55. MAJOR ELEMENT CHEMISTRY OF THE JAPAN TRENCH SEDIMENTS, LEGS 56 AND 57, DEEP SEA DRILLING PROJECT

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ABSTRACT

The bulk chemical composition of 257 argillaceous sediments from cores around the Japan Trench which were drilled during Legs 56 and 57 was determined and examined. These samples are generally enriched in SiO_2 and impoverished in MnO, compared with typical pelagic sediments. SiO_2 is negatively correlated with other oxides. Statistical treatment of data shows that pure silica varies inversely with TiO_2 and Al_2O_3. The silica was derived mainly from planktonic siliceous organisms such as diatoms and radiolarians. Siliceous tests of these organisms disappear during progressive diagenesis, but the resolved silica redeposited in the sediments and the total silica content of the sediments remain constant. Higher SiO_2 in some samples may be due to increased volcanic glass content. On the west slope of the trench, much ferric iron was deposited but not oxidized. In contrast to iron, manganese originally present in the sediments was apparently reduced and not precipitated in this hemipelagic region. Abundant land-derived organic materials maintain a weakly reducing environment within the sediment, which permits the precipitation of ferric iron but not of manganese. The mutual relationship of conservative elements such as SiO_2, TiO_2, and Al_2O_3 indicates that sediments of the west slope of the trench were derived mostly from the land area to the west and that the original materials were chemically homogenized and diluted by biogenic silica. In contrast, the chemistry of core from the trench outer slope (Site 436) shows a vertical trend: SiO_2 progressively decreases downhole, whereas MnO and the Fe_2O_3/FeO ratio increase significantly. The deeper samples are very similar to the pelagic sediments from the Pacific Plate, whereas upper samples resemble the trench inner slope sediments. The vertical trends at this site are plausibly explained by the progressive movement of the ocean plate toward the Japan Trench. When the oceanic plate was in the Central Pacific Ocean, much MnO and Fe_2O_3 were deposited under an oxidizing environment with slow sedimentation, owing to the paucity of organic materials. As the ocean plate moved westward, nearer to the Japanese Islands, hemipelagic sediment derived from these islands were deposited over the pelagic sediments.

No pelagic sediments were detected geochemically in the deposits of the trench inner slope. If the offscraping of the sediment of the oceanic plate is the dominant process at the plate convergence, significant amounts of deep oceanic pelagic sediments that are being scraped off from the oceanic plate should be contained in the trench inner slope. Since the pelagic sediments are known to exist on oceanic crust coming into the trench, it may be that the pelagic sediments are subducted without offscraping against the landward wall of the trench. However, the entire sequence underlying the trench inner slope was not penetrated at any site.

INTRODUCTION

The Japan Trench–island arc system is a typical example of plate convergence accompanied by subduction of oceanic plate beneath the continental plate. The chemical feature of sediments in the trench can be one of the most important keys to an understanding of the subduction mechanism. The bulk chemical composition of the 257 samples drilled during Legs 56 and 57 was determined and examined in this context.

The chemical aspects of argillaceous sediments from piston cores around the Japanese Islands have already been published (Sugisaki, 1978, 1979; Sugisaki and Honza, in press; Sugisaki, in press a). Here I compare the data of Legs 56 and 57 with those from several regions around the Japanese Islands and attempt to place some chemical constraint on models for the observed sediment chemical variations in the DSDP sites.

EXPERIMENTAL METHODS AND RESULTS

The analytical procedure of marine argillaceous sediments involves much work, because the determination of carbonates, interstitial salts, organic materials, and total water content is needed for correction of the data. Furthermore, the usual method of FeO determination with oxidation-reduction titration is not applicable to the marine sediments, because the endpoint of the titration is very vague owing to the presence of organic materials. The improved method is described elsewhere in detail (Sugisaki, in press b) and it is outlined in the following.

The samples for this study were dried at 80°C, ground, and subsequently split into fractions. One fraction was analyzed with an automatic X-ray fluorescence spectrometer JOEL-JSX-100S for Si, Ti, Al, Fe, Mn, Ca, Mg, Na, K, and P. The details of the method have been published (Sugisaki et al., 1977). Other fractions were analyzed for total water, ignition loss, dissolved chlorine, ferrous iron, and carbonate, according to the methods noted in Table 1. The distribution of the samples and the analytical results are given in Table 1. Table 2 lists the silicate composition of samples recalculated by excluding carbonate, salts, water, and residual materials (organic matter and others).

GENERAL CHEMICAL CHARACTERISTICS OF THE SEDIMENTS

The average chemical composition of the sediments and the standard deviation at each site are shown in Table 3. Their similarity is striking. The small standard deviation from the average value reveals a particularly high degree of uniformity in the argillaceous sediments with respect to geochemical characteristics, in spite of the great length of the core.

For comparison, five sets of averages are listed in Table 3, namely that of pelagic sediments from the East Pacific Ocean and those of argillaceous sediments from four regions around the Japanese Islands. The DSDP samples, as well as others, are generally enriched in SiO_2 and impoverished in MnO, in comparison with typical pelagic sediments. Specifically the DSDP samples are higher in SiO_2 than those from the other four regions around the Japanese Islands. Among the former, Site 436 is chemically different from the rest. It is located on the oceanic plate east of the Japan Trench, whereas Sites 434, 435, 438, 439, 440, and 441 are on the landward side. In the next four sections, I discuss the chemical features of sediments from the landward side of the trench.

ANOMALOUS MANGANESE CONTENT AT SITE 434

The average MnO content at Site 434 is about twice that of the other sites (Table 3). Samples with more than 0.1 per cent MnO contain mostly $CaCO_3$ (Figure 1). Some samples containing $CaCO_3$ also show high total Fe content as Fe_2O_3. There are marlstones at several locations in the core, and they may be responsible for the high MnO content at this site. Furthermore, Okada (this volume) described micritic calcareous nodules from this site. They are enriched in manganese and iron. Samples with high total iron and MnO content may indicate incipient formation of manganiferous calcareous nodules, although the MnO/total Fe ratios are considerably different from those of the calcareous nodules described by Okada.

ORIGIN OF EXCESS SILICA

Table 2 indicates the high SiO_2 content in sediments at each site of the west slope of the trench, some of the samples containing 80 per cent SiO_2. This value is high when compared with average pelagic sediments from the Pacific Ocean, with argillaceous sediments near the Japanese Islands (Table 3), and with typical shales. Plausible explanations for the chemical characteristics are (1) source materials inherently high in silica and (2) excess silica deposited along with the sediments.

In order to examine the possibilities, correlation coefficients between SiO_2 and other oxides were calculated for each site (Table 4). SiO_2 correlates negatively with other oxides. The coefficients for Al_2O_3 and TiO_2 are conspicuous. The relation of SiO_2 versus Al_2O_3 at Site 438 is shown in Figure 2. The regression line calculated by the least squares method is $SiO_2 = 100.1 - 2.12\ Al_2O_3$. This formula gives 100.1 per cent of silica when Al_2O_3 is absent. The regression lines calculated in the same way for each site give SiO_2 values between 99 and 101 per cent, except for Site 436, where Al_2O_3 is absent (Table 5). Considering the analytical error, the range of SiO_2 is surprisingly narrow. This indicates that pure silica from a separate source is diluting Al_2O_3 during sedimentation, because the igneous and metamorphic rocks as well as the typical sedimentary rocks regarded as source materials of the sediments do not have the same relation between Al_2O_3 and SiO_2. The regression line at Site 436 is different from those at the other sites, which will be discussed later.

Percentages of SiO_2 for Site 438 when other oxides are absent were calculated from the regression lines for each oxide versus SiO_2 by the same method as for Al_2O_3 (Table 6). Each value of SiO_2 for TiO_2, Al_2O_3, FeO, MgO, and K_2O approximates 100 per cent, whereas that for Fe_2O_3, MnO, CaO, and P_2O_5 is much lower than 100 per cent. This implies that the excess silica was simply added to the elements of the first group but that the elements in the second group coprecipitated with silica. The precipitation of Fe_2O_3 and MnO will be discussed later.

The origin of the excess silica may be explained in terms of (1) acidic glass ejected from active volcanoes, (2) precipitation of siliceous organisms, and (3) inorganic precipitation of silica from sea water. The description of the drilled cores (site chapters, this volume, Pt. 1) shows the presence of significant amounts of such siliceous organisms as diatoms, sponges and radiolarians. The percentages of these organisms were not determined in the samples for chemical analyses. The estimates of percentages of these organisms (smear slides; see site

TABLE 1
Chemical Composition of Sediments

Sample (Interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO[a]	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O[b]	$CaCO_3$[c]	Residual[d]	Salt[e]	Total
Site 434																
Hole 434																
1-1, 140–142	66.51	0.49	11.99	2.62	1.56	0.082	1.85	2.04	3.47	2.08	0.090	4.58	0.0	2.91	0.64	100.90
1-4, 80–82	65.77	0.52	11.52	2.72	1.72	0.071	2.56	2.04	3.42	1.86	0.100	5.79	0.0	1.75	0.67	100.51
2-1, 100–104	67.20	0.47	11.02	2.82	1.63	0.060	2.26	1.60	3.61	1.92	0.076	5.30	0.0	0.87	0.45	99.29
4-1, 80–84	64.58	0.57	13.18	2.80	1.62	0.056	2.51	1.41	3.16	2.33	0.082	6.68	0.0	0.27	0.27	99.51
5-1, 120–124	56.29	0.42	9.86	13.87	1.82	0.250	1.83	1.87	3.09	1.70	0.077	5.94	0.0	1.74	0.37	99.12
6,CC, 31–35	69.41	0.42	10.31	3.26	1.39	0.054	1.69	1.10	2.82	1.80	0.065	7.04	0.0	0.29	0.38	100.02
7-1, 44–48	71.73	0.43	10.20	2.53	1.27	0.041	1.80	1.09	2.17	1.73	0.054	5.70	0.0	0.70	0.28	99.73
7-2, 49–53	71.48	0.42	9.95	2.42	1.44	0.053	1.95	1.03	2.35	1.70	0.058	6.18	0.0	0.22	0.33	99.58
7-2, 50–54	61.12	0.61	14.18	3.32	1.77	0.058	2.98	1.55	3.81	2.50	0.086	7.10	0.0	0.05	0.69	99.82
9-1, 46–50	69.76	0.44	10.46	2.80	1.20	0.061	2.08	1.35	3.01	1.84	0.056	6.51	0.0	0.21	0.42	100.18
9-2, 13–17	74.17	0.39	9.28	2.81	1.09	0.034	2.06	0.93	2.40	1.63	0.054	5.61	0.0	0.10	0.42	100.97
12-1, 80–84	69.79	0.43	10.19	2.50	1.72	0.500	1.26	1.10	2.23	1.81	0.072	4.62	0.0	2.70	0.27	99.18
15-1, 75–80	65.08	0.59	13.21	3.13	1.71	0.054	2.42	1.85	3.08	2.29	0.085	5.24	0.0	0.18	0.36	99.28
15-2, 82–86	64.46	0.56	13.67	3.16	1.58	0.057	2.04	2.75	3.01	1.85	0.077	5.45	0.0	0.32	0.20	99.18
16-1, 22–26	70.26	0.46	10.82	2.78	1.27	0.049	1.83	1.34	2.94	1.79	0.064	5.60	0.0	0.54	0.36	100.10
17-1, 20–22	70.04	0.45	10.40	2.52	1.32	0.041	1.99	1.08	2.53	1.83	0.058	5.79	0.0	1.25	0.37	99.66
19-1, 36–40	59.66	0.37	9.11	12.07	1.60	0.220	2.14	0.10	2.44	1.53	0.082	5.57	5.30	0.42	0.34	100.95
19-2, 56–60	51.95	0.35	8.19	13.72	1.36	0.260	2.03	0.40	2.43	1.35	0.130	4.31	11.52	1.34	0.25	99.58
20-1, 96–99	72.14	0.45	10.32	2.67	1.33	0.055	1.89	0.41	2.05	1.69	0.064	5.62	1.19	0.48	0.25	100.60
22-1, 115–118	71.68	0.45	10.94	2.90	1.15	0.057	1.75	1.16	2.21	1.79	0.053	5.66	0.0	0.66	0.23	100.69
23-1, 66–68	71.58	0.43	10.20	2.72	1.20	0.045	1.72	1.02	2.35	1.74	0.054	5.72	0.0	0.23	0.36	99.36
24-1, 86–90	62.57	0.40	9.16	4.00	1.28	0.110	2.16	0.80	2.19	1.67	0.130	5.70	7.61	0.90	0.28	98.96
25-1, 54–58	65.51	0.43	10.40	4.28	1.50	0.110	1.97	0.12	2.56	1.74	0.086	5.56	4.90	0.29	0.37	99.82
26-1, 40–44	68.81	0.49	11.55	3.04	1.42	0.052	2.01	1.16	2.55	1.93	0.070	6.65	0.0	0.02	0.34	100.10
27-1, 86–90	55.34	0.27	9.11	14.31	1.47	0.270	2.36	0.07	2.26	1.60	0.110	5.10	6.91	0.22	0.17	99.58
28-2, 76–79	66.82	0.53	12.19	3.72	1.60	0.260	1.56	1.04	2.09	2.06	0.110	5.31	1.32	0.49	0.16	99.26
30-1, 81–84	73.07	0.43	9.98	2.30	1.35	0.060	1.57	1.04	2.18	1.63	0.067	6.02	0.0	1.16	0.26	101.12
31-1, 43–47	68.93	0.50	11.91	2.40	1.80	0.160	1.78	0.73	2.53	1.95	0.081	4.89	1.09	1.21	0.25	100.20
33-1, 75–79	61.60	0.44	10.90	8.50	1.74	0.200	2.25	1.14	2.55	1.73	0.099	4.80	3.31	0.06	0.26	99.57
33-1, 84–88	67.39	0.44	10.29	4.11	2.19	0.120	1.66	0.61	2.40	1.81	0.100	5.37	2.41	0.32	0.29	99.51
33-2, 84–88	65.96	0.46	11.43	3.94	1.59	0.110	1.88	0.98	3.10	1.84	0.079	6.15	2.17	0.29	0.49	100.47
Hole 434A																
1-1, 56–60	63.06	0.64	13.87	2.95	2.01	0.074	2.62	3.09	3.44	2.01	0.100	5.24	0.0	0.33	0.38	99.81
1-5,	65.00	0.61	12.90	2.86	1.96	0.064	2.81	1.75	3.51	2.30	0.110	6.42	0.0	0.21	0.44	100.95
Hole 434B																
3-1, 60–64	67.68	0.54	13.15	3.31	1.51	0.069	1.87	1.55	2.43	2.29	0.093	5.06	0.0	0.08	0.29	99.93
4-1, 42–46	68.50	0.54	12.09	3.21	1.44	0.048	1.72	1.38	2.28	1.95	0.072	5.78	0.0	0.20	0.25	99.45
7-1, 35–39	70.56	0.47	10.34	2.64	1.47	0.250	1.45	0.74	1.96	1.74	0.074	6.85	0.68	0.14	0.18	99.54
8-2, 66–70	70.42	0.46	9.48	3.11	1.67	0.130	1.63	0.20	2.13	1.58	0.078	5.66	2.24	1.25	0.22	100.27
9-2, 60–64	79.02	0.33	7.40	1.46	1.33	0.047	1.24	0.86	1.64	1.29	0.052	4.67	0.0	0.57	0.25	100.16
10-1, 80–84	72.42	0.49	11.31	2.36	1.71	0.200	1.50	0.38	2.21	1.66	0.076	4.06	2.03	0.07	0.28	100.76
11-2, 76–80	64.80	0.43	10.09	3.92	1.87	0.190	1.49	0.64	2.01	1.83	0.100	5.26	6.68	0.92	0.27	100.50
15-2, 100–104	73.25	0.43	10.47	2.30	1.51	0.041	1.34	1.00	1.92	1.73	0.062	5.38	0.0	0.07	0.15	99.65
16-1, 90–94	74.83	0.35	10.24	1.82	1.24	0.036	1.17	1.29	2.53	1.70	0.061	4.08	0.0	1.33	0.21	100.89
17-1, 76–80	68.74	0.45	10.70	3.17	1.51	0.120	1.87	0.79	2.22	1.90	0.087	5.37	3.15	0.18	0.25	100.50
19-1, 110–114	66.87	0.55	13.78	3.44	1.50	0.110	1.92	1.03	2.05	2.66	0.079	5.74	0.0	0.76	0.12	100.61
20-1, 60–64	69.46	0.49	12.63	2.22	1.55	0.042	1.70	1.38	2.51	2.06	0.073	5.60	0.0	0.20	0.16	100.07
25-1, 56–60	72.74	0.38	11.14	1.89	1.28	0.067	0.93	1.47	2.54	1.68	0.055	5.43	0.0	0.38	0.20	100.18
25-2, 95–99	67.89	0.48	12.56	2.72	1.71	0.130	1.54	0.15	2.17	2.30	0.073	5.03	1.84	0.42	0.12	99.13
26-1, 100–104	67.11	0.51	12.86	3.62	1.61	0.150	1.89	0.85	2.25	2.38	0.081	5.28	1.08	0.16	0.22	100.06
30-1, 82–84	69.10	0.52	13.25	3.32	1.48	0.041	1.86	0.62	2.01	2.25	0.061	5.61	0.64	0.08	0.11	100.95
32-1, 84–88	67.84	0.51	12.37	3.11	1.60	0.300	1.59	0.44	2.18	2.28	0.094	4.99	3.08	0.14	0.12	100.64
33-1, 86–90	68.41	0.51	12.54	3.02	1.56	0.100	1.77	0.62	2.29	2.36	0.076	5.02	0.68	0.17	0.13	99.25
34-2, 60–64	68.91	0.48	12.53	2.34	1.73	0.099	1.62	0.81	2.28	2.24	0.190	5.20	1.01	0.17	0.12	99.72
35-1, 86–90	69.05	0.52	12.10	2.94	1.76	0.086	2.01	0.85	2.32	1.84	0.076	6.07	0.95	0.22	0.17	100.96
36-1, 15–19	73.62	0.42	10.26	2.44	1.36	0.035	1.65	0.90	1.97	1.65	0.056	5.55	0.0	0.68	0.20	100.79
Site 435																
Hole 435																
1-3, 40–44	62.92	0.57	12.39	2.90	1.86	0.062	2.31	1.92	3.39	1.87	0.100	4.96	2.81	2.51	0.50	101.09
2-2, 50–54	60.80	0.65	13.43	3.01	2.08	0.062	2.53	2.10	3.45	2.12	0.110	5.50	0.92	2.04	0.51	99.32
4-2, 40–44	61.59	0.54	11.61	3.70	1.75	0.050	1.97	1.51	3.16	1.84	0.093	5.47	3.67	1.77	0.48	99.19
5-3, 28–32	62.66	0.62	13.07	2.80	1.98	0.052	2.39	1.70	2.93	2.27	0.110	5.63	1.93	1.29	0.39	99.82
6-1, 100–104	64.03	0.56	13.57	2.65	1.71	0.063	2.20	1.17	3.17	2.39	0.084	5.93	2.53	0.46	0.36	100.87
7-3, 100–104	63.81	0.61	13.48	2.86	1.92	0.065	2.33	3.09	3.20	1.92	0.120	4.11	0.0	1.55	0.29	99.35
8-2, 70–73	56.73	0.56	12.51	9.93	1.91	0.160	2.43	2.34	3.26	1.73	0.095	5.11	1.27	0.93	0.37	99.32
9-2, 70–73	68.09	0.49	12.15	2.28	1.64	0.060	1.81	2.58	3.62	1.85	0.084	5.69	0.0	0.16	0.42	100.91
13-3, 80–84	69.53	0.45	9.70	2.47	1.42	0.036	1.82	1.85	2.69	1.62	0.077	6.80	0.0	1.70	0.49	100.65
14-1, 14–18	67.02	0.35	8.06	2.01	1.09	0.034	1.67	1.59	2.59	0.95	0.093	6.17	6.77	1.73	0.53	100.65
15-2, 10–14	70.76	0.33	10.46	1.58	1.20	0.056	1.41	2.08	2.90	2.22	0.072	5.00	0.0	1.29	0.39	99.76
16-1, 72–74	71.58	0.35	9.13	1.76	1.33	0.045	1.16	1.90	2.81	1.75	0.070	6.53	0.0	1.07	0.44	99.93
29-1, 59–63	64.74	0.58	13.63	3.72	1.79	0.060	2.36	1.26	2.43	2.44	0.091	6.20	0.0	0.27	0.17	99.74

