23. MAJOR-ELEMENT CHEMISTRY OF ARGILLACEOUS SEDIMENTS AT DEEP SEA DRILLING PROJECT SITES 442, 443, AND 444, SHIKOKU BASIN

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ABSTRACT

Bulk chemical composition of 279 samples of argillaceous sediments from DSDP Sites 442, 443, and 444 in the Shikoku Basin (Leg 58) was determined and interpreted. Chemical features indicate that the Shikoku Basin sediments are typically terrigenous and were derived mostly from the Japanese Islands. A local contribution from oceanic islands, such as the Izu-Mariana Islands, to the basin sediments is not as large as expected from geophysical evidence. The Nankai Trough cannot be a barrier against sediment influx to the basin from the Japanese Islands. Except for Ca and Mn, the bulk chemical composition of the sediments is inherited from the source materials, such as granites and volcanics in the Japanese Islands, without remarkable modification. Basal sediments immediately on the basaltic basement, enriched in Mn and Fe, formed under the effect of hydrothermal emanations related to volcanism. From the chemical composition of the sediments, using the formula of Boström et al. (1976), the spreading rate of the Shikoku Basin at 17 to 15 Ma is estimated to have been 1.7 cm/yr, which is not inconsistent with the rate determined from geophysical data.

INTRODUCTION

The Shikoku Basin is one of the most typical marginal basins, and it may provide the evidence to evaluate hypotheses for the genesis of the marginal basins of the western Pacific. The character of the sediments in the basin should constitute such evidence. Bulk chemical composition of 279 samples from DSDP Leg 58 Sites 442, 443, and 444 was determined and examined in this context.

Sugisaki (in press b) has studied sediments of the Japan Trench cored during DSDP Legs 56 and 57, and the chemical aspects of argillaceous sediments from piston cores around the Japanese Islands have been studied during cruises of the Geological Survey of Japan (Sugisaki, 1978; Sugisaki, 1979, in press a; Sugisaki and Honza, in press; Sugisaki and Kinoshita, in press).

The present paper gives critical comparisons of these data and discusses the distribution of elements in argillaceous sediments of the marginal basin, to examine possible sources of the deposits.

ANALYTICAL PROCEDURE AND RESULT

The analytical procedure adopted in this study is the same as that applied to the sediments of Legs 56 and 57 by Sugisaki (in press b).

The distribution of the samples and the analytical results are shown in Tables 1 through 5. Tables 6 through 10 list the silicate compositions of samples recalculated by excluding carbonate, salt, water, and residual materials (organic matter and others); these values are mostly used in the following discussion.

GENERAL CHEMICAL CHARACTERISTICS OF THE SEDIMENTS

$CaCO_3$ was found in some of the samples and was not detected in others (Tables 1 through 5). This suggests that the depositional surface fluctuated above or below the calcium carbonate compensation depth (CCD) during the depositional history. Few data are available concerning present or past level of the CCD in the Shikoku Basin, and the exact depth of deposition cannot be determined. Sugisaki (1978) inferred from piston core data that the CCD in the Nankai Trough and its vicinity is at about 4500 meters. Present water depths at Sites 442, 443, and 444 are 4639, 4372 and 4843 meters, respectively. $CaCO_3$ was not found in the upper part of the cores at Site 442, but it was detected in the others. This evidence is not inconsistent with that for the Nankai Trough.

Table 11 lists the average silicate composition of the sediments at each site. They are closely similar. Furthermore, almost all of the standard deviations are small, which shows a high degree of uniformity of the argillaceous sediments through the entire sampled sequences.

For comparison, several other sets of averages are shown in Table 11, representing piston-core sediments from the Philippine Sea far south of the Leg 58 area, pelagic sediments from the east Pacific Ocean, and argillaceous sediments from five regions around the Japanese Islands. The samples from the Oki area and the Japan Trench are contaminated by quartz (Sugisaki and Kinoshita, in press) and biogenic silica (Sugisaki, in

TABLE 1
Chemical Composition (%) of Argillaceous Sediments of Hole 442A

No.	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	H_2O	$CaCO_3$	Residual*	Salt	Total
1	442A-2-1, 91–93	59.96	0.68	16.00	3.58	2.30	0.10	2.45	1.34	1.30	2.96	0.13	6.51	0.0	1.55	2.15	101.00
2	2-2	60.38	0.67	15.74	3.73	2.01	0.11	2.25	1.51	1.40	2.85	0.14	5.30	0.0	0.94	2.06	99.09
3	2-3, 60–62	58.36	0.66	15.46	3.62	2.27	0.12	2.18	1.45	1.25	2.94	0.13	6.59	0.0	1.67	2.26	98.95
4	2-4, 71–73	57.20	0.68	15.79	3.26	2.33	0.15	2.29	0.84	0.93	3.21	0.11	6.86	3.12	1.53	1.92	100.22
5	2-5, 13–15	64.34	0.55	15.49	2.69	1.90	0.10	1.82	1.25	1.20	3.11	0.11	6.47	0.0	0.09	1.85	100.97
6	2-6, 36–38	60.39	0.67	16.02	3.52	2.31	0.12	2.46	1.45	0.94	3.14	0.11	5.67	0.0	0.39	2.07	99.27
7	3-2, 30–32	60.75	0.58	14.97	2.95	2.02	0.24	2.03	2.35	1.31	3.13	0.09	5.70	0.0	1.41	1.72	99.27
8	3-3, 46–48	57.52	0.65	15.34	3.30	2.11	0.28	2.53	0.91	1.13	3.13	0.11	5.01	3.73	1.23	2.00	98.98
9	3-4, 53–55	58.98	0.70	16.34	3.30	2.38	0.13	2.26	1.20	0.98	3.20	0.11	5.36	0.0	2.35	1.75	99.05
10	3-5, 100–102	59.62	0.70	16.33	3.23	2.46	0.21	2.46	1.41	1.26	3.23	0.12	6.51	0.0	1.49	1.64	100.67
11	3-6, 127–129	55.97	0.69	16.36	3.53	2.24	0.15	2.46	0.07	1.26	3.22	0.10	7.41	4.33	0.94	1.84	100.57
12	3-7, 68–70	57.95	0.68	15.43	3.50	2.19	0.27	2.46	0.57	1.42	2.04	0.13	6.62	4.91	0.26	1.72	100.14
13	4-1, 63–65	56.67	0.67	15.82	3.66	2.22	0.17	2.37	1.68	0.94	3.12	0.11	7.55	0.0	0.45	3.59	99.03
14	4-2, 105–107	59.32	0.70	15.97	3.93	2.17	0.17	2.52	1.17	1.18	3.23	0.12	6.41	0.0	0.17	2.22	99.28
15	4-3, 20–22	53.92	0.65	14.73	3.40	2.17	0.35	2.39	0.62	1.18	3.01	0.13	6.54	7.73	0.18	2.04	99.02
16	4-4, 35–37	52.50	0.64	14.39	3.56	2.00	0.20	2.30	0.55	0.42	3.05	0.11	5.75	11.03	0.20	2.34	99.04
17	4-5, 7–9	56.47	0.67	15.57	3.28	2.14	0.20	2.23	0.31	1.18	3.17	0.11	5.76	5.77	0.19	1.97	99.04
18	5-1, 111–113	60.36	0.68	17.04	3.50	2.15	0.23	2.44	1.31	1.37	3.11	0.13	5.97	0.0	0.18	2.17	100.65
19	5-2, 106–108	56.99	0.69	15.88	3.96	2.08	0.23	2.45	1.25	1.28	3.25	0.11	7.05	0.0	2.07	1.92	99.21
20	5-3, 73–75	60.27	0.66	15.75	3.68	2.05	0.37	2.30	0.14	1.49	3.26	0.10	5.32	3.33	0.16	1.95	100.83
21	5-4, 131–133	57.75	0.73	16.37	3.48	2.26	0.63	2.66	1.10	1.79	3.28	0.11	5.17	0.0	1.93	1.74	99.00
22	5-5, 118–120	60.67	0.74	17.39	3.22	2.33	0.18	2.64	0.14	1.04	3.43	0.10	5.56	1.90	0.18	1.48	101.01
23	6-1, 121–123	59.17	0.75	16.38	3.61	2.34	0.19	2.56	1.02	1.03	3.33	0.11	6.44	0.0	0.11	2.04	99.07
24	6-2, 10–12	58.38	0.66	15.26	3.32	2.12	0.43	2.36	0.09	1.44	3.28	0.11	5.96	3.63	0.66	1.48	99.19
25	6-3, 108–110	60.25	0.66	15.99	3.54	2.06	0.43	2.52	1.36	1.75	3.21	0.17	6.91	0.0	0.08	2.13	101.05
26	6-4, 45–47	60.58	0.71	16.80	3.72	2.18	0.25	2.62	0.35	1.55	3.37	0.11	5.48	1.50	0.19	1.52	100.93
27	6-5, 10–12	60.66	0.69	17.09	3.72	2.00	0.27	2.28	1.19	1.73	3.21	0.13	6.50	0.0	0.20	1.47	101.14
28	6-6, 5–7	58.30	0.67	15.60	3.61	2.12	0.31	2.36	1.25	1.52	3.12	0.11	6.83	0.0	1.65	1.61	99.06
29	7-1, 129–131	57.57	0.70	16.18	4.23	2.02	0.45	2.67	0.94	1.89	3.24	0.12	7.28	0.0	0.32	1.43	99.05
30	7-2, 34–36	59.61	0.70	16.84	3.41	2.22	0.38	2.71	0.02	2.15	3.27	0.12	6.82	0.0	0.47	1.51	100.23
31	7-3, 34–36	59.38	0.71	16.79	4.33	2.04	0.49	2.84	1.09	2.03	3.18	0.12	6.07	0.0	0.35	1.56	100.97
32	7-4, 34–36	63.86	0.48	14.40	2.41	1.60	0.11	1.67	1.10	1.65	3.24	0.08	5.78	0.0	1.75	1.05	99.19
33	7-5, 34–36	58.43	0.68	16.49	3.62	2.20	0.36	2.69	0.40	1.63	3.18	0.11	6.03	3.47	0.29	1.30	100.88
34	8-4, 45–47	58.85	0.69	17.05	3.92	2.08	0.41	2.69	1.17	1.99	3.19	0.13	5.97	0.0	0.82	1.52	100.49
35	8-5, 45–47	61.71	0.67	16.11	4.02	1.97	0.37	2.58	1.28	1.76	3.08	0.12	5.97	0.0	0.14	1.23	101.00
36	10-3, 11–13	56.70	0.70	16.69	4.37	2.13	0.41	2.92	1.11	1.79	3.24	0.12	5.65	0.0	1.72	1.57	99.12
37	10-4, 11–13	58.29	0.59	14.53	5.33	1.67	0.93	2.80	0.22	2.42	3.33	0.09	6.37	1.55	0.14	1.52	99.80
38	11-3, 6–8	57.97	0.73	17.48	3.71	2.24	0.25	2.83	1.01	1.51	3.51	0.11	6.66	0.0	0.66	1.53	100.21
39	13-2, 100–102	51.66	0.67	15.86	3.39	2.37	2.70	3.47	0.83	4.75	2.84	1.15	6.01	3.62	0.72	1.37	101.40
40	14-3, 99–101	56.21	0.75	17.28	4.53	1.96	0.29	2.66	1.07	1.50	3.13	0.12	7.42	0.0	0.90	1.26	99.08
41	15-2, 69–71	54.37	0.70	16.44	4.76	1.61	2.01	3.51	0.10	3.87	3.01	0.12	6.23	2.01	0.04	1.64	100.42
42	15-3, 44–46	56.94	0.72	17.57	4.86	1.72	0.12	2.63	1.04	1.59	3.01	0.11	7.13	0.0	0.77	0.77	98.98
43	15-4, 9–11	57.40	0.74	17.18	5.44	1.53	0.24	2.34	1.21	1.26	2.92	0.11	6.47	0.0	0.14	2.07	99.06
44	16-1, 93–95	56.97	0.73	17.53	4.72	1.64	0.11	2.33	0.87	1.12	3.17	0.12	7.38	0.0	0.69	1.73	99.11
45	16-2, 33–35	56.81	0.72	17.22	4.45	1.78	0.42	2.69	0.98	1.40	3.29	0.12	6.07	0.0	1.32	1.79	99.05
46	17-2, 84–86	59.07	0.70	16.78	4.98	1.54	0.21	2.63	1.36	1.57	3.08	0.13	5.70	0.0	1.76	1.42	100.94
47	18-2, 135–137	56.97	0.71	17.45	4.95	1.71	0.36	2.73	1.66	1.68	2.98	0.16	6.42	0.0	0.52	1.89	100.18
48	18-3, 7–9	56.16	0.74	16.70	5.13	1.42	0.90	2.59	1.54	2.04	2.99	0.19	4.58	0.0	2.39	1.62	99.00
49	19-1, 130–132	56.24	0.74	17.81	5.38	1.53	0.35	2.81	0.12	1.72	3.12	0.13	5.60	2.19	0.65	1.36	99.74
50	19-2, 60–62	57.12	0.73	17.73	5.31	1.51	0.51	2.79	0.55	1.80	3.17	0.15	6.36	1.46	0.05	1.51	100.75
51	19-3, 88–90	57.80	0.73	17.64	5.43	1.51	0.44	2.89	0.22	1.48	3.09	0.14	5.80	1.87	0.19	1.69	100.91
52	20-1, 100–102	55.86	0.71	17.58	5.40	1.38	0.72	2.80	0.70	2.06	2.96	0.17	6.62	1.73	0.15	1.61	100.44
53	21-1, 16–18	57.62	0.69	17.35	5.40	1.41	0.20	2.39	1.14	1.17	3.16	0.15	7.13	0.0	0.15	1.21	99.17
54	21-2, 16–18	58.27	0.72	17.93	5.57	1.46	0.13	2.66	1.18	1.42	3.18	0.12	6.59	0.0	0.58	1.14	100.95
55	21-3, 16–18	60.05	0.69	17.80	5.45	1.39	0.17	2.56	1.21	1.22	3.00	0.17	6.01	0.0	0.15	1.09	100.96
56	21-4, 16–18	57.26	0.69	17.15	6.27	0.49	0.72	2.43	0.93	1.75	3.12	0.14	6.87	0.0	0.37	1.09	99.28
57	21-4, 20–22	58.06	0.70	17.66	6.30	0.49	0.64	2.49	0.97	1.69	3.12	0.14	6.98	0.0	0.22	1.47	100.92
58	22-1, CC	57.77	0.70	17.50	5.54	1.07	0.31	2.64	0.86	1.59	3.22	0.16	7.33	0.0	0.17	1.12	99.97
59	23-1, 28–30	55.54	0.70	17.54	4.98	1.58	0.91	3.26	0.09	2.65	3.11	0.14	6.46	2.42	0.19	1.09	100.67
60	23-3, 57–59	56.01	0.71	17.16	5.37	1.29	1.02	3.20	0.18	2.96	3.03	0.16	6.58	2.09	0.07	1.14	100.96
61	23-4, 143–145	59.50	0.71	18.16	5.35	1.49	0.13	2.43	1.18	1.36	3.06	0.13	6.30	0.0	0.38	1.12	101.29
62	23-5, 16–18	58.40	0.72	17.81	5.77	1.30	0.16	2.68	1.25	1.28	3.08	0.14	7.01	0.0	0.21	1.14	100.95
63	24-1, 128–130	58.42	0.66	16.67	5.01	1.13	0.50	2.48	1.64	2.55	3.04	0.18	6.77	0.0	0.49	1.43	100.98
64	24-2, 140–142	58.11	0.67	16.55	5.11	1.11	0.61	2.71	0.47	2.72	3.00	0.18	6.35	2.09	0.11	1.07	100.86
65	24-3, 50–52	58.75	0.66	17.55	5.51	0.81	0.48	2.47	1.72	2.35	2.89	0.18	6.24	0.0	0.17	1.19	100.98
66	24-4, 50–52	57.64	0.66	16.68	5.29	1.20	0.58	2.55	1.78	2.23	2.92	0.18	7.15	0.0	0.39	1.26	100.50
67	24-5, 50–52	57.97	0.70	16.73	5.49	1.53	0.16	2.03	2.27	1.58	2.53	0.14	5.86	0.0	1.00	1.01	98.99
68	25-2, 111–113	57.00	0.69	16.83	5.66	1.34	0.32	2.29	1.70	1.81	2.78	0.13	4.60	0.0	2.72	1.19	99.07
69	25-3, 126–128	57.08	0.69	16.69	5.57	1.51	1.21	3.01	0.18	3.01	2.82	0.13	3.37	3.04	1.67	1.21	101.19
70	25-4, 126–128	58.04	0.70	16.95	5.48	1.65	0.25	2.46	2.47	1.76	2.62	0.14	4.60	0.0	1.70	1.21	100.02
71	26-2, 100–102	57.06	0.65	16.09	5.71	1.41	0.53	3.13	0.85	2.29	2.47	0.15	5.77	3.04	0.03	1.30	100.47
72	27-2, 124–126	56.18	0.66	15.88	6.18	1.60	0.51	2.77	1.64	1.82	2.41	0.15	5.98	2.07	0.13	1.94	99.92
73	28-1, 62–64	57.64	0.66	16.28	6.41	1.50	0.42	2.65	1.01	1.90	2.62	0.14	5.62	2.14	0.10	1.90	100.99
74	28-2, 53–55	54.92	0.66	16.24	6.18	1.19	0.44	3.23	1.83	1.87	2.87	0.17	6.06	0.0	2.71	1.45	99.81
75	29-1, 88–90	53.60	0.62	14.58	8.63	0.16	0.28	3.75	2.22	2.09	1.87	0.24	7.07	0.0	2.14	1.80	99.05
76	29-3	53.42	0.63	15.05	7.61	0.56	0.74	3.61	2.68	1.71	2.28	0.23	8.06	0.0	0.34	2.12	99.04
77	30-1, 51–53	53.57	0.67	14.95	8.51	0.08	0.85	4.17	2.27	2.36	2.31	0.20	8.14	0.0	0.34	0.92	99.34
78	30-2, 22–24	54.56	0.64	15.75	8.19	0.05	1.24	4.29	1.75	2.90	3.01	0.28	7.04	0.0	0.44	0.78	100.93
79	30-3, 76–78	51.01	0.60	14.39	9.41	0.04	1.67	4.29	1.62	0.52	3.05	0.51	7.16	0.0	0.21	4.61	99.10

