Geological Survey of Japan Cruise Report No. 20, p. 198–214, 1984

XII. MAJOR ELEMENT CHEMISTRY OF PACIFIC MARINE SEDIMENTS AROUND 10°N AND 170°W: SAMPLES FOR GH80-5 CRUISE, GEOLOGICAL SURVEY OF JAPAN

Ryuichi Sugisaki and Koshi Yamamoto**

Introduction

Several core samples and surface sediments were collected during GH80–5 cruise, Geological Survey of Japan. The cruise covered the area of 8°40′–10°10′N and 173°50′–175°W, which occupies a location on the central Pacific transect, Wake to Tahiti, GH80–1 cruise, and is not far from the surveyed area of GH79–1, the northern Central Pacific Basin. The geochemical examination of sediments from the cruises of GH79–1 and GH80–1 has already been published (SUGISAKI 1981a: SUGISAKI and KINOSHITA, 1982).

The main purpose of this investigation is to study distribution of major elements in sediments from GH80–5 cruise, in order to infer geochemical features of different lithologic types of sediments, in comparison with the sediments from the above two cruise areas in the central Pacific.

Methods and Results

One hundred and six sediment samples for this study were selected from 6 cores and 23 box cores. The location and water depth of these samples are listed in Table XII–1. Pelagic clay, siliceous clay, siliceous fossil rich clay and zeolitic clay are the type of these sediments as shown in the table.

The samples were dried at 75°C and subsequently ground. Most elements were determined with an X-ray fluorescence spectrometer: Analyses of other components such as FeO, H_2O and salts and the data display of the bulk composition of them were done according to the method described by Sugisaki (1981b).

Analytical results are shown in Table XII–2. The analytical values were recalculated by excluding carbonates, salts, water and residual materials (organic matter, sulfides and others). These recalculated values (listed in Table XII–3) will be mostly used in the following discussion.

General Characteristics of the Sediments

The water depth from which the samples were collected is over 5,000 m. This exceeds the calcium carbonate compensation depth and the absence of $CaCO_3$ in the

*Department of Earth Sciences, Nagoya University, Chikusa, Nagoya, Japan.

Table XII-1 Description of samples

Sample No.	Station	Observ. No.*	Latitude	Longitude	Depth (m)	Location** (cm)	Sediments
1	1983	P 194	9°49.85′N	174°40.40′W	5896	2-7	Pelagic clay
2	〃	〃	〃	〃	〃	50-55	〃
3	〃	〃	〃	〃	〃	100-105	〃
4	〃	〃	〃	〃	〃	150-155	〃
5	〃	〃	〃	〃	〃	200-205	Zeolitic clay
6	〃	〃	〃	〃	〃	250-255	〃
7	〃	〃	〃	〃	〃	300-305	〃
8	〃	〃	〃	〃	〃	350-355	〃
9	〃	〃	〃	〃	〃	400-405	〃
10	〃	〃	〃	〃	〃	450-455	〃
11	〃	〃	〃	〃	〃	500-505	〃
12	〃	〃	〃	〃	〃	550-555	〃
13	〃	〃	〃	〃	〃	600-605	〃
14	〃	〃	〃	〃	〃	703-708	Siliceous clay
15	1985	P 195	9°30.26′N	174°40.08′W	6025	6-11	Zeolitic clay
16	〃	〃	〃	〃	〃	53-58	〃
17	〃	〃	〃	〃	〃	103-108	〃
18	〃	〃	〃	〃	〃	153-158	〃
19	〃	〃	〃	〃	〃	203-208	〃
20	〃	〃	〃	〃	〃	253-258	〃
21	〃	〃	〃	〃	〃	303-308	〃
22	〃	〃	〃	〃	〃	353-358	〃
23	〃	〃	〃	〃	〃	403-408	〃
24	〃	〃	〃	〃	〃	453-458	〃
25	〃	〃	〃	〃	〃	503-508	〃
26	〃	〃	〃	〃	〃	553-558	〃
27	〃	〃	〃	〃	〃	603-608	〃
28	〃	〃	〃	〃	〃	613-618	〃
29	〃	〃	〃	〃	〃	653-658	〃
30	1990	P 198	10°10.86′N	174°41.22′W	5562	16-21	Pelagic clay
31	〃	〃	〃	〃	〃	61-66	〃
32	〃	〃	〃	〃	〃	111-116	〃
33	〃	〃	〃	〃	〃	161-166	〃
34	〃	〃	〃	〃	〃	211-216	〃
35	〃	〃	〃	〃	〃	261-266	〃
36	〃	〃	〃	〃	〃	311-316	〃
37	〃	〃	〃	〃	〃	361-366	〃
38	〃	〃	〃	〃	〃	411-416	〃
39	〃	〃	〃	〃	〃	461-466	〃
40	〃	〃	〃	〃	〃	511-516	〃
41	〃	〃	〃	〃	〃	561-566	〃
42	〃	〃	〃	〃	〃	611-616	〃
43	〃	〃	〃	〃	〃	661-666	〃
44	〃	〃	〃	〃	〃	711-716	〃
45	2026	P 204	9°04.93′N	174°02.60′W	5936	12-27	〃
46	〃	〃	〃	〃	〃	49-54	〃
47	〃	〃	〃	〃	〃	99-104	〃
48	〃	〃	〃	〃	〃	146-151	〃
49	〃	〃	〃	〃	〃	196-201	〃
50	〃	〃	〃	〃	〃	246-251	〃