TABLE 1 – *Continued*

Sample (Interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO[a]	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O[b]	$CaCO_3$[c]	Residual[d]	Salt[e]	Total
Site 435																
Hole 435A																
1-3, 54–58	61.45	0.64	13.91	3.05	2.12	0.065	2.55	2.58	3.45	2.07	0.110	5.92	1.24	0.57	0.42	100.15
2-1, 43–47	73.80	0.32	6.86	1.81	1.03	0.029	1.33	1.91	2.53	1.16	0.064	7.05	0.0	1.25	0.70	99.84
3-2, 66–70	74.33	0.29	6.70	1.49	0.97	0.048	1.17	1.20	2.43	1.14	0.059	6.13	0.0	2.75	0.67	99.38
4-2, 50–54	72.29	0.38	8.39	1.88	1.34	0.041	1.71	1.19	2.38	1.41	0.056	6.68	0.0	2.00	0.61	100.36
5-3, 90–94	69.26	0.42	9.79	2.24	1.36	0.042	1.59	1.72	2.52	1.57	0.075	6.56	1.17	0.49	0.44	99.25
6-1, 58–62	69.47	0.37	8.38	2.45	1.12	0.034	1.27	1.25	2.23	1.32	0.069	6.87	4.09	0.17	0.49	99.57
7-1, 46–50	72.29	0.38	8.52	2.06	1.31	0.030	1.68	1.18	2.37	1.39	0.065	8.68	0.0	0.42	0.56	100.94
8-1, 43–47	77.59	0.27	5.41	1.40	0.89	0.021	1.22	1.03	2.18	0.89	0.058	7.53	0.0	1.48	0.71	100.67
9-1, 110–114	73.31	0.33	8.01	1.84	1.05	0.026	1.44	1.02	2.45	1.42	0.049	7.15	0.0	1.54	0.63	100.27
10-1, 62–66	72.55	0.41	9.33	2.54	1.19	0.045	1.89	1.37	2.27	1.51	0.068	6.72	0.0	0.66	0.43	100.98
11-2, 66–70	69.97	0.34	7.83	2.14	1.05	0.046	1.45	0.90	2.09	1.31	0.094	6.70	3.71	1.15	0.48	99.25
Site 436																
Hole 436																
1-1, 50–54	60.98	0.64	14.16	3.42	1.80	0.059	2.82	1.94	3.43	2.41	0.100	6.82	0.0	1.73	0.64	100.94
1-4, 50–54	61.69	0.55	13.48	4.27	1.68	0.081	1.95	2.15	3.36	2.19	0.092	6.25	0.0	1.11	0.51	99.36
2-1, 110–114	62.04	0.63	13.79	3.99	2.29	0.083	2.47	2.41	3.29	2.16	0.100	6.35	0.0	0.34	0.55	100.50
3-3, 100–104	62.16	0.57	13.78	3.20	1.69	0.056	2.31	1.41	3.47	2.61	0.083	7.21	0.0	0.44	0.56	99.55
4-2, 130–134	62.69	0.56	12.90	3.70	1.52	0.049	2.93	1.71	3.73	2.17	0.083	7.33	0.0	0.68	0.75	100.80
4-4, 130–134	60.95	0.61	13.91	3.71	1.74	0.067	2.73	1.74	3.21	2.59	0.088	6.90	0.0	0.88	0.60	99.72
5-2, 14–18	60.41	0.61	14.40	3.30	1.92	0.069	2.53	2.67	3.49	2.10	0.097	6.25	0.0	0.84	0.53	99.21
5-4, 14–18	61.77	0.61	14.06	3.85	1.83	0.070	2.75	1.84	3.27	2.45	0.100	6.17	0.0	1.38	0.53	100.67
6-3, 80–84	62.18	0.63	14.76	3.32	1.90	0.063	2.74	2.11	3.26	2.46	0.100	4.50	0.0	2.46	0.50	101.00
6-3, 84–88	64.39	0.55	13.88	2.83	1.73	0.066	2.44	1.89	3.56	2.32	0.085	6.43	0.0	0.29	0.48	100.93
7-6, 6–10	61.64	0.63	14.39	3.48	1.73	0.055	2.71	2.01	3.44	2.51	0.100	6.06	0.0	0.33	0.54	99.62
8-2, 50–54	63.23	0.55	13.47	3.03	1.68	0.075	2.34	2.27	3.62	2.15	0.093	5.96	0.0	0.41	0.58	99.45
8-4, 50–54	62.27	0.57	13.22	3.24	1.72	0.066	2.40	2.01	3.94	2.14	0.089	6.45	0.0	0.58	0.58	99.27
9-3, 113–118	64.86	0.48	12.39	3.45	1.41	0.051	2.47	1.60	3.58	2.23	0.068	6.58	0.0	0.28	0.65	100.10
9-6, 41–46	60.33	0.64	14.32	3.77	1.57	0.055	3.19	1.44	3.20	2.69	0.089	6.95	0.0	0.97	0.58	99.78
10-2, 113–118	63.92	0.54	12.60	3.30	1.40	0.058	2.59	1.37	3.38	2.26	0.074	5.97	0.0	1.65	0.74	99.86
10-5, 113–118	62.56	0.49	13.13	3.66	1.66	0.074	2.51	1.66	3.63	2.21	0.076	5.81	0.0	1.24	0.55	99.26
11-2, 86–90	62.50	0.52	12.10	3.58	1.47	0.061	2.81	1.59	3.76	2.13	0.072	6.67	0.0	1.86	0.81	99.92
11-5, 86–90	62.32	0.52	14.10	3.01	1.73	0.071	2.24	2.36	3.65	2.07	0.110	5.52	0.0	1.01	0.58	99.28
12-2, 36–40	64.61	0.53	13.28	3.25	1.20	0.063	2.31	1.74	3.87	2.22	0.088	5.51	0.0	1.69	0.64	100.99
12-4, 36–40	67.36	0.33	12.27	1.74	1.18	0.073	1.49	1.21	3.37	2.98	0.058	6.04	0.0	0.72	0.63	99.45
13-2, 73–75	61.19	0.50	11.81	4.35	1.47	0.072	2.51	1.59	4.00	2.02	0.074	6.58	0.0	2.19	0.71	99.06
13-4, 73–75	63.00	0.49	11.88	2.80	1.49	0.060	2.28	1.63	3.63	2.14	0.074	5.57	0.0	3.18	0.67	98.90
14-1, 60–64	66.06	0.35	12.14	3.31	1.30	0.073	1.61	1.16	3.49	3.14	0.046	4.24	0.0	2.32	0.56	99.79
14-3, 60–64	69.58	0.31	12.25	1.68	1.02	0.051	1.13	1.59	3.47	2.88	0.047	4.76	0.0	0.17	0.38	99.31
15-1, 90–94	67.57	0.46	11.60	2.41	1.43	0.050	2.16	1.81	3.61	1.92	0.085	6.91	0.0	0.22	0.74	100.98
15-6, 30–34	68.59	0.30	11.98	1.53	1.09	0.058	1.27	1.27	3.35	3.18	0.050	5.67	0.0	0.81	0.49	99.64
16-2, 90–94	69.66	0.41	10.27	2.85	1.26	0.048	1.95	1.32	3.19	1.75	0.062	7.30	0.0	0.17	0.64	100.88
17-4, 30–34	64.55	0.56	12.49	2.79	1.69	0.061	1.95	2.02	3.41	1.95	0.090	5.87	0.0	1.04	0.65	99.12
18-2, 34–38	64.35	0.46	11.71	3.42	1.43	0.062	1.91	1.67	3.69	2.06	0.062	6.98	0.0	1.62	0.72	100.15
19-1, 66–70	64.37	0.44	12.02	3.09	1.26	0.066	1.66	1.82	3.70	2.31	0.120	6.34	0.0	1.22	0.70	99.12
19-4, 86–90	64.57	0.47	12.04	3.82	1.21	0.044	2.07	1.84	3.26	1.93	0.057	5.68	0.0	1.50	0.64	99.12
20-1, 105–109	67.82	0.41	12.21	2.11	1.59	0.057	1.46	1.60	3.42	2.11	0.062	5.90	0.0	0.12	0.51	99.38
21-2, 64–68	64.57	0.56	13.86	2.68	1.60	0.053	2.01	1.56	3.25	2.45	0.088	5.90	0.0	0.58	0.59	99.75
22-1, 52–56	62.10	0.53	13.04	4.04	1.49	0.055	2.50	1.27	3.34	2.58	0.064	7.07	0.0	0.43	0.61	99.13
23-2, 35–39	64.23	0.56	13.62	3.17	1.39	0.043	2.19	1.54	3.36	2.43	0.064	6.63	0.0	0.11	0.64	99.97
23-5, 35–39	64.42	0.55	13.53	2.75	1.70	0.058	2.20	1.52	3.31	2.55	0.082	6.87	0.0	0.06	0.56	100.16
24-1, 53–57	64.55	0.56	14.13	3.36	1.35	0.061	2.18	1.24	3.16	2.64	0.076	6.34	0.0	0.71	0.61	100.97
25-1, 74–78	65.27	0.49	13.14	3.46	1.14	0.050	1.94	1.06	3.03	2.67	0.063	6.20	0.0	0.54	0.63	99.69
27-1, 106–110	64.29	0.56	14.76	3.59	1.36	0.048	2.16	1.01	3.03	2.70	0.063	6.69	0.0	0.01	0.70	100.97
27-2, 106–110	62.59	0.56	13.50	4.17	1.48	0.041	2.49	1.04	3.14	2.57	0.061	6.50	0.0	0.75	0.59	99.47
28-1, 56–60	65.00	0.54	13.95	3.45	1.19	0.040	2.19	0.87	3.15	2.57	0.068	6.72	0.0	0.39	0.64	100.76
29-1, 70–74	67.45	0.44	13.55	3.20	1.22	0.078	1.58	1.56	3.26	2.45	0.064	5.66	0.0	0.08	0.50	101.11
29-2, 70–74	66.05	0.39	13.10	3.28	0.81	0.067	1.71	0.97	3.05	3.09	0.057	5.29	0.0	1.80	0.54	100.20
30-1, 74–78	66.28	0.38	12.98	2.45	0.95	0.120	1.38	1.05	3.00	3.13	0.055	5.15	0.0	1.74	0.39	99.07
30-3, 74–78	64.03	0.53	13.97	3.66	1.05	0.055	2.09	1.18	2.88	2.56	0.065	3.85	0.0	2.56	0.55	99.04
31-2, 40–44	64.41	0.42	12.10	3.52	0.95	0.180	1.69	1.38	3.09	2.31	0.170	6.50	0.0	2.33	0.54	99.59
31-4, 40–44	61.95	0.58	14.76	4.40	0.99	0.650	1.40	1.29	3.20	2.51	0.077	6.04	0.0	1.80	0.51	100.16
32-2, 46–50	61.90	0.55	13.42	4.59	0.80	0.560	1.46	0.96	3.08	2.57	0.070	7.08	0.0	2.28	0.49	99.81
33-1, 52–56	63.46	0.48	13.67	3.82	0.90	0.350	1.43	1.10	3.16	2.78	0.110	6.66	0.0	1.88	0.47	100.26
33-4, 52–56	60.51	0.58	14.42	4.65	1.02	0.310	2.04	1.31	3.23	2.55	0.092	8.34	0.0	1.13	0.48	100.65
34-2, 60–64	62.02	0.59	14.09	4.66	0.99	0.180	2.24	1.26	2.96	2.49	0.083	6.23	0.0	0.86	0.50	99.17
34-6, 60–64	63.64	0.55	13.72	4.77	0.80	0.170	2.11	1.07	3.10	2.49	0.074	6.00	0.0	1.35	0.49	100.33
35-1, 60–64	60.36	0.58	14.01	4.68	0.83	0.900	0.83	0.78	3.51	2.75	0.080	6.75	0.0	2.39	0.58	99.02
35-4, 60–64	58.57	0.65	15.18	5.25	0.88	0.120	2.35	0.93	3.02	2.85	0.080	8.19	0.0	1.84	0.53	100.44
36-2, 50–54	62.02	0.62	15.86	5.23	0.61	0.450	1.61	0.80	2.56	2.81	0.140	5.91	0.0	1.93	0.39	100.95
36-6, 50–54	62.76	0.53	15.42	4.04	0.83	0.240	1.42	0.87	3.04	3.21	0.090	7.95	0.0	0.32	0.42	101.13
37-2, 70–74	62.07	0.59	15.30	5.17	0.68	0.280	1.84	0.70	2.65	2.86	0.097	6.89	0.0	0.76	0.47	100.35
37-6, 70–74	60.88	0.45	16.44	4.02	0.32	0.370	2.51	0.67	2.92	2.26	0.074	6.44	0.0	1.34	0.31	99.01