*Residual materials were calculated by subtracting CO_2 and H_2O from ignition loss. They may contain sulfur, organic matter, and other materials.

TABLE 2
Chemical Composition (%) of Argillaceous Sediments of Hole 442B

No.	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	H_2O	$CaCO_3$	Residual*	Salt	Total
1	442B-1-1, 76–78	68.85	0.35	12.71	1.39	0.77	0.061	0.69	1.67	1.96	3.96	0.11	4.02	0.0	1.23	1.26	99.03
2	1-2, 24–26	55.66	0.65	15.72	5.56	1.39	0.026	2.83	2.16	1.14	2.64	0.16	3.23	0.0	5.56	2.42	99.14
3	1-2, 137–139	66.36	0.46	13.21	2.34	1.29	0.41	1.03	2.22	3.05	3.33	0.13	4.92	0.0	1.12	1.09	100.96
4	2-1, 36–38	47.43	0.57	12.88	8.51	0.03	1.16	3.70	1.96	3.05	1.98	0.32	6.38	9.70	0.71	1.79	100.16
5	2-2, 17–19	50.86	0.59	13.44	9.75	0.05	1.99	4.98	1.81	4.45	2.34	0.35	7.18	0.0	1.71	1.61	101.11
6	2-3, 9–11	51.11	0.58	13.87	8.58	0.12	1.58	5.21	1.89	3.67	2.29	0.31	8.70	0.0	0.77	1.80	100.47
7	2-4, 62–64	52.58	0.62	14.88	7.91	0.12	1.47	4.61	1.67	3.36	2.66	0.19	7.26	0.0	0.93	0.94	99.21
8	2-5, 47–49	53.58	0.62	14.75	9.00	0.11	1.67	4.45	1.63	3.53	2.94	0.29	5.17	0.0	2.29	0.80	100.83
9	3-1, 48–50	54.62	0.60	15.26	7.48	0.10	0.74	3.82	1.23	2.20	2.88	0.18	7.77	0.0	0.80	1.42	99.11
10	3-2, 40–42	49.55	0.51	11.59	11.31	0.40	3.54	4.18	1.24	5.54	2.88	0.24	8.02	0.0	0.33	0.93	100.26
11	3-2, 115–117	49.47	0.43	10.43	14.66	0.08	2.67	4.44	1.37	4.39	2.47	0.15	7.17	0.0	1.14	1.05	99.93
12	3-3, 6–8	50.66	0.48	11.84	9.82	0.08	2.66	6.07	0.96	4.01	2.22	0.16	9.23	0.0	0.61	1.90	100.69

*(See note at Table 1.)

press b; Sugisaki and Honza, in press), respectively. The samples from the Nankai Trough and its vicinity (Sugisaki, 1978) and from the two areas of the Japan Sea, around the Yamato Bank (Sugisaki, 1979) and the Nishitsugaru Basin (Sugasaki, in press a), are typical terrigenous sediments. The average SiO_2 content of the Leg 58 samples amounts to almost 64 per cent, which is much higher than that for the south Philippine Sea and east Pacific Ocean. This indicates that the Shikoku Basin sediments are not typically pelagic, but resemble the terrigenous sediments around the Japanese Islands. This shows an effect on the Shikoku Basin sediments of sediment influx from siliceous continental crust. On the other hand, the SiO_2 content of the sediments from the Shikoku Basin is a little lower than that for the Nankai Trough. This indicates that the influence of continental crust on the sediments is reduced southward. In fact, the sediments of the Shikoku Basin are mostly derived from the Japanese Islands. This will be discussed later.

Another aspect of the Leg 58 samples is moderately high manganese content, much higher than in samples from the regions around the Japanese Islands, and lower than in samples from the south Philippine Sea and the east Pacific Ocean. This implies a moderate sedimentation rate in the Shikoku Basin compared to other areas. Sugisaki (1978) suggested that sediments characterized by low Mn and high Si contents in the Nankai Trough and its vicinity gradually change into pelagic sediments with high Mn and low Si contents. The present data indicate that such change is proceeding in the region of Leg 58.

HYDROTHERMAL ASPECT OF THE BASAL SEDIMENTS

The temporal variation in content of some oxides at each site is illustrated in Figure 1. Lithologic units were recognized according to color of the sediments, dominant paleontological and mineralogical components, and sedimentary structures. The deeper parts of the cores tend to be more enriched in Mn and Fe. The considerable increase in Mn and Fe in the oldest sediments is striking, especially at Site 442. The points representing the oldest sediments at Site 442 in Figure 1 are the average values for four samples collected within 3 meters of the basalt basement (Table 12).

The most likely explanation is that volcanic emanations are responsible for enrichment in Mn and Fe. Hydrothermal emanations originating at mid-ocean ridges have been thought to provide a substantial source of Mn. Sediments enriched in Mn and Fe immediately overlying volcanic basements are found to have been deposited on or near an ocean ridge system with high heat flow (Boström and Peterson, 1969); hot fluids rich in Fe, Mn, and other metals moved upwards through lavas, giving rise to ferromanganoan deposits. Mineralizing emanations enriched in Mn and in dissolved gases with a high ratio ^3He / ^4He were recently found in the Galapagos Rift Zone (Klinkhammer et al., 1977; Lupton et al., 1977). Furthermore, iron-rich mudstones called "umber," directly overlying pillow lavas of the Troodes Massif, Cyprus, are interpreted as precipitates connected with late stages of volcanism on a Cretaceous ocean ridge (Robertson and Hudson 1973). Table 12 also shows the chemical composition of red shale which directly overlies pillow basalts in the Shimanto Belt, Cretaceous geosynclinal area, southwest Japan. These sediments are similar in their high contents of Mn and Fe. The majority of the Shimanto shales are not associated with basalts and are impoverished in Mn and Fe. This can be considered evidence for a hydrothermal effect on the basal sediments at Site 442.

On the other hand, the basal sediments at Sites 443 and 444 are not remarkable for their concentrations of Mn and Fe. The sediments immediately on the basalt basement at Site 442 are paleontologically dated at 15 to 17 m.y., whereas those at Sites 443 and 444 are 14 to 15 m.y. old (Klein et al., 1978). This suggests that the hydrothermal activity waned before deposition at the latter sites.

Boström (1973) empirically found a relationship between the composition of basal sediments and spreading rates at plate-generating zones. The relationship is expressed by the following formula (Boström et al., 1976):

$$(Fe + Mn)/Al = 0.59 \exp (0.53 SR)$$

where SR is the spreading rate in cm/yr. If this formula is applied to the Shikoku Basin sediments, the spreading rate at Site 442 is 1.7 cm/yr, and that at Sites 443 and 444 is 0.5 cm/yr.

According to the estimation by Kobayashi and Nakada (1978) on the basis of magnetic-anomaly data, the