Table XII-1 (continued)

Sample No.	Station	Observ. No.*	Latitude	Longitude	Depth (m)	Location** (cm)	Sediments
51	2026	P 204	9°04.93′N	174°02.60′W	5936	296-301	Pelagic clay
52	〃	〃	〃	〃	〃	346-351	〃
53	〃	〃	〃	〃	〃	396-401	〃
54	〃	〃	〃	〃	〃	446-451	〃
55	〃	〃	〃	〃	〃	496-501	〃
56	〃	〃	〃	〃	〃	546-551	Siliceous ooze
57	〃	〃	〃	〃	〃	646-651	〃
58	〃	〃	〃	〃	〃	696-701	〃
59	2046	P 206	9°01.65′N	174°08.89′W	5744	5-10	Pelagic clay
60	〃	〃	〃	〃	〃	52-57	〃
61	〃	〃	〃	〃	〃	102-107	〃
62	〃	〃	〃	〃	〃	152-157	〃
63	〃	〃	〃	〃	〃	202-207	〃
64	〃	〃	〃	〃	〃	252-257	〃
65	〃	〃	〃	〃	〃	302-307	〃
66	〃	〃	〃	〃	〃	352-357	〃
67	〃	〃	〃	〃	〃	402-407	〃
68	〃	〃	〃	〃	〃	452-457	〃
69	〃	〃	〃	〃	〃	502-507	〃
70	〃	〃	〃	〃	〃	552-557	〃
71	〃	〃	〃	〃	〃	602-607	〃
72	2049	P 207	8°41.24′N	174°04.25′W	6014	5-10	〃
73	〃	〃	〃	〃	〃	55-60	〃
74	〃	〃	〃	〃	〃	105-110	〃
75	〃	〃	〃	〃	〃	155-160	〃
76	〃	〃	〃	〃	〃	205-210	〃
77	〃	〃	〃	〃	〃	255-260	〃
78	〃	〃	〃	〃	〃	305-310	〃
79	〃	〃	〃	〃	〃	355-360	Zeolitic clay
80	〃	〃	〃	〃	〃	405-410	〃
81	〃	〃	〃	〃	〃	455-460	〃
82	〃	〃	〃	〃	〃	505-510	〃
83	〃	〃	〃	〃	〃	555-560	〃
84	〃	〃	〃	〃	〃	605-610	Nanno ooze
85	〃	〃	〃	〃	〃	655-660	〃
86	〃	〃	〃	〃	〃	705-710	〃
87	1981	B 33	9°50.10′N	174°29.89′W	5869		Pelagic clay
88	1984	34	9°40.48′N	174°40.75′W	5952		Siliceous fossil rich clay
89	1987	35	9°50.31′N	174°50·99′W	5952		Pelagic clay
90	1989	36	10°00.11′N	174°40.35′W	5691		Siliceous fossil rich clay
91	1991	37	10°10.10′N	174°30.84′W	5598		Siliceous clay
92	1994	38	9°46.67′N	174°50.44′W	5952		Siliceous fossil rich clay
93	1998	39	9°42.29′N	174°50.16′W	5910		〃
94	2003	40	9°55.51′N	174°30.68′W	5848		〃
95	2014	41	9°42.06′N	174°31.16′W	5867		〃
96	2017	42	8°59.81′N	173°59.87′W	5890		〃
97	2019	43	9°09.87′N	173°54.84′W	5977		〃
98	2020	44	9°10.18′N	174°04.92′W	5983		〃
99	2022	45	9°00.44′N	174°09.44′W	5814		〃
100	2024	47	8°46.44′N	174°06.51′W	5869		〃

Table XII–1 (continued)

Sample No.	Station	Observ. No.*	Latitude	Longitude	Depth (m)	Location** (cm)	Sediments
101	2027	48	8°59.69'N	174°05.61'W	5777		Siliceous fossil rich clay
102	2030	49	9°01.09'N	174°04.49'W	5853		〃
103	2032	50	9°02.85'N	174°04.00'W	5926		〃
104	2034	51	9°04.43'N	174°03.23'W	5952		〃
105	2036	52	9°01.92'N	173°58.92'W	5980		〃
106	2038	53	9°03.03'N	173°58.07'W	5931		〃
107	2040	54	9°04.71'N	173°57.70'W	5952		〃
108	2042	55	9°03.87'N	174°08.30'W	5879		〃
109	2044	56	9°02.31'N	174°08.39'W	5841		〃

* P indicates piston corer. B does box corer. ** Distance from the top of core.

samples except for one (No. 85) is reasonably expected (Tables XII–1 and XII–3).