TABLE 1 – *Continued*

Sample (Interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO[a]	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O[b]	$CaCO_3$[c]	Residual[d]	Salt[e]	Total
Site 436																
Hole 436 (cont.)																
38-2, 66–70	62.26	0.53	15.50	5.04	0.34	0.520	1.63	0.95	3.05	3.11	0.120	7.03	0.0	0.77	0.29	101.15
39-1, 60–64	58.61	0.60	16.46	6.63	0.11	0.680	1.80	0.87	2.70	2.44	0.150	9.05	0.0	1.03	0.23	101.36
39-6, 60–64	56.84	0.67	18.58	6.89	0.09	2.140	0.18	0.68	2.42	3.15	0.320	8.69	0.0	0.15	0.23	101.03
40-3, 50–54	55.50	0.67	18.62	6.85	0.10	2.140	0.18	0.58	2.07	3.74	0.280	7.80	0.0	0.52	0.25	99.29
40-4, 50–54	56.50	0.67	18.67	6.81	0.24	2.320	0.18	0.63	1.99	3.86	0.300	7.79	0.0	0.56	0.23	100.75
Site 438																
Hole 438																
1-2, 98–102	64.65	0.43	12.90	2.42	1.77	0.068	1.55	2.31	3.02	1.98	0.076	4.07	1.83	0.70	1.29	99.07
3-2, 60–64	58.66	0.57	11.92	2.88	1.95	0.050	2.27	2.80	2.17	2.06	0.100	5.17	4.75	2.20	1.58	99.13
5-4, 30–34	61.44	0.55	12.61	5.41	1.73	0.088	2.61	3.37	2.86	1.99	0.092	4.30	0.0	1.11	1.02	99.17
7-2, 60–64	65.53	0.47	10.85	2.33	1.72	0.059	1.90	2.22	2.38	1.67	0.092	7.12	0.0	1.42	1.64	99.40
9-2, 132–136	69.69	0.45	11.43	2.26	1.51	0.047	1.73	1.90	2.27	1.90	0.086	5.94	0.0	0.75	1.34	101.30
10-3, 100–104	64.52	0.52	11.63	2.67	1.93	0.064	2.07	2.92	2.36	1.62	0.100	5.07	0.0	1.98	1.43	98.89
11-2, 76–80	65.39	0.52	10.93	2.99	1.76	0.056	1.78	2.68	2.38	1.68	0.092	6.19	0.0	1.49	1.25	99.18
Hole 438A																
1-2, 66–70	58.74	0.59	13.44	4.76	1.80	0.083	2.27	3.57	2.74	1.76	0.110	5.23	1.81	1.14	1.45	99.49
3-2, 72–76	61.57	0.52	12.71	4.10	1.69	0.067	2.31	1.91	2.82	2.12	0.091	5.38	2.70	0.40	1.29	99.68
5-2, 145–147	62.94	0.42	11.55	2.04	1.38	0.051	1.43	1.38	2.69	1.77	0.090	5.29	4.87	1.84	1.05	98.79
7-2, 41–42	65.16	0.43	8.92	2.08	1.49	0.030	1.64	0.24	1.66	1.50	0.078	10.20	3.30	0.59	1.75	99.08
9-1, 22–24	69.59	0.40	8.02	1.92	1.30	0.034	1.37	1.01	1.87	1.30	0.065	8.51	1.74	0.23	2.02	99.38
11-2, 84–88	70.02	0.33	6.53	1.64	1.08	0.030	1.19	0.55	1.91	1.02	0.064	9.35	2.70	0.41	2.22	99.04
13-2, 9–13	70.86	0.32	6.47	1.49	1.17	0.029	1.21	1.90	1.51	1.00	0.064	8.72	0.0	1.86	2.68	99.29
17-2, 62–64	66.22	0.47	9.89	2.27	1.72	0.040	1.89	1.19	1.74	1.67	0.077	9.00	0.0	1.40	1.62	99.20
19-2, 60–64	68.97	0.41	8.95	1.98	1.58	0.039	1.60	1.45	1.84	1.58	0.066	8.02	0.0	0.49	1.96	98.95
21-2, 40–44	68.87	0.45	9.31	2.20	1.70	0.037	1.80	1.09	1.93	1.58	0.074	8.34	0.0	0.11	2.04	99.52
23-1, 34–38	68.88	0.39	8.06	1.98	1.44	0.031	1.39	0.97	1.58	1.37	0.062	10.92	0.0	1.90	1.68	100.65
24-2, 20–22	68.44	0.47	9.64	2.54	1.55	0.035	1.72	1.06	1.99	1.64	0.077	7.90	0.0	0.07	1.66	98.79
25-2, 120–124	66.56	0.44	9.73	2.33	1.48	0.039	1.60	1.88	1.80	1.61	0.069	10.27	0.0	0.94	1.67	100.41
27-2, 50–54	71.56	0.37	7.70	1.76	1.24	0.028	1.39	1.18	1.34	1.32	0.063	9.40	0.0	0.26	1.83	99.45
29-2,	70.43	0.30	6.15	1.82	0.92	0.017	1.18	0.66	1.39	1.08	0.045	11.76	0.0	2.98	2.00	100.73
31-2, 40–44	70.26	0.30	6.29	1.69	0.94	0.024	1.01	-0.16	1.15	1.09	0.072	7.84	6.28	1.91	2.00	100.69
33-2, 36–46	67.70	0.40	9.51	2.68	1.37	0.057	1.19	2.54	1.91	1.40	0.082	8.64	0.0	2.45	1.34	101.26
35-2, 10–14	69.96	0.33	10.10	1.75	1.49	0.050	1.29	1.50	2.22	1.91	0.066	7.35	0.0	0.33	1.25	99.59
39-2, 100–102	69.43	0.38	8.34	2.01	1.33	0.030	1.25	0.75	1.39	1.48	0.700	7.83	3.67	0.21	1.36	100.16
41-2, 121–123	69.71	0.40	8.78	2.15	1.26	0.028	1.39	1.38	1.66	1.56	0.064	8.49	0.0	0.47	1.69	99.02
43-2, 132–136	67.69	0.47	10.59	2.77	1.65	0.040	1.72	1.34	1.97	1.88	0.067	6.61	0.0	0.99	0.99	98.78
47-2, 72–76	72.26	0.45	9.66	2.26	1.47	0.028	1.87	0.82	1.59	1.69	0.070	7.62	0.0	0.05	1.14	100.97
49-2, 80–82	68.90	0.45	9.54	2.13	1.72	0.039	1.87	0.99	1.61	1.72	0.074	8.16	0.0	0.83	0.93	98.96
51-2, 27–29	65.28	0.54	11.91	2.46	2.06	0.044	2.30	1.60	2.13	2.20	0.081	7.98	0.0	1.54	0.82	100.94
53-1, 116–120	65.38	0.41	8.39	2.07	1.47	0.027	1.73	1.00	1.74	1.57	0.063	12.25	0.0	3.70	1.05	100.85
55-2, 30–32	65.42	0.39	7.93	1.88	1.34	0.026	1.47	0.68	1.63	1.47	0.059	12.39	0.0	4.84	1.13	100.65
57-2, 20–24	69.86	0.47	10.11	2.33	1.72	0.035	2.04	1.03	2.06	1.85	0.073	7.57	0.0	0.07	1.01	100.21
59-2, 74–78	67.64	0.45	9.90	2.59	1.59	0.030	2.08	1.64	1.88	1.93	0.072	7.28	0.0	2.25	1.07	100.41
63-1, 42–44	70.66	0.39	8.08	1.94	1.32	0.042	1.57	0.68	1.35	1.42	0.063	7.23	2.66	0.23	1.43	99.07
65-1, 77–79	71.26	0.37	8.11	2.07	1.18	0.024	1.54	0.67	1.47	1.59	0.049	8.64	0.0	0.87	1.23	99.06
70-2, 64–67	69.02	0.48	10.74	2.79	1.44	0.036	1.95	0.68	1.60	1.89	0.065	7.22	0.0	1.79	0.67	100.37
71-2, 121–125	71.95	0.38	8.33	2.55	0.85	0.023	1.48	0.48	1.25	1.48	0.054	9.36	0.0	1.80	1.15	101.13
73-2, 67–68	71.12	0.47	10.50	2.80	1.13	0.030	1.72	0.88	1.53	1.70	0.051	7.33	0.0	0.81	0.91	100.98
85-2, 72–74	67.83	0.49	11.16	2.91	1.33	0.032	1.68	1.37	1.50	1.72	0.067	6.84	0.0	2.58	0.88	100.39
Hole 438B																
7-2, 98–102	67.84	0.50	12.74	2.83	1.64	0.038	1.68	1.42	1.65	1.93	0.078	6.69	0.0	1.54	0.38	100.95
9-2, 100–102	63.52	0.62	13.73	3.43	1.72	0.071	1.68	2.76	2.50	1.80	0.093	5.10	1.46	0.30	0.32	99.09
11-2, 59–66	65.15	0.62	13.73	3.34	1.72	0.055	1.65	3.12	1.73	1.50	0.110	5.96	0.0	1.43	0.40	100.52
12-3, 128–130	68.64	0.51	11.01	2.67	1.77	0.040	1.51	1.97	1.55	1.63	0.083	8.09	0.0	0.32	0.40	100.20
13-2, 78–80	67.59	0.47	9.85	2.46	1.58	0.035	1.63	0.39	1.30	1.44	0.073	8.66	3.70	0.32	0.58	100.07
15-1, 57–58	65.80	0.60	12.65	2.98	2.03	0.049	2.12	1.71	1.75	1.84	0.093	8.21	0.0	0.35	0.38	100.56
17-2, 61–65	64.89	0.65	14.99	3.08	2.27	0.042	2.90	0.97	1.96	2.48	0.110	6.30	0.0	0.16	0.16	100.96
19-2, 28–32	66.53	0.52	12.06	4.80	2.46	0.031	2.99	0.96	1.97	2.74	0.087	4.94	0.0	0.31	0.09	100.49
21-2, 75–78	67.44	0.52	13.67	2.81	1.55	0.024	1.89	2.01	2.29	2.10	0.068	3.95	0.0	0.56	0.11	98.99
23-2, 104–105	64.83	0.62	14.43	2.47	2.15	0.032	2.38	0.91	2.08	2.39	0.084	5.26	0.0	1.34	0.12	99.09
Site 439																
Hole 439																
7-2, 90–93	64.88	0.55	12.63	3.39	1.69	0.042	1.87	1.94	1.73	1.90	0.089	8.37	0.0	0.35	0.69	100.12
9-2, 16–19	70.61	0.43	10.29	2.92	1.33	0.036	1.66	1.21	1.30	1.64	0.063	8.44	0.0	0.32	0.67	100.92
11-2, 29–32	63.64	0.66	14.14	3.52	2.19	0.078	1.67	2.53	2.32	2.11	0.120	6.55	0.0	1.16	0.31	100.99
13-1, 86–88	64.53	0.62	14.62	2.95	1.69	0.030	2.29	1.50	2.35	2.28	0.079	5.60	0.0	0.31	0.29	99.14
15-2, 105–107	66.76	0.59	13.76	2.61	1.69	0.034	1.97	1.35	2.07	2.18	0.075	5.92	0.0	0.88	0.27	100.15
17-3, 28–31	64.84	0.62	14.58	3.02	1.60	0.029	2.24	1.54	2.43	2.17	0.071	6.37	0.0	0.30	0.25	100.06
19-1, 57–58	64.79	0.54	13.57	2.77	1.55	0.034	2.08	1.61	2.45	2.16	0.068	6.43	0.0	1.54	0.23	99.82
21-2, 68–70	69.60	0.55	13.26	2.43	1.67	0.032	1.99	1.01	2.12	2.10	0.078	5.75	0.0	0.25	0.12	100.96
23-2, 17–19	66.98	0.51	14.54	1.95	1.80	0.026	1.63	1.06	2.64	2.35	0.080	3.25	1.58	1.11	0.17	99.68
29-1, 114–119	68.68	0.45	14.62	1.49	1.73	0.035	1.26	1.45	2.42	2.06	0.083	2.82	3.17	0.01	0.37	100.63
31-2, 86–88	67.13	0.44	12.08	1.04	2.89	0.082	1.43	0.19	1.58	2.27	0.130	3.11	6.58	0.98	0.10	100.03