TABLE 3
Chemical Composition (%) of Argillaceous Sediments of Hole 443

No.	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	H_2O	$CaCO_3$	Resid-ual*	Salt	Total
1	443-1-1, 125–127	52.06	0.61	14.88	3.58	2.03	0.53	2.94	0.61	2.05	3.04	0.12	4.07	9.21	2.86	2.00	100.59
2	1-4, 108–110	57.77	0.65	15.92	3.33	2.28	0.29	2.38	0.39	1.60	3.05	0.15	4.30	1.94	2.45	2.57	99.07
3	2-1, 71–73	58.11	0.68	15.48	3.79	2.14	0.44	2.71	0.63	1.82	3.08	0.17	4.10	1.47	2.83	2.67	100.11
4	2-3, 45–47	59.11	0.72	14.52	3.58	2.42	0.16	3.08	0.16	1.61	3.42	0.12	5.35	1.88	1.48	1.46	99.06
5	3-1, 16–18	60.37	0.73	14.92	3.30	2.34	0.20	3.06	1.05	1.32	3.47	0.13	2.62	0.0	4.10	1.46	99.06
6	3-2, 77–79	61.89	0.73	15.08	3.02	2.42	0.16	2.96	0.13	1.04	3.45	0.11	4.38	1.90	1.91	1.63	100.82
7	3-5, 84–86	57.30	0.67	13.87	3.35	2.31	0.56	3.19	0.33	1.77	3.37	0.12	5.19	5.51	0.22	2.19	99.96
8	4-1, 111–113	58.72	0.66	13.93	3.42	2.15	0.43	2.66	0.02	1.42	3.31	0.12	2.71	6.08	2.52	2.27	100.42
9	4-2, 109–111	52.88	0.62	14.78	3.74	2.05	0.46	2.48	1.42	1.26	3.04	0.11	5.20	5.74	2.91	2.34	99.03
10	4-3, 39–41	61.80	0.72	16.76	3.06	2.41	0.17	2.39	0.15	1.11	3.22	0.13	4.72	1.72	0.52	2.13	101.00
11	4-3, 45–47	56.03	0.66	15.60	3.09	2.14	0.34	2.36	0.18	1.53	3.01	0.15	3.56	6.88	1.85	2.18	99.57
12	5-1, 61–63	56.93	0.71	16.29	3.48	2.30	0.25	2.64	0.41	1.77	3.28	0.13	6.37	2.95	0.77	1.45	99.72
13	5-2, 36–38	55.80	0.69	15.84	3.69	2.25	0.41	2.79	0.14	1.63	3.18	0.11	6.47	4.88	0.25	1.35	99.48
14	5-3, 99–101	53.27	0.64	14.80	3.66	2.12	0.35	2.69	0.07	1.78	3.00	0.12	5.11	7.71	2.13	1.67	99.12
15	5-4, 31–33	57.43	0.58	14.89	2.91	2.20	0.37	2.01	2.67	1.99	2.93	0.12	6.59	2.73	0.28	1.79	99.48
16	6-2, 44–46	58.02	0.60	15.55	3.02	2.04	0.36	2.06	0.26	2.12	2.90	0.13	4.33	6.79	0.65	1.85	100.69
17	6-3, 44–46	42.89	0.50	11.64	2.99	1.57	0.56	1.74	5.48	2.01	2.49	0.13	4.65	14.67	5.71	1.36	98.39
18	6-4, 44–46	62.94	0.63	16.01	2.63	2.05	0.11	1.94	1.30	1.84	3.14	0.10	6.30	0.0	0.91	1.08	100.99
19	6-5, 44–46	57.43	0.66	15.78	3.45	2.12	0.20	2.28	0.60	1.58	3.05	0.13	6.27	3.85	0.28	1.32	99.01
20	8-4, 106–108	53.95	0.65	15.08	3.61	2.28	0.44	2.33	0.03	1.10	3.13	0.16	5.45	8.01	1.29	1.95	99.45
21	8-5, 58–60	57.35	0.71	16.27	3.51	2.28	0.33	2.85	0.40	1.38	3.32	0.12	5.80	3.05	0.78	1.46	99.60
22	9-3, 28–30	53.36	0.67	15.33	3.80	1.99	0.25	2.47	0.27	1.05	3.04	0.17	6.26	8.01	1.08	1.53	99.28
23	9-5, 26–28	58.56	0.71	16.71	3.57	2.22	0.19	2.65	0.15	1.24	3.34	0.11	5.66	3.52	0.20	1.13	99.96
24	10-1, 69–71	58.11	0.67	16.84	3.94	1.97	0.28	2.44	0.13	1.53	3.05	0.12	5.84	2.20	0.54	1.54	99.20
25	10-1, 138–140	57.91	0.65	15.90	3.90	2.01	0.27	2.50	0.34	1.36	3.05	0.12	6.51	2.78	0.01	1.59	98.89
26	10-2, 39–41	60.16	0.62	15.02	3.82	1.90	0.27	2.50	1.64	1.53	2.93	0.11	6.20	0.0	1.02	1.34	99.05
27	10-2, 138–140	58.00	0.65	15.85	3.95	1.97	0.29	2.14	0.60	1.83	3.10	0.11	6.70	3.10	0.53	1.54	100.36
28	10-3, 43–45	57.43	0.64	15.87	4.29	2.07	0.27	2.57	1.38	1.36	3.07	0.11	7.92	0.0	0.47	1.58	99.03
29	10-4, 51–53	58.45	0.66	15.97	4.32	1.93	0.24	2.31	0.69	1.89	3.11	0.13	6.21	2.06	0.32	1.66	99.95
30	10-4, 135–137	56.95	0.66	16.07	3.86	2.12	0.26	2.68	0.17	1.49	3.11	0.12	6.54	3.08	0.42	1.53	99.07
31	10-5, 48–50	56.00	0.66	16.00	4.20	1.97	0.30	2.69	0.40	1.66	3.18	0.11	5.96	4.17	0.09	1.88	99.27
32	10-5, 132–134	54.05	0.66	14.67	3.92	1.95	0.42	2.63	0.18	1.69	3.02	0.12	4.91	8.71	0.40	1.70	99.02
33	10-6, 108–110	59.29	0.54	14.68	4.29	1.81	0.12	2.31	0.07	1.35	3.45	0.082	5.95	3.41	0.58	1.14	99.07
34	11-2, 108–110	52.04	0.63	14.62	3.42	2.01	0.36	2.27	0.46	1.97	3.10	0.13	4.86	12.73	0.35	1.39	100.34
35	11-3, 108–110	53.01	0.63	14.73	3.94	2.07	0.60	2.61	0.19	2.29	2.97	0.17	4.68	9.47	1.09	1.52	99.97
36	11-4, 108–110	59.03	0.69	16.25	3.61	2.11	0.17	2.64	0.21	1.55	3.22	0.11	6.41	2.01	1.72	1.36	101.10
37	11-5, 108–110	58.79	0.64	16.00	3.53	2.05	0.38	2.47	0.20	1.84	3.37	0.11	6.72	1.70	0.80	1.37	99.97
38	11-6, 70–72	59.25	0.71	16.32	3.55	2.24	0.14	2.52	1.30	1.61	3.11	0.11	5.88	0.0	1.09	1.29	99.13
39	14-4, 120–122	57.48	0.71	16.85	4.16	2.25	0.30	2.58	1.08	1.75	3.27	0.11	6.78	0.0	0.39	1.40	99.11
40	14-5, 120–122	58.86	0.65	16.23	4.05	1.99	0.08	2.20	1.22	1.38	3.29	0.097	5.53	0.0	2.38	1.21	99.17
41	14-6, 106–108	59.73	0.70	16.53	3.33	2.28	0.16	2.12	0.55	1.57	3.12	0.12	5.78	2.49	0.45	1.21	100.14
42	15-4, 48–50	59.23	0.76	17.72	3.19	2.26	0.14	2.43	0.27	1.57	3.38	0.13	5.96	2.03	0.58	1.21	100.87
43	15-5, 63–65	56.30	0.70	16.63	4.47	2.19	0.60	2.91	0.37	1.95	3.32	0.13	5.84	1.29	0.40	1.48	98.58
44	15-6, 63–65	57.22	0.72	17.10	4.11	2.15	0.30	2.80	0.24	1.52	3.33	0.12	5.92	1.46	0.67	1.37	99.03
45	15-7, 28–30	57.47	0.71	16.89	4.06	2.16	0.28	2.66	0.30	1.16	3.18	0.13	6.69	1.67	0.14	1.56	99.06
46	17-4, 11–13	52.81	0.70	15.95	3.77	2.11	0.45	2.46	0.16	1.35	3.15	0.11	6.03	8.08	0.61	1.50	99.24
47	18-1, 98–100	56.12	0.68	16.18	4.38	2.03	0.47	2.81	1.05	1.86	3.04	0.12	5.08	2.80	1.77	1.58	99.97
48	18-2, 98–100	59.47	0.61	16.30	3.47	1.89	0.14	2.01	0.18	1.31	3.34	0.10	6.88	2.47	0.10	1.29	99.56
49	18-3, 98–100	64.22	0.42	13.95	2.07	1.47	0.17	1.14	1.20	1.88	2.73	0.083	4.29	3.17	1.48	0.97	99.24
50	21-2, 13–15	56.04	0.72	17.19	4.71	1.75	0.55	2.97	0.24	1.72	3.21	0.12	6.49	2.00	0.35	1.42	99.48
51	23-1, 110–112	56.61	0.70	16.70	5.15	1.48	0.36	2.80	0.25	2.99	3.21	0.12	6.77	2.06	0.30	1.02	100.52
52	23-2, 95–97	59.37	0.63	16.17	4.14	1.72	0.35	2.48	1.58	1.84	3.21	0.13	6.35	0.0	0.91	1.19	100.08
53	23-3, 40–42	56.72	0.48	14.89	3.50	1.24	0.31	1.66	0.29	1.53	3.17	0.098	4.86	8.00	1.24	0.93	98.92
54	23-4, 50–52	59.96	0.54	15.83	3.95	1.38	0.33	2.12	0.19	1.58	3.35	0.095	7.14	1.88	0.22	1.04	99.60
55	24-1, 70–72	55.66	0.69	16.58	5.19	1.66	0.51	3.14	0.87	1.74	2.89	0.15	6.72	3.20	0.16	1.18	100.33
56	24-3, 42–44	54.91	0.70	16.68	4.86	1.67	0.28	2.89	0.49	1.21	3.03	0.14	5.95	3.23	1.37	1.63	99.05
57	24-3, 90–92	56.31	0.72	16.42	4.73	1.95	0.37	2.69	1.25	1.66	2.79	0.13	6.68	1.32	0.64	1.41	99.08
58	24-4, 95–97	55.26	0.69	16.58	5.13	1.77	0.39	2.99	0.43	1.89	2.81	0.14	6.69	2.25	0.85	1.51	99.38
59	24-5, 71–73	50.63	0.66	14.66	5.41	2.40	0.23	2.84	1.93	1.17	2.11	0.12	3.34	10.23	1.32	1.96	99.02
60	24-6, 74–76	46.67	0.61	13.98	4.75	1.39	0.61	2.46	0.30	1.27	2.53	0.15	5.24	18.84	0.18	1.86	100.85
61	25-2, 72–74	50.13	0.85	14.29	5.15	4.40	0.22	3.02	4.51	0.88	1.04	0.09	2.46	10.40	0.46	1.10	99.00
62	25-2, 123–125	45.69	0.57	13.45	4.24	1.45	0.53	2.38	0.30	1.83	2.36	1.63	2.71	20.87	2.17	1.29	101.47
63	25-3, 86–88	56.56	0.69	16.34	5.01	2.09	0.32	2.73	2.30	1.30	2.45	0.12	6.31	2.85	0.36	1.64	101.07
64	26-1, 82–84	57.14	0.67	16.27	4.80	2.21	0.38	2.53	2.58	1.67	2.52	0.13	5.69	0.0	1.22	1.20	99.01
65	26-2, 142–144	50.11	0.64	14.19	4.80	2.07	0.48	2.53	0.13	1.78	2.32	0.12	3.22	14.46	1.69	1.09	99.64

TABLE 3 – *Continued*

No.	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	H_2O	$CaCO_3$	Resid-ual*	Salt	Total
66	443-27-1, 80–82	60.32	0.58	14.88	3.80	1.94	0.28	2.10	0.62	2.07	2.34	0.12	6.52	2.26	0.17	1.31	99.32
67	27-2, 22–24	55.37	0.65	15.65	5.23	1.49	0.83	2.90	0.53	2.28	2.85	0.16	5.94	4.01	1.07	1.37	100.33
68	27-3, 11–13	57.64	0.59	15.89	1.56	1.41	1.33	2.98	0.12	3.64	2.94	0.21	3.95	4.25	2.32	1.12	99.94
69	27-4, 55–57	55.62	0.68	16.37	4.95	1.48	0.25	2.43	1.19	1.10	3.00	0.15	7.62	0.0	2.16	1.10	98.09
70	28-1, 108–110	60.30	0.69	17.20	5.13	1.44	0.10	2.20	0.96	1.04	3.08	0.13	6.35	0.0	1.45	0.85	100.93
71	28-2, 16–18	58.35	0.67	16.94	5.12	1.38	0.29	2.52	1.03	1.52	3.12	0.14	5.57	0.0	1.58	1.09	99.32
72	29-1, 87–89	57.21	0.65	16.57	4.75	1.46	0.43	2.46	0.19	1.82	2.83	0.13	6.79	1.98	0.69	1.15	99.10
73	29-2, 61–63	56.96	0.67	17.26	5.10	1.44	0.37	2.64	1.11	1.08	3.05	0.12	6.27	0.0	1.17	1.84	99.08
74	29-3, 85–87	56.64	0.67	16.89	4.56	1.60	0.39	2.58	0.49	4.77	3.04	0.14	5.61	1.37	0.95	1.21	100.92
75	29-4, 56–58	58.03	0.61	17.08	4.98	1.71	0.39	2.65	1.52	1.90	2.99	0.15	5.96	0.0	1.86	1.19	101.03
76	29-5, 46–48	57.00	0.67	16.74	5.39	1.53	0.54	2.74	0.08	2.08	2.88	0.14	6.28	2.99	0.00	1.23	100.29
77	30-2, 132–134	57.10	0.63	15.60	4.64	1.62	0.67	3.06	0.78	2.39	2.74	0.16	5.65	3.27	0.25	1.05	99.61
78	31-1, 119–121	57.64	0.66	15.95	5.06	1.86	0.13	2.44	2.46	1.65	2.43	0.13	6.93	0.0	0.56	1.15	99.05
79	31-2, 62–64	57.56	0.67	16.12	4.96	2.10	0.48	2.86	1.91	2.71	2.30	0.14	5.16	2.57	0.55	0.99	101.08
80	31-3, 44–46	56.84	0.66	15.35	4.84	2.34	0.45	2.90	1.44	1.97	2.42	0.14	5.19	2.40	1.19	1.23	99.36
81	31-4, 44–46	56.67	0.65	15.42	4.91	1.95	0.54	2.82	1.72	2.29	2.51	0.14	6.06	1.86	0.33	1.20	99.07
82	31-5, 30–32	59.49	0.63	15.12	4.90	2.02	0.47	2.54	1.03	2.02	2.51	0.12	4.06	2.61	0.43	1.20	99.15
83	32-1, 129–131	52.52	0.65	14.93	4.70	2.28	0.51	2.43	2.24	2.34	2.04	0.12	5.22	7.41	0.85	1.15	99.38
84	33-1, 38–40	52.39	0.76	14.54	4.71	2.26	0.25	2.31	1.75	2.15	2.08	0.16	5.08	9.35	0.31	1.02	99.10
85	33-2, 38–40	62.57	0.40	13.54	2.85	1.63	0.22	1.35	2.38	2.50	3.36	0.085	5.47	0.0	1.68	1.03	99.06
86	33-3, 38–40	51.98	0.64	14.10	4.70	1.92	0.35	2.12	1.83	2.08	2.22	0.13	4.66	11.02	0.28	1.05	99.08
87	34-2, 11–13	55.62	0.55	13.99	4.41	1.65	0.25	2.25	1.63	1.89	2.27	0.11	6.33	6.43	0.35	1.32	99.05
88	34-3, 11–13	48.27	0.56	13.28	4.81	1.55	0.40	2.24	1.53	2.03	2.16	0.14	4.75	15.26	0.84	1.20	99.02
89	34-4, 11–13	45.42	0.48	11.98	3.65	1.26	0.37	1.54	0.88	1.74	2.04	0.11	2.81	23.01	2.42	1.37	99.07
90	34-5, 11–13	55.45	0.64	14.75	4.13	2.05	0.16	2.31	1.81	1.86	2.03	0.11	4.35	7.41	0.71	1.24	99.01
91	35-1, 56–58	45.07	0.41	10.98	3.51	1.53	0.34	1.53	0.47	1.99	2.22	0.095	2.73	27.23	0.76	1.07	99.93
92	35-3, 7–9	48.74	0.59	13.15	5.09	1.83	0.36	2.27	0.84	1.51	2.12	0.12	5.69	15.04	1.37	1.86	100.57
93	36-1, 36–38	46.47	0.60	12.84	4.77	1.87	0.29	1.90	4.44	1.51	2.00	0.098	5.77	13.20	1.80	1.31	98.87
94	36-2, 103–105	42.56	0.56	11.96	4.56	1.80	0.36	2.10	6.88	1.72	1.95	0.12	4.74	14.19	4.55	1.18	99.23
95	36-3, 89–91	40.41	0.52	11.56	4.82	1.37	1.55	2.62	7.56	2.64	2.06	0.10	4.30	14.05	5.14	1.90	100.60
96	36-4, 114–116	55.65	0.65	16.08	5.40	1.78	0.12	4.13	2.67	1.43	2.73	0.083	6.51	0.0	0.89	1.80	99.92
97	36-5, 87–89	46.19	0.57	12.53	4.78	1.58	1.21	2.54	0.67	2.04	2.37	0.097	5.61	18.42	0.14	1.89	100.64
98	39-1, 76–78	54.01	0.67	15.13	4.97	2.02	0.19	2.51	0.76	1.56	2.53	0.086	4.53	8.09	0.44	1.52	99.03
99	39-1, 129–131	49.54	0.60	13.74	4.58	1.71	0.48	2.77	0.18	1.94	2.59	0.10	5.70	15.01	0.31	1.57	100.82
100	39-2, 50–52	39.78	0.48	10.22	3.74	1.39	3.01	2.43	4.41	3.85	1.88	1.11	4.07	21.00	3.59	1.41	102.37
101	40-1, 56–58	55.88	0.68	16.12	6.26	1.64	0.17	2.85	2.23	1.57	2.73	0.13	7.30	0.0	0.58	1.34	99.47
102	40-2, 10–12	56.86	0.67	16.02	5.96	1.64	0.36	2.89	2.22	1.28	2.72	0.14	6.90	0.0	0.16	2.06	99.88
103	42-1, 66–68	56.89	0.63	15.45	6.19	1.46	0.61	3.25	1.57	2.30	3.06	0.11	6.45	0.0	1.60	1.45	101.01
104	42-2, 13–15	56.29	0.64	15.27	5.52	1.87	0.49	2.71	0.41	2.01	2.88	0.12	6.86	2.78	0.05	1.54	99.45
105	43-1, 38–40	59.01	0.60	15.04	4.83	1.63	0.20	2.64	1.86	1.60	2.91	0.11	6.73	0.0	0.68	1.21	99.05
106	43-2, 78–80	59.09	0.61	14.57	4.31	2.12	2.27	2.33	2.54	1.75	2.87	0.19	5.89	0.0	0.73	1.57	100.84
107	45-1, 79–81	57.76	0.66	14.93	5.49	1.85	0.51	3.01	1.17	2.27	2.62	0.14	6.05	2.15	0.21	1.25	100.07
108	45-2, 67–69	60.85	0.58	14.59	4.54	2.07	0.093	2.20	2.66	1.69	2.79	0.11	5.98	0.0	0.27	1.10	99.52
109	46-1, 44–46	45.35	0.59	11.46	5.53	1.60	0.77	2.54	0.62	2.05	1.94	0.19	4.58	20.56	0.20	1.07	99.05
110	46-2, 44–46	56.59	0.66	14.72	6.21	1.81	0.75	3.17	1.08	3.00	2.42	0.12	5.78	3.08	0.12	1.29	100.80
111	47-1, 36–38	57.94	0.62	14.90	6.08	1.74	0.13	2.87	2.15	1.52	2.57	0.10	6.42	0.0	0.84	1.21	99.08
112	48-1, 129–131	43.45	0.47	10.86	4.71	1.32	0.50	1.71	0.07	1.42	2.03	0.16	3.83	28.32	0.71	1.20	100.76
113	49-2, 25–27	55.13	0.57	13.74	9.15	0.55	0.51	4.07	0.44	1.27	2.66	0.11	6.89	3.76	0.52	0.56	99.93
114	49-2, 114–116	35.90	0.45	9.67	6.99	0.30	0.73	3.27	4.52	0.59	1.85	0.14	6.15	28.11	1.78	0.55	101.00