Table XII–4 shows the comparison of the average compositions of the marine sediments collected from some cruise regions of the Geological Survey of Japan and DSDP. A salient feature of the present samples is (1) low SiO_2 content and (2) high concentrations of Na_2O and P_2O_5.

SiO_2 content of most samples in the present cruise is almost 60%, although sample Nos. 57 and 58 show exceptionally high SiO_2 content; they contain abundant radioralians. In the two cruise regions, GH79–1 and GH80–1, adjacent to the present region, the SiO_2 content is generally high and it is negatively correlated with Al_2O_3 content. High biological activity pertaining to silica is responsible for the feature (SUGISAKI 1981a: SUGISAKI and KINOSHITA, 1982). Whereas in this region the low concentrations of SiO_2 and Al_2O_3 imply a low biological activity of silica.

Geochemical inspection of the sediments from the central Pacific Basin during GH79–1 cruise suggested that the sediments are mainly terrigenous and that marine volcanics of oceanic islands and ocean floors contribute little to the sediments (SUGISAKI 1981a). Figure XII–1 plots the relation among Al_2O_3–MgO–TiO_2: The plot is helpful in the examination of sediment sources because the mutual relation of these elements does not greatly change during sedimentation on the ocean floor (SUGISAKI 1981a). The compositional points on the figure are mostly located between the points of averaged granites and basalts, which are representative of the continental crust, and they cluster around the averaged point of GH79–1 samples. This indicates that the main source of the sediments in the present area is also the continental crust. Meanwhile, it is clear that some chemical species deposited and incorporated to the terrigenous sediments.

Na_2O content of the marine sediments is generally low. For example, EL WAKEEL and RILEY (1961) gave 1.98% as a world wide average of Na_2O content. SUGISAKI (1981a), SUGISAKI and KINOSHITA (1982) reported a similar value for the central Pacific sediments. On the other hand, the agrillacous sediments on continental shelfs and trench inner slopes around the Japanese Islands show high sodium content of 3–4% (SUGISAKI 1978: SUGISAKI 1980a). A tendency for Na_2O to be lower in the central Pacific sediments than in shelf and trench inner slope sediments can be discerned in each representative analysis listed in Table XII–4. Nevertheless, the average of

Table XII-2 Analyses of samples (dried at 70°C) for major constituents (% weight)

No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O	$CaCO_3$	Res*	Salt	Total
1	51.93	0.61	13.87	6.49	0.17	0.65	2.75	1.22	3.65	2.43	0.39	8.26	0.0	0.49	6.90	99.82
2	47.71	0.64	14.76	6.83	0.13	1.16	2.92	1.19	2.98	2.40	0.36	12.22	0.0	0.83	6.50	100.62
3	47.34	0.66	14.89	7.18	0.13	1.22	2.95	1.23	2.63	2.42	0.43	12.98	0.0	0.75	6.20	101.01
4	47.89	0.66	15.10	7.34	0.04	1.45	3.25	1.18	3.29	2.39	0.38	11.22	0.0	0.34	6.31	100.85
5	47.96	0.49	14.50	6.21	0.11	1.44	3.42	2.04	3.26	2.10	1.08	12.50	0.0	1.28	4.47	100.86
6	47.17	0.48	13.39	5.78	0.13	1.38	3.54	2.08	2.96	1.93	1.06	13.59	0.0	2.18	5.38	101.05
7	49.00	0.46	14.20	5.80	0.11	1.39	3.81	2.26	3.79	2.02	1.18	10.91	0.0	0.51	5.58	101.01
8	45.84	0.43	13.35	5.55	0.06	1.36	3.45	2.24	3.21	2.04	1.21	17.49	0.0	1.12	4.29	101.64
9	46.91	0.45	13.72	5.86	0.06	1.47	2.99	2.19	3.58	2.35	1.16	13.96	0.0	1.09	4.72	100.51
10	47.68	0.41	12.23	5.57	0.15	1.80	3.39	4.54	2.68	2.53	2.65	11.51	0.0	0.37	3.51	99.02
11	48.46	0.39	12.12	5.28	0.10	1.87	3.45	4.36	2.89	2.40	2.75	12.36	0.0	1.00	3.68	101.11
12	47.01	0.38	12.19	5.11	0.08	1.74	3.62	4.58	2.79	2.26	2.89	12.56	0.0	1.72	3.68	100.79
13	48.85	0.41	12.95	5.45	0.10	1.66	3.78	3.70	3.16	2.43	2.23	11.57	0.0	0.45	4.06	100.80
14	66.92	0.20	6.02	2.58	0.04	0.79	1.91	2.06	2.73	1.05	1.13	9.01	0.0	0.27	6.00	100.71
15	47.92	0.54	13.21	6.38	0.06	1.26	2.87	1.62	3.67	2.41	0.76	14.81	0.0	0.55	5.00	101.06
16	47.38	0.45	12.19	5.93	0.05	1.56	3.41	2.06	4.25	2.49	1.09	8.86	0.0	5.63	5.00	100.36
17	50.65	0.46	13.02	5.93	0.22	1.75	3.00	2.16	4.54	3.10	1.15	8.40	0.0	0.71	5.20	100.29
18	49.21	0.42	12.65	5.45	0.18	1.68	3.45	2.46	3.60	2.55	1.36	11.63	0.0	1.34	4.85	100.84
19	46.61	0.39	11.51	5.11	0.29	1.63	3.44	2.09	3.95	2.22	1.10	12.88	0.0	3.97	4.87	100.05
20	49.22	0.44	12.30	5.63	0.28	1.62	3.41	1.79	3.21	2.34	0.90	11.76	0.0	2.57	5.48	100.95
21	52.35	0.46	13.17	5.76	0.32	1.77	3.78	2.02	3.45	2.32	1.06	7.58	0.0	0.54	5.98	100.57
22	52.27	0.46	12.77	6.24	0.15	1.80	3.79	2.07	3.34	2.40	1.05	8.45	0.0	0.01	5.70	100.50
23	51.52	0.46	12.89	6.10	0.27	1.79	3.66	2.04	3.60	2.39	1.02	6.75	0.0	1.55	6.12	100.15
24	47.71	0.42	11.30	5.70	0.34	1.66	3.30	1.83	3.78	2.19	0.88	14.80	0.0	1.17	5.54	100.62
25	47.89	0.44	11.18	6.05	0.19	1.67	3.46	1.80	3.65	2.22	0.82	14.88	0.0	1.26	5.60	101.11
26	47.14	0.43	11.05	5.97	0.08	1.75	3.21	2.06	3.44	2.14	1.02	16.54	0.0	0.78	5.48	101.10
27	46.55	0.61	13.51	6.41	0.24	1.36	3.24	1.12	3.77	2.17	0.36	14.60	0.0	1.19	5.79	100.92
28	48.61	0.43	13.14	5.42	0.14	1.83	3.87	4.04	2.90	2.23	2.43	9.72	0.0	0.85	4.39	100.01

