composed of diatomaceous ooze (Fig. X-6). Because diatom tests have lower specific gravity, and minute ornamentation and pores on their surfaces keep water, bulk density of diatomaceous ooze is remarkably lower than those of hemipelagic and pelagic clay and radiolarian ooze

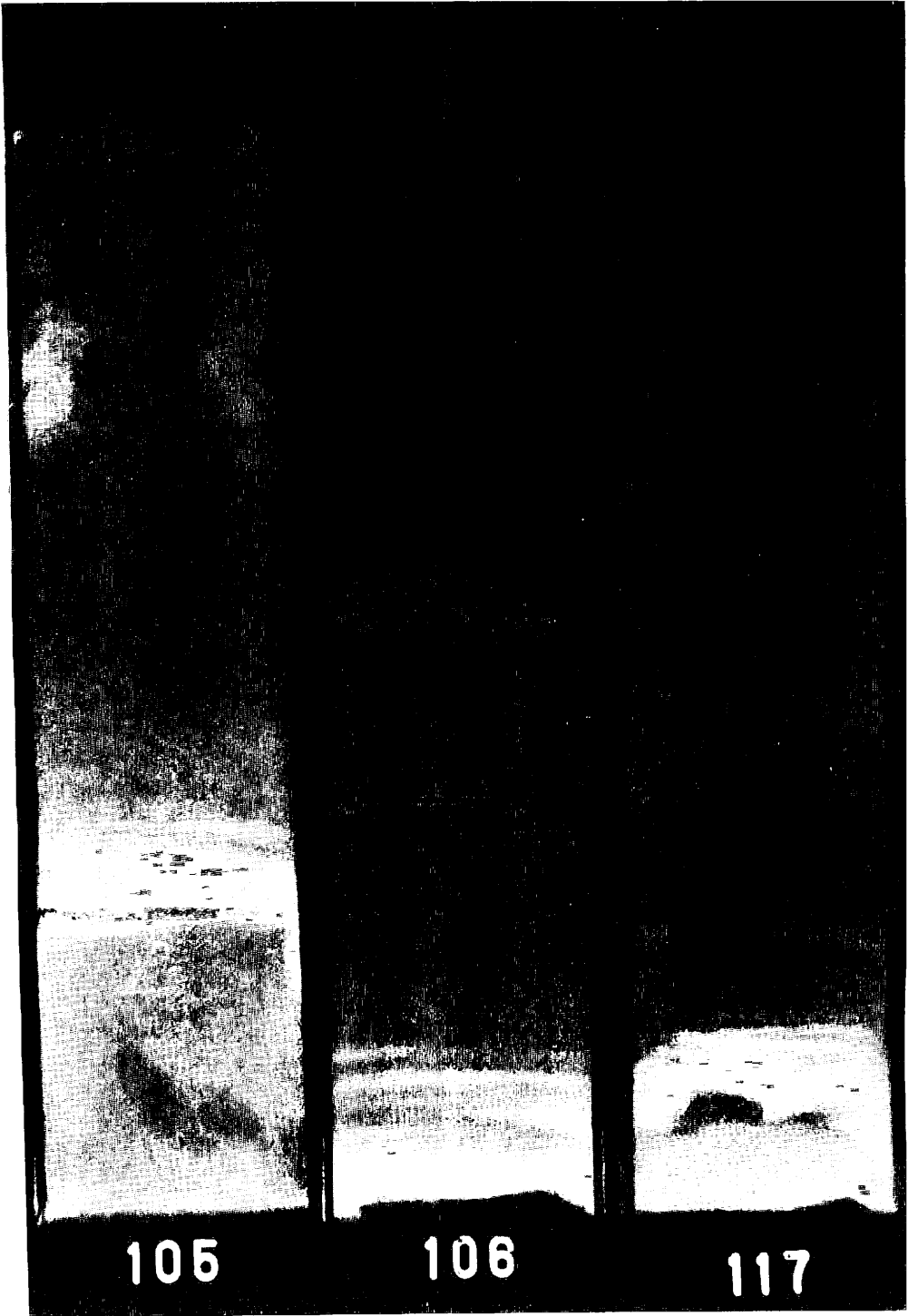


Fig. X-5 Soft-x radiographs of grab samples collected from the Suruga Trough.

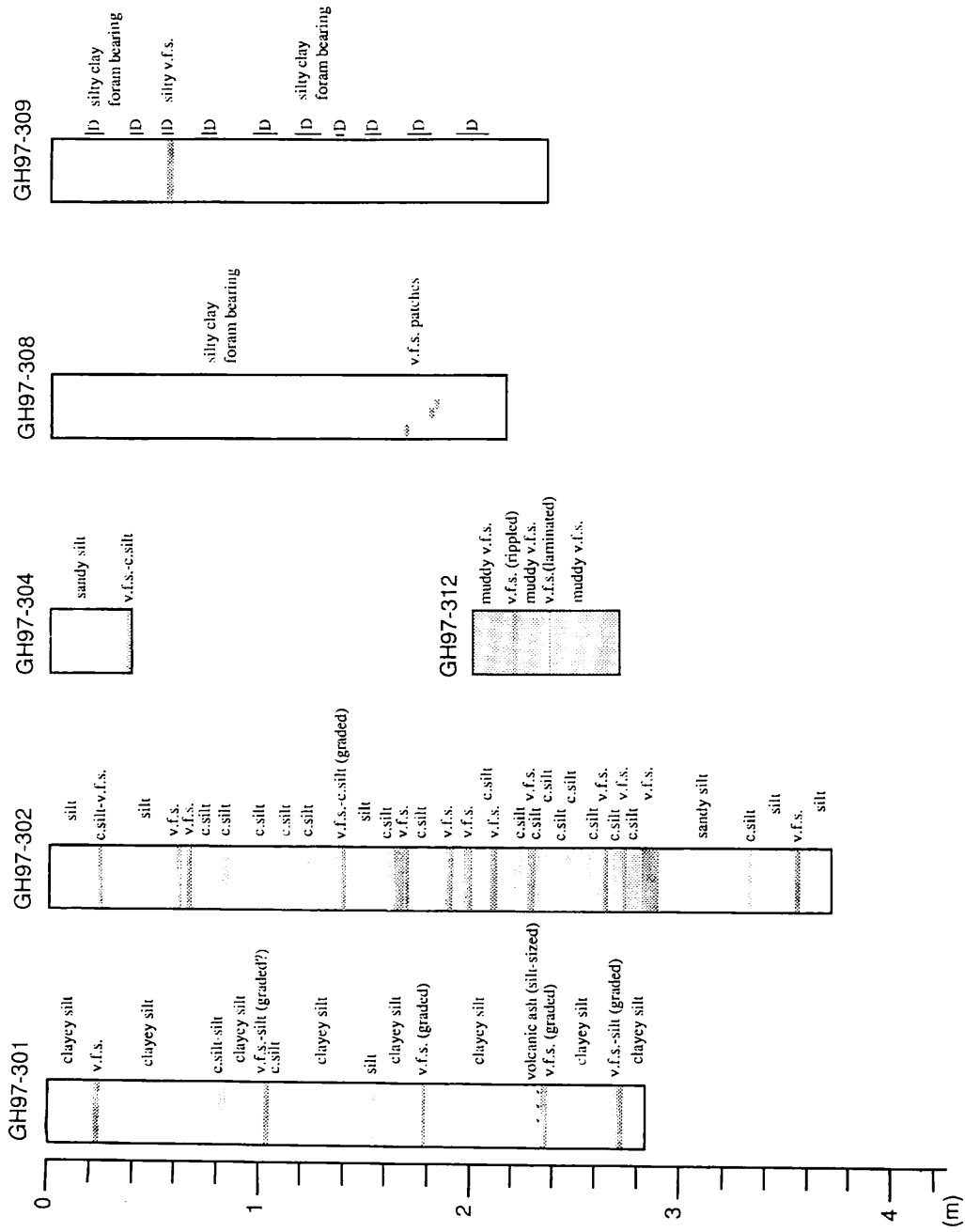


Fig. X-6 Columnar sections of cored materials. D: dark colored part.