*(See note at Table 1.)

spreading rate of the Shikoku Basin was 4 to 6 cm/yr between 26 and 22 Ma, and it subsequently decreased to about half that rate (2–3 cm/yr). Rates after 18 Ma seem to vary with time and place. Watts and Weissel (1975) estimated the rate between 22 and 19 Ma to be 2.2 cm/yr. The rate estimated from chemical parameters at Site 442 is apparently not inconsistent with the geophysical estimate for the last period of spreading. Spreading slowed during deposition of the basal sediments at Sites 443 and 444 (15–14 Ma), if the chemical parameters provide a valid indication.

POSSIBLE SOURCES OF THE SEDIMENTS IN THE SHIKOKU BASIN

Seismic profiles obtained by Murauchi and Asanuma (1977), Karig (1975), and others showed that there are three coalescing clastic wedges in the basin. A wedge on the north side of the basin was penetrated at DSDP Site 297; a second, on the west side of the basin, was penetrated at Site 442; and the third, on the east side, was penetrated at Sites 443 and 444. The direction of thickening of these wedges suggests that the north

TABLE 4
Chemical Composition (%) of Argillaceous Sediments of Hole 444

No.	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	H_2O	$CaCO_3$	Residual*	Salt	Total
1	444-3-1, 12–14	59.40	0.68	16.10	3.54	2.27	0.26	2.58	0.57	1.94	2.95	0.14	5.05	1.81	0.19	1.52	99.00
2	3-2, 22–24	56.10	0.68	15.83	4.05	2.09	0.77	3.54	0.35	2.10	3.19	0.13	5.10	3.53	1.72	1.59	100.76
3	3-3, 20–22	58.70	0.73	16.13	3.91	2.22	0.17	2.59	0.66	1.30	3.12	0.14	5.83	1.26	0.52	1.78	99.07
4	4-1, 116–118	57.58	0.72	16.24	3.59	1.99	0.21	2.78	0.11	1.59	3.29	0.12	5.46	2.08	1.27	1.79	98.82
5	4-2, 116–118	59.28	0.70	15.89	4.24	2.06	0.13	2.59	0.58	1.57	3.05	0.14	5.66	1.59	0.17	1.66	99.30
6	4-3, 20–22	57.93	0.73	16.37	4.63	1.97	0.17	2.52	0.21	1.38	3.19	0.12	6.25	1.68	0.94	1.37	99.46
7	4-3, 114–116	56.04	0.67	15.34	4.61	1.48	0.60	2.11	0.68	2.43	2.90	0.15	5.05	3.99	1.49	1.50	99.03
8	5-1, 76–78	58.90	0.72	15.70	4.15	2.54	0.21	2.33	2.56	1.93	2.45	0.13	5.12	0.0	0.83	1.36	98.92
9	5-2, 92–94	56.07	0.69	16.12	4.54	1.74	0.22	2.45	0.61	1.37	3.14	0.13	5.99	6.28	0.07	1.51	100.92
10	5-3, 60–62	56.52	0.74	16.82	4.14	2.20	0.48	3.05	0.31	1.92	3.11	0.15	5.28	2.15	1.38	1.59	99.85
11	5-4, 68–70	56.96	0.70	16.42	3.64	2.83	0.20	2.64	1.01	1.74	3.08	0.16	5.99	2.01	0.03	1.59	99.00
12	7-1, 50–52	57.86	0.72	16.55	4.81	1.72	0.25	2.50	1.70	1.58	2.89	0.15	6.42	0.0	0.39	1.53	99.08
13	7-2, 77–79	58.09	0.72	16.62	4.76	1.85	0.21	2.68	1.60	1.95	2.97	0.14	6.87	0.0	0.41	1.50	100.37
14	7-3, 43–45	60.07	0.65	15.22	3.48	1.81	0.33	2.08	2.12	2.86	2.74	0.13	6.19	0.0	0.26	1.10	99.03
15	7-4, 12–14	62.10	0.64	16.07	3.74	1.63	0.16	2.19	1.83	1.86	3.03	0.12	6.13	0.0	0.36	1.25	101.10
16	7-6, 28–30	57.55	0.72	16.74	4.59	2.11	0.13	2.38	2.00	1.17	2.85	0.16	5.44	0.0	1.39	1.69	98.92
17	9-1, 110–112	60.71	0.64	14.82	3.35	2.67	0.15	2.18	3.80	2.02	2.20	0.15	5.20	0.0	0.33	1.09	99.31
18	10-1, 52–54	58.60	0.64	16.08	4.38	1.71	0.19	2.62	1.75	1.95	2.73	0.14	7.31	0.0	0.51	1.45	100.05
19	10-2, 52–54	56.22	0.68	16.34	4.75	1.70	0.32	2.91	1.73	1.67	3.00	0.15	6.61	0.0	1.23	1.78	99.09

*(See note at Table 1.)

wedge was probably derived from the Japanese Islands, whereas the west and east wedges were derived from the Kyushu–Palau Ridge and the Iwo Jima Ridge, respectively. Geochemical data obtained in the present study can be used to evaluate these possibilities.

The relationships among SiO_2, TiO_2 and Al_2O_3 (Figure 2) are helpful in the examination of the sediment source, because these components tend to remain in the resistates and hydrolysates during sedimentation (e.g., Rankama and Sahama, 1950), and their relative abundances are preserved during weathering. The points in Figure 2 fall along a line connecting points for averaged Japanese granites and averaged Quaternary volcanics. Points for averaged shales in the Shimanto Belt (Cretaceous geosynclinal area) and the Chichibu terrain (Paleozoic geosynclinal area), the Japanese Islands, also plot near the line. The point for Izu–Mariana volcanics plots off the line; this strongly suggests that the Shikoku Basin sediments were mostly derived from the Japanese Islands, and not from the Izu–Mariana Islands. Sediments from the east Pacific Ocean and the Philippine Sea plot in an area of lower silica. The SiO_2 content of Nankai Trough sediments, which were also derived from the Japanese Islands (Sugisaki, 1978), is a little higher than that of the Leg 58 samples (Table 11). Silica in sediments off the coast of southwest Japan tends to decrease southward, probably because of the influence of oceanic and basic materials derived from islands such as the Izu–Mariana islands. Such local contribution to the Shikoku Basin sediments, however, is not as large as expected from seismic evidence. The closely similar plots for the three sites on the ternary diagrams of Figure 2 reinforce the inference.

The temporal variation in SiO_2 content at each site is rather small and does not show any trend (Figure 1), indicating continuous influx of terrigenous sediments from the north. Karig (1975) presumed that the Pliocene development of the Nankai Trough as a sediment trap reduced or completely eliminated the supply of the sediments from the north. However, the geochemical data of the sediments show that the Nankai Trough cannot have been a barrier to sediment influx from the north.

CHEMICAL ALTERATION OF THE SEDIMENTS

The sediments must have undergone some alteration during diagenesis. To what extent was the original composition of the sediments changed? The sediments in the Japan Trench were observed to be considerably contaminated by biogenic silica (Sugisaki, in press c) and they are not suitable for evaluating chemical alteration. On the other hand, Shikoku Basin samples with a small amount of silica contamination will serve the present purpose.

Figure 3 exemplifies the relationships among TiO_2, total Fe as Fe_2O_3, and MgO. The averaged variations of these elements in granites and volcanics in the Japanese Islands were plotted in the figure together with some averaged sediments from various regions. General aspects emerge from the plot: (1) Most sediments of the Shikoku Basin, which plot between the averaged volcanics and granites, originated in the Japanese Islands, (2) A local contribution, for example from the Izu–Mariana islands, falls short in explaining the origin of sediments of the Shikoku Basin as a whole, (3) The variation trend of these elements in the present samples is closely similar to those for the granites and volcanics. SiO_2, TiO_2 and Al_2O_3 have been cited as elements mutually stable during weathering; in addition, the relative concentrations of Mg, Ti, and Fe in the sediments were inherited from the source materials without remarkable modification.

Examination of trends for other elements leads us to the conclusion that Si, Ti, Al, total Fe, Mg, and K behave as conservative elements, while Ca, Mn, and FeO/Fe_2O_3 change remarkably during the sedimentary processes. Fe_2O_3 is negatively correlated with FeO (Figure 4) and positively correlated with total Fe, indicating oxidation.