Table XII–2 (continued)

No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O	$CaCO_3$	Res*	Salt	Total
29	48.71	0.71	16.04	7.49	0.20	1.57	2.95	1.10	3.09	2.48	0.28	8.73	0.0	0.15	6.61	100.11
30	50.32	0.44	12.26	5.81	0.18	1.70	3.38	1.90	3.67	2.34	0.86	10.02	0.0	0.67	6.19	99.74
31	49.62	0.63	14.46	6.44	0.14	0.99	2.78	1.06	3.02	2.54	0.25	12.35	0.0	0.75	5.49	100.53
32	50.81	0.65	15.43	6.61	0.18	1.11	2.85	1.06	2.92	2.60	0.26	8.73	0.0	0.89	6.02	100.11
33	49.92	0.69	15.93	7.06	0.21	1.25	3.33	1.26	2.70	2.59	0.32	7.64	0.0	0.64	6.96	100.50
34	48.26	0.66	14.68	6.75	0.14	1.07	3.09	1.09	2.60	2.54	0.31	13.11	0.0	0.46	5.85	100.61
35	46.30	0.61	13.60	6.41	0.14	1.02	3.07	1.00	2.57	2.35	0.27	16.48	0.0	0.60	6.06	100.48
36	45.68	0.63	13.49	6.47	0.11	0.97	3.10	0.95	2.45	2.36	0.24	16.53	0.0	1.50	5.85	100.33
37	48.06	0.63	14.41	6.64	0.21	1.20	3.47	1.03	2.91	2.33	0.27	13.16	0.0	0.05	6.14	100.51
38	50.65	0.69	15.55	7.16	0.17	1.23	3.53	1.13	2.43	2.51	0.31	8.53	0.0	0.77	6.29	100.95
39	45.08	0.61	13.45	6.47	0.12	1.14	3.20	0.96	2.37	2.23	0.28	18.53	0.0	0.58	5.95	100.96
40	45.09	0.63	13.58	6.68	0.12	1.25	3.09	1.09	1.90	2.18	0.36	18.12	0.0	0.78	5.63	100.50
41	49.12	0.67	14.70	6.95	0.15	1.43	3.60	1.22	2.10	2.39	0.41	9.54	0.0	0.09	6.62	99.00
42	53.04	0.67	15.19	6.77	0.19	1.05	3.17	1.20	2.90	2.75	0.32	6.86	0.0	0.32	6.36	100.80
43	49.07	0.64	14.61	6.70	0.15	1.40	3.86	1.24	2.22	2.27	0.35	8.57	0.0	0.57	6.90	98.56
44	48.57	0.64	14.07	6.77	0.13	1.55	3.78	1.26	2.90	2.25	0.39	9.20	0.0	0.97	7.00	99.48
45	47.83	0.68	15.18	7.22	0.11	1.26	3.13	1.07	2.77	2.55	0.28	12.10	0.0	0.75	5.77	100.70
46	45.76	0.67	14.45	7.14	0.06	1.46	3.06	0.99	2.07	2.34	0.25	15.62	0.0	0.07	6.58	100.51
47	47.57	0.71	15.17	7.53	0.14	1.64	3.42	1.07	2.58	2.37	0.29	11.89	0.0	0.47	6.09	100.95
48	44.39	0.66	13.81	6.96	0.13	1.53	2.97	1.11	1.46	2.16	0.35	18.12	0.0	0.07	6.57	100.28
49	43.39	0.59	12.83	6.43	0.14	1.93	3.02	1.07	0.97	1.99	0.33	17.00	0.0	2.88	6.78	99.35
50	45.15	0.64	13.33	6.85	0.11	0.78	3.17	1.09	1.73	2.06	0.33	19.18	0.0	4.35	6.13	104.89
51	46.18	0.63	14.11	7.09	0.13	2.28	3.26	1.30	1.68	2.02	0.44	15.37	0.0	0.66	5.87	101.02
52	50.15	0.56	14.32	6.15	0.08	1.94	3.86	1.59	1.76	1.93	0.70	8.45	0.0	1.53	6.73	99.75
53	50.01	0.52	14.21	6.21	0.11	1.81	3.21	1.83	3.51	2.79	0.94	9.61	0.0	2.76	3.95	101.46
54	51.08	0.58	15.33	6.76	0.16	2.06	2.39	2.27	3.65	3.58	1.14	7.77	0.0	0.67	3.16	100.60
55	49.02	0.50	13.87	6.01	0.12	1.96	2.49	2.42	3.06	3.37	1.32	9.20	0.0	2.66	3.86	99.86
56	48.89	0.44	11.80	5.76	0.16	2.14	3.45	2.71	2.85	2.53	1.52	12.13	0.0	1.52	5.10	101.00
57	75.25	0.03	0.74	0.58	0.04	0.07	0.51	0.46	0.23	0.30	0.13	8.46	0.0	0.55	11.52	98.88
58	75.08	0.03	0.77	0.51	0.04	0.06	0.70	0.46	1.97	0.26	0.12	11.32	0.0	0.35	8.10	99.77