TABLE 1 – *Continued*

Sample (Interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO[a]	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O[b]	$CaCO_3$[c]	Residual[d]	Salt[e]	Total
Site 440																
Hole 440																
1-2, 53–57	59.00	0.59	11.95	2.51	1.95	0.057	2.40	1.50	2.10	1.98	0.110	8.67	4.14	0.84	1.37	99.17
3-1, 86–90	61.88	0.55	12.05	2.79	1.76	0.057	2.44	1.82	2.38	1.95	0.098	9.38	0.0	0.89	1.97	100.03
5-1, 70–74	63.05	0.56	12.16	2.71	1.89	0.056	2.52	1.21	2.29	1.87	0.110	7.75	2.28	0.01	1.66	100.12
7-1, 135–139	60.58	0.62	13.40	2.88	2.03	0.052	2.52	1.78	2.63	2.10	0.110	8.31	0.0	1.90	1.10	100.01
Hole 440A																
3-1, 16–20	61.36	0.61	12.60	2.76	2.13	0.054	2.60	0.93	2.36	2.14	0.120	8.44	2.44	1.44	1.21	101.20
5-3, 114–118	62.45	0.64	13.71	3.23	1.78	0.056	2.63	1.87	2.60	2.17	0.110	6.59	0.0	1.86	0.98	100.68
7-1, 48–52	60.41	0.57	12.82	2.60	1.93	0.043	2.38	0.71	2.26	2.38	0.110	8.32	3.48	1.07	0.94	100.04
Hole 440B																
1-1, 94–98	64.57	0.50	10.90	2.44	1.42	0.042	2.30	1.62	2.21	1.77	0.090	7.58	0.0	1.40	2.21	99.06
5-1, 106–110	63.41	0.57	13.18	2.55	1.87	0.074	2.12	1.97	3.20	2.06	0.110	6.25	0.0	1.45	0.97	99.79
7-1, 70–74	61.81	0.64	13.95	3.28	1.95	0.047	2.84	1.42	2.43	2.33	0.099	7.57	0.0	1.63	0.97	100.97
9-1, 133–137	63.38	0.54	12.27	3.08	1.75	0.044	2.27	1.72	2.58	1.98	0.088	8.34	0.0	1.44	0.93	100.41
11-1, 24–28	64.71	0.53	12.11	2.80	1.76	0.050	2.14	1.68	2.35	1.90	0.093	8.24	0.0	1.56	0.91	100.83
13-1, 144–148	64.73	0.55	12.41	2.89	1.73	0.049	2.15	1.64	2.30	2.05	0.082	7.26	0.0	1.63	0.78	100.25
15-1, 24–28	63.56	0.59	13.13	2.66	1.75	0.042	2.32	1.43	2.22	2.37	0.090	6.95	0.0	1.23	0.89	99.23
17-1, 33–38	64.04	0.55	12.29	3.47	1.81	0.280	1.83	0.85	2.23	1.98	0.100	6.28	2.26	0.43	0.89	99.30
19-1, 138–142	66.97	0.50	11.96	2.64	1.65	0.054	1.97	1.84	2.32	1.88	0.081	6.84	0.0	1.54	0.91	101.14
21-4, 48–52	62.48	0.40	11.30	2.39	1.32	0.100	1.44	1.06	2.68	1.84	0.096	8.74	3.74	0.58	0.76	98.93
23-1, 110–114	63.58	0.53	11.48	3.09	1.69	0.140	2.07	1.39	2.12	1.87	0.096	7.62	1.49	1.15	0.74	99.06
27-1, 120–122	71.52	0.49	7.86	1.58	1.28	0.043	1.34	1.10	1.52	1.20	0.054	8.21	0.0	1.69	0.99	98.88
31-1, 124–128	70.38	0.35	8.36	1.92	1.07	0.029	1.24	1.09	1.55	1.50	0.052	9.98	0.0	1.15	0.81	99.47
33-1, 131–135	64.36	0.40	9.58	2.10	1.35	0.035	1.54	1.08	1.81	1.69	0.056	13.29	0.0	2.64	0.76	100.68
35-1, 114–117	70.50	0.30	8.70	1.62	1.00	0.028	1.15	0.92	1.92	1.83	0.043	9.14	0.0	1.87	0.89	99.92
37-1, 44–46	71.07	0.33	7.71	2.27	1.03	0.029	1.22	1.21	1.36	1.26	0.049	8.36	0.0	2.36	0.82	99.07
39-1, 92–94	71.34	0.32	7.16	2.03	0.90	0.033	1.25	1.29	1.20	1.15	0.430	9.56	0.0	1.99	1.05	99.71
41-1, 102–105	72.79	0.34	7.66	2.26	0.90	0.027	1.27	0.75	1.23	1.29	0.050	8.28	0.0	1.76	1.09	99.70
43-1, 80–83	71.19	0.35	7.92	2.18	1.06	0.031	1.39	1.59	1.33	1.31	0.053	7.78	0.0	2.06	0.83	99.09
45-1, 134–138	71.07	0.40	8.94	2.11	1.26	0.034	1.56	0.87	1.24	1.43	0.054	8.19	0.0	1.03	0.85	99.04
49-1, 70–72	72.69	0.29	7.65	1.96	0.90	0.027	1.24	0.86	1.20	1.40	0.050	8.61	0.0	1.20	0.91	98.98
53-1, 82–84	70.61	0.44	9.57	2.30	1.75	0.120	1.65	1.04	1.56	1.68	0.067	8.28	0.0	1.16	0.53	100.75
55-1, 64–67	69.04	0.42	10.45	2.31	1.56	0.053	1.67	1.73	1.73	1.84	0.063	6.88	0.0	2.06	0.49	100.29
57-1, 21–26	70.49	0.42	9.46	1.93	1.56	0.031	1.70	0.84	1.53	1.64	0.059	7.22	0.0	1.49	0.66	99.02
59-1, 106–108	70.38	0.41	9.54	2.41	1.55	0.044	1.74	0.70	1.48	1.53	0.062	7.65	2.20	0.52	0.71	100.92
61-1, 70–72	69.12	0.50	11.81	2.45	1.72	0.043	2.09	0.81	1.81	1.99	0.068	7.48	0.0	0.98	0.48	101.34
63-1, 58–60	68.63	0.34	7.63	2.04	1.03	0.031	1.41	0.54	1.23	1.35	0.044	13.96	0.0	1.90	0.86	100.98
67-1, 124–126	69.08	0.45	10.43	2.76	1.64	0.046	1.97	0.84	1.52	1.88	0.065	7.49	0.0	1.65	0.59	100.41
69-1, 136–139	66.66	0.50	11.45	2.86	1.76	0.048	1.88	1.11	1.68	1.99	0.074	6.78	0.0	1.79	0.44	99.03
71-1, 51–54	65.41	0.58	12.96	2.78	2.34	0.065	2.57	1.02	2.04	2.36	0.088	5.83	0.0	0.56	0.40	99.01
Site 441																
Hole 441																
1-2, 52–56	62.02	0.65	13.69	3.17	1.99	0.089	2.63	3.22	2.59	1.90	0.110	5.23	0.0	0.54	1.37	99.20
7-1, 43–45	66.52	0.43	10.06	2.61	1.46	0.067	1.83	1.26	2.05	1.68	0.062	10.02	0.0	0.46	1.46	99.96
8-1, 140–144	70.02	0.40	9.27	2.27	1.29	0.045	1.51	1.10	1.76	1.43	0.059	7.87	0.0	1.08	1.13	99.23
Hole 441A																
5-1, 96–100	67.47	0.59	13.49	1.84	2.54	0.062	1.86	0.45	2.03	2.50	0.110	4.25	1.22	1.04	0.21	99.66
11-1, 28–30	62.89	0.52	12.81	2.98	1.55	0.140	1.65	1.35	1.81	2.27	0.076	10.56	0.0	2.03	0.31	100.94
12-1, 130–133	62.22	0.44	9.76	2.28	1.55	0.069	1.76	0.39	1.32	1.83	0.061	15.89	1.12	0.20	0.89	99.78
13-1, 98–102	65.80	0.45	9.95	2.54	1.68	0.053	1.74	0.26	1.36	1.79	0.072	10.11	1.51	2.32	0.66	100.30
H-1-4, 22–27[f]	65.45	0.44	10.78	2.68	1.30	0.040	1.47	1.29	1.90	1.74	0.064	8.63	0.0	4.32	0.97	101.07
Hole 441B																
1-1, 27–30	67.73	0.46	10.78	2.50	1.65	0.054	1.95	0.97	1.91	1.74	0.058	7.73	0.0	0.86	0.86	99.24
2-1, 89–91	64.19	0.51	13.09	2.60	1.97	0.130	1.97	0.43	1.93	2.47	0.099	7.02	1.31	0.98	0.66	99.35

[a] FeO was determined colorimetrically with *o*-phenanthroline.
[b] H_2O was gravitationally determined by the method of Shapiro and Brannock (1955a).
[c] $CaCO_3$ was calculated from CO_2 content, which was manometrically measured by the method of Shapiro and Brannock (1955b).
[d] Residual materials were calculated by subtracting CO_2 and H_2O from ignition loss. They may contain sulfur, organic materials, and other components.
[e] Salt was calculated from water soluble chlorine, assuming that pore water has the same composition as sea water.
[f] Wash core through and interval longer than the core barrel.

TABLE 2
Chemical Composition Recalculated by Excluding Carbonates, Residual Materials, Water, and Salts

Sample (Interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Fe_2O_3/FeO	Total Fe as Fe_2O_3
Site 434													
Hole 434													
1-1, 140–142	71.68	0.53	12.92	2.82	1.68	0.088	2.00	2.20	3.74	2.24	0.097	1.68	4.69
1-4, 80–82	71.26	0.56	12.48	2.95	1.86	0.077	2.77	2.21	3.70	2.02	0.108	1.58	5.02
2-1, 100–104	72.52	0.51	11.89	3.04	1.76	0.065	2.44	1.73	3.90	2.07	0.082	1.73	5.00
4-1, 80–84	69.98	0.62	14.28	3.03	1.76	0.061	2.71	1.53	3.42	2.52	0.089	1.73	4.98
5-1, 120–124	61.81	0.46	10.83	15.23	2.00	0.275	2.01	2.05	3.39	1.87	0.085	7.62	17.45
6,CC, 31–35	75.19	0.46	11.17	3.53	1.51	0.059	1.83	1.19	3.05	1.95	0.070	2.34	5.20
7-1, 44–48	77.09	0.46	10.96	2.72	1.36	0.044	1.94	1.17	2.33	1.86	0.058	1.99	4.23
7-2, 49–53	76.99	0.45	10.72	2.61	1.55	0.057	2.10	1.11	2.53	1.83	0.062	1.68	4.33
7-2, 50–54	66.45	0.66	15.42	3.61	1.92	0.063	3.24	1.69	4.14	2.72	0.093	1.88	5.75
9-1, 46–50	74.97	0.47	11.24	3.01	1.29	0.066	2.24	1.45	3.23	1.98	0.060	2.33	4.44
9-2, 13–17	78.20	0.41	9.78	2.96	1.15	0.036	2.17	0.98	2.53	1.72	0.057	2.58	4.24
12-1, 80–84	76.20	0.47	11.13	2.73	1.88	0.546	1.37	1.20	2.43	1.98	0.079	1.45	4.81
15-1, 75–80	69.60	0.63	14.13	3.35	1.83	0.058	2.59	1.98	3.30	2.45	0.091	1.83	5.38
15-2, 82–86	69.15	0.60	14.66	3.39	1.69	0.061	2.19	2.95	3.23	1.98	0.083	2.00	5.28
16-1, 22–26	75.06	0.49	11.56	2.97	1.36	0.052	1.95	1.43	3.14	1.91	0.068	2.19	4.48
17-1, 20–22	75.92	0.49	11.27	2.73	1.43	0.044	2.15	1.17	2.74	1.98	0.063	1.91	4.33
19-1, 36–40	66.79	0.41	10.20	13.52	1.79	0.246	2.39	0.11	2.73	1.71	0.092	7.54	15.51
19-2, 56–60	63.23	0.43	9.97	16.70	1.66	0.316	2.47	0.49	2.96	1.64	0.158	10.09	18.54
20-1, 96–99	77.51	0.48	11.09	2.87	1.43	0.059	2.03	0.44	2.20	1.82	0.069	2.01	4.46
22-1, 115–118	76.14	0.48	11.62	3.08	1.22	0.061	1.86	1.23	2.35	1.90	0.056	2.52	4.44
23-1, 66–68	76.92	0.46	10.96	2.92	1.29	0.048	1.85	1.10	2.53	1.87	0.058	2.26	4.35
24-1, 86–90	74.07	0.47	10.84	4.73	1.52	0.130	2.56	0.95	2.59	1.98	0.154	3.12	6.42
25-1, 54–58	73.85	0.48	11.72	4.83	1.69	0.124	2.22	0.14	2.88	1.96	0.097	2.86	6.71
26-1, 40–44	73.92	0.53	12.41	3.27	1.53	0.056	2.16	1.25	2.74	2.07	0.075	2.14	4.96
27-1, 86–90	63.48	0.31	10.45	16.41	1.69	0.310	2.71	0.09	2.59	1.84	0.126	9.73	18.29
28-2, 76–79	72.65	0.58	13.25	4.05	1.74	0.283	1.69	1.13	2.28	2.24	0.120	2.33	5.98
30-1, 81–84	78.00	0.46	10.65	2.45	1.44	0.064	1.67	1.11	2.33	1.74	0.072	1.70	4.06
31-1, 43–47	74.30	0.54	12.84	2.59	1.94	0.172	1.92	0.79	2.73	2.10	0.087	1.33	4.74
33-1, 75–79	67.58	0.48	11.96	9.32	1.91	0.219	2.46	1.25	2.80	1.90	0.109	4.88	11.44
33-2, 84–88	72.19	0.50	12.51	4.32	1.74	0.120	2.05	1.08	3.39	2.01	0.086	2.48	6.25
Hole 434A													
1-1, 56–60	67.19	0.68	14.78	3.14	2.14	0.079	2.79	3.29	3.66	2.14	0.107	1.47	5.52
1-5,	69.24	0.65	13.74	3.05	2.09	0.068	2.99	1.86	3.74	2.45	0.117	1.46	5.37
Hole 434B													
3-1, 60–64	71.62	0.57	13.92	3.50	1.60	0.073	1.98	1.64	2.57	2.42	0.098	2.19	5.28
4-1, 42–46	73.48	0.58	12.97	3.44	1.54	0.051	1.84	1.48	2.45	2.09	0.077	2.23	5.16
7-1, 35–39	76.96	0.51	11.28	2.88	1.60	0.273	1.59	0.81	2.14	1.90	0.081	1.79	4.66
8-2, 66–70	77.48	0.51	10.43	3.43	1.84	0.143	1.79	0.22	2.34	1.74	0.086	1.86	5.47
9-2, 60–64	83.47	0.35	7.82	1.54	1.40	0.050	1.31	0.91	1.73	1.36	0.055	1.10	3.11
10-1, 80–84	76.78	0.52	11.99	2.50	1.81	0.212	1.60	0.40	2.34	1.76	0.081	1.38	4.52
11-2, 76–80	74.17	0.49	11.55	4.49	2.14	0.217	1.70	0.74	2.30	2.09	0.114	2.10	6.87
15-2, 100–104	77.88	0.46	11.13	2.45	1.61	0.044	1.42	1.06	2.04	1.84	0.066	1.52	4.23
16-1, 90–94	78.54	0.37	10.75	1.91	1.30	0.038	1.23	1.35	2.66	1.78	0.064	1.47	3.36
17-1, 76–80	75.08	0.49	11.69	3.46	1.65	0.131	2.04	0.87	2.42	2.08	0.095	2.10	5.30
19-1, 110–114	71.15	0.59	14.66	3.66	1.60	0.117	2.04	1.10	2.18	2.83	0.084	2.30	5.44
20-1, 60–64	73.81	0.52	13.42	2.36	1.65	0.045	1.80	1.47	2.67	2.19	0.078	1.43	4.19
25-1, 56–60	77.24	0.40	11.83	2.00	1.36	0.071	0.99	1.56	2.70	1.78	0.058	1.47	3.51
25-2, 95–99	74.02	0.52	13.69	2.97	1.86	0.142	1.68	0.16	2.36	2.51	0.080	1.59	5.04
26-1, 100–104	71.92	0.55	13.78	3.88	1.73	0.161	2.03	0.92	2.41	2.55	0.087	2.25	5.80
30-1, 82–84	73.11	0.55	14.02	3.51	1.57	0.043	1.97	0.66	2.13	2.38	0.065	2.24	5.25
32-1, 84–88	73.49	0.55	13.40	3.37	1.73	0.325	1.72	0.48	2.36	2.47	0.102	1.94	5.30
33-1, 86–90	73.36	0.55	13.45	3.23	1.67	0.107	1.90	0.66	2.45	2.53	0.082	1.93	5.09
34-2, 60–64	73.92	0.51	13.44	2.51	1.86	0.106	1.74	0.87	2.44	2.40	0.204	1.35	4.57
35-1, 86–90	73.81	0.56	12.93	3.15	1.88	0.092	2.15	0.91	2.47	1.97	0.081	1.67	5.24
36-1, 15–19	78.02	0.45	10.87	2.58	1.44	0.037	1.75	0.95	2.09	1.75	0.059	1.79	4.19
Site 435													
Hole 435													
1-3, 40–44	69.67	0.63	13.72	3.21	2.06	0.069	2.56	2.13	3.76	2.07	0.111	1.56	5.50
2-2, 50–54	67.30	0.72	14.87	3.33	2.30	0.069	2.80	2.33	3.81	2.35	0.122	1.45	5.89
4-2, 40–44	70.14	0.62	13.22	4.21	1.99	0.057	2.24	1.72	3.60	2.10	0.106	2.11	6.42
5-3, 28–32	69.17	0.68	14.43	3.09	2.19	0.057	2.64	1.87	3.23	2.51	0.121	1.41	5.52