TABLE 5
Chemical Composition (%) of Argillaceous Sediments of Hole 444A

No.	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	H_2O	$CaCO_3$	Resid-ual*	Salt	Total
1	444A-1-1, 64–66	57.04	0.70	17.71	4.86	1.93	0.24	2.95	0.59	1.62	3.03	0.17	6.01	2.43	0.14	1.59	101.01
2	1-2, 64–66	55.68	0.68	15.82	4.68	1.94	0.21	2.51	2.32	1.83	2.46	0.15	6.01	2.57	0.43	1.81	99.10
3	1-3, 64–66	39.79	0.53	12.02	4.05	1.11	0.32	1.69	0.09	1.08	2.56	0.20	3.73	29.22	0.53	2.07	99.00
4	1-4, 64–66	54.89	0.69	16.19	4.68	1.74	0.34	2.60	0.94	1.24	2.92	0.16	8.27	2.44	0.30	2.88	100.28
5	1-5, 64–66	58.88	0.67	17.03	4.76	1.85	0.21	2.66	1.49	1.44	2.78	0.15	5.59	1.30	0.21	2.13	101.16
6	1-6, 64–66	56.87	0.66	16.17	4.88	1.71	0.29	2.40	2.14	1.86	2.74	0.16	5.95	0.0	1.70	1.50	99.03
7	2-2, 92–94	61.40	0.47	12.51	2.75	1.54	0.15	1.31	2.06	2.08	1.88	0.084	5.70	4.88	1.09	1.32	99.23
8	2-3, 23–25	59.61	0.59	15.91	4.02	1.94	0.11	2.31	1.95	1.39	2.93	0.12	5.75	0.0	0.89	1.51	99.04
9	2-4, 23–25	56.07	0.68	16.19	4.90	1.98	0.33	2.53	2.68	2.40	2.51	0.18	6.91	0.0	1.43	1.36	100.14
10	3-2, 62–64	55.77	0.71	16.55	5.11	1.63	0.35	2.90	2.50	1.98	2.53	0.17	6.85	0.0	0.18	1.88	99.11
11	3-3, 62–64	55.35	0.74	16.21	4.76	2.20	0.33	2.87	2.79	2.15	2.32	0.19	4.89	0.0	2.87	1.34	99.01
12	3-4, 62–64	55.49	0.71	16.57	5.32	1.71	0.42	2.97	1.17	1.83	2.62	0.18	5.42	2.24	0.64	1.59	98.88
13	3-5, 62–64	57.58	0.71	16.43	5.04	1.67	0.39	2.77	2.42	2.26	2.56	0.17	6.61	0.0	0.23	1.52	100.37
14	6-1, 38–40	57.71	0.65	17.13	5.93	1.04	0.36	2.94	1.96	1.82	2.73	0.18	5.69	0.0	1.11	1.78	101.03
15	6-2, 38–40	55.14	0.65	16.95	5.78	1.11	0.35	2.55	1.85	1.73	2.66	0.19	7.04	0.0	1.34	1.69	99.02
16	6-3, 38–40	54.85	0.69	16.31	6.30	1.11	0.49	2.79	1.86	1.94	2.68	0.14	7.81	0.0	0.32	1.75	99.04
17	6-4, 38–40	58.08	0.68	17.01	5.46	1.01	0.39	2.61	1.52	2.16	2.95	0.18	6.00	0.0	1.33	1.53	100.92
18	6-5, 38–40	57.14	0.67	17.18	5.56	1.28	0.32	2.69	2.14	1.97	2.65	0.16	6.91	0.0	0.32	1.37	100.36
19	7-1, 56–58	56.19	0.70	16.81	6.22	1.11	0.41	3.05	2.09	1.92	2.70	0.17	7.34	0.0	0.00	1.42	100.14
20	8-1, 69–71	56.80	0.71	17.09	6.24	1.19	0.30	3.01	1.70	1.66	2.58	0.14	6.82	0.0	0.75	1.78	100.76
21	9-1, 28–30	55.55	0.66	15.61	5.77	1.75	0.42	2.54	3.22	0.12	2.07	0.14	6.05	0.0	0.02	5.24	99.15
22	9-2, 28–30	54.93	0.72	15.57	5.73	2.57	0.57	3.54	4.50	2.86	1.78	0.16	6.55	0.0	0.05	1.43	100.97
23	9-3, 28–30	54.40	0.71	15.08	5.70	2.67	0.53	3.60	4.08	2.45	1.82	0.14	6.06	0.0	0.48	1.39	99.12
24	9-4, 28–30	55.94	0.74	15.08	5.10	3.11	0.30	3.10	3.17	2.29	1.61	0.54	5.87	2.35	0.57	1.21	100.99
25	9-5, 28–30	54.92	0.72	15.21	5.27	3.31	0.26	3.27	4.53	2.20	1.72	0.14	5.99	0.0	0.05	1.46	99.04
26	10-1, 104–106	52.03	0.76	13.93	6.19	3.33	0.22	3.14	4.61	1.29	1.34	0.12	4.56	6.84	0.41	1.78	100.55
27	10-2, 104–106	55.38	0.65	13.44	3.54	2.91	0.19	2.11	3.50	2.21	1.24	0.13	4.54	8.85	0.45	1.12	100.25
28	11-1, 112–114	65.73	0.42	12.89	1.94	1.62	0.14	1.44	2.58	2.42	2.04	0.097	4.87	0.0	1.88	0.98	99.05
29	11-2, 118–120	59.40	0.63	15.38	3.77	2.38	0.19	2.19	3.77	2.02	1.83	0.14	4.66	0.0	1.47	1.23	99.06
30	11-3, 115–117	59.46	0.40	11.43	2.07	1.60	0.15	1.29	0.78	2.12	1.72	0.081	4.03	11.92	0.32	1.69	99.06
31	11-4, 60–62	54.62	0.56	14.24	3.88	2.69	0.21	2.39	3.29	1.61	1.92	0.14	5.79	4.74	1.37	1.88	99.33
32	12-1, 94–96	46.52	0.63	13.11	4.27	2.78	0.26	2.79	0.56	1.68	1.93	0.12	2.77	19.54	1.25	1.70	99.91
33	12-2, 119–121	52.27	0.66	14.23	5.47	2.44	0.17	3.03	4.10	1.79	1.77	0.14	5.03	5.74	1.00	2.10	99.93
34	13-1, 91–93	54.77	0.74	15.30	5.79	3.46	0.17	3.36	5.72	1.51	1.40	0.13	4.83	0.0	0.35	1.64	99.18
35	13-2, 68–70	55.37	0.73	15.69	5.70	2.84	0.31	2.92	3.95	1.44	1.98	0.13	5.56	0.0	0.53	1.77	98.93
36	13-3, 30–32	55.95	0.70	15.17	5.56	2.78	0.16	2.98	3.36	1.53	2.17	0.13	5.79	0.0	1.32	1.46	99.05
37	14-1, 73–75	56.39	0.66	14.87	4.51	2.73	0.24	2.80	2.34	1.63	2.03	0.15	5.81	2.53	0.92	1.86	99.47
38	14-2, 73–75	62.56	0.58	13.26	2.57	2.73	0.14	1.95	3.47	2.28	1.53	0.13	5.41	0.0	1.22	1.26	99.08
39	14-3, 73–75	69.00	0.45	11.50	1.10	1.93	0.079	0.63	2.56	2.47	1.73	0.082	5.29	0.0	2.54	1.61	100.98
40	14-4, 26–28	56.42	0.66	15.66	5.06	1.97	0.21	2.74	2.81	1.73	2.38	0.16	7.14	0.0	0.75	1.46	99.14
41	15-1, 44–46	58.22	0.65	16.27	4.64	2.27	0.26	2.81	4.10	2.22	1.94	0.18	5.73	0.0	0.51	1.19	101.00
42	15-2, 44–46	67.08	0.40	12.05	1.73	1.71	0.12	1.09	2.61	2.34	2.03	0.083	5.26	0.0	1.46	1.03	98.99
43	15-3, 44–46	60.92	0.62	15.02	4.41	2.09	0.16	2.47	2.69	1.42	2.06	0.13	6.51	0.0	0.51	1.58	100.59
44	16-1, 44–46	55.84	0.65	15.84	5.87	2.46	0.10	3.33	3.26	1.34	2.40	0.12	5.55	0.0	1.21	1.34	99.30
45	16-3, 74–76	62.08	0.50	12.69	2.95	1.49	0.15	1.72	3.57	1.73	2.82	0.097	7.35	0.0	1.47	0.70	99.32
46	21-1, 122–124	60.33	0.49	14.49	3.82	2.05	0.10	2.84	1.97	1.28	3.20	0.12	5.67	0.0	1.52	1.14	99.02
47	21-2, 33–35	57.19	0.65	14.61	5.84	2.31	0.21	3.83	3.63	1.80	2.27	0.17	4.46	0.0	1.63	0.97	99.58
48	21-2, 35–37	57.84	0.63	14.48	5.13	2.47	0.21	3.16	3.60	1.79	2.16	0.18	5.09	0.0	1.52	0.92	99.18
49	21-2, 39–41	59.42	0.61	14.30	4.46	2.31	0.21	2.93	3.57	1.77	2.19	0.18	5.56	0.0	0.67	0.83	99.02
50	22-1, 75–77	61.30	0.61	13.25	2.67	2.88	0.20	2.00	3.13	2.79	2.31	0.12	4.19	0.0	2.77	0.82	99.04
51	22-2, 75–77	60.92	0.51	13.69	3.47	2.01	0.33	2.25	1.53	2.10	2.59	0.11	4.84	2.26	1.38	1.01	98.99
52	22-3, 95–97	57.45	0.64	14.42	6.61	1.65	0.39	4.06	1.86	1.83	2.84	0.11	6.40	0.0	1.08	1.52	100.86
53	22-3, 99–101	55.09	0.64	13.59	6.72	1.78	1.17	5.18	0.33	3.26	2.59	0.12	4.11	3.68	1.41	1.28	100.95
54	22-4, 84–86	51.82	0.60	13.29	5.50	1.77	0.52	4.10	2.15	1.87	2.48	0.11	7.48	4.44	1.05	2.24	99.43
55	23-1, 24-25	47.79	0.50	11.24	4.88	1.39	0.54	1.95	0.21	2.73	2.22	0.20	3.51	20.00	1.44	0.94	99.55

*Residual materials were calculated by subtracting CO_2 and H_2O from ignition loss. They may contain sulfur, organic matter, and other materials.

The emphasis in a majority of mineralogical and geochemical studies has been on the role of chemical and mechanical sorting during weathering and sedimentation. Nevertheless, the bulk chemical composition of sediments, except for some elements such as Mn and Ca, may remain essentially unchanged over a vast region, although elements may migrate locally within the region.

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TABLE 6
Chemical Composition (%) Recalculated by Excluding Carbonates, Residual Materials, Water, and Salts, Hole 442A

No.	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
1	66.04	0.75	17.62	3.95	2.53	0.11	2.69	1.48	1.43	3.26	0.14	1.56	6.76
2	66.50	0.74	17.34	4.10	2.21	0.12	2.48	1.66	1.54	3.14	0.15	1.85	6.56
3	65.99	0.75	17.48	4.09	2.57	0.14	2.46	1.64	1.42	3.32	0.15	1.59	6.94
4	65.91	0.78	18.19	3.76	2.68	0.17	2.63	0.97	1.08	3.70	0.13	1.40	6.74
5	69.51	0.59	16.74	2.90	2.05	0.11	1.97	1.35	1.30	3.36	0.12	1.41	5.19
6	66.26	0.74	17.58	3.87	2.53	0.13	2.70	1.59	1.04	3.45	0.12	1.52	6.68
7	67.17	0.64	16.55	3.27	2.23	0.27	2.25	2.60	1.45	3.46	0.11	1.46	5.75
8	66.11	0.75	17.63	3.80	2.42	0.32	2.91	1.04	1.30	3.60	0.13	1.57	6.49
9	65.84	0.78	18.24	3.69	2.66	0.15	2.52	1.34	1.09	3.57	0.12	1.39	6.64
10	65.50	0.77	17.94	3.54	2.70	0.23	2.70	1.55	1.38	3.55	0.13	1.31	6.55
11	65.04	0.80	19.01	4.10	2.60	0.17	2.86	0.08	1.46	3.74	0.12	1.58	7.00
12	66.89	0.78	17.81	4.04	2.53	0.31	2.85	0.65	1.64	2.35	0.15	1.60	6.84
13	64.82	0.77	18.09	4.19	2.54	0.19	2.71	1.92	1.08	3.57	0.13	1.65	7.01
14	65.56	0.77	17.65	4.34	2.40	0.19	2.78	1.29	1.31	3.57	0.13	1.81	7.01
15	65.33	0.79	17.85	4.12	2.63	0.42	2.89	0.75	1.43	3.65	0.16	1.57	7.04
16	65.86	0.80	18.05	4.46	2.51	0.25	2.88	0.70	0.53	3.83	0.14	1.78	7.25
17	66.17	0.79	18.24	3.85	2.51	0.23	2.61	0.37	1.39	3.71	0.13	1.53	6.63
18	65.38	0.74	18.46	3.79	2.33	0.25	2.65	1.42	1.49	3.37	0.14	1.63	6.38
19	64.64	0.78	18.01	4.49	2.36	0.26	2.77	1.42	1.46	3.69	0.13	1.90	7.11
20	66.91	0.73	17.49	4.09	2.28	0.41	2.56	0.16	1.65	3.62	0.11	1.80	6.62
21	64.05	0.81	18.16	3.86	2.51	0.70	2.95	1.22	1.98	3.64	0.12	1.54	6.64
22	66.03	0.81	18.93	3.50	2.54	0.20	2.87	0.16	1.14	3.73	0.11	1.38	6.32
23	65.39	0.83	18.10	3.99	2.59	0.21	2.82	1.13	1.13	3.68	0.12	1.54	6.86
24	66.75	0.75	17.45	3.80	2.42	0.49	2.69	0.11	1.65	3.75	0.13	1.57	6.49
25	65.54	0.72	17.39	3.85	2.24	0.47	2.74	1.48	1.90	3.49	0.19	1.72	6.34
26	65.68	0.77	18.21	4.03	2.36	0.27	2.84	0.38	1.68	3.65	0.12	1.71	6.66
27	65.25	0.74	18.38	4.00	2.15	0.29	2.45	1.28	1.86	3.45	0.14	1.86	6.39
28	65.52	0.75	17.53	4.06	2.38	0.35	2.66	1.40	1.71	3.51	0.12	1.70	6.71
29	63.95	0.78	17.97	4.70	2.24	0.50	2.97	1.04	2.10	3.60	0.13	2.10	7.20
30	65.19	0.77	18.42	3.73	2.43	0.42	2.97	0.02	2.35	3.58	0.13	1.54	6.43
31	63.85	0.76	18.05	4.66	2.19	0.53	3.05	1.17	2.18	3.42	0.13	2.12	7.10
32	70.48	0.53	15.89	2.66	1.77	0.12	1.85	1.21	1.82	3.58	0.091	1.51	4.62
33	65.07	0.76	18.36	4.04	2.45	0.40	3.00	0.45	1.81	3.54	0.12	1.65	6.76
34	63.85	0.75	18.50	4.25	2.26	0.45	2.92	1.27	2.16	3.46	0.14	1.88	6.76
35	65.88	0.72	17.20	4.29	2.10	0.40	2.75	1.37	1.88	3.29	0.13	2.04	6.63
36	62.87	0.78	18.51	4.85	2.36	0.46	3.24	1.23	1.99	3.59	0.13	2.05	7.47
37	64.61	0.65	16.11	5.91	1.85	1.03	3.11	0.24	2.68	3.69	0.11	3.19	7.97
38	63.46	0.80	19.13	4.06	2.45	0.27	3.10	1.11	1.66	3.84	0.12	1.66	6.79
39	57.60	0.75	17.68	3.78	2.64	3.01	3.86	0.93	5.30	3.17	1.28	1.43	6.71
40	62.81	0.84	19.31	5.06	2.19	0.32	2.97	1.20	1.67	3.50	0.13	2.31	7.50
41	60.08	0.77	18.17	5.26	1.78	2.22	3.88	0.11	4.27	3.33	0.13	2.96	7.24
42	63.05	0.80	19.46	5.38	1.90	0.13	2.91	1.15	1.76	3.33	0.12	2.82	7.50
43	63.51	0.82	19.01	6.02	1.69	0.27	2.59	1.34	1.40	3.23	0.12	3.56	7.90
44	63.79	0.82	19.63	5.28	1.84	0.12	2.61	0.97	1.26	3.55	0.13	2.88	7.32
45	63.21	0.80	19.16	4.95	1.98	0.47	2.99	1.09	1.55	3.66	0.13	2.50	7.15
46	64.17	0.76	18.23	5.41	1.67	0.23	2.86	1.48	1.71	3.35	0.14	3.23	7.27
47	62.36	0.78	19.10	5.42	1.87	0.39	2.99	1.82	1.83	3.26	0.18	2.89	7.50
48	62.12	0.82	18.47	5.68	1.57	1.00	2.87	1.70	2.26	3.31	0.21	3.61	7.42
49	62.53	0.82	19.80	5.98	1.70	0.39	3.12	0.14	1.91	3.47	0.15	3.52	7.87
50	62.51	0.80	19.40	5.81	1.65	0.56	3.06	0.60	1.97	3.47	0.16	3.52	7.65
51	63.26	0.80	19.31	5.95	1.65	0.48	3.16	0.24	1.62	3.38	0.15	3.60	7.78
52	61.83	0.79	19.46	5.97	1.53	0.80	3.10	0.77	2.28	3.28	0.19	3.91	7.67
53	63.54	0.76	19.13	5.96	1.55	0.22	2.64	1.26	1.29	3.48	0.17	3.83	7.69
54	62.90	0.78	19.36	6.01	1.58	0.14	2.87	1.27	1.54	3.43	0.13	3.81	7.76
55	64.08	0.74	18.99	5.81	1.48	0.18	2.73	1.29	1.31	3.20	0.18	3.92	7.46
56	62.96	0.76	18.86	6.89	0.54	0.79	2.67	1.02	1.93	3.43	0.15	12.79	7.49
57	62.94	0.76	19.14	6.82	0.53	0.69	2.70	1.05	1.83	3.38	0.15	12.85	7.41
58	63.23	0.77	19.16	6.06	1.17	0.34	2.89	0.94	1.74	3.52	0.18	5.18	7.37
59	61.36	0.77	19.38	5.51	1.75	1.01	3.60	0.10	2.93	3.44	0.16	3.15	7.45
60	61.49	0.78	18.84	5.89	1.42	1.12	3.51	0.20	3.25	3.33	0.18	4.16	7.47
61	63.64	0.76	19.42	5.73	1.59	0.14	2.60	1.26	1.45	3.27	0.14	3.59	7.50
62	63.08	0.78	19.24	6.23	1.40	0.17	2.89	1.35	1.39	3.33	0.15	4.43	7.79