Table XII-2 (continued)

No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O	$CaCO_3$	Res*	Salt	Total
59	49.66	0.67	13.53	7.32	0.18	3.46	2.65	1.11	3.08	2.45	0.26	7.72	0.0	2.60	6.00	100.68
60	50.52	0.66	15.19	6.98	0.18	1.34	3.09	1.07	2.93	2.54	0.26	8.84	0.0	0.40	0.67	100.67
61	46.53	0.63	14.05	6.89	0.11	1.35	2.88	1.02	2.48	2.34	0.25	10.87	0.0	2.58	6.20	98.23
62	49.69	0.63	15.12	6.84	0.16	1.30	3.17	1.02	2.86	2.42	0.25	7.55	0.0	0.96	7.23	99.20
63	49.16	0.66	14.58	6.79	0.14	1.29	3.29	0.97	2.41	2.37	0.22	8.02	0.0	2.66	6.99	99.55
64	48.54	0.62	14.12	6.75	0.11	1.55	3.46	1.00	2.15	2.23	0.24	11.64	0.0	1.47	6.49	100.36
65	46.79	0.63	14.00	6.69	0.14	1.36	3.28	0.92	2.28	2.20	0.22	15.50	0.0	0.62	6.19	100.82
66	50.29	0.69	15.39	7.27	0.14	1.52	3.56	1.04	2.61	2.32	0.22	8.23	0.0	0.77	6.50	100.55
67	48.34	0.67	14.42	7.24	0.09	1.57	3.40	1.08	2.08	2.23	0.30	12.34	0.0	0.63	6.04	100.43
68	49.90	0.67	14.85	7.15	0.14	1.77	3.55	1.17	2.39	2.24	0.34	7.26	0.0	0.78	6.89	99.10
69	45.96	0.59	12.91	6.44	0.09	1.46	3.26	1.05	2.30	2.03	0.30	15.17	0.0	1.33	6.20	99.09
70	46.09	0.58	12.71	6.42	0.10	1.56	3.28	1.05	1.96	1.96	0.29	16.31	0.0	0.36	6.35	99.01
71	45.72	0.56	12.55	6.11	0.16	1.50	3.39	1.02	2.28	2.00	0.27	17.86	0.0	0.78	6.36	100.57
72	52.55	0.58	12.85	5.99	0.17	0.60	2.36	0.96	2.65	2.41	0.24	9.39	0.0	1.63	7.36	99.74
73	50.35	0.68	15.29	7.12	0.11	1.36	2.85	1.06	2.28	2.53	0.27	8.79	0.0	0.44	6.78	99.90
74	54.93	0.48	13.62	6.14	0.13	1.66	3.27	2.03	3.02	2.65	1.03	4.50	0.0	1.79	5.21	100.45
75	47.47	0.7C	15.36	7.37	0.13	1.81	3.00	1.04	0.59	2.36	0.27	8.18	0.0	0.54	10.22	99.04
76	48.71	0.71	16.23	7.68	0.15	1.45	3.54	1.07	3.41	2.38	0.26	6.93	0.0	1.16	6.62	100.31
77	47.65	0.72	16.06	7.77	0.11	1.66	3.44	1.21	3.06	2.34	0.37	7.79	0.0	0.31	6.64	99.13
78	42.38	0.60	13.38	6.63	0.12	0.55	2.92	1.03	2.68	2.05	0.29	18.76	0.0	0.11	6.72	99.22
79	48.94	0.63	15.53	7.32	0.14	0.89	3.67	1.26	3.65	2.12	0.41	7.73	0.0	0.41	7.31	100.02
80	47.00	0.58	14.30	6.79	0.13	2.94	3.81	1.45	3.28	2.50	0.66	8.14	0.0	1.12	6.78	99.47
82	46.21	0.47	12.36	5.66	0.11	1.58	2.77	2.37	3.82	3.40	1.34	10.49	0.0	2.54	5.86	99.00
83	50.51	0.48	12.99	5.61	0.13	1.78	3.62	2.42	3.49	3.14	1.35	8.28	0.0	2.18	5.69	101.66
84	47.64	0.45	11.77	5.39	0.10	1.28	3.75	2.55	4.03	3.10	1.42	11.14	0.0	0.90	7.34	100.86
85	23.94	0.19	4.52	2.67	0.07	0.39	1.63	6.05	1.18	1.41	0.68	1.87	52.00	1.31	4.03	101.94
87	50.54	0.53	14.16	6.50	0.11	0.96	2.83	1.56	3.71	2.45	0.67	7.97	0.0	1.98	6.58	100.54
88	52.14	0.57	13.85	6.43	0.11	1.03	2.85	1.40	3.93	2.42	0.50	6.66	0.0	1.66	7.42	100.96