TABLE 2 – *Continued*

Sample (Interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Fe_2O_3/FeO	Total Fe as Fe_2O_3
Site 435 (cont.)													
Hole 435 (cont.)													
6-1, 100–104	69.90	0.61	14.81	2.89	1.87	0.069	2.40	1.28	3.46	2.61	0.092	1.55	4.97
7-3, 100–104	68.32	0.65	14.43	3.06	2.06	0.070	2.50	3.31	3.43	2.06	0.128	1.49	5.34
8-2, 70–73	61.90	0.61	13.65	10.83	2.08	0.175	2.65	2.55	3.55	1.89	0.104	5.20	13.15
9-2, 70–73	71.94	0.52	12.84	2.41	1.73	0.063	1.91	2.73	3.82	1.95	0.089	1.39	4.33
13-3, 80–84	75.86	0.49	10.58	2.70	1.55	0.039	1.98	2.02	2.94	1.77	0.084	1.74	4.42
14-1, 14–18	78.42	0.41	9.43	2.35	1.28	0.040	1.96	1.86	3.03	1.11	0.109	1.84	3.77
15-2, 10–14	76.03	0.35	11.24	1.69	1.29	0.060	1.52	2.23	3.12	2.39	0.077	1.31	3.13
16-1, 72–74	77.90	0.38	9.94	1.92	1.45	0.049	1.26	2.07	3.06	1.90	0.076	1.32	3.53
29-1, 59–63	69.54	0.62	14.64	4.00	1.92	0.064	2.54	1.35	2.60	2.62	0.098	2.08	6.13
Hole 435A													
1-3, 54–58	66.79	0.70	15.12	3.32	2.30	0.071	2.77	2.81	3.74	2.25	0.120	1.44	5.88
2-1, 43–47	81.24	0.35	7.55	1.99	1.13	0.032	1.46	2.10	2.79	1.28	0.070	1.75	3.25
3-2, 66–70	82.75	0.32	7.46	1.66	1.08	0.053	1.30	1.34	2.70	1.27	0.066	1.54	2.86
4-2, 50–54	79.38	0.42	9.21	2.07	1.47	0.045	1.88	1.31	2.61	1.55	0.061	1.40	3.70
5-3, 90–94	76.45	0.46	10.81	2.47	1.50	0.046	1.76	1.90	2.78	1.73	0.083	1.65	4.14
6-1, 58–62	78.99	0.42	9.53	2.78	1.27	0.039	1.44	1.42	2.54	1.50	0.078	2.18	4.20
7-1, 46–50	79.20	0.42	9.33	2.26	1.44	0.033	1.84	1.29	2.59	1.52	0.071	1.58	3.86
8-1, 43–47	85.31	0.30	5.95	1.54	0.98	0.023	1.34	1.13	2.39	0.98	0.064	1.57	2.63
9-1, 110–114	80.61	0.36	8.81	2.03	1.15	0.029	1.59	1.12	2.69	1.56	0.054	1.76	3.31
10-1, 62–66	77.87	0.44	10.01	2.72	1.28	0.048	2.03	1.47	2.43	1.62	0.073	2.13	4.14
11-2, 66–70	80.23	0.39	8.98	2.46	1.20	0.053	1.66	1.03	2.39	1.50	0.108	2.04	3.80
Site 436													
Hole 436													
1-1, 50–54	66.46	0.70	15.43	3.73	1.96	0.064	3.08	2.11	3.74	2.63	0.109	1.90	5.91
1-4, 50–54	67.42	0.60	14.73	4.67	1.84	0.089	2.14	2.35	3.67	2.39	0.101	2.54	6.71
2-1, 110–114	66.52	0.68	14.79	4.28	2.46	0.089	2.65	2.58	3.53	2.32	0.107	1.74	7.01
3-3, 100–104	68.06	0.62	15.09	3.51	1.85	0.061	2.53	1.54	3.79	2.86	0.091	1.89	5.56
4-2, 130–134	68.11	0.61	14.01	4.02	1.65	0.053	3.19	1.86	4.06	2.36	0.090	2.43	5.86
4-4, 130–134	66.73	0.67	15.23	4.06	1.90	0.073	2.98	1.90	3.52	2.84	0.096	2.13	6.17
5-2, 14–18	65.96	0.67	15.72	3.60	2.10	0.075	2.76	2.92	3.81	2.29	0.106	1.72	5.93
5-4, 14–18	66.71	0.66	15.18	4.15	1.98	0.076	2.97	1.99	3.53	2.65	0.108	2.10	6.35
6-3, 80–84	66.48	0.67	15.78	3.55	2.03	0.067	2.93	2.26	3.49	2.63	0.107	1.75	5.81
6-3, 84–88	68.70	0.59	14.81	3.02	1.85	0.070	2.60	2.02	3.80	2.48	0.091	1.63	5.07
7-6, 6–10	66.50	0.68	15.52	3.75	1.87	0.059	2.92	2.17	3.71	2.71	0.108	2.01	5.83
8-2, 50–54	68.35	0.59	14.56	3.28	1.82	0.081	2.53	2.45	3.91	2.32	0.101	1.81	5.30
8-4, 50–54	67.94	0.62	14.42	3.53	1.88	0.072	2.62	2.19	4.30	2.33	0.097	1.88	5.62
9-3, 113–118	70.05	0.52	13.38	3.73	1.52	0.055	2.67	1.73	3.87	2.41	0.073	2.45	5.42
9-6, 41–46	66.09	0.70	15.69	4.12	1.72	0.060	3.49	1.58	3.50	2.95	0.097	2.40	6.04
10-2, 113–118	69.86	0.59	13.77	3.61	1.53	0.063	2.83	1.50	3.69	2.47	0.081	2.36	5.31
10-5, 113–118	68.25	0.53	14.32	3.99	1.81	0.081	2.74	1.81	3.96	2.41	0.083	2.20	6.00
11-2, 86–90	69.00	0.57	13.36	3.95	1.62	0.067	3.10	1.76	4.15	2.35	0.079	2.43	5.75
11-5, 86–90	67.61	0.56	15.30	3.26	1.88	0.077	2.43	2.56	3.96	2.25	0.119	1.74	5.35
12-2, 36–40	69.35	0.57	14.26	3.48	1.29	0.068	2.48	1.87	4.15	2.38	0.094	2.71	4.92
12-4, 36–40	73.17	0.36	13.33	1.89	1.28	0.079	1.62	1.31	3.66	3.24	0.063	1.47	3.31
13-2, 73–75	68.31	0.56	13.18	4.85	1.64	0.080	2.80	1.78	4.46	2.26	0.083	2.96	6.68
13-4, 73–75	70.41	0.55	13.28	3.13	1.67	0.067	2.55	1.82	4.05	2.39	0.083	1.88	4.98
14-1, 60–64	71.29	0.38	13.10	3.57	1.40	0.079	1.74	1.25	3.76	3.39	0.050	2.54	5.13
14-3, 60–64	74.02	0.33	13.03	1.78	1.09	0.054	1.20	1.69	3.69	3.06	0.050	1.64	2.99
15-1, 90–94	72.57	0.49	12.46	2.59	1.54	0.054	2.32	1.94	3.88	2.06	0.091	1.69	4.30
15-6, 30–34	74.02	0.32	12.93	1.65	1.18	0.063	1.37	1.37	3.62	3.43	0.054	1.40	2.96
16-2, 90–94	75.09	0.44	11.07	3.07	1.36	0.052	2.10	1.42	3.44	1.89	0.067	2.26	4.58
17-4, 30–34	70.08	0.59	13.70	3.43	1.67	0.060	2.65	1.54	3.71	2.50	0.083	2.05	5.28
18-2, 34–38	70.85	0.51	12.89	3.77	1.57	0.068	2.11	1.84	4.06	2.27	0.068	2.39	5.52
19-1, 66–70	70.85	0.48	13.23	3.40	1.39	0.073	1.82	2.00	4.08	2.54	0.132	2.45	4.94
19-4, 86–90	70.72	0.51	13.19	4.18	1.33	0.048	2.27	2.02	3.57	2.11	0.062	3.15	5.65
20-1, 105–109	73.04	0.44	13.15	2.28	1.71	0.061	1.58	1.72	3.68	2.27	0.067	1.33	4.18
21-2, 64–68	69.67	0.60	14.95	2.89	1.73	0.057	2.17	1.68	3.51	2.64	0.095	1.68	4.81
22-1, 52–56	68.23	0.58	14.33	4.44	1.64	0.060	2.75	1.40	3.66	2.83	0.070	2.71	6.26
23-2, 35–39	69.37	0.60	14.71	3.42	1.50	0.046	2.37	1.66	3.63	2.62	0.069	2.28	5.09
23-5, 35–39	69.52	0.59	14.60	2.97	1.83	0.063	2.37	1.64	3.57	2.75	0.088	1.62	5.01
24-1, 53–57	69.18	0.60	15.14	3.60	1.45	0.065	2.34	1.33	3.38	2.83	0.081	2.49	5.21
25-1, 74–78	70.70	0.53	14.23	3.75	1.23	0.054	2.11	1.15	3.28	2.89	0.068	3.04	5.12
27-1, 106–110	68.71	0.60	15.77	3.84	1.45	0.051	2.31	1.08	3.24	2.89	0.067	2.64	5.45

TABLE 2 – *Continued*

Sample (Interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Fe_2O_3/FeO	Total Fe as Fe_2O_3
Site 436 (Cont.)													
Hole 436 (cont.)													
27-2, 106–110	68.30	0.61	14.73	4.55	1.62	0.045	2.71	1.13	3.43	2.80	0.067	2.81	6.34
28-1, 56–60	69.88	0.58	15.00	3.71	1.28	0.043	2.36	0.94	3.39	2.76	0.073	2.90	5.13
29-1, 70–74	71.10	0.46	14.28	3.38	1.29	0.082	1.67	1.64	3.44	2.58	0.067	2.63	4.81
29-2, 70–74	71.35	0.42	14.15	3.54	0.87	0.072	1.85	1.05	3.29	3.34	0.062	4.05	4.52
30-1, 74–78	72.21	0.41	14.14	2.67	1.04	0.131	1.51	1.14	3.27	3.41	0.060	2.58	3.82
30-3, 74–78	69.54	0.58	15.17	3.98	1.14	0.060	2.27	1.28	3.13	2.78	0.071	3.49	5.25
31-2, 40–44	71.39	0.47	13.41	3.91	1.05	0.199	1.87	1.53	3.43	2.56	0.188	3.71	5.08
31-4, 40–44	67.48	0.63	16.08	4.79	1.08	0.708	1.53	1.41	3.48	2.73	0.084	4.44	5.99
32-2, 46–50	68.81	0.61	14.92	5.10	0.89	0.623	1.62	1.07	3.42	2.86	0.078	5.74	6.09
33-1, 52–56	69.54	0.53	14.98	4.19	0.99	0.384	1.56	1.21	3.46	3.05	0.121	4.24	5.28
33-4, 52–56	66.71	0.64	15.90	5.12	1.12	0.342	2.25	1.44	3.56	2.81	0.101	4.56	6.37
34-2, 60–64	67.73	0.64	15.39	5.09	1.08	0.197	2.45	1.38	3.24	2.72	0.091	4.71	6.29
34-6, 60–64	68.81	0.59	14.83	5.16	0.86	0.184	2.28	1.16	3.35	2.69	0.080	5.96	6.12
35-1, 60–64	67.59	0.65	15.69	5.24	0.93	1.008	0.93	0.87	3.93	3.08	0.090	5.64	6.27
35-4, 60–64	65.16	0.72	16.89	5.84	0.98	0.134	2.62	1.03	3.36	3.17	0.089	5.97	6.93
36-2, 50–54	66.89	0.67	17.11	5.64	0.66	0.485	1.74	0.86	2.76	3.03	0.151	8.58	6.37
36-6, 50–54	67.89	0.57	16.68	4.37	0.90	0.260	1.54	0.94	3.28	3.47	0.097	4.86	5.37
37-2, 70–74	67.30	0.64	16.59	5.61	0.74	0.304	1.99	0.76	2.87	3.10	0.105	7.61	6.43
37-6, 70–74	66.96	0.49	18.08	4.43	0.35	0.407	2.76	0.74	3.21	2.49	0.081	12.58	4.82
38-2, 66–70	66.91	0.57	16.66	5.42	0.37	0.559	1.76	1.02	3.28	3.34	0.129	14.83	5.82
39-1, 60–64	68.70	0.62	15.46	4.60	0.97	0.303	1.69	1.60	2.95	2.94	0.162	4.73	5.68
39-6, 60–64	61.81	0.73	20.21	7.49	0.10	2.327	0.19	0.74	2.63	3.43	0.348	76.56	7.60
40-3, 50–54	61.17	0.74	20.52	7.55	0.11	2.359	0.20	0.64	2.28	4.12	0.309	68.49	7.67
40-4, 50–54	61.30	0.73	20.26	7.39	0.26	2.517	0.19	0.68	2.16	4.19	0.325	28.39	7.68
Site 438													
Hole 438													
1-2, 98–102	70.90	0.47	14.15	2.66	1.94	0.075	1.70	2.54	3.32	2.17	0.083	1.37	4.81
3-2, 60–64	68.66	0.67	13.95	3.37	2.28	0.059	2.65	3.27	2.54	2.41	0.117	1.48	5.91
5-4, 30–34	66.25	0.59	13.60	5.83	1.87	0.095	2.81	3.63	3.08	2.15	0.099	3.13	7.90
7-2, 60–64	73.45	0.53	12.16	2.61	1.93	0.066	2.13	2.49	2.66	1.87	0.103	1.35	4.75
9-2, 132–136	74.71	0.48	12.25	2.42	1.62	0.050	1.85	2.04	2.44	2.04	0.092	1.50	4.22
10-3, 100–104	71.36	0.58	12.86	2.96	2.13	0.071	2.29	3.23	2.61	1.79	0.111	1.39	5.33
11-2, 76–80	72.45	0.58	12.11	3.32	1.95	0.062	1.97	2.97	2.63	1.86	0.102	1.70	5.48
Hole 438A													
1-2, 66–70	65.37	0.66	14.96	5.30	2.00	0.092	2.53	3.98	3.04	1.96	0.122	2.64	7.52
3-2, 72–76	68.48	0.58	14.14	4.56	1.88	0.075	2.57	2.12	3.14	2.36	0.101	2.43	6.65
5-2, 145–147	73.41	0.49	13.47	2.38	1.61	0.059	1.67	1.61	3.13	2.06	0.105	1.48	4.16
7-2, 41–42	78.29	0.52	10.72	2.50	1.79	0.036	1.97	0.29	1.99	1.80	0.094	1.40	4.49
9-1, 22–24	80.10	0.46	9.23	2.20	1.50	0.039	1.57	1.17	2.16	1.50	0.075	1.47	3.87
11-2, 84–88	83.00	0.39	7.74	1.94	1.28	0.036	1.41	0.65	2.27	1.21	0.076	1.52	3.37
13-2, 9–13	82.38	0.37	7.52	1.73	1.36	0.034	1.40	2.21	1.75	1.16	0.074	1.27	3.24
17-2, 62–64	75.96	0.54	11.34	2.60	1.97	0.046	2.17	1.36	2.00	1.92	0.088	1.32	4.79
19-2, 60–64	77.96	0.46	10.12	2.24	1.79	0.044	1.81	1.64	2.08	1.79	0.075	1.26	4.23
21-2, 40–44	77.35	0.51	10.46	2.47	1.91	0.042	2.02	1.22	2.16	1.77	0.083	1.29	4.59
23-1, 34–38	79.95	0.45	9.36	2.30	1.67	0.036	1.61	1.13	1.84	1.59	0.072	1.37	4.16
24-2, 20–22	76.76	0.53	10.81	2.85	1.74	0.039	1.93	1.19	2.23	1.84	0.086	1.64	4.78
25-2, 120–124	76.04	0.50	11.12	2.66	1.69	0.045	1.83	2.15	2.06	1.84	0.079	1.57	4.54
27-2, 50–54	81.35	0.42	8.75	2.00	1.41	0.032	1.59	1.34	1.53	1.50	0.072	1.42	3.57
29-2,	83.86	0.36	7.32	2.16	1.10	0.020	1.40	0.79	1.65	1.29	0.054	1.98	3.38
31-2, 40–44	85.00	0.36	7.61	2.04	1.14	0.029	1.22	–0.20	1.39	1.32	0.087	1.79	3.30
33-2, 36–46	76.21	0.45	10.70	3.01	1.54	0.064	1.34	2.86	2.15	1.58	0.092	1.95	4.73
35-2, 10–14	77.17	0.36	11.14	1.93	1.64	0.055	1.42	1.65	2.44	2.11	0.073	1.18	3.76
39-2, 100–102	79.72	0.44	9.58	2.31	1.53	0.034	1.43	0.86	1.59	1.70	0.804	1.51	4.01
41-2, 121–123	78.88	0.45	9.93	2.43	1.43	0.032	1.57	1.56	1.87	1.77	0.072	1.71	4.02
43-2, 132–136	75.06	0.52	11.74	3.07	1.83	0.044	1.91	1.49	2.19	2.08	0.074	1.68	5.10
47-2, 72–76	77.25	0.48	10.26	2.32	1.77	0.041	2.00	0.96	1.77	1.85	1.294	1.31	4.29
49-2, 80–82	77.38	0.51	10.71	2.39	1.93	0.044	2.10	1.11	1.81	1.93	0.083	1.24	4.54
51-2, 27–29	72.05	0.60	13.15	2.72	2.27	0.049	2.53	1.77	2.35	2.43	0.089	1.19	5.24
53-1, 116–120	77.98	0.49	10.01	2.46	1.75	0.032	2.07	1.19	2.07	1.87	0.075	1.41	4.41
55-2, 30–32	79.49	0.47	9.64	2.29	1.63	0.032	1.78	0.83	1.98	1.79	0.072	1.40	4.10
57-2, 20–24	76.29	0.51	11.04	2.54	1.88	0.038	2.23	1.12	2.24	2.02	0.080	1.35	4.63
59-2, 74–78	75.32	0.50	11.02	2.89	1.77	0.033	2.32	1.83	2.09	2.15	0.080	1.63	4.85
63-1, 42–44	80.74	0.45	9.23	2.22	1.51	0.048	1.79	0.77	1.55	1.62	0.072	1.47	3.90