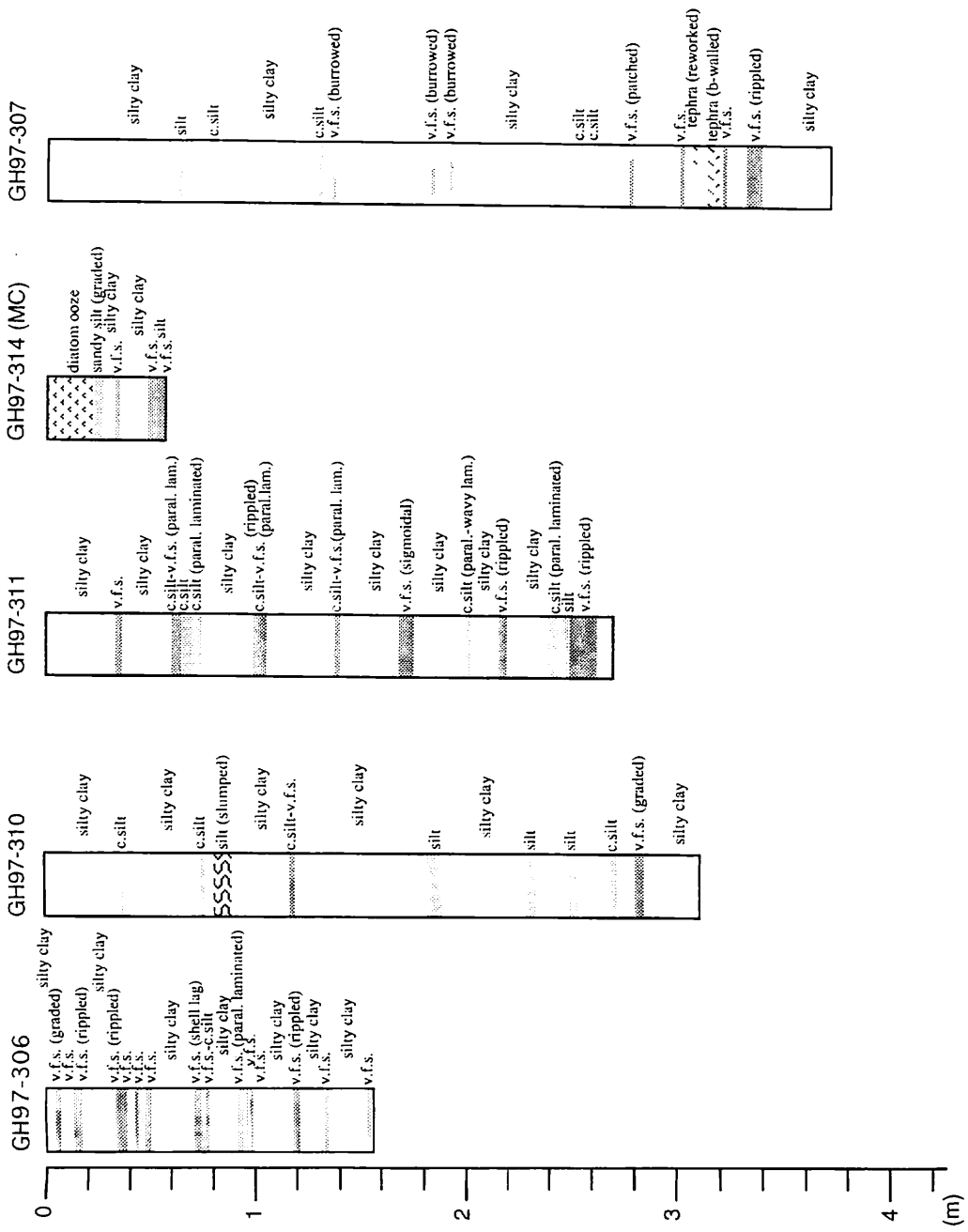


Fig. X-6 (continued)

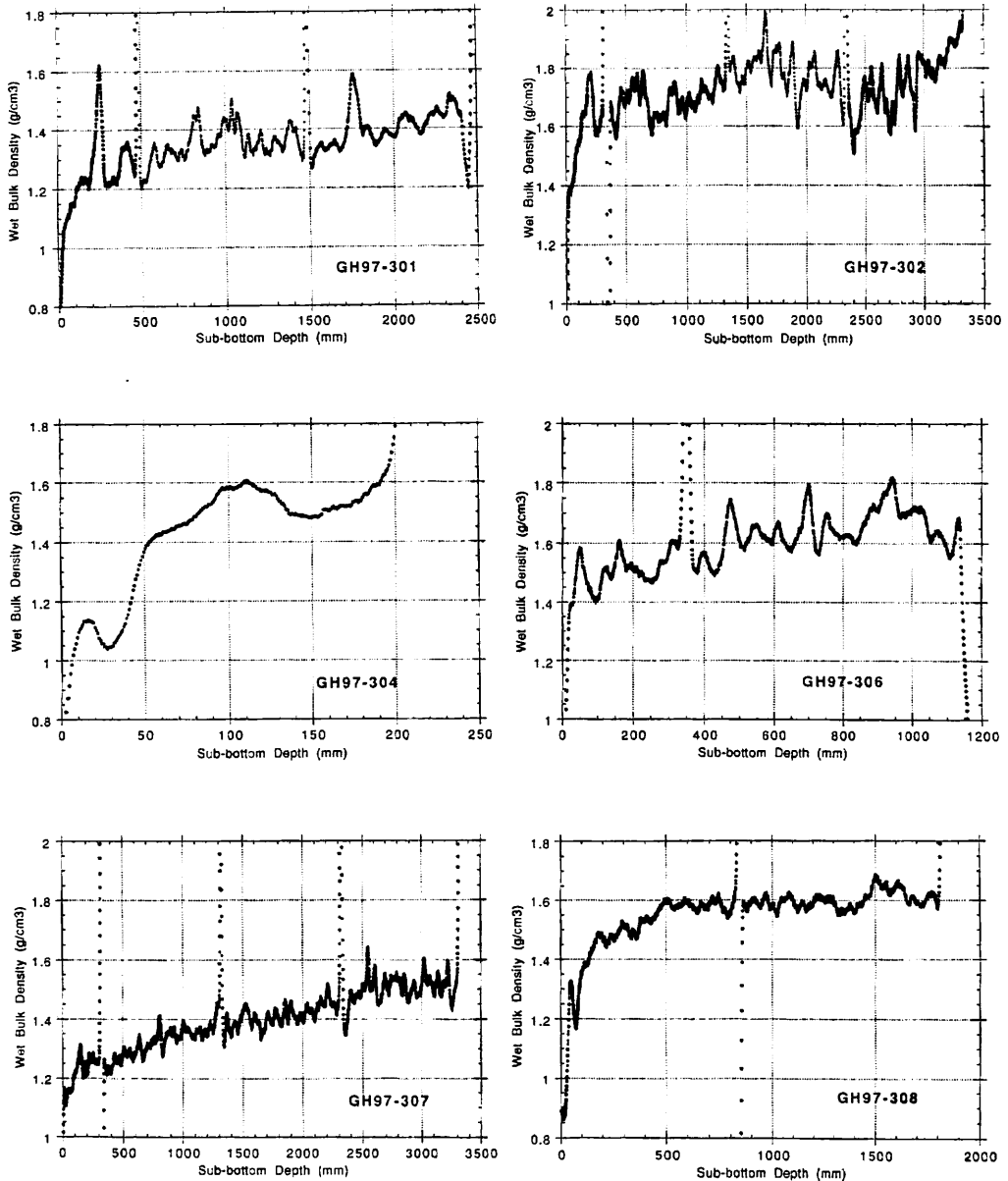


Fig. X-7 Examples of bulk density profile of cored materials.

(Ikehara *et al.*, 1992).

Age controls and sedimentation rates

Several tephra layers are found in some samples. Characteristics of the volcanic glass shards were summarized in Table X-2. Based on the indexes of volcanic glass shards, a tephra layer of core GH97-307 is correlated to Kikai-Akahoya (K-Ah) ash (6.3 ka (Machida and Arai, 1978) or 6.8 ¹⁴C ka (Fukuzawa, 1995) from the Kikai Caldera of

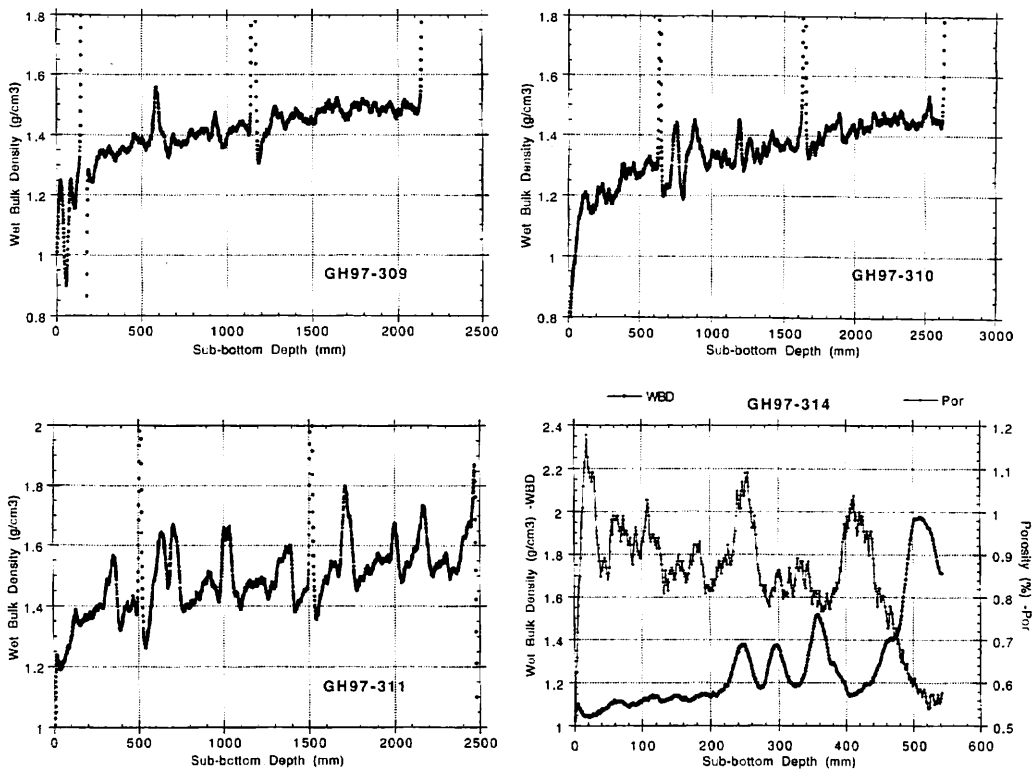


Fig. X-7 (continued)

the south Kyushu. Therefore, sedimentation rate of core GH97-307 is estimated to be around 45 cm/1000 years.

On the other hand, very thin surface sediment cover was found in the topographic high from the Omaezaki Spar to Daini-Tenryu Knoll, and steep slope of the Suruga Trough. This indicates that very low sedimentation rate in these areas. Also, on the slope off Atsumi Peninsula (st. 252), K-Ah ash was found at the sub-bottom depth of 18-19 cm. For those the sedimentation rate is estimated to be less than 3 cm/1000 years.

Turbidite deposition

As mentioned above, turbidites in the Suruga Trough and the Tenryu Submarine Canyon are coarser, thicker and have higher occurrence than those in the slope basins. Turbidite is formed in relation to large earthquakes (Heezen and Ewing, 1952; Okusa *et al.*, 1987), large floods (Otsuka *et al.*, 1973) and large storms (Okusa *et al.*, 1987). Sea level change also affects to the submarine slope failures (Stanley and Silverberg, 1969) and formation of deep-sea fan (Posamentier *et al.*, 1988).

Only a few thin turbidites with finer grain size are found in the upper part of the core collected from the proximal area of Kumano Trough (GH97-307). But below K-Ah ash, turbidites became thicker and coarser, and showed more frequent occurrence. The same stratigraphic change was reported from the central Kumano Trough (Arita

and Kinoshita, 1988). Depositional age of K-Ah ash corresponds to the termination of postglacial sea level rising. According to postglacial transgression, the Ise Bay was formed. Formation of the large bay protected coarse material transport from land to offshore through the Anoriguchi Submarine Canyon. Then, postglacial sea level change might govern the turbidite deposition along the Anoriguchi Submarine Canyon.