Table XII-2 (continued)

No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	H_2O	$CaCO_3$	Res*	Salt	Total
89	51.71	0.57	13.92	6.46	0.11	0.90	2.84	1.41	4.17	2.43	0.55	7.73	0.0	2.22	6.67	101.69
90	51.18	0.61	13.30	6.17	0.19	0.96	2.63	1.18	4.09	2.38	0.32	7.92	0.0	0.34	8.66	99.92
91	50.67	0.61	13.52	6.22	0.18	0.91	2.54	1.23	3.09	2.42	0.33	6.76	0.0	3.56	8.25	100.30
92	51.88	0.52	12.72	5.90	0.18	0.64	2.52	1.33	3.43	2.30	0.49	7.71	0.0	1.86	8.42	99.90
93	51.12	0.58	13.95	6.40	0.12	0.98	2.93	1.43	3.18	2.47	0.51	8.47	0.0	1.36	7.53	101.02
94	51.29	0.59	13.48	6.24	0.14	0.85	2.59	1.20	3.54	2.45	0.32	7.46	0.0	0.30	8.48	98.94
95	51.01	0.59	14.31	6.54	0.12	1.05	2.76	1.30	3.04	2.47	0.43	8.20	0.0	0.78	7.75	100.34
96	50.36	0.57	12.81	5.97	0.17	0.98	2.44	1.11	2.61	2.36	0.27	7.86	0.0	1.56	10.18	99.25
97	49.70	0.56	12.11	5.75	0.19	0.86	2.47	1.13	2.99	2.27	0.28	8.67	0.0	2.27	10.62	99.87
98	50.68	0.56	12.19	5.55	0.26	0.75	2.39	1.14	2.92	2.29	0.26	7.06	0.0	1.43	11.21	98.69
99	51.07	0.59	13.08	6.05	0.15	0.96	2.75	1.11	3.29	2.40	0.26	8.72	0.0	0.67	8.89	99.98
100	50.82	0.60	13.25	6.26	0.08	1.41	2.63	1.10	3.04	2.40	0.26	9.54	0.0	0.84	8.55	100.77
101	50.94	0.59	13.11	6.15	0.13	1.06	2.65	1.09	3.45	2.37	0.26	7.25	0.0	0.83	9.31	99.19
102	50.09	0.57	12.75	5.91	0.14	0.91	2.66	1.06	4.03	2.33	0.26	7.62	0.0	2.78	8.75	99.86
103	51.31	0.59	13.41	6.05	0.15	1.05	2.41	1.08	2.46	2.43	0.26	7.38	0.0	0.56	10.94	100.18
104	50.45	0.58	13.20	5.98	0.12	1.49	2.62	1.09	4.06	2.36	0.28	7.61	0.0	0.59	9.72	100.15
105	49.06	0.57	12.60	5.89	0.08	1.36	2.56	1.13	4.43	2.26	0.29	7.08	0.0	0.33	11.59	99.23
106	49.99	0.56	12.79	5.90	0.13	1.00	2.58	1.12	4.10	2.31	0.31	8.22	0.0	0.42	10.20	99.62
107	49.99	0.58	13.24	6.30	0.11	1.48	2.62	1.15	3.59	2.35	0.33	7.43	0.0	1.77	8.42	99.36
108	49.95	0.57	13.07	6.09	0.13	1.39	2.64	1.08	3.65	2.38	1.63	9.53	0.0	0.32	9.06	101.49
109	49.29	0.54	12.79	5.87	0.10	1.14	2.52	1.04	3.97	2.33	0.27	8.62	0.0	1.24	9.44	99.15

*Residual materials were calculated by subtracting CO_2 and H_2O from ignition loss. They may contain sulfur, organic materials and others. The details were described by Sugisaki(1981 b).