TABLE 2 – *Continued*

Sample (Interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Fe_2O_3/ FeO	Total Fe as Fe_2O_3
Site 438 (cont.)													
Hole 438A (cont.)													
65-1, 77–79	80.67	0.42	9.18	2.34	1.34	0.027	1.74	0.76	1.67	1.80	0.055	1.75	3.83
70-2, 64–67	76.11	0.53	11.84	3.08	1.59	0.040	2.15	0.75	1.76	2.08	0.072	1.94	4.84
71-2, 121–125	81.01	0.43	9.38	2.87	0.96	0.026	1.66	0.54	1.40	1.67	0.061	2.99	3.93
73-2, 67–68	77.36	0.51	11.42	3.05	1.23	0.033	1.87	0.96	1.66	1.85	0.055	2.48	4.42
85-2, 72–74	75.29	0.54	12.39	3.23	1.48	0.036	1.87	1.52	1.67	1.91	0.074	2.19	4.87
Hole 438B													
7-2, 98–102	73.47	0.54	13.80	3.06	1.78	0.041	1.81	1.54	1.78	2.09	0.084	1.72	5.04
9-2, 100–102	69.10	0.67	14.94	3.73	1.87	0.077	1.83	3.00	2.71	1.96	0.101	1.99	5.81
11-2, 59–66	70.26	0.67	14.81	3.60	1.85	0.059	1.78	3.36	1.87	1.62	0.119	1.94	5.66
12-3, 128–130	75.11	0.56	12.05	2.92	1.94	0.044	1.66	2.16	1.70	1.78	0.091	1.51	5.08
13-2, 78–80	77.86	0.54	11.35	2.84	1.82	0.040	1.88	0.44	1.50	1.66	0.084	1.56	4.86
15-1, 57–58	71.82	0.65	13.81	3.26	2.22	0.053	2.31	1.87	1.91	2.01	0.102	1.47	5.72
17-2, 61–65	68.79	0.69	15.89	3.26	2.41	0.045	3.07	1.03	2.08	2.63	0.117	1.36	5.94
19-2, 28–32	69.92	0.55	12.67	5.04	2.59	0.033	3.14	1.01	2.07	2.88	0.091	1.95	7.91
21-2, 75–78	71.46	0.55	14.48	2.97	1.64	0.025	2.00	2.13	2.43	2.23	0.072	1.81	4.80
23-2, 104–105	70.18	0.67	15.62	2.67	2.33	0.035	2.58	0.99	2.25	2.59	0.091	1.15	5.26
Site 439													
Hole 439													
7-2, 90–93	71.52	0.61	13.92	3.74	1.86	0.046	2.06	2.14	1.91	2.09	0.098	2.01	5.81
9-2, 16–19	77.18	0.47	11.25	3.19	1.45	0.039	1.81	1.32	1.42	1.79	0.069	2.20	4.81
11-2, 29–32	68.45	0.71	15.21	3.78	2.36	0.084	1.80	2.72	2.50	2.27	0.129	1.61	6.40
13-1, 86–88	69.43	0.67	15.73	3.18	1.82	0.032	2.47	1.61	2.53	2.45	0.085	1.75	5.20
15-2, 105–107	71.72	0.63	14.78	2.81	1.82	0.037	2.11	1.45	2.22	2.34	0.081	1.55	4.82
17-3, 28–31	69.62	0.67	15.65	3.24	1.72	0.031	2.40	1.65	2.61	2.33	0.076	1.89	5.15
19-1, 57–58	70.72	0.59	14.81	3.02	1.69	0.037	2.27	1.76	2.67	2.36	0.074	1.79	4.90
21-2, 68–70	73.39	0.58	13.98	2.57	1.76	0.034	2.10	1.06	2.23	2.21	0.082	1.46	4.52
23-2, 17–19	71.58	0.55	15.54	2.08	1.92	0.028	1.75	1.14	2.82	2.51	0.085	1.08	4.22
29-1, 114–119	72.85	0.48	15.51	1.58	1.84	0.037	1.33	1.54	2.56	2.19	0.088	0.86	3.62
31-2, 86–88	75.21	0.49	13.53	1.16	3.24	0.092	1.60	0.21	1.77	2.54	0.146	0.36	4.76
Site 440													
Hole 440													
1-2, 53–57	70.12	0.70	14.20	2.99	2.32	0.068	2.85	1.78	2.50	2.35	0.131	1.29	5.56
3-1, 86–90	70.49	0.63	13.73	3.18	2.00	0.065	2.78	2.07	2.72	2.22	0.112	1.59	5.41
5-1, 70–74	71.30	0.63	13.75	3.06	2.14	0.063	2.85	1.37	2.59	2.11	0.124	1.43	5.44
7-1, 135–139	68.30	0.70	15.11	3.25	2.29	0.059	2.84	2.01	2.96	2.37	0.124	1.42	5.79
Hole 440A													
3-1, 16–20	69.99	0.70	14.37	3.15	2.43	0.062	2.97	1.06	2.69	2.44	0.137	1.30	5.85
5-3, 114–118	68.44	0.70	15.02	3.54	1.95	0.061	2.88	2.05	2.85	2.38	0.121	1.82	5.71
7-1, 48–52	70.06	0.66	14.87	3.02	2.24	0.050	2.77	0.82	2.62	2.76	0.128	1.35	5.51
Hole 440B													
1-1, 94–98	73.49	0.57	12.41	2.78	1.62	0.048	2.62	1.84	2.52	2.01	0.102	1.72	4.58
5-1, 106–110	69.59	0.63	14.47	2.80	2.05	0.081	2.33	2.16	3.51	2.26	0.121	1.36	5.08
7-1, 70–74	68.07	0.70	15.36	3.62	2.15	0.052	3.13	1.56	2.67	2.57	0.109	1.68	6.00
9-1, 133–137	70.66	0.60	13.68	3.43	1.95	0.049	2.53	1.92	2.88	2.21	0.098	1.76	5.60
11-1, 24–28	71.80	0.59	13.44	3.11	1.95	0.055	2.37	1.86	2.60	2.11	0.103	1.59	5.28
13-1, 144–148	71.46	0.61	13.70	3.19	1.91	0.054	2.37	1.81	2.54	2.26	0.091	1.67	5.31
15-1, 24–28	70.50	0.65	14.56	2.94	1.94	0.047	2.57	1.59	2.47	2.63	0.100	1.52	5.10
17-1, 33–38	71.61	0.61	13.74	3.88	2.02	0.313	2.05	0.95	2.50	2.21	0.112	1.92	6.13
19-1, 138–142	72.91	0.54	13.02	2.87	1.80	0.059	2.14	2.00	2.52	2.05	0.088	1.60	4.87
21-4, 48–52	73.41	0.47	13.28	2.81	1.55	0.117	1.69	1.25	3.14	2.16	0.113	1.81	4.54
23-1, 110–114	72.20	0.60	13.04	3.51	1.92	0.159	2.35	1.58	2.41	2.12	0.109	1.83	5.64
27-1, 120–122	81.28	0.56	8.93	1.79	1.45	0.049	1.52	1.25	1.73	1.36	0.061	1.23	3.41
31-1, 124–128	80.40	0.40	9.55	2.19	1.22	0.033	1.41	1.25	1.77	1.71	0.059	1.80	3.55
33-1, 131–135	76.62	0.48	11.41	2.50	1.61	0.042	1.83	1.29	2.15	2.01	0.067	1.56	4.29
35-1, 114–117	80.10	0.34	9.89	1.84	1.14	0.032	1.31	1.05	2.19	2.08	0.049	1.62	3.10
37-1, 44–46	81.20	0.38	8.81	2.59	1.18	0.033	1.39	1.38	1.55	1.44	0.056	2.20	3.90
39-1, 92–94	81.90	0.37	8.22	2.33	1.03	0.038	1.44	1.48	1.37	1.32	0.494	2.26	3.48
41-1, 102–105	82.18	0.38	8.65	2.55	1.02	0.030	1.44	0.85	1.39	1.46	0.056	2.51	3.68

TABLE 2 – *Continued*

Sample (Interval in cm)	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Fe_2O_3/FeO	Total Fe as Fe_2O_3
Site 440 (cont.)													
Hole 440B (cont.)													
43-1, 80–83	80.52	0.40	8.96	2.47	1.20	0.035	1.58	1.80	1.50	1.48	0.060	2.06	3.80
45-1, 134–138	79.88	0.45	10.05	2.37	1.42	0.038	1.76	0.98	1.40	1.61	0.061	1.67	3.94
49-1, 70–72	82.36	0.33	8.67	2.22	1.02	0.031	1.40	0.97	1.35	1.59	0.057	2.18	3.35
53-1, 82–84	77.73	0.49	11.18	2.73	1.67	0.065	1.69	0.87	1.64	1.83	0.109	1.63	4.59
55-1, 64–67	75.99	0.46	11.50	2.54	1.72	0.058	1.83	1.90	1.90	2.03	0.069	1.48	4.45
57-1, 21–26	78.63	0.47	10.55	2.15	1.74	0.035	1.90	0.94	1.70	1.83	0.066	1.23	4.08
59-1, 106–108	78.35	0.46	10.62	2.68	1.73	0.049	1.93	0.78	1.64	1.70	0.069	1.55	4.60
61-1, 70–72	74.80	0.54	12.78	2.65	1.86	0.047	2.26	0.88	1.96	2.15	0.074	1.42	4.72
63-1, 58–60	81.44	0.40	9.05	2.42	1.22	0.037	1.68	0.64	1.45	1.60	0.052	1.98	3.77
67-1, 124–126	76.18	0.50	11.50	3.04	1.81	0.051	2.17	0.93	1.68	2.07	0.072	1.68	5.05
69-1, 136–139	74.05	0.56	12.72	3.18	1.96	0.053	2.09	1.23	1.87	2.21	0.082	1.63	5.35
71-1, 51–54	70.93	0.63	14.05	3.01	2.54	0.070	2.79	1.11	2.22	2.56	0.095	1.19	5.83
Site 441													
Hole 441													
1-2, 52–56	67.37	0.71	14.87	3.44	2.16	0.097	2.85	3.50	2.81	2.06	0.119	1.59	5.84
7-1, 43–45	75.57	0.49	11.43	2.96	1.66	0.076	2.08	1.43	2.33	1.91	0.070	1.79	4.81
8-1, 140–144	78.54	0.45	10.40	2.54	1.45	0.050	1.69	1.23	1.98	1.60	0.066	1.76	4.15
Hole 441A													
5-1, 96–100	72.60	0.63	14.51	1.98	2.73	0.067	2.00	0.48	2.19	2.69	0.118	0.72	5.01
11-1, 28–30	71.43	0.59	14.55	3.38	1.76	0.159	1.88	1.53	2.06	2.58	0.086	1.92	5.34
12-1, 130–133	76.17	0.54	11.95	2.79	1.90	0.084	2.15	0.48	1.62	2.24	0.075	1.47	4.90
13-1, 98–102	76.78	0.53	11.61	2.97	1.96	0.062	2.03	0.31	1.58	2.09	0.084	1.51	5.15
H-1-4, 22–27[a]	75.10	0.50	12.37	3.07	1.49	0.046	1.69	1.48	2.18	2.00	0.073	2.06	4.73
Hole 441B													
1-1, 27–30	75.43	0.51	12.00	2.78	1.84	0.060	2.17	1.08	2.12	1.94	0.065	1.51	4.82
2-1, 89–91	71.82	0.57	14.65	2.91	2.20	0.145	2.20	0.48	2.15	2.76	0.111	1.32	5.36

[a]See Table 1, footnote f.

chapters) at the location nearest to samples selected for chemical analysis were obtained from the core description and plotted against the SiO_2 content (Figure 3). The correlation is rather obscure considered over an entire core. If the core is divided into several parts, the correlation between SiO_2 and siliceous organism content becomes clear within each part. This is noteworthy if we remember that the comparison of chemical analyses with microscopic observation was not done within the same sample and that the accuracy of microscopic determinations is usually lower than that of chemical analyses for silica. The correlation strongly suggests that the siliceous organisms are responsible for the higher SiO_2 of DSDP samples in the Japan Trench. Furthermore, in comparison with the upper part of a core, the lower part at any given level of siliceous organism content tends to be higher in silica; namely, the deeper the part in the core, the steeper the correlation line (Figure 3). The dissolution–redeposition mechanism of silica during the process of the diagenetic maturation of siliceous ooze seems to explain the different slopes of the regression lines. According to the experiments conducted by hydrothermal conditions at 150°C and at room temperature (Kastner et al., 1977), siliceous tests of radiolarians or diatoms were corroded and silica as opal-CT lepispheres redeposited around them. The rate of diagenesis of siliceous ooze is strongly affected by temperature and time. The degree of diagenesis of marine sediments may be greater at depth. As diagenesis proceeds, the tests of siliceous organisms tend to disappear and the silica from the tests to be redeposited in the sediments. In the process, the total amount of silica in the sediments remains constant. As a result, the regression line on the SiO_2 organisms diagram becomes steeper. Some samples (illustrated by closed circles in Figure 3A) show higher SiO_2 content in spite of their lower siliceous organism content. These samples contain a great deal of volcanic glass, which may be responsible for the higher silica content.