On the other hand, periodic occurrence of turbidites was found in the cores from the slope basins. That is, 2-3 layers/20 cm in GH97-306 and 5-6 layers/m in GH97-310 and -311 (Fig. X-7). The slope basins are several thousand m deep, isolated from each other, and not connected to rivers. These physiographic conditions suggest the most probable origin of the turbidite is large earthquake. Along the Nankai Trough, large earthquakes occurred every 100-150 year (e.g. Sangawa, 1993). The periodic occurrence of turbidites indicates the possibility of paleoseismicity analysis by using deep-sea turbidites.

Higher occurrence of turbidites was found in the Suruga Trough and the Tenryu Submarine Canyon, canyon head of which locates on the narrow shelf and connects large Fuji-gawa and Tenryu-gawa Rivers. Therefore, at least some of the turbidites might be related to river floods.

Summary

Sedimentation off Tokai region has been affected by not only material supply from land, volcanic islands and submarine rock exposures, but also primary productivity, tectonic movements including earthquake, and sea level fluctuation. Grain size and composition analyses will provide us more detailed figure of sedimentation. Those data will be useful for environmental and tectonic studies.

References

- Arita, M. and Kinoshita, Y.(1988) *Sedimentological Map of Kumano-nada* (with explanatory notes). Marine Geol. Map, no. 32, Geol. Surv. Japan, 26p (in Japanese with English Abstract).
- Fukuzawa, H.(1995) Non-glacial varved lake sediment as a natural timekeeper and detector on environmental changes. *The Quat. Res. (Daiyonki-kenkyu)*, **34**, 135-149 (in Japanese with English Abstract).
- Heezen, B.C. and Ewing, M.(1952) Turbidity currents and submarine slumps, and the 1929 Grand Banks Earthquake. *Am. J. Sci.*, **250**, 849-873.
- Ikehara, K.(1989) Some physical properties of shelf to basin deposits off San'in and Hokuriku district, southern part of Japan Sea. *Bull. Geol. Surv. Japan*, **40**, 239-250 (in Japanese with English Abstract).
- Ikehara, K., Nishimura, A., Kawahata, H. and Iizasa, K.(1992) Physical properties of marine sediments from Philippine Sea and West Caroline Basin. *In Preliminary Reports on Marine Geological Study on Material Cycle in the Ocean in FY1991*, Geol. Surv. Japan, 134-163 (in Japanese).
- Machida, H. and Arai, F.(1978) Akahoya Ash -a Holocene widespread tephra erupted from the Kikai Caldera. south Kyushu, Japan. *The Quat. Res. (Daiyonki-*

- kenkyu*), **17**, 143-163 (in Japanese with English Abstract).
- Ogawa, F. and Matsumoto, K.(1978) Correlation of the mechanical and index properties of soils in harbour districts. *Rep. Port&Harb. Res. Inst.*, **17**, 89p (in Japanese with English Abstract).
- Okusa, S., Nemoto, K., Kiyota, K., Tokuyama, Y. and Doi, H.(1987) Submarine slope failures around Japanese islands. Abst. 22th Japan National Conf. Soil Mech. Found. Eng., 1453-1456 (in Japanese).
- Otsuka, K., Kagami, H., Honza, E., Nasu, N. and Kobayashi, K.(1973) Submarine slumping as a cause of turbidity currents in Sagami Bay. *Kaiyo-kagaku (Mar. Sci. Monthly)*, **5**, 446-452 (in Japanese).
- Posamentier, H.W., Jervey, M.T. and Vail, P.R.(1988) Eustatic controls on clastic deposition I -Conceptual framework. In Wilgus, C.K., Hastings, B.S., Kendall, C.G.St.C., Posamentier, H.W., Ross, C.A. and Van Wagoner, J.C., eds., *Sea-level Changes: An Integrated Approach*, SEPM Spec. Publ., no. 42, 109-124.
- Sangawa, A.(1993) The paleo-earthquake study using traces of the liquefaction. *The Quat. Res. (Daiyonki-kenkyu)*, **32**, 249-255 (in Japanese with English Abstract).
- Stanley, D. and Silverberg, N.(1969) Recent slumping on the continental slope off Sable Island Bank, southeast Canada. *Earth Planet. Sci. Lett.*, **6**, 123-133.
- Tanaka, Y.(1999) Calcareous nannofossil biostratigraphy of surface sediments off Tokai area. In *Cruise Report No.24*, Geological Survey of Japan, Tsukuba, Japan, 199-203.
- Yoshikawa, S.(1976) The volcanic ash layers of the Osaka Group. *J. Geol. Soc. Japan*, **82**, 497-515 (in Japanese with English Abstract).

Table X-1 List of sampling location, water depth and brief description. Each of latitude and longitude values has an error of about 0.02-0.05'.

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
55	4/12/97	8:26	34° 22.839'	138° 49.894'	146	K-Grab	Grayish olive poorly-sorted shelly very coarse sand (5cm)/ shelly very coarse sand and very coarse sand (5.5cm) (total: 10.5cm)
40	4/12/97	9:18	34° 35.08'	138° 53.586'	59	Ibid.	Rocky bottom? Sponge and calcareous algae
30	4/12/97	10:10	34° 37.194'	138° 57.920'	90	Ibid.	Yellowish brown well-sorted fine-very fine sand, shell fragment rich (14cm)
21	4/12/97	10:57	34° 40.438'	139° 01.250'	109	Ibid.	Grayish olive clean very fine sand (13cm)
14	4/12/97	11:45	34° 42.920'	139° 04.959'	400	Ibid.	Olive black very fine sand (14cm)
11	4/12/97	12:49	34° 45.3749'	139° 08.7963'	570	Ibid.	Olive black muddy very fine sand , foraminifer bearing (15cm)
9	4/12/97	14:10	34° 50.8869'	139° 09.5155'	830	Ibid.	Olive black muddy very fine sand (16cm)
8	4/12/97	15:18	34° 54.3572'	139° 12.2507'	690	Ibid.	Olive black muddy very fine sand, poorly-sorted, foraminifer bearing (8.5cm)
1	4/13/97	9:51	35° 13.367'	139° 12.821'	640	Ibid.	Olive black sandy silt (5cm)/ Olive black well-sorted silt (9.5cm)/ olive black medium sand (4cm) (total: 18.5cm)
2	4/13/97	10:49	35° 10.856'	139° 11.370'	740	Ibid.	Olive black silt (20cm)
3	4/13/97	11:42	35° 07.8114'	139° 12.68'	375	Ibid.	Olive black muddy very coarse sand, poorly-sorted (17.5cm)
5	4/13/97	12:59	35° 07.3041'	139° 06.1940'	431	Ibid.	Olive black silt (22cm)
4	4/13/97	14:02	35° 04.7548'	139° 13.660'	840	Ibid.	Olive black silt, medium sand mixed (20cm)
6	4/13/97	14:55	35° 02.0690'	139° 13.556'	422	Ibid.	Olive black muddy very fine sand (16cm)
7	4/13/97	15:47	34° 59.5213'	139° 12.4870'	655	Ibid.	Olive black muddy very fine sand
56	4/14/97	8:18	34° 29.565'	138° 52.827'	700	Ibid.	Grayish olive well-sorted fine sand, shell fragment and heavy mineral bearing (14.5cm)
41	4/14/97	9:16	34° 32.114'	138° 56.612'	125	Ibid.	Rocky or gravelly bottom, shelly very coarse sand with granules
31	4/14/97	10:02	34° 34.620'	139° 00.415'	290	Ibid.	Pebbles with shell fragment rich medium sand
22	4/14/97	10:52	34° 37.170'	139° 04.351'	424	Ibid.	Grayish olive medium sand, granule-pebble, shell fragment and heavy mineral bearing (9cm)
15	4/14/97	11:41	34° 39.645'	139° 07.997'	439	Ibid.	Olive black fine-medium sand, shell fragment and heavy mineral bearing (7cm)
12	4/14/97	13:01	34° 42.506'	139° 11.451'	558	Ibid.	Olive black fine sand, granule, heavy mineral and foraminifer bearing (11cm)
10	4/14/97	14:07	34° 48.147'	139° 12.313'	594	Ibid.	Olive black muddy fine-very fine sand, granule bearing
301	4/14/97	16:57	35° 01.035'	139° 16.934'	1383	Gravity Corer	Olive black clayey silt intercalated with 7 turbidite beds and 2 ash beds (total: 285cm)
13	4/15/97	12:30	34° 38.9135'	139° 14.6240'	465	K-Grab	Olive black medium-fine sand, granule bearing, poorly-sorted (11cm)
16	4/15/97	13:24	34° 36.7161'	139° 10.8251'	505	Ibid.	Olive black medium sand, pebble bearing, poorly-sorted (6cm)
23	4/15/97	14:29	34° 34.512'	139° 05.9244'	493	Ibid.	Pebbly medium-coarse sand, foraminifer bearing
24	4/15/97	15:30	34° 30.9901'	139° 10.1183'	425	Ibid.	Olive black medium-fine sand, clean, angular granule-pebble bearing (12cm)
17	4/15/97	16:23	34° 33.4228'	139° 13.7484'	530	Ibid.	Gravelly medium-coarse sand, shell fragment bearing (9cm)
42	4/16/97	8:23	34° 28.978'	138° 59.584'	600	Ibid.	Rocky or gravelly bottom, poorly-sorted medium-coarse sand with granules
32	4/16/97	9:21	34° 31.444'	139° 03.264'	465	Ibid.	Rocky or gravelly bottom, poorly-sorted medium-coarse sand with granules (5.5cm)
33	4/16/97	10:19	34° 28.69'	139° 06.555'	535	Ibid.	Grayish olive well-sorted fine sand, granule bearing (1.3cm)