TABLE 6 – *Continued*

No.	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
63	63.30	0.72	18.06	5.43	1.22	0.54	2.69	1.78	2.77	3.29	0.20	4.44	6.79
64	63.69	0.73	18.14	5.60	1.22	0.67	2.97	0.51	2.98	3.29	0.20	4.60	6.95
65	62.92	0.71	18.80	5.90	0.87	0.51	2.65	1.84	2.52	3.10	0.19	6.80	6.86
66	62.86	0.72	18.19	5.76	1.31	0.63	2.78	1.94	2.43	3.18	0.20	4.41	7.22
67	63.62	0.77	18.36	6.02	1.68	0.18	2.23	2.49	1.73	2.78	0.15	3.59	7.89
68	62.94	0.76	18.59	6.25	1.48	0.35	2.53	1.88	2.00	3.07	0.14	4.22	7.90
69	62.11	0.75	18.16	6.06	1.64	1.32	3.28	0.19	3.27	3.07	0.14	3.69	7.89
70	62.74	0.76	18.32	5.92	1.78	0.27	2.66	2.67	1.90	2.83	0.15	3.32	7.90
71	63.16	0.72	17.81	6.32	1.56	0.59	3.47	0.94	2.53	2.73	0.17	4.05	8.06
72	62.56	0.73	17.68	6.88	1.78	0.57	3.09	1.83	2.02	2.68	0.17	3.86	8.86
73	63.18	0.72	17.85	7.03	1.64	0.46	2.90	1.11	2.08	2.87	0.15	4.28	8.86
74	61.30	0.74	18.13	6.90	1.33	0.49	3.60	2.04	2.08	3.20	0.19	5.19	8.37
75	60.88	0.70	16.56	9.81	0.18	0.32	4.26	2.52	2.37	2.12	0.27	53.95	10.01
76	60.35	0.71	17.00	8.59	0.63	0.84	4.08	3.03	1.94	2.58	0.26	13.59	9.30
77	59.56	0.74	16.62	9.46	0.09	0.95	4.63	2.52	2.62	2.57	0.22	106.39	9.56
78	58.88	0.69	17.00	8.84	0.05	1.34	4.63	1.89	3.13	3.25	0.30	163.89	8.90
79	58.56	0.69	16.52	10.80	0.05	1.92	4.93	1.86	0.60	3.50	0.59	235.14	10.85

TABLE 7
Chemical Composition (%) Recalculated by Excluding Carbonates, Residual Materials, Water, and Salts, Hole 442B

No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	$\frac{Fe_2O_3}{FeO}$	Total Fe
1	74.42	0.38	13.74	1.51	0.83	0.066	0.74	1.81	2.12	4.28	0.12	1.81	2.43
2	63.30	0.74	17.88	6.32	1.58	0.030	3.22	2.46	1.30	3.00	0.18	4.00	8.07
3	70.72	0.49	14.08	2.49	1.37	0.44	1.10	2.37	3.25	3.55	0.14	1.81	4.02
4	58.14	0.70	15.79	10.43	0.04	1.42	4.53	2.40	3.73	2.43	0.39	283.56	10.47
5	56.13	0.65	14.83	10.76	0.06	2.20	5.50	2.00	4.91	2.58	0.39	195.09	10.83
6	57.30	0.65	15.55	9.61	0.13	1.77	5.84	2.12	4.11	2.57	0.35	71.47	9.76
7	58.37	0.69	16.52	8.78	0.13	1.63	5.12	1.85	3.73	2.95	0.21	65.89	8.93
8	57.88	0.67	15.93	9.72	0.12	1.80	4.81	1.76	3.82	3.18	0.31	81.80	9.85
9	61.29	0.67	17.12	8.39	0.11	0.83	4.29	1.38	2.47	3.23	0.20	74.79	8.52
10	54.47	0.56	12.74	12.43	0.44	3.89	4.59	1.36	6.09	3.17	0.26	28.26	12.92
11	54.63	0.47	11.52	16.19	0.09	2.95	4.91	1.51	4.84	2.73	0.17	183.26	16.29
12	56.95	0.54	13.31	11.04	0.09	2.99	6.82	1.08	4.51	2.50	0.18	122.76	11.14

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TABLE 8
Chemical Composition (%) Recalculated by Excluding Carbonates, Residual Materials, Water, and Salts, Hole 443

No.	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
1	63.14	0.74	18.05	4.35	2.46	0.64	3.57	0.73	2.48	3.69	0.15	1.77	7.08
2	65.80	0.74	18.13	3.79	2.60	0.33	2.71	0.45	1.82	3.47	0.17	1.46	6.67
3	65.26	0.76	17.38	4.26	2.40	0.49	3.04	0.70	2.04	3.46	0.19	1.77	6.93
4	66.50	0.81	16.33	4.03	2.72	0.18	3.46	0.18	1.81	3.85	0.14	1.48	7.05
5	66.42	0.80	16.42	3.63	2.57	0.22	3.36	1.16	1.45	3.82	0.14	1.41	6.49
6	68.01	0.80	16.57	3.32	2.66	0.18	3.26	0.15	1.15	3.79	0.12	1.25	6.27
7	65.98	0.77	15.97	3.86	2.66	0.65	3.68	0.38	2.04	3.88	0.14	1.45	6.82
8	67.62	0.76	16.04	3.94	2.48	0.50	3.06	0.02	1.64	3.81	0.14	1.59	6.69
9	63.83	0.75	17.84	4.52	2.47	0.56	2.99	1.72	1.52	3.67	0.13	1.83	7.27
10	67.24	0.78	18.24	3.33	2.62	0.19	2.60	0.16	1.20	3.50	0.14	1.27	6.25
11	65.85	0.78	18.33	3.63	2.51	0.40	2.78	0.21	1.79	3.54	0.18	1.44	6.43
12	64.56	0.81	18.47	3.95	2.61	0.28	2.99	0.46	2.00	3.72	0.15	1.51	6.85
13	64.49	0.80	18.31	4.26	2.60	0.47	3.22	0.17	1.88	3.68	0.13	1.64	7.15
14	64.57	0.78	17.94	4.44	2.57	0.42	3.26	0.08	2.16	3.64	0.15	1.73	7.30
15	65.19	0.66	16.90	3.31	2.50	0.42	2.28	3.03	2.25	3.33	0.14	1.32	6.08
16	66.64	0.69	17.86	3.47	2.34	0.41	2.37	0.30	2.43	3.33	0.15	1.48	6.08
17	59.57	0.69	16.17	4.15	2.18	0.78	2.41	7.62	2.79	3.46	0.18	1.90	6.57
18	67.90	0.68	17.27	2.84	2.21	0.12	2.10	1.40	1.99	3.39	0.11	1.28	5.30
19	65.80	0.76	18.08	3.96	2.43	0.23	2.61	0.69	1.81	3.49	0.15	1.63	6.66
20	65.19	0.79	18.22	4.36	2.76	0.53	2.82	0.03	1.33	3.78	0.19	1.58	7.42
21	64.79	0.80	18.38	3.96	2.58	0.37	3.22	0.45	1.56	3.75	0.14	1.54	6.82
22	64.76	0.81	18.60	4.61	2.42	0.30	3.00	0.33	1.28	3.69	0.21	1.91	7.29
23	65.47	0.79	18.68	3.99	2.48	0.21	2.96	0.16	1.39	3.73	0.12	1.61	6.75
24	65.24	0.75	18.91	4.42	2.21	0.31	2.74	0.14	1.71	3.42	0.14	2.00	6.88
25	65.81	0.74	18.07	4.43	2.28	0.31	2.84	0.39	1.54	3.47	0.14	1.94	6.97
26	66.47	0.69	16.60	4.22	2.10	0.30	2.76	1.81	1.69	3.24	0.12	2.01	6.55
27	65.55	0.73	17.91	4.46	2.23	0.33	2.42	0.68	2.06	3.50	0.12	2.01	6.94
28	64.48	0.72	17.82	4.82	2.32	0.30	2.88	1.55	1.53	3.45	0.12	2.07	7.40
29	65.16	0.74	17.80	4.82	2.15	0.27	2.58	0.77	2.11	3.47	0.15	2.24	7.21
30	65.08	0.75	18.37	4.42	2.42	0.30	3.06	0.20	1.71	3.55	0.14	1.82	7.11
31	64.24	0.76	18.35	4.82	2.26	0.34	3.09	0.46	1.91	3.65	0.13	2.13	7.33
32	64.88	0.79	17.61	4.71	2.34	0.50	3.15	0.21	2.03	3.63	0.14	2.01	7.31
33	67.38	0.61	16.68	4.87	2.06	0.14	2.62	0.08	1.54	3.92	0.093	2.37	7.16
34	64.23	0.78	18.05	4.22	2.48	0.44	2.81	0.57	2.44	3.83	0.16	1.70	6.97
35	63.70	0.76	17.70	4.73	2.49	0.72	3.14	0.23	2.75	3.57	0.20	1.90	7.50
36	65.89	0.77	18.14	4.03	2.36	0.19	2.94	0.24	1.73	3.59	0.12	1.71	6.65
37	65.78	0.72	17.90	3.95	2.29	0.43	2.76	0.22	2.06	3.77	0.12	1.72	6.50
38	65.20	0.78	17.96	3.91	2.47	0.15	2.78	1.43	1.78	3.42	0.12	1.59	6.65
39	63.49	0.78	18.61	4.59	2.49	0.33	2.85	1.19	1.93	3.61	0.12	1.85	7.36
40	65.36	0.72	18.02	4.50	2.21	0.099	2.44	1.35	1.53	3.65	0.11	2.03	6.95
41	66.21	0.78	18.32	3.69	2.53	0.18	2.35	0.61	1.74	3.46	0.13	1.46	6.50
42	65.03	0.83	19.46	3.50	2.48	0.15	2.67	0.30	1.72	3.71	0.14	1.41	6.26
43	62.86	0.78	18.57	4.99	2.45	0.67	3.24	0.41	2.18	3.71	0.15	2.04	7.70
44	63.86	0.80	19.08	4.59	2.40	0.34	3.12	0.27	1.70	3.72	0.13	1.91	7.25
45	64.57	0.80	18.98	4.56	2.43	0.32	2.99	0.34	1.30	3.57	0.15	1.88	7.26
46	63.61	0.84	19.21	4.55	2.54	0.54	2.97	0.19	1.62	3.79	0.13	1.79	7.37
47	63.24	0.77	18.23	4.94	2.29	0.53	3.16	1.18	2.10	3.43	0.14	2.16	7.48
48	66.95	0.69	18.35	3.91	2.13	0.16	2.27	0.21	1.48	3.76	0.11	1.84	6.27
49	71.89	0.47	15.62	2.31	1.65	0.19	1.28	1.35	2.10	3.06	0.093	1.41	4.14
50	62.81	0.81	19.27	5.27	1.96	0.62	3.33	0.27	1.93	3.60	0.14	2.69	7.45
51	62.65	0.77	18.48	5.69	1.64	0.40	3.10	0.28	3.31	3.55	0.13	3.48	7.51
52	64.80	0.69	17.65	4.52	1.88	0.38	2.71	1.72	2.01	3.50	0.14	2.41	6.60
53	67.61	0.57	17.75	4.17	1.48	0.37	1.97	0.35	1.82	3.78	0.12	2.82	5.82
54	67.13	0.60	17.72	4.42	1.55	0.37	2.37	0.21	1.77	3.75	0.11	2.86	6.14
55	62.49	0.77	18.61	5.82	1.86	0.57	3.53	0.97	1.95	3.24	0.17	3.12	7.89
56	63.21	0.81	19.20	5.60	1.92	0.32	3.33	0.56	1.40	3.49	0.16	2.91	7.74
57	63.25	0.81	18.44	5.32	2.19	0.42	3.02	1.40	1.86	3.13	0.15	2.43	7.75
58	62.74	0.78	18.82	5.83	2.01	0.44	3.40	0.49	2.14	3.19	0.16	2.90	8.06
59	61.62	0.80	17.84	6.59	2.92	0.28	3.46	2.35	1.43	2.57	0.15	2.26	9.83
60	62.46	0.82	18.71	6.35	1.86	0.82	3.29	0.41	1.70	3.39	0.20	3.41	8.42