Table XII-3 Analyses for major constituents on a carbonate, water and residual materials free basis (% weight)

No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Fe_3/ToFe	Tot Fe
1	61.70	0.72	16.48	7.71	0.20	0.77	3.26	1.45	4.34	2.89	0.46	97.17	7.94
2	58.84	0.79	18.20	8.42	0.16	1.43	3.60	1.47	3.67	2.96	0.44	97.93	8.60
3	58.39	0.81	18.37	8.85	0.16	1.50	3.64	1.52	3.24	2.98	0.53	98.03	9.03
4	57.72	0.80	18.20	8.85	0.05	1.75	3.92	1.42	3.97	2.88	0.46	99.37	8.91
5	58.06	0.59	17.55	7.52	0.13	1.74	4.14	2.47	3.94	2.54	1.31	98.07	7.66
6	59.04	0.60	16.76	7.23	0.16	1.73	4.44	2.60	3.71	2.42	1.33	97.56	7.41
7	58.32	0.55	16.90	6.90	0.13	1.65	4.53	2.69	4.51	2.40	1.40	97.93	7.05
8	58.21	0.55	16.95	7.05	0.08	1.73	4.38	2.84	4.07	2.59	1.54	98.79	7.14
9	58.11	0.56	16.99	7.25	0.07	1.82	3.71	2.71	4.43	2.91	1.44	98.91	7.33
10	57.01	0.49	14.62	6.66	0.18	2.15	4.06	5.43	3.20	3.03	3.17	97.10	6.86
11	57.64	0.46	14.42	6.28	0.12	2.22	4.10	5.19	3.44	2.85	3.27	97.94	6.41
12	56.88	0.46	14.75	6.18	0.10	2.11	4.38	5.54	3.38	2.73	3.50	98.29	6.29
13	57.66	0.48	15.29	6.43	0.12	1.96	4.47	4.37	3.73	2.87	2.53	98.00	6.56
14	78.33	0.23	7.05	3.02	0.05	0.92	2.23	2.41	3.19	1.23	1.32	98.23	3.08
15	59.38	0.67	16.37	7.90	0.08	1.56	3.55	2.01	4.55	2.99	0.94	98.90	7.99
16	58.59	0.56	15.07	7.33	0.07	1.93	4.21	2.55	5.26	3.08	1.35	99.02	7.41
17	58.91	0.54	15.14	6.89	0.26	2.04	3.49	2.51	5.28	3.61	1.34	96.04	7.18
18	59.28	0.51	15.24	6.57	0.22	2.02	4.16	2.96	4.34	3.07	1.64	96.46	6.81
19	59.50	0.50	14.69	6.52	0.37	2.08	4.39	2.67	5.04	2.83	1.40	94.06	6.93
20	60.66	0.54	15.16	6.94	0.35	2.00	4.21	2.21	3.96	2.88	1.11	94.76	7.32
21	60.54	0.53	15.23	6.67	0.37	2.05	4.37	2.34	2.99	2.68	1.23	94.19	7.08
22	60.54	0.53	14.79	7.23	0.17	2.08	4.39	2.40	3.86	2.78	1.22	97.40	7.42
23	60.09	0.54	15.03	7.11	0.31	2.09	4.27	2.38	4.20	2.79	1.19	95.31	7.46
24	60.30	0.53	14.28	7.21	0.43	2.10	4.17	2.31	4.78	2.77	1.11	93.78	7.69
25	60.34	0.55	14.09	7.62	0.24	2.10	4.36	2.27	4.59	2.80	1.03	96.93	7.89
26	60.21	0.55	14.11	7.63	0.10	2.24	4.11	2.63	4.39	2.73	1.30	98.59	7.74
27	58.67	0.77	17.03	8.08	0.30	1.71	4.08	1.41	4.76	2.73	0.45	96.01	8.42
28	57.16	0.51	15.45	6.38	0.16	2.15	4.55	4.75	3.41	2.62	2.86	97.21	6.56
29	57.56	0.83	18.95	8.85	0.24	1.86	3.49	1.30	3.65	2.93	0.33	97.12	9.11
30	60.73	0.53	14.80	7.01	0.22	2.05	4.08	2.29	4.43	2.82	1.04	96.67	7.25
31	60.56	0.77	17.65	7.86	0.17	1.21	3.40	1.29	3.69	3.10	0.31	97.64	8.05
32	60.15	0.77	18.27	7.82	0.21	1.31	3.37	1.25	3.46	3.08	0.31	97.06	8.06
33	58.55	0.81	18.68	8.28	0.25	1.47	3.91	1.48	3.17	3.04	0.38	96.80	8.55
34	59.44	0.81	18.08	8.32	0.17	1.32	3.81	1.34	3.20	3.13	0.38	97.75	8.51