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
34	4/16/97	11:10	34° 25.2107'	139° 09.1957'	340	K-Grab	Rocky or gravelly bottom, very poorly-sorted muddy shelly very coarse sand with lithic fine sand
25	4/16/97	12:23	34° 27.7644'	139° 12.9781'	155	Ibid.	Rocky or gravelly bottom, calcareous algae with shelly coarse sand
35	4/16/97	13:19	34° 22.2884'	139° 11.1619'	282	Ibid.	Olive gray pumiceous fine sand, biotite bearing (13.5cm)
45	4/16/97	14:10	34° 19.8624'	139° 08.3093'	453	Ibid.	Olive gray pumiceous fine sand, biotite bearing (16cm)
46	4/16/97	14:58	34° 16.5672'	139° 11.3025'	116	Ibid.	Algal balls with coarse-medium sand with granules
47	4/16/97	15:50	34° 13.8069'	139° 14.4335'	157	Ibid.	Light gray pumiceous coarse sand (13cm)
62	4/16/97	16:49	34° 11.755'	139° 10.3770'	87	Ibid.	Light gray medium sand (16cm)
63	4/17/97	7:47	34° 52.2433'	138° 25.983'	610	Ibid.	Olive black silt (0.5cm)/ dark olive gray silt (20.5cm) (total: 21cm)
48	4/17/97	8:36	34° 54.762'	138° 28.852'	66	Ibid.	Olive black very fine sand (14cm)
36	4/17/97	9:27	34° 57.316'	138° 32.742'	275	Ibid.	Olive gray coarse silt, relatively well-sorted, very loose (0.5cm)/ olive black silt (19cm) (total: 19.5cm)
27	4/17/97	10:27	34° 59.834'	138° 36.506'	983	Ibid.	Dark olive silt, very loose (0.5cm)/ olive gray silt (6cm)/ black granules, angular (6.5cm)/ pebbles (2cm) (total: 15cm)
26	4/17/97	11:54	35° 02.220'	138° 34.285'	695	Ibid.	Olive black sandy silt, loose (8.5cm)
18	4/17/97	12:54	35° 04.7730'	138° 38.401'	610	Ibid.	Grayish olive silt (0.5cm)/ olive black silt (15.5cm)/ olive black sandy silt (6cm) (total: 22cm)
13.5	4/17/97	14:05	35° 05.4783'	138° 44.7369'	772	Ibid.	Grayish olive silt (2cm)/ olive gray silt (8.5cm)/ black very fine sand (1cm)/ olive black sandy silt (4.5cm)/ black silt (3.5cm) (total: 19.5cm)
20	4/17/97	15:28	34° 59.1630'	138° 42.1217'	622	Ibid.	Olive gray silt (0.5cm)/ olive black silt (18.5cm) (total: 19cm)
29	4/17/97	16:40	34° 53.5328'	138° 42.4381'	515	Ibid.	Olive black sandy silt, oxidized layer filmed (22cm)
39	4/17/97	17:51	34° 48.1217'	138° 41.7335'	459	Ibid.	Dark olive sandy silt (0.5cm)/ olive black (21.5cm) (total: 22cm)
77	4/18/97	10:10	34° 46.655'	138° 24.218'	735	Ibid.	Grayish olive oxidized silt (filmed)/ olive black silt (6cm)/ dark olive gray silt (16cm) (total: 22cm)
89	4/18/97	11:04	34° 44.186'	138° 20.461'	295	Ibid.	Dark olive silt (0.5cm)/ grayish olive silt (1.5cm)/ olive gray silt (15cm) (total: 17cm)
101	4/18/97	11:48	34° 41.717'	138° 16.771'	37	Ibid.	Olive black very fine sand, micaceous? (10cm)
112	4/18/97	12:40	34° 36.3497'	138° 16.7235'	30	Ibid.	Rocky bottom, living calcareous algae coated mudstones
102	4/18/97	13:21	34° 38.4674'	138° 19.8907'	252	Ibid.	Dark oxidized olive silt (filmed)/ olive black silt (4cm)/ olive black silt (13cm)/ black silt (3.5cm) (total: 20.5cm)
90	4/18/97	14:09	34° 40.9960'	138° 23.6659'	510	Ibid.	Grayish olive oxidized silt (0.5cm)/ olive black silt (3.5cm)/ dark olive gray silt (17cm) (total: 21cm)
78	4/18/97	14:59	34° 43.4911'	138° 27.3992'	467	Ibid.	Grayish oxidized olive silt (0.5cm)/ olive black silt (6.5cm)/ dark olive gray silt (14cm) (total: 21cm)
65	4/18/97	15:44	34° 45.9346'	138° 31.695'	223	Ibid.	Olive black muddy very fine sand, poorly-sorted (15cm)

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
64	4/18/97	16:43	34° 49.1411'	138° 28.2093'	936	K-Grab	Dark olive oxidized silt (0.5cm)/ olive black silt (4.5cm)/ olive black silt (15cm) (total: 20cm)
49	4/18/97	17:44	34° 51.5752'	138° 32.74'	616	Ibid.	Dark olive muddy very fine sand, poorly sorted (6cm)
111	4/19/97	8:27	34° 10.410'	138° 46.949'	1460	Ibid.	Dark olive oxidized muddy very fine sand (1cm)/ olive black very fine sand (1cm)/ olive black very fine sand (5.5cm)/ olive black very fine sand (13.5cm) (total: 21cm)
110	4/19/97	9:56	34° 12.638'	138° 44.766'	1945	Ibid.	Brownish black very fine sand (2.5cm)/ olive black very fine sand (2.5cm)/ olive black very fine sand (14cm) (total: 19cm)
98	4/19/97	11:32	34° 14.755'	138° 48.621'	1690	Ibid.	Dark grayish yellow very fine sand, foraminifer bearing (2cm)/ grayish olive very fine sand (2.5cm)/ grayish olive pumiceous very fine sand (2.5cm)/ grayish olive very fine sand (1.5cm) (total: 7.5cm)
99	4/19/97	12:53	34° 12.1056'	138° 51.400'	1294	Ibid.	Dark olive muddy very fine sand, pumiceous?, foraminifer bearing (4cm)/ grayish olive pumiceous very fine sand (7.5cm)/ alternation of grayish olive very fine sand and ash (2.5cm)/ gray fine ash (2cm) (total: 16cm)
100	4/19/97	14:03	34° 09.9471'	138° 52.9674'	1025	Ibid.	Olive black very fine sand, foraminifer bearing (3cm)/ grayish olive very fine sand (10.5cm) (total: 13.5cm)
88	4/19/97	15:14	34° 12.2506'	138° 56.7328'	835	Ibid.	Grayish olive oxidized muddy very fine sand (1.5cm)/ dark olive gray very fine sand (19.5cm) (total: 21cm)
75	4/19/97	16:20	34° 14.7078'	139° 00.5525'	660	Ibid.	Grayish olive very fine sand (2.5cm)/ brownish black fine sand (1.5cm)/ grayish olive fine sand (7cm) (total: 11cm)
76	4/19/97	17:11	34° 11.6476'	139° 03.4305'	88	Ibid.	Light yellow orange very coarse shell sand
61	4/20/97	8:10	34° 14.152'	139° 07.62'	70	Ibid.	Gray clean very coarse sand, poorly-sorted, pumice rich, granule bearing (7.5cm)
60	4/20/97	8:58	34° 17.149'	139° 04.327'	530	Ibid.	Grayish olive clean fine sand, pumice rich (2cm)/ grayish olive fine sand (6cm)/ olive yellow fine sand (2cm) (total: 10cm)
59	4/20/97	9:47	34° 20.225'	139° 01.445'	139	Ibid.	Very coarse shell sand, rocky or gravelly bottom?
A	4/20/97	10:30	34° 20.003'	139° 04.624'	345	Dredge	Calcareous sandstone, conglomerate (including dacitic clast) and scoria.
		10:49	34° 20.186'	139° 04.270'	257		
44	4/20/97	11:35	34° 22.715'	139° 05.386'	180	K-Grab	Very coarse shell sand
B	4/20/97	12:51	34° 23.0979'	139° 05.9232'	360	Dredge	Opx-cpx andesitic volcanic breccia with crystalline tuff- or volcanic sandstone-like matrix
		13:08	34° 22.7651'	139° 05.8848'	230		
C	4/20/97	14:08	34° 25.5831'	139° 09.8911'	270	Ibid.	Several cobbles of cpx andesite and limestone.
		14:22	34° 25.8213'	139° 09.9192'	180		
D	4/20/97	15:32	34° 28.1442'	139° 03.6794'	540	Ibid.	Several blocks (boulder to cobble size) of volcanic rock with thick ferromanganese oxide crust. Rock types are ol-cpx basalt, dolerite, hyaloclastic breccia.
		15:50	34° 28.2712'	139° 03.4872'	460		Hydrothermal Mn and/or qz fragments are also found.