TABLE 8 – *Continued*

No.	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
61	59.27	1.01	16.90	6.09	5.20	0.26	3.57	5.33	1.04	1.23	0.11	1.17	11.87
62	61.39	0.77	18.07	5.69	1.95	0.71	3.20	0.40	2.46	3.17	2.19	2.92	7.86
63	62.91	0.77	18.17	5.57	2.32	0.36	3.04	2.56	1.44	2.73	0.13	2.40	8.15
64	62.86	0.74	17.90	5.28	2.43	0.42	2.78	2.84	1.83	2.77	0.14	2.17	7.99
65	63.29	0.81	17.92	6.06	2.61	0.61	3.20	0.17	2.25	2.93	0.15	2.32	8.97
66	67.73	0.65	16.71	4.27	2.18	0.31	2.36	0.70	2.32	2.63	0.14	1.96	6.69
67	62.96	0.74	17.80	5.95	1.69	0.94	3.29	0.60	2.59	3.24	0.18	3.51	7.83
68	65.27	0.67	17.99	1.77	1.60	1.51	3.37	0.13	4.12	3.33	0.24	1.11	3.54
69	63.78	0.78	18.77	5.67	1.70	0.29	2.79	1.36	1.26	3.44	0.17	3.34	7.56
70	65.35	0.75	18.64	5.56	1.56	0.11	2.39	1.04	1.13	3.34	0.14	3.56	7.29
71	64.06	0.74	18.60	5.62	1.52	0.32	2.77	1.13	1.67	3.43	0.15	3.71	7.30
72	64.65	0.73	18.73	5.36	1.65	0.49	2.78	0.21	2.05	3.20	0.15	3.25	7.20
73	63.43	0.75	19.22	5.68	1.60	0.41	2.94	1.24	1.20	3.40	0.13	3.54	7.46
74	61.72	0.73	18.40	4.97	1.74	0.43	2.81	0.54	5.20	3.31	0.15	2.85	6.91
75	63.07	0.66	18.56	5.41	1.86	0.42	2.88	1.65	2.07	3.25	0.16	2.91	7.48
76	63.48	0.75	18.64	6.00	1.70	0.60	3.05	0.09	2.32	3.21	0.16	3.52	7.90
77	63.88	0.70	17.45	5.19	1.81	0.75	3.43	0.87	2.67	3.07	0.18	2.86	7.20
78	63.76	0.73	17.64	5.60	2.06	0.14	2.69	2.72	1.82	2.69	0.14	2.72	7.89
79	62.70	0.73	17.56	5.40	2.29	0.52	3.12	2.08	2.96	2.51	0.15	2.36	7.94
80	63.61	0.74	17.18	5.42	2.62	0.50	3.24	1.62	2.21	2.71	0.16	2.07	8.33
81	63.24	0.73	17.21	5.48	2.18	0.60	3.15	1.92	2.55	2.80	0.16	2.52	7.90
82	65.48	0.69	16.64	5.40	2.22	0.52	2.80	1.13	2.22	2.76	0.13	2.43	7.87
83	61.97	0.77	17.62	5.54	2.69	0.60	2.86	2.65	2.76	2.41	0.14	2.06	8.53
84	62.85	0.91	17.44	5.65	2.71	0.30	2.77	2.10	2.58	2.50	0.19	2.08	8.66
85	68.85	0.44	14.90	3.13	1.79	0.24	1.48	2.62	2.75	3.70	0.094	1.75	5.13
86	63.34	0.78	17.18	5.72	2.34	0.43	2.59	2.23	2.53	2.71	0.16	2.45	8.32
87	65.73	0.65	16.53	5.21	1.95	0.30	2.66	1.93	2.23	2.68	0.13	2.67	7.37
88	62.72	0.73	17.25	6.25	2.01	0.52	2.91	1.99	2.63	2.81	0.18	3.10	8.48
89	65.39	0.69	17.25	5.25	1.81	0.53	2.21	1.26	2.51	2.94	0.16	2.90	7.27
90	65.00	0.75	17.29	4.84	2.40	0.19	2.71	2.13	2.18	2.38	0.13	2.02	7.51
91	66.14	0.60	16.11	5.15	2.25	0.50	2.25	0.69	2.92	3.26	0.14	2.29	7.65
92	63.62	0.77	17.16	6.64	2.39	0.47	2.96	1.09	1.97	2.77	0.16	2.78	9.29
93	60.52	0.78	16.72	6.21	2.44	0.38	2.48	5.78	1.96	2.60	0.13	2.55	8.92
94	57.07	0.75	16.04	6.11	2.41	0.48	2.82	9.23	2.31	2.61	0.16	2.53	8.80
95	53.73	0.69	15.37	6.41	1.82	2.06	3.48	10.05	3.51	2.74	0.13	3.52	8.43
96	61.34	0.72	17.72	5.95	1.96	0.13	4.55	2.94	1.57	3.01	0.091	3.03	8.13
97	61.94	0.76	16.80	6.41	2.12	1.62	3.41	0.90	2.73	3.18	0.13	3.03	8.77
98	63.96	0.79	17.92	5.89	2.39	0.23	2.98	0.90	1.85	3.00	0.10	2.46	8.55
99	63.33	0.77	17.56	5.85	2.19	0.61	3.54	0.23	2.48	3.31	0.13	2.68	8.28
100	55.02	0.66	14.14	5.17	1.92	4.16	3.36	6.10	5.32	2.60	1.54	2.69	7.30
101	61.91	0.75	17.86	6.93	1.82	0.19	3.16	2.47	1.74	3.02	0.14	3.82	8.95
102	62.65	0.74	17.65	6.56	1.81	0.40	3.19	2.45	1.41	3.00	0.15	3.63	8.57
103	62.17	0.69	16.88	6.76	1.60	0.67	3.55	1.72	2.51	3.34	0.12	4.24	8.53
104	63.81	0.73	17.31	6.26	2.12	0.56	3.07	0.47	2.27	3.26	0.14	2.95	8.62
105	65.26	0.66	16.63	5.34	1.80	0.22	2.92	2.06	1.77	3.22	0.12	2.96	7.34
106	63.78	0.66	15.73	4.66	2.29	2.45	2.51	2.74	1.89	3.10	0.21	2.03	7.20
107	63.89	0.73	16.51	6.08	2.05	0.56	3.33	1.30	2.51	2.90	0.16	2.97	8.35
108	66.02	0.63	15.83	4.93	2.25	0.10	2.39	2.89	1.83	3.03	0.12	2.19	7.42
109	62.43	0.81	15.78	7.61	2.20	1.06	3.50	0.85	2.82	2.67	0.26	3.46	10.06
110	62.50	0.73	16.26	6.86	2.00	0.83	3.51	1.20	3.32	2.67	0.13	3.43	9.08
111	63.94	0.68	16.44	6.71	1.92	0.14	3.17	2.37	1.68	2.84	0.11	3.49	8.84
112	65.14	0.70	16.28	7.07	1.98	0.75	2.57	0.10	2.12	3.04	0.24	3.57	9.27
113	62.51	0.65	15.58	10.37	0.62	0.58	4.61	0.50	1.43	3.02	0.13	16.63	11.07
114	55.74	0.70	15.01	10.85	0.47	1.13	5.08	7.01	0.92	2.87	0.22	23.29	11.37

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TABLE 9
Chemical Composition (%) Recalculated by Excluding Carbonates, Residual Materials, Water, and Salts, Hole 444

No.	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
1	65.68	0.75	17.80	3.91	2.51	0.29	2.86	0.64	2.15	3.26	0.16	1.56	6.70
2	63.16	0.77	17.82	4.56	2.35	0.87	3.98	0.39	2.36	3.59	0.15	1.94	7.17
3	65.46	0.81	17.99	4.36	2.48	0.19	2.89	0.74	1.45	3.48	0.16	1.76	7.11
4	65.27	0.82	18.41	4.07	2.26	0.24	3.15	0.13	1.80	3.73	0.14	1.80	6.57
5	65.70	0.78	17.61	4.70	2.28	0.14	2.87	0.64	1.74	3.38	0.16	2.06	7.24
6	64.93	0.82	18.35	5.19	2.21	0.19	2.82	0.23	1.55	3.58	0.14	2.35	7.64
7	64.41	0.77	17.63	5.29	1.70	0.69	2.43	0.78	2.79	3.33	0.17	3.11	7.18
8	64.29	0.79	17.14	4.53	2.77	0.23	2.54	2.79	2.10	2.67	0.14	1.63	7.61
9	64.39	0.79	18.51	5.21	2.00	0.25	2.82	0.70	1.57	3.61	0.15	2.61	7.43
10	63.19	0.83	18.81	4.63	2.46	0.54	3.41	0.35	2.14	3.48	0.17	1.88	7.37
11	63.73	0.78	18.37	4.08	3.17	0.22	2.95	1.13	1.94	3.45	0.18	1.29	7.60
12	63.77	0.79	18.24	5.30	1.90	0.28	2.76	1.87	1.75	3.19	0.17	2.80	7.41
13	63.42	0.79	18.15	5.20	2.02	0.23	2.93	1.75	2.12	3.24	0.15	2.58	7.45
14	65.66	0.71	16.64	3.80	1.98	0.36	2.27	2.32	3.12	3.00	0.14	1.92	6.00
15	66.52	0.69	17.21	4.00	1.75	0.17	2.34	1.96	1.99	3.25	0.13	2.29	5.94
16	63.66	0.80	18.52	5.08	2.33	0.14	2.63	2.21	1.29	3.15	0.18	2.18	7.68
17	65.49	0.69	15.99	3.62	2.88	0.16	2.35	4.10	2.18	2.37	0.16	1.26	6.82
18	64.55	0.70	17.71	4.82	1.88	0.21	2.89	1.93	2.14	3.01	0.15	2.56	6.92
19	62.83	0.76	18.26	5.31	1.90	0.36	3.25	1.93	1.87	3.35	0.17	2.79	7.42

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TABLE 10
Chemical Composition (%) Recalculated by Excluding Carbonates, Residual Materials, Water, and Salts, Hole 444A

No.	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
1	62.80	0.77	19.50	5.36	2.12	0.26	3.24	0.65	1.78	3.34	0.19	2.52	7.72
2	63.07	0.77	17.92	5.31	2.20	0.24	2.84	2.63	2.07	2.79	0.17	2.41	7.75
3	62.71	0.84	18.95	6.38	1.75	0.50	2.67	0.15	1.71	4.03	0.32	3.65	8.32
4	63.54	0.80	18.74	5.41	2.01	0.39	3.01	1.09	1.43	3.38	0.19	2.69	7.65
5	64.06	0.73	18.53	5.18	2.01	0.23	2.89	1.62	1.56	3.02	0.16	2.58	7.42
6	63.27	0.73	17.99	5.43	1.90	0.32	2.68	2.38	2.06	3.05	0.18	2.85	7.54
7	71.20	0.55	14.51	3.19	1.79	0.17	1.52	2.39	2.41	2.18	0.097	1.78	5.17
8	65.59	0.65	17.51	4.43	2.13	0.12	2.55	2.15	1.53	3.22	0.13	2.07	6.80
9	61.99	0.75	17.90	5.42	2.19	0.37	2.79	2.96	2.65	2.78	0.20	2.47	7.85
10	61.83	0.79	18.35	5.66	1.81	0.39	3.22	2.77	2.20	2.80	0.19	3.13	7.67
11	61.56	0.82	18.03	5.30	2.45	0.37	3.19	3.10	2.39	2.58	0.21	2.17	8.02
12	62.36	0.80	18.62	5.98	1.92	0.47	3.33	1.32	2.05	2.94	0.20	3.11	8.11
13	62.58	0.77	17.86	5.48	1.82	0.42	3.01	2.63	2.46	2.78	0.19	3.02	7.50
14	62.42	0.70	18.53	6.42	1.12	0.39	3.18	2.12	1.97	2.95	0.20	5.71	7.67
15	61.99	0.73	19.06	6.49	1.25	0.39	2.86	2.08	1.94	2.99	0.21	5.20	7.88
16	61.52	0.77	18.29	7.06	1.25	0.55	3.13	2.09	2.17	3.01	0.16	5.67	8.45
17	63.09	0.74	18.48	5.93	1.10	0.42	2.84	1.65	2.35	3.20	0.20	5.40	7.15
18	62.28	0.73	18.72	6.06	1.40	0.35	2.93	2.33	2.15	2.89	0.17	4.34	7.61
19	61.50	0.77	18.40	6.80	1.21	0.45	3.34	2.29	2.10	2.96	0.19	5.60	8.15
20	62.13	0.78	18.69	6.82	1.30	0.33	3.29	1.86	1.82	2.82	0.15	5.24	8.27
21	63.24	0.75	17.77	6.56	1.99	0.48	2.89	3.67	0.14	2.36	0.16	3.29	8.78
22	59.10	0.77	16.75	6.17	2.77	0.61	3.81	4.84	3.08	1.92	0.17	2.23	9.24
23	59.66	0.78	16.54	6.25	2.93	0.58	3.95	4.47	2.69	2.00	0.15	2.14	9.51
24	61.48	0.81	16.57	5.61	3.42	0.33	3.41	3.49	2.52	1.77	0.59	1.64	9.41
25	59.99	0.79	16.61	5.76	3.62	0.28	3.57	4.95	2.40	1.88	0.15	1.59	9.78
26	59.83	0.87	16.02	7.12	3.83	0.25	3.61	5.31	1.49	1.54	0.14	1.86	11.37
27	64.93	0.76	15.76	4.15	3.41	0.22	2.47	4.10	2.59	1.45	0.15	1.22	7.94
28	71.98	0.46	14.12	2.12	1.77	0.15	1.58	2.83	2.65	2.23	0.11	1.20	4.10
29	64.77	0.69	16.77	4.12	2.60	0.21	2.39	4.11	2.20	2.00	0.15	1.59	7.00
30	73.32	0.49	14.10	2.55	1.97	0.19	1.59	0.96	2.61	2.12	0.10	1.29	4.75
31	63.84	0.65	16.64	4.54	3.14	0.25	2.79	3.85	1.89	2.24	0.16	1.44	8.03
32	62.32	0.84	17.56	5.72	3.72	0.35	3.73	0.75	2.25	2.59	0.16	1.54	9.86
33	60.73	0.77	16.53	6.35	2.83	0.20	3.52	4.76	2.08	2.06	0.16	2.24	9.50
34	59.31	0.80	16.57	6.27	3.75	0.18	3.64	6.19	1.63	1.52	0.14	1.67	10.44
35	60.80	0.80	17.23	6.26	3.12	0.34	3.21	4.34	1.58	2.17	0.14	2.01	9.73
36	61.83	0.77	16.76	6.14	3.07	0.18	3.29	3.71	1.69	2.40	0.14	2.00	9.56
37	63.83	0.75	16.83	5.10	3.09	0.27	3.17	2.65	1.85	2.30	0.17	1.65	8.53
38	68.60	0.64	14.54	2.81	2.99	0.15	2.13	3.81	2.50	1.68	0.14	0.94	6.14
39	75.38	0.49	12.56	1.21	2.11	0.086	0.69	2.80	2.70	1.89	0.090	0.57	3.55
40	62.83	0.73	17.44	5.64	2.19	0.23	3.05	3.13	1.92	2.65	0.18	2.57	8.07
41	62.23	0.69	17.39	4.96	2.43	0.28	3.01	4.38	2.38	2.07	0.19	2.04	7.65
42	73.52	0.44	13.21	1.90	1.87	0.13	1.19	2.86	2.57	2.22	0.091	1.01	3.98
43	66.23	0.67	16.33	4.79	2.27	0.17	2.68	2.92	1.55	2.24	0.14	2.11	7.32
44	61.22	0.71	17.37	6.43	2.70	0.11	3.65	3.57	1.47	2.63	0.13	2.38	9.43
45	69.13	0.56	14.13	3.29	1.66	0.17	1.91	3.98	1.93	3.14	0.11	1.98	5.13
46	66.52	0.54	15.98	4.21	2.26	0.11	3.13	2.17	1.41	3.53	0.13	1.86	6.73
47	61.82	0.70	15.79	6.32	2.50	0.23	4.14	3.92	1.94	2.45	0.18	2.53	9.09
48	63.11	0.69	15.80	5.60	2.70	0.23	3.44	3.93	1.95	2.36	0.20	2.08	8.60
49	64.62	0.66	15.55	4.85	2.51	0.23	3.19	3.88	1.93	2.38	0.20	1.93	7.64
50	67.18	0.67	14.52	2.93	3.16	0.22	2.19	3.43	3.06	2.53	0.13	0.93	6.43
51	68.06	0.57	15.30	3.87	2.25	0.37	2.51	1.71	2.34	2.89	0.12	1.72	6.37
52	62.54	0.70	15.70	7.19	1.80	0.43	4.42	2.02	1.99	3.09	0.12	4.00	9.19
53	60.89	0.71	15.02	7.43	1.97	1.29	5.73	0.36	3.60	2.86	0.13	3.78	9.62
54	61.54	0.71	15.78	6.53	2.10	0.62	4.87	2.55	2.22	2.95	0.13	3.11	8.87
55	64.88	0.68	15.26	6.62	1.89	0.73	2.65	0.29	3.71	3.01	0.27	3.51	8.72

TABLE 11
Average Chemical Compositions (%) and Standard Deviations of Sediments from Leg 58 Sites and Other Areas