Figure 4 shows the vertical variation of SiO_2 at each site. SiO_2 tends to be higher prior to the late Tertiary. Various types of diatomaceous deposits occur in various horizons of the Neogene strata in such Circum-Japan Sea areas as the Noto Peninsula. Upper Tertiary sediments of the central Japan Sea contain large diatom deposits (Sugisaki, 1979). From the evidence, we can conclude that the favorable environment for diatom development had prevailed in the Japan Trench as well as in the Japan Sea during the late Cenozoic.

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Figure 5 shows the relationship between Fe_2O_3 and total iron as Fe_2O_3 in samples from Site 438. The slope of the regression line is nearly 1. The regression lines for other sites also have a slope of approximately 1, except for Site 440 (Table 7), indicating the deposition of ferric

TABLE 3
Chemical Composition of Sediments in Averages and Their Standard Deviations

	Site 434	Site 435	Site 436	Site 438	Site 439	Site 440	Site 441	Sikoku Basin and Nankai Trough[a]	Japan Trench[b]	Off Tsugaru Japan Sea	Central Japan Sea[d]	Pacific Pelagic Sediments[e]
Numbers of Sample	54	24	66	52	12	39	10	29	82	87	69	35
SiO_2	73.38 ± 4.22	74.79 ± 6.05	68.69 ± 2.70	75.65 ± 4.63	71.97 ± 2.59	74.91 ± 4.67	74.13 ± 3.25	66.69 ± 2.16	68.84 ± 2.78	66.58 ± 2.02	65.80 ± 3.84	49.84
TiO_2	0.51 ± 0.074	0.50 ± 0.13	0.58 ± 0.096	0.51 ± 0.085	0.59 ± 0.082	0.54 ± 0.11	0.55 ± 0.076	0.72 ± 0.06	0.62 ± 0.068	0.67 ± 0.052	0.73 ± 0.11	1.22
Al_2O_3	12.11 ± 1.54	11.27 ± 2.77	14.95 ± 1.76	11.50 ± 2.18	14.54 ± 1.33	12.09 ± 2.23	12.84 ± 1.65	16.50 ± 0.54	13.60 ± 1.47	16.12 ± 0.63	16.54 ± 1.96	17.38
Fe_2O_3	4.17 ± 3.41	2.96 ± 1.81	4.07 ± 1.24	2.85 ± 0.82	2.76 ± 0.84	2.81 ± 0.48	2.88 ± 0.41		2.41 ± 1.06	3.83 ± 0.39	1.90 ± 0.59	
FeO	1.67 ± 0.25	1.61 ± 0.42	1.35 ± 0.52	1.74 ± 0.33	1.95 ± 0.48	1.76 ± 0.41	1.92 ± 0.39		2.93 ± 0.63	1.81 ± 0.29	1.90 ± 0.59	
MnO	0.12 ± 0.10	0.056 ± 0.029	0.26 ± 0.51	0.046 ± 0.017	0.045 ± 0.022	0.064 ± 0.050	0.085 ± 0.039	0.087 ± 0.053	0.067 ± 0.022	0.069 ± 0.042	0.48 ± 1.95	1.98
MgO	2.03 ± 0.44	2.00 ± 0.50	2.18 ± 0.68	1.96 ± 0.43	1.97 ± 0.35	2.14 ± 0.54	2.08 ± 0.33	2.29 ± 0.33	3.11 ± 0.30	3.31 ± 0.42	2.91 ± 0.72	3.48
CaO	1.15 ± 0.65	1.85 ± 0.61	1.55 ± 0.51	1.60 ± 0.95	1.51 ± 0.63	1.38 ± 0.45	2.08 ± 0.33	1.52 ± 0.90	2.38 ± 1.19	1.93 ± 0.90	1.04 ± 0.65	4.06
Na_2O	2.72 ± 0.54	3.05 ± 0.49	3.54 ± 0.42	2.12 ± 0.48	2.29 ± 0.43	2.18 ± 0.45	2.10 ± 0.35	3.28 ± 0.34	3.77 ± 0.49	3.00 ± 0.54	2.16 ± 0.75	5.39
K_2O	2.05 ± 0.30	1.84 ± 0.47	2.75 ± 0.45	1.90 ± 0.34	2.28 ± 0.21	2.03 ± 0.37	2.19 ± 0.38	3.08 ± 0.38	2.12 ± 0.30	2.49 ± 0.28	3.47 ± 0.47	3.01
P_2O_5	0.088 ± 0.028	0.090 ± 0.022	0.10 ± 0.056	0.12 ± 0.19	0.092 ± 0.024	0.10 ± 0.070	0.087 ± 0.022	0.14 ± 0.012	0.15 ± 0.13	0.17 ± 0.15	0.16 ± 0.075	
Fe_2O_3/FeO	2.48 ± 0.11	1.81 ± 0.081	6.63 ± 2.72	1.66 ± 0.077	1.50 ± 0.39	1.65 ± 0.083	1.57 ± 5.01		0.89 ± 0.031	2.16 ± 0.023	3.65 ± 5.34	
Total Fe as Fe_2O_3	6.03 ± 0.26	4.74 ± 0.21	5.57 ± 0.33	4.79 ± 0.077	4.39 ± 0.21	4.76 ± 0.18	5.01 ± 0.45	6.01 ± 0.01	5.67 ± 0.024	5.85 ± 0.023	6.94 ± 1.54	9.29

[a] Sugisaki (1978).
[b] Sugisaki and Honza (in press).
[c] Sugisaki (in press a).
[d] Sugisaki (in press b).
[e] Goldberg and Arrhenius (1958).

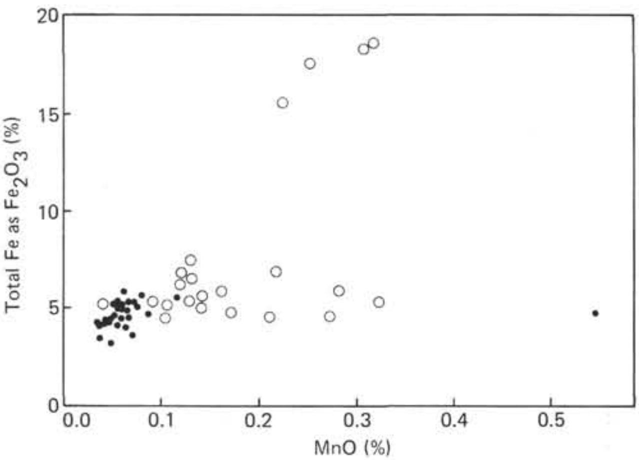

Figure 1. *The relation between MnO and total Fe as Fe_2O_3 at Site 434. (Open circles = samples containing $CaCO_3$ and closed circles = samples without $CaCO_3$).*

TABLE 4
Correlation Coefficients between SiO_2 and Other Oxides

	Site 434	Site 435	Site 436	Site 438	Site 439	Site 440	Site 441
SiO_2	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TiO_2	−0.323	−0.929	−0.868	−0.864	−0.877	−0.933	−0.923
Al_2O_3	−0.400	−0.952	−0.885	−0.946	−0.839	−0.992	−0.922
Fe_2O_3	−0.739	−0.695	−0.823	−0.787	−0.484	−0.824	−0.416
FeO	−0.513	−0.947	−0.271	−0.763	0.087	−0.888	−0.538
MnO	−0.332	−0.768	−0.650	−0.722	0.081	−0.307	−0.604
MgO	−0.680	−0.900	0.082	−0.744	−0.492	−0.920	−0.701
CaO	−0.260	−0.629	0.158	−0.710	−0.677	−0.524	−0.613
Na_2O	−0.579	−0.802	0.457	−0.701	−0.771	−0.884	−0.726
K_2O	−0.346	−0.783	−0.363	−0.756	−0.456	−0.910	−0.538
P_2O_5	−0.507	−0.769	−0.697	0.045	−0.025	−0.090	−0.810
Total Fe as Fe_2O_3	−0.765	−0.813	−0.878	−0.887	−0.488	−0.927	−0.886

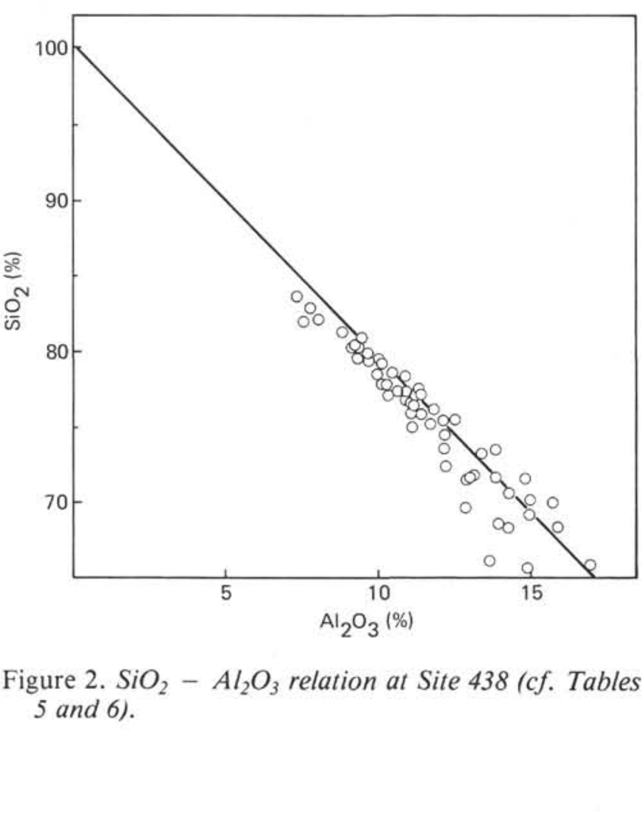

Figure 2. *SiO_2 − Al_2O_3 relation at Site 438 (cf. Tables 5 and 6).*

TABLE 5
SiO_2 − Al_2O_3 Relation by Least Squares Method

Site 434	$SiO_2 = 100.2 - 2.11\ Al_2O_3$ [a]
Site 435	$SiO_2 = 99.40 - 2.18\ Al_2O_3$
Site 436	$SiO_2 = 91.62 - 1.53\ Al_2O_3$
Site 438	$SiO_2 = 100.1 - 2.12\ Al_2O_3$
Site 439	$SiO_2 = 100.3 - 1.94\ Al_2O_3$
Site 440	$SiO_2 = 99.14 - 2.00\ Al_2O_3$
Site 441	$SiO_2 = 99.42 - 1.97\ Al_2O_3$

[a] This formula was calculated excluding 7 samples of high content of iron (Figure 1). The formula for all samples at Site 434 is $SiO_2 = 106.6 - 2.74\ Al_2O_3$.

TABLE 6
Weight Per Cent of SiO_2 Extrapolated from Regression Equations for Each Oxide, Site 438

TiO_2	103.6
Al_2O_3	100.1
Fe_2O_3	91.75
FeO	99.88
MnO	88.18
MgO	96.81
CaO	83.40
Na_2O	96.27
K_2O	101.4
P_2O_5	78.56
Total Fe as Fe_2O_3	96.83

iron in each site. The increase of Fe_2O_3 may be due to the inorganic precipitation from the sea water under oxidizing conditions. On the other hand, FeO content does not fluctuate as much as Fe_2O_3. This implies that FeO from original sources was not oxidized but remained unchanged in the hemipelagic zone, although the iron in deep sea sediments is generally considered to be mostly oxidized into Fe_2O_3. The present interpretation supports the inference in the preceding section that Fe_2O_3 coprecipitated with silica whereas FeO did not.