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
43	4/20/97	16:41	34° 25.9509'	139° 02.3421'	753	K-Grab	Dark grayish yellow fine-very fine sand, clean and well-sorted, heavy mineral rich (1.5cm)/ dark olive fine-very fine sand (7cm)/ dark olive gray fine-very fine sand (5.5cm) (total: 14cm)
E	4/21/97	9:35 10:15	34° 12.802' 34° 12.546'	138° 50.755' 138° 50.119'	1339 1000	Dredge	A large amount of volcanic rocks (boulder to cobble size) and two rounded cobble. Volcanic rocks are opx-cpx andesite, volcanic breccia, pumiceous breccia, pumiceous lapilli tuff, tuffaceous sandstone. Min-coated Opx-cpx andesite
87	4/21/97	11:33	34° 15.382'	138° 54.14'	1330	K-Grab	Grayish yellow brown medium-coarse sand, poorly-sorted, pumiceous (2.5cm)/ grayish olive pumiceous fine sand (4cm)/ gray very fine sand (1cm)/ grayish olive very coarse sand sized pumice (1.5cm) 0-7.5cm inverse graded (total: 9cm)
74	4/21/97	12:52	34° 17.906'	138° 57.767'	495	Ibid.	Grayish olive muddy biokkeletal medium sand, shell rich, poorly-sorted (1cm)/ grayish olive sandy clay with lithic granules (5.5cm) (total: 6.5cm)
F	4/21/97	13:38 13:52	34° 18.334' 34° 18.381'	138° 58.731' 138° 58.865'	395 308	Dredge	Several blocks (boulder to cobble size) of volcanic breccia, dacite, tuff breccia and limestone.
73	4/21/97	16:16	34° 22.154'	138° 53.235'	1200	K-Grab	Grayish olive fine sand, relatively well-sorted, foraminifer bearing
58	4/21/97	18:15	34° 24.51'	138° 57.679'	905	Ibid.	Olive black very fine sand, relatively well-sorted, foraminifer bearing (3.5cm)/ olive black very fine sand (7.5cm) (total: 11cm)
57	4/21/97	19:18	34° 26.595'	138° 55.673'	860	Ibid.	Brownish black very fine sand, pumiceous, well-sorted, biotite bearing (3cm)/ olive black very fine sand (2cm)/ grayish olive very fine sand (3.5cm) (total: 8.5cm)
86	4/22/97	7:59	34° 17.143'	138° 52.740'	1470	Ibid.	Grayish olive pumiceous fine sand, clean and well-sorted, foraminifer bearing (9cm)
85	4/22/97	9:32	34° 21.718'	138° 48.71'	1390	Ibid.	Olive black fine sand, clean and well-sorted, pumice and foraminifer bearing, lithic granules on the surface (2.5cm)/ olive black very fine-fine sand (8.5cm) (total: 11cm)
72	4/22/97	11:10	34° 24.181'	138° 51.967'	1112	Ibid.	Olive black fine sand, clean and well-sorted, heavy mineral rich, pumice and foraminifer bearing (4cm)/ black fine-very fine heavy mineral sand, well-sorted (0.5cm) (total: 4.5cm)
71	4/22/97	12:31	34° 27.1511'	138° 49.702'	720	Ibid.	Dull yellow orange very coarse shell sand, lithic very coarse sand-granule bearing, coral fragment rich (6cm)
70	4/22/97	13:29	34° 30.1407'	138° 45.5937'	505	Ibid.	Rocky bottom, rock fragments with medium-coarse sand
69	4/22/97	14:25	34° 33.2465'	138° 42.6923'	807	Ibid.	Olive black sandy silt, foraminifer bearing (2cm)/ olive black silt (19cm) (total: 21cm)
54	4/22/97	15:20	34° 35.9594'	138° 46.9068'	145	Ibid.	Brownish black fine sand, clean, moderate-poorly-sorted, shell fragment bearing (2cm)/ black fine sand, clean (8cm) (total: 10cm)
53	4/22/97	16:09	34° 39.2264'	138° 43.9270'	200	Ibid.	Olive black very fine sand, shell fragment bearing (1.5cm)/ olive black very fine sand (10.5cm) (total: 12cm)
68	4/22/97	17:21	34° 36.4411'	138° 39.6234'	1340	Ibid.	Grayish olive silt, very loose (2cm) viscid clay and glaucony at the bottom

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
81	4/23/97	19:18	34° 33.9698'	138° 35.7657'	2557	K-Grab	Grayish olive oxidized silty clay (filmed)/ dark olive gray silty clay (1cm)/ olive gray silty clay-silt, graded (5.5cm)/ grayish olive silty clay (6cm)/ dark olive gray very fine sand (1.5cm)/ dark olive gray silty clay (7.5cm)/ dark olive gray very fine sand (0.5cm) (total: 22cm)
302	4/23/97	9:28	35° 04.825'	138° 37.923'	545	Gravity Corer	Olive black silt intercalated with 27 turbidite beds (coarse silt-very fine sand sized) (total: 334-371cm)
19	4/23/97	10:40	35° 02.386'	138° 40.161'	1125	K-Grab	Olive black silt, loose (around 2cm), black medium sand (around 5cm thick) and rounded pebbles underlay
28	4/23/97	12:13	34° 56.7115'	138° 39.4307'	1343	Ibid.	Olive black oxidized silt (1cm)/ olive gray silt (1.5cm)/ olive black silt (14.5cm) (total: 17cm)
37	4/23/97	13:33	34° 54.2787'	138° 35.7474'	865	Ibid.	Olive black oxidized sandy silt (filmed)/ grayish olive silt (1.5cm)/ olive gray silt (4.5cm)/ dark olive gray silt (16cm) (total: 22cm)
38	4/23/97	14:56	34° 51.331'	138° 38.6452'	1324	Ibid.	Grayish olive oxidized silt (1cm)/ olive black silt (7cm)/ dark olive gray silt (11.5cm) (total: 19.5cm)
50	4/23/97	17:06	34° 48.5766'	138° 34.9632'	1280	Ibid.	A rounded sandstone cobble, gravelly bottom?
51	4/23/97	18:29	34° 45.4864'	138° 38.230'	1310	Ibid.	Olive black sandy silt
120	4/24/97	11:21	34° 10.000'	138° 41.81'	2100	Ibid.	Brownish black oxidized silt, foraminifer bearing (filmed)/ olive black silt (2cm)/ olive black silt (18cm) (total: 20cm)
G	4/24/97	13:28	34° 21.1399'	138° 45.4865'	987	Dredge	Large blocks of opx-cpx andesite, extensively andesite and cobble size sandstone. Mn-crust is also contained.
97	4/24/97	15:14	34° 19.587'	138° 44.3687'	990	K-Grab	Rocky bottom, Mn-crust
96	4/24/97	16:44	34° 22.2066'	138° 41.3926'	990	Ibid.	Olive black oxidized sandy silt, foraminifer bearing (1.5cm)/ olive black sandy silt (4.5cm)/ olive black very fine sand (16cm) (total: 22cm)
84	4/24/97	17:56	34° 24.8269'	138° 45.1695'	605	Ibid.	No sample
109	4/25/97	9:02	34° 16.559'	138° 40.937'	1550	Ibid.	Olive black muddy very fine sand, foraminifer rich (0.5cm)/ olive black muddy very fine sand, viscid (2cm)/ gray muddy very fine sand, viscid (10.5cm) (total: 13cm)
119	4/25/97	11:38	34° 13.940'	138° 37.87'	2440	Ibid.	Olive black very fine sand
303	4/25/97	14:19	34° 10.7997'	138° 32.0243'	3591	Gravity Corer	Pilot core only. Brownish black diatomaceous mud (filmed)/ Olive black silty clay (2.5cm)/ dark olive gray silty clay intercalated with 2 turbidite beds (very fine sand sized) (27.5cm) (total: 30cm)
127	4/25/97	17:17	34° 14.5604'	138° 30.2790'	3455	K-Grab	Rocky bottom? Only a few amount of very fine sand
118	4/25/97	19:19	34° 17.1997'	138° 34.764'	1537	Ibid.	Olive black muddy very fine sand, foraminifer bearing (3.5cm)/ olive black muddy very fine sand (16.5cm) (total: 20cm)
304	4/26/97	8:25	34° 50.372'	138° 26.805'	885	Gravity Corer	Dark olive gray sandy silt (39cm)
H	4/26/97	9:54	34° 42.274'	138° 28.591'	257	Rock Corer	Olive black very fine sand (25cm)/ dark olive gray sandy silt (slightly viscid: 83cm)/ dark olive gray silt (viscid: 44cm) (total: 152cm)

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
66	4/26/97	11:18	34° 42.865'	138° 34.131'	1265	K-Grab	Dark olive gray very fine sand and mud pellets
52	4/26/97	12:40	34° 42.355'	138° 40.9971'	386	Ibid.	Olive black sandy silt (4cm)/ olive gray sandy silt (17cm) (total: 21cm)
67	4/26/97	13:52	34° 39.6553'	138° 36.9154'	1140	Ibid.	Olive black oxidized sandy silt (1cm)/ grayish olive silt (4.5cm)/ olive black clay, viscid (3.5cm) (total: 9cm)
80	4/26/97	15:21	34° 37.2054'	138° 33.251'	1573	Ibid.	Brownish black oxidized clayey silt (filmed)/ olive black silt (3.5cm)/ dark olive gray silt (16.5cm) (total: 20cm)
79	4/26/97	16:29	34° 40.2217'	138° 30.5618'	293	Ibid.	Black fine-very fine sand, shell fragment and foraminifer bearing, clean and well-sorted (1.5cm)/ black fine-very fine sand, clean and well-sorted, foraminifer bearing (14cm) (total: 15.5cm)
I	4/26/97	17:19	34° 40.2217'	138° 30.5618'	570	Dredge	A large amount of mudstone and sandstone with less conglomerate, tuff breccia, and rounded pebbles of mainly sandstone.
91	4/26/97	17:43	34° 42.1165'	138° 31.8945'	440	Ibid.	Olive black muddy medium sand, shell fragment rich, very poorly-sorted (5cm)
108	4/27/97	8:16	34° 19.825'	138° 37.832'	1256	Ibid.	Grayish olive very fine sand, foraminifer bearing (2.5cm)/ olive gray muddy very fine sand, shell fragment bearing (12.5cm) (total: 15cm)
107	4/27/97	9:55	34° 22.770'	138° 35.194'	1924	Ibid.	Brownish black sandy silt (filmed)/ dark brown silt (1cm)/ dark olive gray silt (20cm) (total: 21cm)
95	4/27/97	11:25	34° 25.234'	138° 38.514'	1520	Ibid.	Grayish olive silt (21cm) Surface was partly covered by the oxidized layer
84	4/27/97	12:52	34° 24.4795'	138° 45.2203'	608	Ibid.	Olive black fine-very fine sand, clean (1cm)/ dark olive gray fine-very fine sand, clean, shell fragment bearing (13.5cm) (total: 14.5cm)
83	4/27/97	14:02	34° 27.676'	138° 42.332'	945	Ibid.	Grayish olive oxidized silt, foraminifer bearing (1cm)/ olive black silt (21cm) (total: 22cm)
82	4/27/97	15:28	34° 30.9015'	138° 39.3307'	1640	Ibid.	Brownish black oxidized silty clay, loose, foraminifer bearing (filmed)/ grayish olive silty clay (11cm) (total: 11cm)
94	4/27/97	17:27	34° 28.294'	138° 35.523'	2765	Ibid.	Olive black silty clay, loose (3cm)/ olive black very fine sand, graded (1.5cm)/ olive black silty clay (3cm)/ olive black coarse silt (2cm)/ olive black silty clay with very fine sand patches (5.5cm)/ black very fine sand, graded (4cm) (total: 19cm)
135	4/28/97	8:58	34° 18.625'	138° 20.686'	445	Ibid.	Olive black medium-fine sand, granule and shell fragment bearing (6.5cm)
134	4/28/97	9:48	34° 21.560'	138° 17.786'	335	Ibid.	Olive black medium-fine sand, shell fragment bearing, angular pebbles on the surface (5cm)
124	4/28/97	10:32	34° 24.011'	138° 21.395'	110	Ibid.	Gravelly bottom, a few angular cobble-pebbles
123	4/28/97	11:14	34° 27.087'	138° 18.445'	82	Ibid.	Olive black medium-fine sand, shell fragment rich, granule bearing
133	4/28/97	11:59	34° 24.567'	138° 14.811'	105	Ibid.	Grayish olive medium-coarse sand, shell fragment rich, granule bearing (2cm)/ grayish olive fine sand, shell fragment bearing (7.5cm)/ grayish olive fine sand, granule bearing (0.5cm) (total: 10cm)
132	4/28/97	13:03	34° 27.5677'	138° 11.9045'	58	Ibid.	Rocky bottom, olive black medium sand, shell fragment bearing, siltstone or viscid clay underlay