	Site 442	Site 443	Site 444	Nankai Trough[a]	Japan Trench[b]	Yamato Bank Area[c]	Nishitsugaru Basin[d]	Around the Oki Islands[e]	South Philippine Sea[f]	East Pacific Ocean Pelagic Sediments[g]
Number of Samples	91	114	74	29	82	69	87	45	15	35
SiO_2	63.44 ± 3.27	64.07 ± 2.54	64.04 ± 3.22	66.68 ± 1.99	68.84 ± 2.78	65.80 ± 3.84	66.58 ± 2.02	75.59 ± 2.57	54.78 ± 0.59	49.84
TiO_2	0.74 ± 0.08	0.74 ± 0.07	0.73 ± 0.09	0.72 ± 0.06	0.62 ± 0.07	0.73 ± 0.11	0.67 ± 0.05	0.50 ± 0.082	1.05 ± 0.10	1.22
Al_2O_3	17.77 ± 1.53	17.57 ± 1.06	17.03 ± 1.52	16.51 ± 0.64	13.60 ± 1.47	16.54 ± 1.96	16.12 ± 0.63	12.81 ± 1.39	21.54 ± 0.86	17.38
Total Fe as Fe_2O_3	7.57 ± 1.20	7.51 ± 1.20	7.68 ± 1.45	6.01 ± 0.65	5.67 ± 0.92	6.94 ± 1.54	5.85 ± 0.45	4.03 ± 0.81	11.45 ± 1.34	9.29
MnO	0.65 ± 0.73	0.50 ± 0.49	0.32 ± 0.20	0.09 ± 0.06	0.07 ± 0.02	0.48 ± 1.95	0.07 ± 0.04	0.044 ± 0.013	0.68 ± 0.27	1.98
MgO	3.13 ± 0.92	2.96 ± 0.52	2.97 ± 0.76	2.29 ± 0.36	3.11 ± 0.37	2.91 ± 0.71	3.31 ± 0.42	1.16 ± 0.34	3.45 ± 0.26	3.48
CaO	1.28 ± 0.69	1.40 ± 1.78	2.48 ± 1.42	1.51 ± 0.93	2.38 ± 1.19	1.04 ± 0.65	1.93 ± 0.90	1.57 ± 0.53	1.30 ± 0.15	4.06
Na_2O	2.13 ± 1.04	2.07 ± 0.69	2.10 ± 0.54	3.29 ± 0.36	3.77 ± 0.49	2.16 ± 0.75	3.00 ± 0.54	1.28 ± 0.18	2.51 ± 0.45	5.39
K_2O	3.32 ± 0.38	3.26 ± 0.44	2.74 ± 0.59	3.09 ± 0.41	2.12 ± 0.30	3.47 ± 0.47	2.49 ± 0.28	2.99 ± 0.25	2.93 ± 0.16	3.01
P_2O_5	0.18 ± 0.14	0.18 ± 0.23	0.17 ± 0.06	0.14 ± 0.01	0.15 ± 0.13	0.16 ± 0.075	0.17 ± 0.15	0.097 ± 0.021	0.37 ± 0.15	

[a] Sugisaki (1978); this area comprises the continental shelf and slope of the Pacific Side of southwest Japan, the Nankai Trough, and the northern Shikoku Basin.
[b] Sugisaki and Honza (in press).
[c] Sugisaki (in press b).
[d] Sugisaki (in press a).
[e] Sugisaki and Kinoshita (in press).
[f] Tiba (1974); core at Lat. 14°09 'N, Long. 130°04 'E.
[g] Goldberg and Arrhenius (1958).

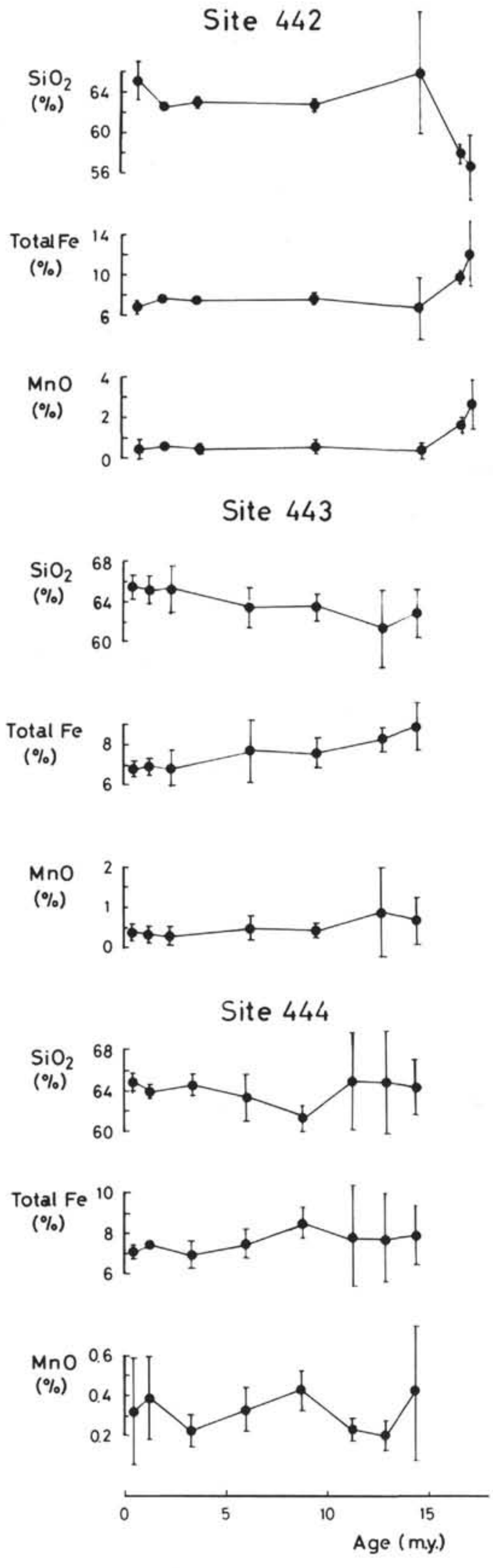

Figure 1. *Temporal variation of SiO_2, total Fe as Fe_2O_3, and MnO at the Shikoku Basin sites. Each point represents an average value for each lithologic unit of the cored sediments (see respective site chapters, this volume). The error bar shows standard deviation.*

TABLE 12
Chemical Compositions (%) of Manganese-Rich Sediments (silicate composition excluding carbonate, water, etc.)

	Lithologic Unit V, Site 442[a]	Red Shale[b]
SiO_2	56.83 ± 3.18	60.38
TiO_2	0.56 ± 0.083	0.73
Al_2O_3	13.67 ± 2.42	17.13
Total Fe as Fe_2O_3	12.21 ± 3.26	12.65
MnO	2.67 ± 1.30	1.18
MgO	5.15 ± 1.14	1.01
CaO	1.33 ± 0.18	0.55
Na_2O	4.48 ± 1.50	1.95
K_2O	2.91 ± 0.35	4.82
P_2O_5	0.20 ± 0.04	0.18

[a]Average of four sediment samples within 3 meters of basalt basement.
[b]Red shale above pillow basalt body in the Shimanto Belt in Kyushu, Cretaceous geosynclinal area, southwest Japan; Sugisaki et al. (1979) describe the chemical composition of the basalt.

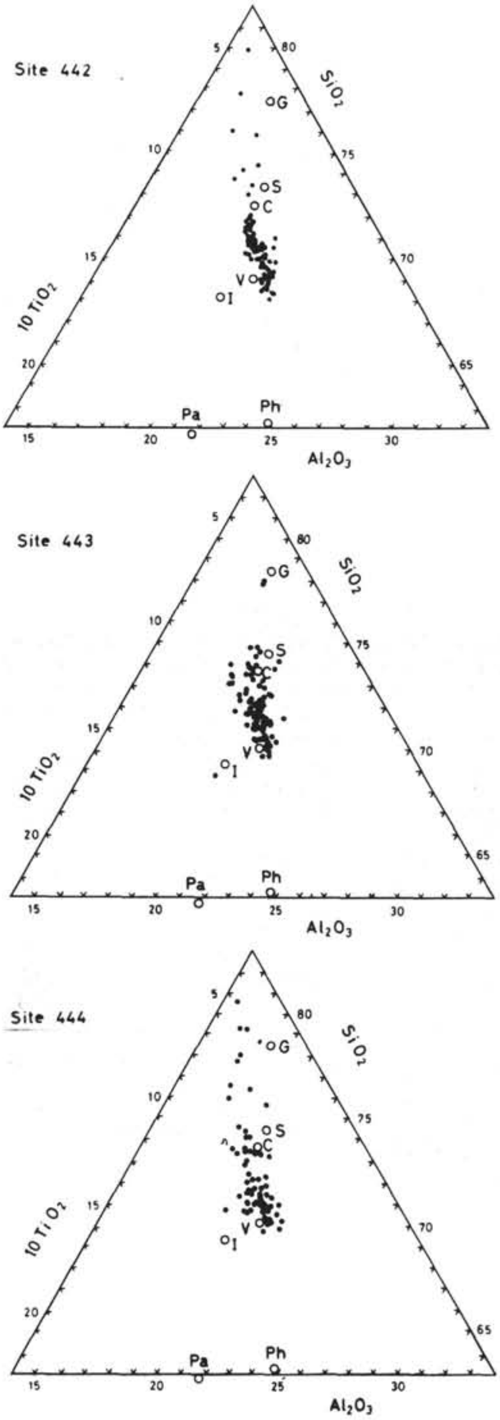

Figure 2. *Relationships among SiO_2, TiO_2 and Al_2O_3. Closed circles represent argillaceous sediments analyzed. Open circles represent averaged rocks: G, Japanese granites (Geological Survey of Japan, 1960); V, Quaternary volcanics (Sugisaki, 1976); C, shales from the Paleozoic Chichibu terrain, Japan (Ono, 1976); S, shales from the Mesozoic Shimanto terrain, Japan (Ono, 1976); I, Quaternary volcanics from the Izu–Mariana Islands (Sugisaki, 1976); Ph, average sediments in a core from the Philippine Sea (Lat. 14°09"N, Long. 130°04"E; Tiba, 1974); Pa, sediments from the east Pacific Ocean (Goldberg and Arrhenius, 1958).*

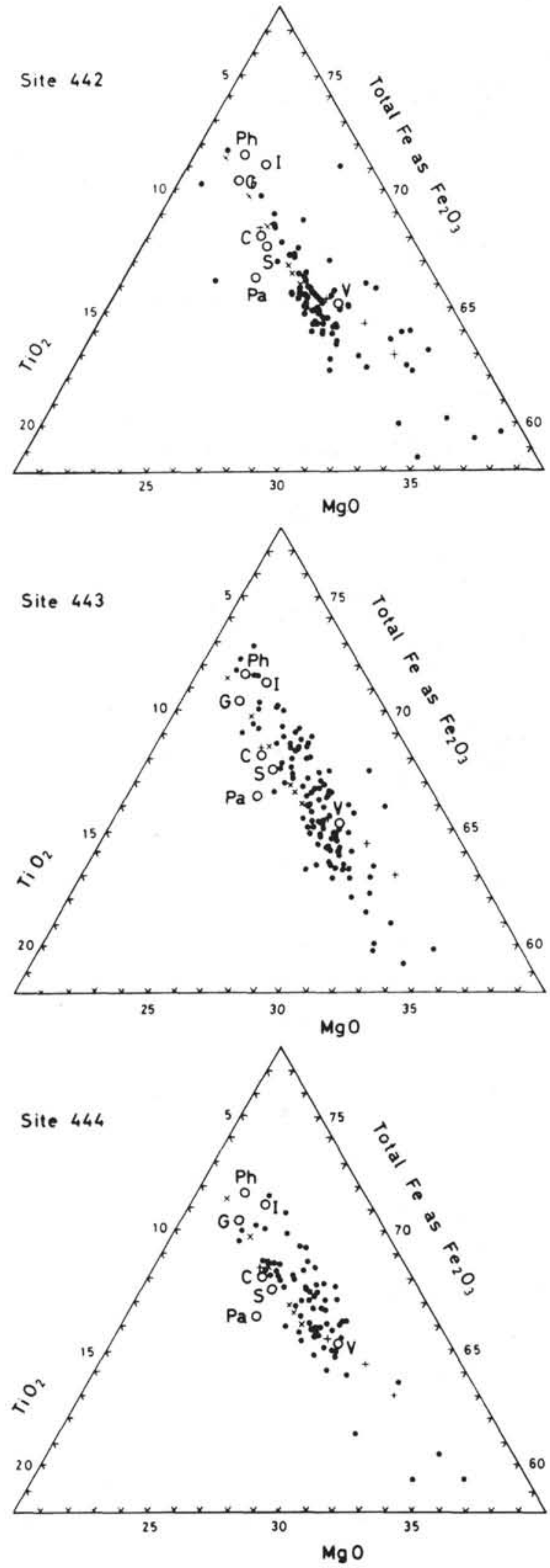

Figure 3. *Relationships among TiO_2, total Fe as Fe_2O_3, and MgO. Crosses and Xs represent averaged variation trends of Japanese volcanics (Sugisaki, 1976) and Japanese granites (Aramaki et al., 1972), respectively. Other symbols are the same as those in Figure 2.*

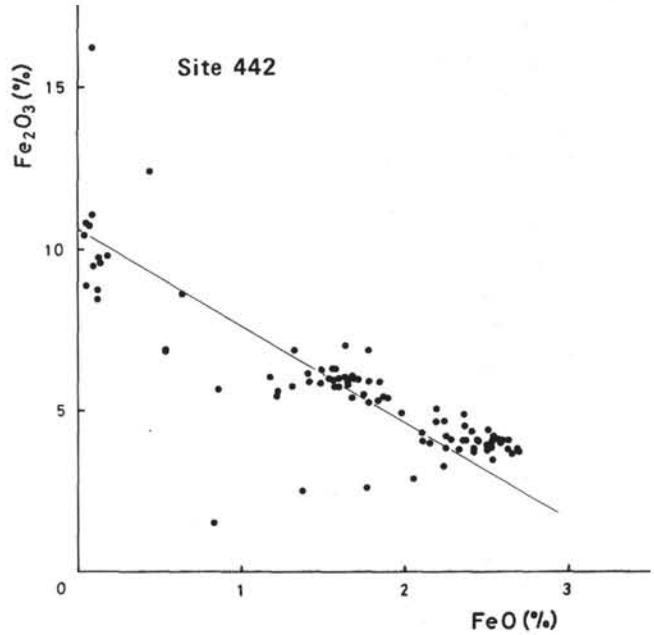

Figure 4. *Relation between FeO and Fe_2O_3 at Site 442. The regression line is $Fe_2O_3 = -2.93FeO + 10.62$, with a correlation coefficient of -0.832.*