As I stated earlier, although manganese also appears to precipitate with silica, the MnO content at each site is generally low. This may be attributed to the following mechanisms. (1) MnO does not precipitate as much as Fe_2O_3 in a hemipelagic environment. (2) Precipitated MnO is confined to sediments which accumulated rapidly. (3) MnO dissolves under a reducing condition created by organic materials derived from the lands. The redox potential at *p*H 8 for oxidation reaction from Fe^{++} to Fe^{+++} is − 0.2 volts, whereas that from Mn^{++} to Mn^{++++} is + 0.5 volts (Pourbaix, 1963). Manganese is therefore easily reduced and barely precipitated com-

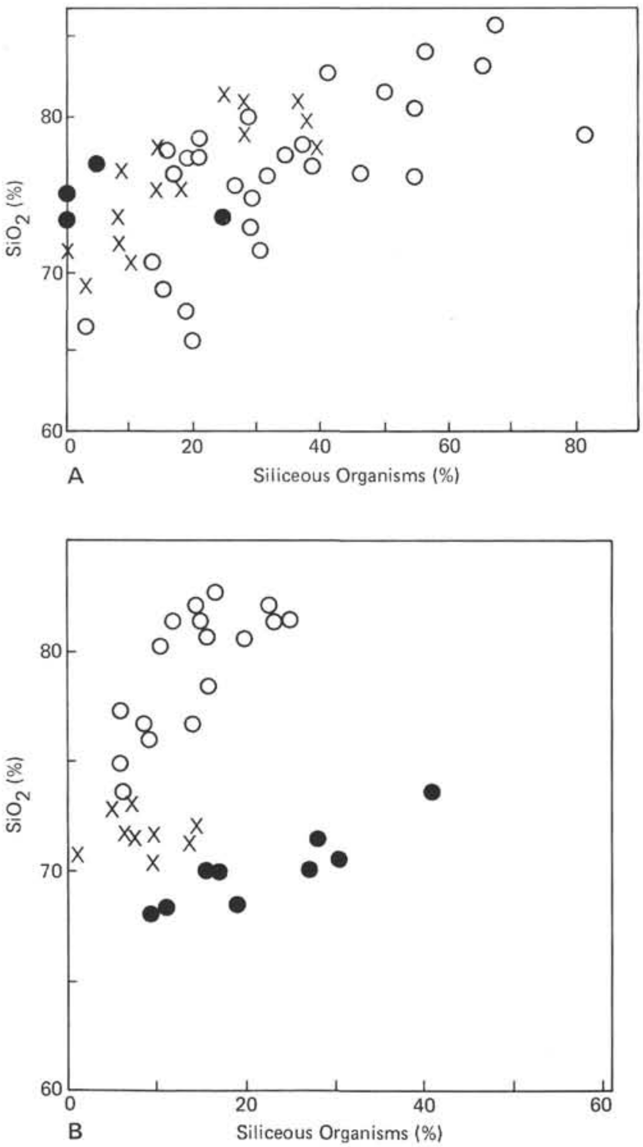

Figure 3. A. *The relationship between SiO_2 and siliceous organisms content (diatom, radiolarian, and sponge) at Site 438. (Open circles = samples shallower than 600 meters. Closed circles = samples with more than 60 per cent volcanic glass. × = samples deeper than 600 meters. Regression line for shallower samples excluding the closed circles is $SiO_2 = 66.52 + 0.284$ [organism content], with a correlation coefficient of 0.644. For deeper samples it is $SiO_2 = 69.95 + 0.330$ [organism content], with a correlation coefficient of 0.789.)* B. *The relationship between SiO_2 and siliceous organisms at Site 440. (Closed circles = samples shallower than 200 meters. Regression line is $SiO_2 = 66.33 + 0.166$ [organism content], with a correlation coefficient of 0.891. Open circles = samples deeper than 350 meters. Regression line is $SiO_2 = 72.48 + 0.451$ [organism content], with a correlation coefficient of 0.503. × = samples between 200 and 350 meters in depth.)*

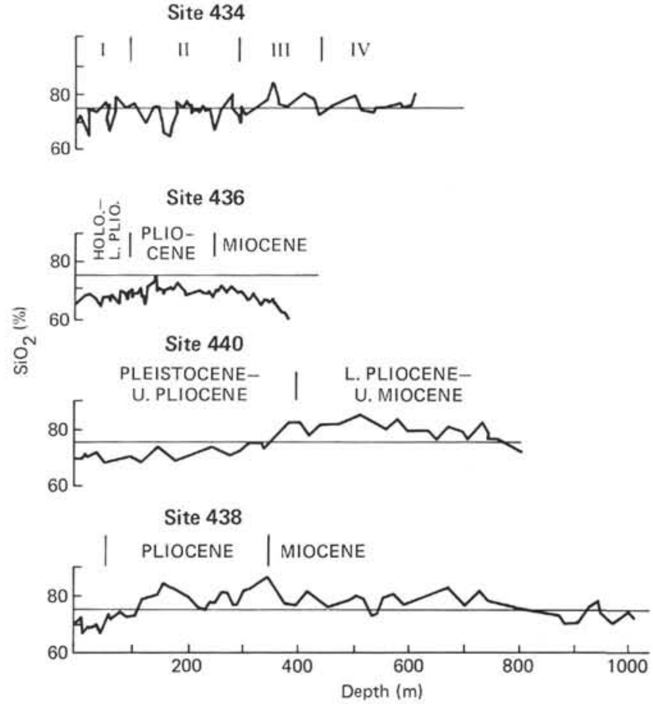

Figure 4. *SiO_2 variation with depth. For Site 434, the geological age is obscure because of repetition of the biostratigraphic horizon; sections deeper than 300 meters are regarded as late Miocene (Roman numerals for Site 434 represent lithologic units: I = diatomaceous ooze, II = spicular diatomaceous mudstone and diatomaceous-spicular mudstone, III = vitric diatomaceous mudstone and diatomaceous vitric mudstone, IV = tuffite.)*

pared with iron. CH_4 and H_2S at Site 434, on the west slope of the trench, show the reducing environment. As I discuss later, Site 436, on the east side of the trench, displays higher MnO content and a higher Fe_2O_3/FeO ratio, suggesting an oxidizing environment.

ORIGIN OF THE WEST SLOPE SEDIMENTS OF THE JAPAN TRENCH

Figure 6 illustrates the relationship among SiO_2, TiO_2, and Al_2O_3. These elements tend to remain in the resistates and hydrolyzates during sedimentation processes (Rankama and Sahama, 1950). Because the mutual abundance of these conservative elements probably remains stationary during weathering, the diagram is expected to be helpful in examining sediment sources. Because most samples are contaminated by biogenic silica, only those with Al_2O_3 content higher than 14 per cent were plotted. The points are located along a line connecting averaged Japanese granites and averaged mudstones from the Chichibu geosynclinal areas. The distribution on the diagram exhibits a striking contrast with that of argillaceous sediments from the Nankai Trough and the Shikoku Basin (Sugisaki, 1978) and the Japan Sea (Sugisaki, 1979, in press a). The points from these regions are located between averaged Japanese granites and averaged Quaternary volcanics. The Kitakami high-

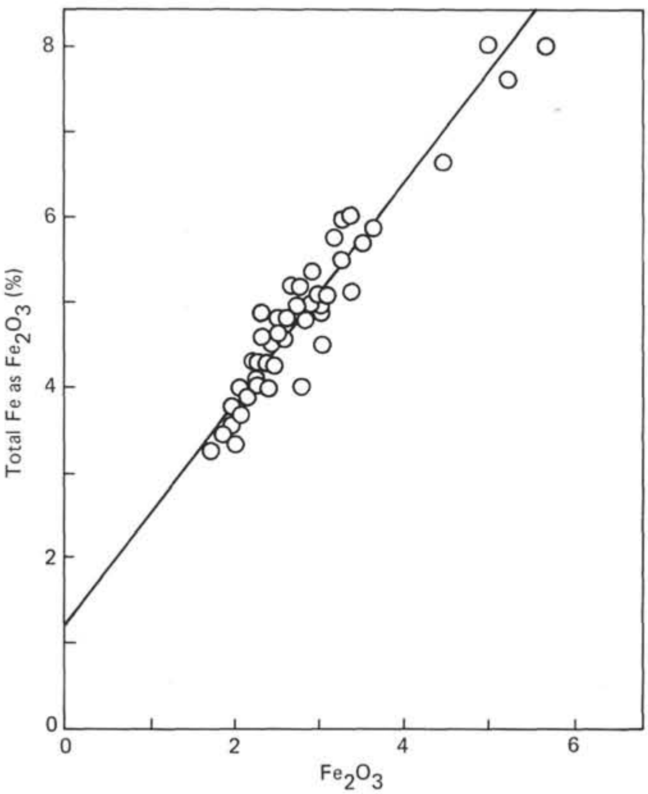

Figure 5. *The relationship between Fe_2O_3 and total Fe as Fe_2O_3 at Site 438.*

TABLE 7
Fe_2O_3 – Total Fe as Fe_2O_3 Relation by Least Squares Method

Site 434	Total Fe = 1.021 Fe_2O_3 + 1.756
Site 435	Total Fe = 1.155 Fe_2O_3 + 1.329
Site 438	Total Fe = 1.277 Fe_2O_3 + 1.150
Site 439	Total Fe = 0.880 Fe_2O_3 + 2.50
Site 440	Total Fe = 1.80 Fe_2O_3 + 0.301
Site 441	Total Fe = 1.097 Fe_2O_3 + 1.852

lands, which are the hinterland of the area of Legs 56 and 57, are composed mainly of granites and Chichibu geosynclinal sediments. This suggests that the sediments derived mainly from the land area to the west, comprising the Kitakami and Abukuma highlands, Hokkaido, and other land areas, and that the original materials, which were chemically homogeneous, suffered subsequent contamination by biogenic silica.

Many samples contain volcanic glass, as previously stated. Since the composition of the glass was not determined, only the samples with a volcanic glass content greater than 60 per cent and at a location nearest to the samples selected for chemical analyses were plotted on the diagram. These points deviate from those of the closed circle samples and move toward the SiO_2 apex of the diagram. The high content of SiO_2 in some samples may be due partly to high amounts of volcanic glass.

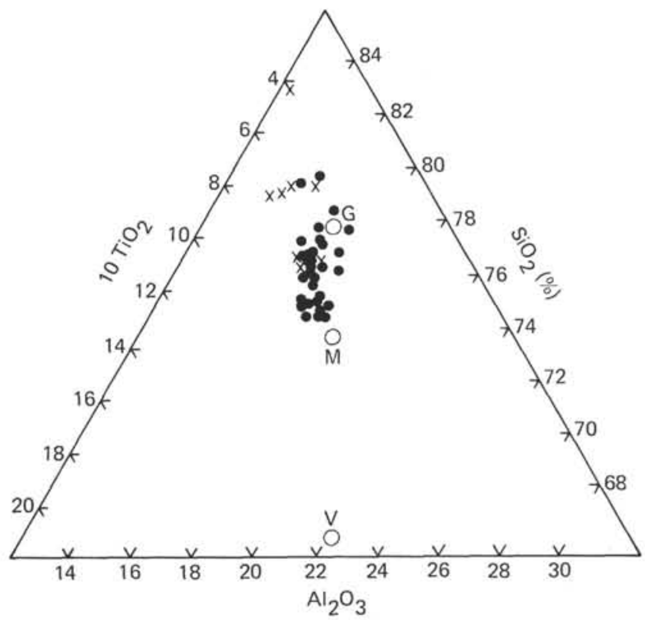

Figure 6. *Relationship of SiO_2-TiO_2-Al_2O_3 on the west slope of the Japan Trench. (Closed circles = samples with more than 14 per cent Al_2O_3. × = samples with more than 60 per cent volcanic glass. Open circles = averaged Japanese rocks. G = granite [calculated from 440 analyses by the Geological Survey of Japan, 1960], M = mudstones from the Chichibu geosynclinal area [300 analyses, Katada et al., 1977], V = quaternary volcanic rocks [769 analyses, Sugisaki, 1970].)*

CHEMICAL TREND AT SITE 436

Core recovered from Site 436, on the east slope of the Japan Trench, displays a striking chemical variation from cores from the west slope. As sample depth increases, SiO_2 content decreases, whereas the MnO content and Fe_2O_3/FeO ratios increase noticeably. The MnO content of the three deepest samples is almost 2.5 per cent, or about 50 times as high as the upper part of the core. The deep samples characterized by high MnO and Fe_2O_3 content and low SiO_2 content are closely similar if not identical to the pelagic sediments from the Pacific Ocean listed in Table 3. By contrast, the upper part of the core is chemically similar to the west slope sediments, which derived from the Japanese Islands and were contaminated by the biogenic silica.

The SiO_2-TiO_2-Al_2O_3 diagram in Figure 7 illustrates that samples from the upper part of the section (Holocene to late Miocene) derive mainly from the same area as for the west slope sediments (cf. Figure 6), whereas samples from the lower section (Miocene and older) deviate downward, indicating different sources for deeper and shallower sediments.

The vertical tendency of the core at Site 436 can be explained by the movement of the ocean plate. The MnO content was plotted against the absolute age of each sample, which was tentatively assigned by the interpolation of the paleontological age of the core (Figure 8). MnO

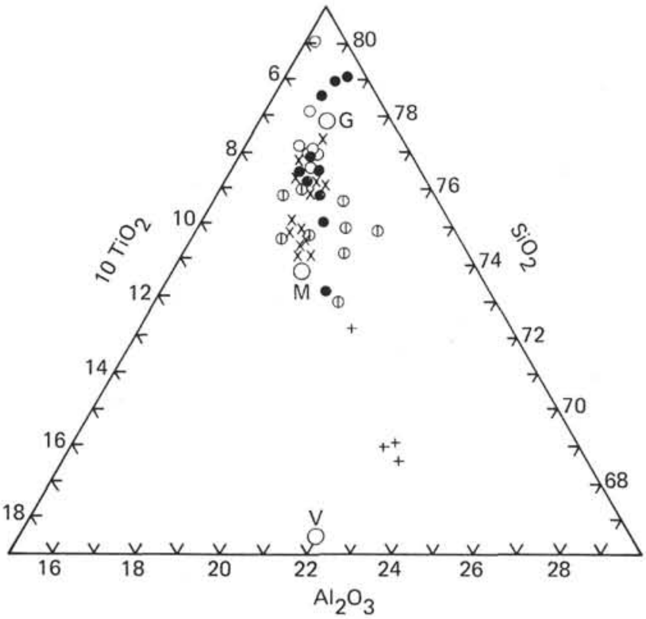

Figure 7. *Relationship of SiO_2-TiO_2-Al_2O_3 at Site 436. (× = Holocene to late Pliocene samples. Open circles = Pliocene. Closed circles = late Miocene. Bisected circles = Miocene. Crosses = oldest samples in the core.)*

content increases exponentially with time. When the oceanic plate was in the Central Pacific Ocean, MnO and Fe_2O_3 were deposited under an oxidizing environment. As the ocean plate moved westward and approached the Japanese Islands, the tremendous volume of hemipelagic sediments, containing much organic material derived from the islands, gradually deposited over the original pelagic sediments. The continuous movement at a uniform rate of the plate toward the Japanese Islands gave rise to the chemical trend exemplified by the progressive change of MnO.

CONCLUSIONS

It should again be emphasized that the sediments on the west slope of the Japan Trench were derived chiefly from the Japanese Islands and were accompanied by the precipitation of biogenic silica and ferric iron. Deeper sediment overlying oceanic crust (Site 436) consists of typical pelagic material which was conveyed by the plate movement from the East Pacific Ocean. From the viewpoint of plate convergence, the upper part of the subducted oceanic lithosphere is generally assumed to have accreted to the inner trench slope via offscraping (e.g., Karig and Sharman, 1975). But the picture is by no means as simple as it was once thought to be (e.g., Scholl et al., 1977). If the offscraping of the oceanic plate is the dominant process at a convergent margin, a significant amount of deep oceanic pelagic sediment scraped off the plate should be contained in the accreting wedge. Yet the present study presents conflicting evidence. No pelagic sediments were geochemically detected in the trench inner slope deposits, though the possibility remains that pelagic sediments occur at greater depths, under the trench inner slope, and that the present drilling cores did not reach those depths. When we remember that typical pelagic sediments occur at the outer slope of the trench, as observed at Site 436, it seems likely that much of the pelagic sediment is subducted without being offscraped as suggested by volume calculations (e.g., von Huene, Nasu, et al, Site 441 chapter).

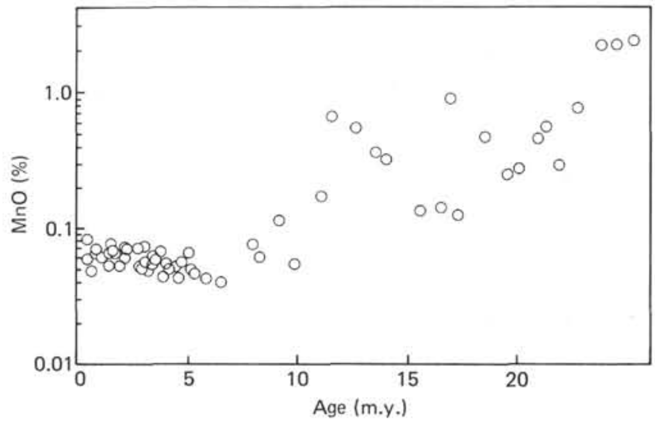

Figure 8. *MnO variation with age in the sediments at Site 436. Age was assigned by the interpolation of the paleontological age.*

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