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
122	4/28/97	13:41	34° 30.2425'	138° 15.5215'	75	K-Grab	Olive black fine-medium sand, clasn, shell fragment bearing, cross-laminated? (4.5cm)/ olive black medium sand (5.5cm)/ olive black very coarse sand, shell fragment bearing (3cm) (total: 13cm)
121	4/28/97	14:22	34° 33.1199'	138° 12.7925'	40	Ibid.	Dark olive gray very coarse shell sand with pebbles (5cm)
131	4/28/97	15:06	34° 31.0409'	138° 08.9003'	87	Ibid.	Olive black oxidized very fine sand (filmed)/ olive black muddy very fine sand, rounded granule bearing (10cm) (total: 10cm)
130	4/28/97	15:52	34° 34.1068'	138° 05.9575'	72	Ibid.	Olive black oxidized very fine sand (0.5cm)/ dark olive gray very fine sand, shell fragment bearing (12.5cm) (total: 13cm)
129	4/28/97	16:34	34° 37.5281'	138° 02.5074'	30	Ibid.	Olive black very fine sand, well-sorted, mica bearing (9cm)
J	5/3/97	8:53	34° 38.093'	138° 26.484'	94	Rock Corer	Olive black very fine sand (5cm)/ dark olive gray semiconsolidated silt (32cm) (total: 37cm)
92	5/3/97	10:00	34° 34.6584'	138° 29.5605'	1100	K-Grab	Grayish olive silty clay (9cm)/ dark olive gray silty clay (12.5cm) (total: 21.5cm)
104	5/3/97	11:08	34° 32.2013'	138° 25.8243'	970	Ibid.	Grayish olive oxidized clayey silt (0.5cm)/ grayish olive clayey silt (5.5cm)/ dark olive gray clayey silt (13cm) (total: 19cm)
103	5/3/97	12:19	34° 35.3620'	138° 22.8666'	368	Ibid.	Olive black oxidized muddy very fine sand (0.5cm)/ grayish olive muddy very fine sand (0.5cm)/ dark olive gray very fine sand (19cm) (total: 20cm)
113	5/3/97	13:14	34° 32.9205'	138° 19.1531'	57	Ibid.	Olive gray very fine sand, shell fragment bearing (8cm)
114	5/3/97	14:04	34° 29.7179'	138° 22.2005'	68	Ibid.	Grayish olive muddy pebbles, poorly-sorted, shell and its fragment bearing (7.5cm)
115	5/3/97	15:08	34° 26.4876'	138° 24.9779'	950	Ibid.	Rocky bottom, only a few amount of grayish olive muddy very fine sand
93	5/4/97	8:27	34° 31.7049'	138° 32.4726'	1895	Ibid.	Grayish olive muddy very fine sand (3cm)/ olive black muddy very fine sand (15.5cm) (total: 18.5cm)
105	5/4/97	10:16	34° 29.2196'	138° 28.7261'	2035	Ibid.	Olive black sandy silt (0.5cm)/ olive black silt (1.5cm)/ olive black silt (8.5cm)/ olive gray silty clay (3cm)/ olive black very fine sand, graded, shell fragment bearing (2.5cm)/ grayish olive silty clay (5cm) (total: 21cm)
106	5/4/97	12:25	34° 26.1562'	138° 31.9419'	2715	Ibid.	Olive black oxidized silty clay (0.2cm)/ olive black very fine sand (0.2cm)/ olive black silty clay (0.8cm)/ olive black very fine sand (0.2cm)/ grayish olive silty clay (3.6cm)/ grayish olive very fine sand (0.2cm)/ olive black silty clay (0.3cm)/ olive black silty clay (3.5cm)/ alternation of olive black very fine sand and silty clay (3cm)/ olive black very fine sand (2cm) (total: 14cm)
116	5/4/97	16:06	34° 23.498'	138° 28.2187'	2431	Ibid.	Olive black clayey silt (2cm)/ olive black granule-pebble, matrix-supported (9.5cm) (total: 11.5cm)
125	5/4/97	17:41	34° 20.8947'	138° 24.4836'	926	Ibid.	Olive black muddy very fine sand (2cm)/ dark olive gray sandy silt (3cm)/ dark olive gray silt, viscid (5.5cm) (total: 10.5cm)

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
117	5/5/97	10:40	34° 20.403'	138° 31.421'	2770	K-Grab	Brownish black oxidized silt (filmed)/ olive black coarse silt (0.5cm)/ grayish olive silty clay (6cm)/ olive black coarse silt (3.5cm)/ olive black coarse silt, parallel laminated (4.5cm)/ olive black very fine sand (1.5cm)/ grayish olive silty clay (1cm)/ olive black silt (2cm)/ very fine sand at the base (total: 19cm)
126	5/5/97	13:02	34° 17.7286'	138° 27.5995'	2345	Ibid.	Olive black oxidized silt (1cm)/ brownish black silt (0.5cm)/ grayish olive clayey silt (0.5cm)/ dark olive gray silt (6.5cm)/ dark olive gray silt, more sandy than the upper unit (6.5cm)/ pebbles at the base (total: 15cm)
136	5/5/97	15:10	34° 15.2519'	138° 23.5472'	2175	Ibid.	Rocky bottom, semiconsolidated mud, no surface sediments
137	5/5/97	17:31	34° 12.1819'	138° 26.4258'	3339	Ibid.	Rocky bottom?, grayish olive viscid clay attached with olive black silty clay
158	5/6/97	8:52	34° 07.1603'	138° 19.5385'	2325	Ibid.	Olive black muddy fine-very fine sand, foraminifer bearing (11cm)
147	5/6/97	10:57	34° 09.588'	138° 23.428'	3006	Ibid.	Olive gray silty clay (2cm)/ dark olive gray silt (19cm) (total: 21cm)
146	5/6/97	13:09	34° 12.6901'	138° 20.0767'	1370	Ibid.	Dark olive gray muddy very fine sand (filmed)/ semiconsolidated mudstone
157	5/6/97	14:36	34° 10.4655'	138° 16.0283'	933	Ibid.	Olive black foraminifer rich very fine sand (0.5cm)/ viscid clay
156	5/6/97	16:01	34° 13.4899'	138° 13.1779'	1473	Ibid.	Olive black muddy very fine sand (6cm)/ olive gray viscid clay (5cm) (total: 11cm)
145	5/6/97	17:07	34° 15.9087'	138° 17.0639'	294	Ibid.	Gravelly bottom, a cobble with shell fragment rich poorly-sorted medium-course sand
K	5/6/97	18:18	34° 19.2251'	138° 16.9426'	82	Rock Corer	Olive black shelly medium-course sand (8.5cm)/ dark olive gray semiconsolidated silt, foraminifer and shell fragment bearing (13.5cm) (total: 22cm)
144	5/6/97	19:11	34° 19.2967'	138° 14.1952'	618	K-Grab	Olive black muddy very fine sand (5cm)/ olive gray very fine sand (3.5cm)/ dark olive gray viscid clay (1cm) (total: 9.5cm)
305	5/7/97	9:39	33° 55.4227'	138° 21.0690'	3700	Gravity Corer	No sample
306	5/7/97	13:07	34° 02.5147'	138° 15.1361'	2665	Ibid.	Dark olive gray silt intercalated with 10 turbidite beds (very fine sand sized) (156cm)
169	5/7/97	15:25	34° 04.5899'	138° 15.3568'	2145	K-Grab	Olive black muddy fine sand (5.5cm)/ olive black muddy granule (2.5cm) (total: 8cm)
168	5/7/97	17:10	34° 07.7878'	138° 12.4731'	1752	Ibid.	Olive black muddy very fine sand, foraminifer bearing (2cm)/ grayish olive silt (3cm)/ dark olive gray viscid silt (5cm) (total: 10cm)
167	5/7/97	18:41	34° 11.1669'	138° 09.4179'	1596	Ibid.	Olive black muddy very fine sand, foraminifer bearing (2.5cm)/ olive gray viscid silt (8cm) (total: 10.5cm)
138	5/8/97	8:06	34° 37.9700'	137° 56.7737'	51	Ibid.	Olive black very fine sand, well-sorted, mica bearing (15.5cm)
149	5/8/97	9:02	34° 35.4630'	137° 52.2376'	285	Ibid.	Grayish olive-olive black silty clay (19.5cm)
148	5/8/97	9:34	34° 36.9868'	137° 50.8127'	102	Ibid.	Olive black sandy silt, mica bearing (18.5cm)
159	5/8/97	10:29	34° 35.9057'	137° 45.4380'	87	Ibid.	Olive black very fine sand, clean and well-sorted, mica bearing (18.5cm)
171	5/8/97	11:25	34° 36.6055'	137° 38.6450'	77	Ibid.	Olive black very fine sand, well-sorted, mica bearing (17cm)
170	5/8/97	11:54	34° 38.2007'	137° 37.0443'	43	Ibid.	Olive black very fine sand, well-sorted, mica bearing (8cm)
182	5/8/97	12:52	34° 36.8364'	137° 32.0461'	50	Ibid.	Olive black very fine sand, well-sorted, mica bearing (9cm)

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
193	5/9/97	13:33	34° 34.4910'	137° 28.0197'	64	K-Grab	Olive black very fine sand, clean and well-sorted, mica and shell fragment bearing (1.5cm)
204	5/9/97	14:13	34° 32.1121'	137° 24.2791'	75	Ibid.	Grayish olive-olive black very fine sand, clean and well-sorted, mica and shell fragment bearing (16cm)
203	5/9/97	14:43	34° 33.9824'	137° 22.3674'	40	Ibid.	Olive brown fine sand, clean and well-sorted (13cm)
213	5/9/97	15:22	34° 32.0425'	137° 17.9994'	42	Ibid.	Sandy granule-pebble, shell fragment bearing (10cm)
223	5/9/97	16:00	34° 29.2057'	137° 14.6999'	56	Ibid.	Olive black very fine sand, clean and well-sorted, mica bearing (10cm)
232	5/9/97	16:39	34° 27.7219'	137° 10.1558'	48	Ibid.	Olive black very fine sand, clean and well-sorted, mica bearing (11.5cm)
240	5/9/97	17:20	34° 24.9947'	137° 06.4269'	51	Ibid.	Olive brown fine sand, clean and well-sorted (12cm)
247	5/9/97	17:57	34° 22.5828'	137° 02.7407'	61	Ibid.	Olive black very fine sand, clean and well-sorted, mica bearing (11.5cm)
253	5/9/97	18:40	34° 19.0852'	137° 00.0224'	73	Ibid.	Olive black-gray very fine sand, clean and well-sorted, mica bearing (12cm)
307	5/10/97	9:05	33° 48.9546'	137° 05.8609'	1990	Gravity Corer	Olive gray-olive black silty clay intercalated with 14 turbidite beds (very fine sand-silt-sized) and a tephra layer (371cm)
262	5/10/97	12:07	34° 05.4655'	137° 00.6278'	1410	K-Grab	Grayish olive-olive gray silty clay (21.5cm)
260	5/10/97	13:35	34° 07.8639'	137° 04.1154'	1502	Ibid.	Brownish black silty clay (2cm)/ grayish olive silty clay (4cm), semiconsolidated mud underly (total: 6cm)
261	5/10/97	15:04	34° 05.0537'	137° 07.0935'	1625	Ibid.	Olive black-olive gray sandy clay (20cm)
257	5/10/97	16:38	34° 07.8402'	137° 11.0213'	1517	Ibid.	Olive black-olive gray silty clay (21.5cm)
258	5/10/97	18:11	34° 05.0452'	137° 13.6379'	1765	Ibid.	Olive black silty clay (21cm)
250	5/11/97	9:35	34° 13.1221'	137° 11.7440'	1050	Ibid.	Grayish olive sandy silt (7cm)/ olive gray viscoid clayey silt, foraminifer and shell fragment bearing (9cm) (total: 16cm)
251	5/11/97	10:57	34° 10.1477'	137° 14.1397'	1400	Ibid.	Grayish olive sandy silt, foraminifer bearing (6cm)/ dark olive gray viscoid silt (4cm) (total: 10cm)
252	5/11/97	12:35	34° 07.0600'	137° 17.8301'	1385	Ibid.	Grayish olive sandy silt (0.5cm)/ grayish olive-olive gray silt (21.5cm), 18-20cm a tephra layer (total: 22cm)
245	5/11/97	13:57	34° 09.7809'	137° 21.3973'	1252	Ibid.	Grayish olive-olive gray silty clay, foraminifer bearing (21.5cm)
246	5/11/97	15:20	34° 06.5546'	137° 24.4770'	1406	Ibid.	Grayish olive-olive gray silty clay (20.5cm)
238	5/11/97	16:39	34° 09.1285'	137° 28.1428'	1377	Ibid.	Olive black-grayish olive silty clay (21.5cm)
239	5/11/97	18:00	34° 05.9248'	137° 31.0830'	1344	Ibid.	Olive black sandy silt (1.5cm)/ olive gray silt (7.5cm)/ dark olive gray viscoid silt (12.5cm) (total: 21.5cm)
308	5/12/97	8:24	34° 15.0580'	137° 25.0859'	1025	Gravity Corer	Grayish olive-olive gray silty clay, foraminifer bearing (216cm)
237	5/12/97	15:23	34° 12.2621'	137° 25.1205'	1208	K-Grab	Olive black-olive gray silty clay (21.5cm)
228	5/12/97	16:41	34° 14.7249'	137° 28.8556'	1211	Ibid.	Grayish olive-olive gray sandy silt, foraminifer bearing (23cm)
229	5/12/97	18:01	34° 11.3149'	137° 31.8807'	1321	Ibid.	Grayish olive-olive gray silty clay (22cm)
309	5/13/97	13:31	34° 14.1813'	137° 29.0572'	1290	Gravity Corer	Alternation of olive gray (light colored) and olive black (dark colored) silty clay intercalated with a very fine sand layer (235.5cm)

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
230	5/13/97	15:41	34° 08.4698'	137° 34.8460'	1730	K-Grab	Brownish black silty clay (2cm)/ olive black-olive gray silty clay (5.5cm), gravels underly? (total: 7.5cm)
231	5/13/97	17:08	34° 05.0586'	137° 37.8190'	1225	Ibid.	Grayish olive sandy clay, foraminifer bearing, basement? fragment
310	5/14/97	10:03	33° 50.9693'	137° 47.1903'	2560	Gravity Corer	Olive black-olive gray silty clay intercalated with 5 turbidite layers (coarse silt-very fine sand sized) (311.5cm)
222	5/14/97	13:21	34° 05.1934'	137° 44.0273'	766	K-Grab	Olive black fine sand, foraminifer rich (1cm)/ viscid silt (9cm) (total: 10cm)
221	5/14/97	14:19	34° 07.6504'	137° 41.4035'	1030	Ibid.	Olive gray fine-very fine sand, foraminifer bearing (6cm)/ olive gray very fine sand (9cm) (total: 15cm)
220	5/14/97	15:32	34° 10.9108'	137° 38.5680'	1295	Ibid.	Olive black-olive gray sandy clay (7.5cm)
219	5/14/97	16:53	34° 13.7483'	137° 35.4019'	1589	Ibid.	Olive black silty clay (6cm)/ gray silt (8cm)/ olive black very fine sand, graded?, mica bearing (8cm) (total: 22cm)
199	5/15/97	8:02	34° 15.6472'	137° 46.8527'	930	Ibid.	Olive black silty clay, foraminifer bearing (22cm)
210	5/15/97	9:11	34° 13.2500'	137° 42.1821'	1100	Ibid.	Olive black silty clay (21.5cm)
209	5/15/97	10:26	34° 16.3601'	137° 39.2652'	1475	Ibid.	Olive gray silty clay with pebbles and cobbles
208	5/15/97	11:37	34° 19.7468'	137° 36.1299'	1065	Ibid.	Grayish olive silty clay (0.5cm)/ Grayish olive silt (19.5cm) (total:20cm)
218	5/15/97	13:01	34° 16.9557'	137° 32.4269'	1163	Ibid.	Olive black sandy clay (1.5cm)/ grayish olive viscid silty clay (6.5cm) (total: 8cm)
217	5/15/97	14:11	34° 20.1428'	137° 29.4652'	1077	Ibid.	Olive gray silty clay (7.5cm)/ olive gray muddy granule (1cm)/ olive gray silty clay (12cm)/ olive black muddy granule (1cm) (total: 21.5cm)
207	5/15/97	15:11	34° 22.7604'	137° 33.2068'	735	Ibid.	Grayish olive-olive black silty clay (22cm)
196	5/15/97	16:07	34° 25.2144'	137° 37.0772'	685	Ibid.	Olive gray muddy very fine sand (2cm)/ grayish olive viscid silty clay (3.5cm)/ dark olive gray viscid silt (4.5cm) (total: 10cm)
197	5/15/97	16:14	34° 22.0883'	137° 39.8681'	1171	Ibid.	Grayish olive silt (3.5cm)/ olive gray coarse silt (0.5cm)/ olive gray silty clay (13cm)/ dark olive gray muddy medium-coarse sand, shell fragment rich (4cm) (total: 21cm)
311	5/16/97	9:46	34° 05.0248'	138° 08.0312'	2420	Gravity Corer	Grayish olive-olive gray silty clay intercalated with 12 turbidite layers (coarse silt-very fine sand sized) (270cm)
180	5/16/97	11:45	34° 08.3406'	138° 05.3710'	1385	K-Grab	Grayish olive muddy very fine sand (7cm)/ olive gray silt (14cm) (total: 21cm)
192	5/16/97	13:06	34° 06.0034'	138° 01.7401'	1260	Ibid.	Olive black muddy very fine sand, foraminifer rich (6cm)/ olive gray silt (15cm) (total: 21cm)
191	5/16/97	14:12	34° 08.9759'	137° 58.6854'	887	Ibid.	Grayish olive very fine sand, foraminifer rich (4cm)/ olive black muddy very fine sand (14cm) (total: 18cm)
179	5/16/97	15:16	34° 11.4724'	138° 02.4615'	900	Ibid.	Grayish olive muddy very fine sand (5cm)/ granule-pebble (3cm)/ olive gray muddy very fine sand (6cm) (total: 14cm)
312	5/16/97	16:25	34° 14.7779'	138° 02.8706'	1237	Gravity Corer	Olive black muddy very fine sand with 2 very fine sand layers (turbidite) (70cm)
166	5/16/97	17:54	34° 14.0837'	138° 06.3196'	1141	K-Grab	Olive black muddy very fine sand, foraminifer bearing (6cm)/ olive gray semiconsolidated silt (4cm) (total: 10cm)

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
198	5/17/97	12:54	34° 18.7672'	137° 42.7503'	1317	K-Grab	Grayish olive silty clay with rounded granule-pebbles (4cm)
184	5/17/97	14:49	34° 30.8175'	137° 37.9713'	291	Ibid.	Olive gray-olive black sandy silt (12cm)/ olive gray viscoid silty clay (3cm) (total: 15cm)
185	5/17/97	15:39	34° 27.6236'	137° 46.7846'	666	Ibid.	Grayish olive silty clay (14cm)
186	5/17/97	16:37	34° 24.5692'	137° 43.7191'	725	Ibid.	Grayish olive silt (1cm)/ olive gray sandy silt (12cm)/ gray viscoid silty clay with very fine sand patches (7cm) (total: 20cm)
174	5/17/97	17:37	34° 27.1037'	137° 47.5111'	656	Ibid.	Rocky bottom, grayish olive muddy very fine sand, foraminifer bearing
165	5/18/97	8:42	34° 17.1089'	138° 03.3702'	1080	Ibid.	Grayish olive sandy silt (0.5cm)/ olive gray silt (17.5cm)/ gray very fine sand, bioturbated, foraminifer bearing (4cm) (total: 22cm)
154	5/18/97	9:41	34° 19.6901'	138° 07.1721'	400	Ibid.	Grayish olive muddy fine sand, poorly sorted (0.5cm), angular pebbles on the surface/ olive gray muddy fine sand, shell fragment bearing (8cm) (total: 8.5cm)
155	5/18/97	10:47	34° 16.4772'	138° 10.1986'	1255	Ibid.	Grayish olive silt (1cm)/ olive gray sandy silt (7cm)/ gray viscoid silt (6cm) (total: 14cm)
313	5/18/97	13:48	34° 11.8797'	138° 30.1166'	3590	Multiple Corer	No sample
314	5/18/97	17:07	34° 30.1849'	138° 36.3075'	2711	Ibid.	Olive black-grayish olive diatomaceous ooze (22.5cm)/ olive gray-gray silty clay intercalated with 4 turbidite layers (very fine sand sized) (34.5cm) (total: 57cm)
L	5/18/97	7:57	34° 38.5395'	139° 14.0653'	361	Dredge	A large amount of two kinds of volcanic rocks. One type is an altered and fragile lapilli tuff boulder. Another is a subaqueous volcanic bomb mantled with reddish brown palagonite rind.
M	5/19/97	9:11	34° 34.3412'	139° 15.3244'	332	Ibid.	A large amount of porphyritic dacite blocks (boulder to cobble size) with less aphyritic basalt cobble. Dacitic blocks often includes basic inclusions.
143	8/5/97	10:32	34° 25.58'	138° 10.98'	153	K-Grab	Olive gray muddy coarse-very coarse shell sand, granule bearing (12cm)
142	8/5/97	11:53	34° 25.76'	138° 7.91'	97	Ibid.	Gray shell fragment rich fine sand (8cm)
153-3	8/5/97	13:56	34° 22.98699'	138° 3.95975'	286	Ibid.	Shell fragment bearing very fine sand
141	8/5/97	15:18	34° 28.90304'	138° 5.03313'	360	Ibid.	Olive gray very fine sand (18cm)
140	8/5/97	16:27	34° 31.83995'	138° 1.89908'	324	Ibid.	Grayish olive muddy very fine sand (11cm)
172	8/7/97	10:58	34° 33.65403'	138° 41.52705'	171	Ibid.	Grayish olive muddy very fine sand (17cm)
183	8/7/97	12:07	34° 34.24392'	138° 34.3124'	116	Ibid.	Very fine sand (18cm)
194	8/7/97	12:54	34° 31.72364'	138° 30.76192'	155	Ibid.	Olive gray very fine sand
205	8/7/97	13:41	34° 29.21643'	138° 27.0754'	161	Ibid.	Olive gray shell fragment with very fine sand (15cm)
215-2	8/7/97	14:42	34° 26.88584'	138° 23.20732'	164	Ibid.	Olive gray shell fragment and mica bearing very fine sand (16cm)
214	8/7/97	15:38	34° 29.78545'	138° 20.39873'	90	Ibid.	Olive black shell fragment bearing very fine sand (10cm)
224	8/7/97	16:23	34° 27.23024'	138° 16.7913'	96	Ibid.	Grayish olive well-sorted very fine sand (8cm)
225-2	8/7/97	17:23	34° 24.17516'	138° 19.69068'	168	Ibid.	Olive black shell fragment bearing fine-very fine sand (10cm)
234	8/7/97	18:08	34° 21.61745'	138° 16.06967'	158	Ibid.	Black shell fragment bearing fine-very fine sand (7cm)
233-3	8/7/97	19:15	34° 24.68609'	138° 12.86154'	98	Ibid.	Olive black well-sorted very fine-fine sand, mica and shell fragment bearing (11cm)

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
254	8/8/97	7:45	34° 17.31143'	138° 2.1884'	153	K-Grab	Grayish olive fine-very fine sand, rounded granule-cobble bearing (8.5cm)
259	8/8/97	9:54	34° 11.4093'	138° 0.6887'	680	Ibid.	Grayish olive sandy silt (10cm) basement rock just below sandy silt
255	8/8/97	11:16	34° 13.9408'	138° 4.7689'	694	Ibid.	Very fine sand
249	8/8/97	12:27	34° 16.84798'	138° 8.56869'	283	Ibid.	Olive gray very fine-fine sand
248	8/8/97	13:14	34° 19.89728'	138° 5.60259'	111	Ibid.	Grayish olive very fine-fine sand, mica bearing
241	8/8/97	14:00	34° 22.24843'	138° 9.50474'	102	Ibid.	Grayish olive well-sorted very fine-fine sand, shell fragment bearing (10cm)
242	8/8/97	14:42	34° 19.17851'	138° 12.44277'	198	Ibid.	Olive black shell fragment and pumice bearing fine sand (10cm)
243-2	8/8/97	16:00	34° 16.5555'	138° 15.07197'	465	Ibid.	Grayish olive foraminifer bearing very fine sand (10.5cm)
235-2	8/8/97	17:17	34° 19.03247'	138° 19.39374'	360	Ibid.	Olive gray shell fragment and pumice bearing fine-very fine sand (13cm)
236	8/8/97	18:48	34° 16.22482'	138° 21.54818'	818	Ibid.	Foraminifer bearing fine sand
212-4	8/9/97	8:47	34° 7.4553'	138° 47.5018'	487	Ibid.	Grayish olive foraminifer bearing fine sand (filmed)/grayish olive silty clay
211-4	8/9/97	11:15	34° 9.9269'	138° 44.3073'	897	Ibid.	Olive gray foraminifer rich fine sand
256	8/11/97	8:46	34° 11.7206'	138° 7.6379'	1187	Ibid.	Sandy silt, foraminifer bearing, poorly sorted (8cm)
244	8/11/97	11:00	34° 13.498'	138° 18.1543'	961	Ibid.	Clayey silt (19cm)
227	8/11/97	13:01	34° 18.72968'	138° 25.8526'	1114	Ibid.	Silty clay (20cm)
226	8/11/97	14:20	34° 21.37736'	138° 22.42933'	755	Ibid.	Muddy very fine sand (7cm)
216	8/11/97	15:30	34° 23.67909'	138° 26.35387'	267	Ibid.	Shell fragment bearing fine-medium sand, mudstone
206	8/11/97	16:39	34° 26.06253'	138° 30.17585'	274	Ibid.	Muddy fine sand, poorly sorted (7cm)
195	8/11/97	17:35	34° 28.75565'	138° 34.06283'	465	Ibid.	Muddy very fine sand, poorly sorted (12cm)
173	8/11/97	19:09	34° 30.50488'	138° 44.46497'	567	Ibid.	Sandy silt (21cm)
160	8/11/97	20:12	34° 33.1106'	138° 48.3993'	273	Ibid.	Very fine sand (13cm)
161-2	8/12/97	9:48	34° 30.8179'	138° 52.8054'	713	Ibid.	Very fine sand (13cm)
150	8/12/97	10:43	34° 32.7209'	138° 54.8534'	460	Ibid.	Muddy very fine sand (17cm)
139	8/12/97	11:35	34° 35.1585'	138° 58.6775'	195	Ibid.	Muddy very fine sand (18.5cm)
151	8/12/97	12:50	34° 29.65741'	138° 57.95723'	621	Ibid.	Sandy silt (20cm)
162	8/12/97	14:09	34° 26.98221'	138° 54.0346'	807	Ibid.	Sandy silt (21cm)
175	8/12/97	15:25	34° 24.38509'	138° 50.49264'	916	Ibid.	Silty clay (7cm)
187	8/12/97	16:46	34° 21.87178'	138° 46.59321'	1000	Ibid.	Sandy silt (21.5cm)
188	8/12/97	18:06	34° 18.19883'	138° 48.60203'	771	Ibid.	Very fine sand (20cm)
176	8/12/97	19:23	34° 21.13551'	138° 53.36402'	480	Ibid.	Fine sand, angular granule-pebble and shell fragment bearing
152	8/13/97	9:16	34° 26.3571'	138° 0.83'	442	Ibid.	Muddy very fine sand (13cm)
163	8/13/97	10:18	34° 23.3799'	138° 56.9288'	516	Ibid.	Muddy very fine sand, poorly sorted, granule and foraminifer bearing (16cm)
164	8/13/97	11:21	34° 20.7335'	138° 59.994'	551	Ibid.	Fine sand, foraminifer and granule bearing (2.5cm)
177	8/13/97	12:32	34° 18.09522'	138° 56.3392'	632	Ibid.	Very fine sand, foraminifer bearing (10.5cm)
178	8/13/97	13:42	34° 15.07351'	138° 59.67434'	869	Ibid.	Very fine sand, foraminifer bearing (14.5cm)
190	8/13/97	14:45	34° 12.46045'	138° 55.42228'	838	Ibid.	Very fine sand, foraminifer bearing (12.5cm)

Table X-1 (continued)

Station	Date	Time	Latitude	Longitude	Water Depth	Sampler	Description
189	8/13/97	15:49	34° 15.80164'	138° 52.48746'	771	K-Grab	Very fine sand, heavy mineral and foraminifer bearing (9.5cm)
200	8/13/97	16:51	34° 13.03913'	138° 48.46978'	842	Ibid.	Muddy very fine sand, foraminifer bearing (17.5cm)
201	8/13/97	17:59	34° 9.97739'	138° 51.58663'	512	Ibid.	Fine sand, foraminifer rich, basement rock? (5cm)
202	8/13/97	19:16	34° 6.26514'	138° 55.48218'	921	Ibid.	Muddy very fine sand, foraminifer bearing (20cm)

Table X-2 Characteristics of volcanic glass shards. Glass type after Yoshikawa (1976).

Sample No.	Sub-bottom Depth (cm)	Index of Volcanic Glass		Count	Mode	Glass Type*
		Minimum	Maximum			
99		1.493	1.504	30	1.495-1.498	C, T, H, It-type
252	18-19			1	1.510-1.512	H, C, T-type
		1.510	1.514	30		
307	312-318	1.500	1.503	2	1.511-1.513	H, C, T-type
		1.511	1.514	30		
308	77	1.510	1.515	30	1.510-1.512	T, C, H-type
308	185.5-186.5	1.497	1.511	11	1.499-1.501	H, C-type
311	151-152	1.494	1.501	30	1.495-1.497	C, T, H, It-type

*; H-type: large broken bubble wall type, T-type: fibrous and pumice type,

C-type: intermediate form between H-type and T-type, It-type: irregular type