Table XII-3 (continued)

No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Fe_3/ToFe	Tot Fe
35	59.86	0.79	17.58	8.29	0.18	1.32	3.97	1.29	3.32	3.04	0.35	97.63	8.49
36	59.75	0.82	17.65	8.46	0.14	1.27	4.06	1.24	3.20	3.09	0.31	98.14	8.62
37	59.22	0.78	17.76	8.18	0.26	1.48	4.28	1.27	3.58	2.87	0.33	96,60	8.46
38	59.34	0.81	18.22	8.39	0.20	1.44	4.14	1.32	2.84	2.94	0.36	97.43	8.61
39	59.39	0.80	17.72	8.52	0.16	1.50	4.22	1.26	3.12	2.94	0.37	97.98	8.70
40	59.35	0.83	17.88	8.79	0.16	1.65	4.07	1.43	2.50	2.87	0.47	98.04	8.96
41	59.36	0.81	17.76	8.40	0.18	1.73	4.35	1.47	2.54	2.89	0.50	97.66	8.60
42	60.79	0.77	17.41	7.76	0.22	1.20	3.64	1.38	3.33	3.15	0.37	96.97	8.00
43	59.47	0.78	17.71	8.12	0.18	1.70	4.67	1.50	2.69	2.75	0.42	97.57	8.33
44	59.01	0.78	17.09	8.22	0.16	1.88	4.59	1.53	3.53	2.73	0.47	97.91	8.40
45	58.27	0.83	18.49	8.79	0.13	1.54	3.81	1.30	3.38	3.11	0.34	98.33	8.94
46	58.48	0.86	18.47	9.13	0.08	1.87	3.90	1.27	2.64	2.99	0.32	99.03	9.21
47	57.67	0.86	18.39	9.13	0.17	1.99	4.15	1.30	3.12	2.87	0.35	97.98	9.32
48	58.77	0.87	18.29	9.21	0.17	2.03	3.93	1.47	1.94	2.86	0.46	97.97	9.40
49	59.69	0.81	17.65	8.85	0.19	2.66	4.15	1.47	1.33	2.74	0.45	97.64	9.07
50	60.01	0.85	17.72	9.10	0.15	1.04	4.21	1.45	2.30	2.74	0.44	98.25	9.26
51	58.37	0.80	17.83	8.96	0.16	2.88	4.12	1.64	2.13	2.55	0.56	98.00	9.14
52	60.39	0.67	17.24	7.40	0.10	2.34	4.65	1.91	2.12	2.32	0.84	98.54	7.51
53	58.73	0.61	16.69	7.29	0.13	2.13	3.77	2.15	4.12	3.28	1.10	98.07	7.43
54	57.39	0.65	17.22	7.60	0.18	2.31	2.69	2.55	4.10	4.02	1.28	97.44	7.80
55	58.26	0.59	16.48	7.14	0.14	2.33	2.96	2.88	3.64	4.01	1.57	97.83	7.30
56	59.44	0.53	14.35	7.01	0.19	2.60	4.19	3.29	3.47	3.08	1.85	97.01	7.22
57	96.05	0.04	0.94	0.74	0.05	0.09	0.65	0.59	0.29	0.38	0.17	92.59	0.80
58	93.85	0.04	0.96	0.63	0.05	0.08	0.87	0.58	2.46	0.33	0.15	92.12	0.69
59	58.86	0.79	16.04	8.68	0.21	4.10	3.14	1.32	3.65	2.90	0.31	97.34	8.91
60	59.60	0.78	17.92	8.23	0.21	1.58	3.64	1.26	3.46	3.00	0.31	97.21	8.47
61	59.23	0.80	17.88	8.77	0.14	1.72	3.66	1.30	3.15	2.98	0.32	98.26	8.92
62	59.54	0.75	18.12	8.20	0.19	1.56	3.79	1.22	3.43	2.90	0.30	97.47	8.41
63	60.04	0.81	17.81	8.30	0.17	1.58	4.02	1.18	2.94	2.89	0.27	97.76	8.49
64	60.10	0.77	17.48	8.35	0.14	1.92	4.29	1.24	2.66	2.76	0.30	98.22	8.51
65	59.60	0.80	17.83	8.53	0.18	1.73	4.18	1.17	2.90	2.80	0.28	97.73	8.72
66	59.13	0.81	18.09	8.55	0.16	1.79	4.19	1.22	3.07	2.73	0.26	97.91	8.74
67	59.37	0.82	17.71	8.89	0.12	1.93	4.18	1.33	2.55	2.74	0.37	98.58	9.02
68	59.28	0.80	17.64	8.50	0.17	2.10	4.21	1.39	2.84	2.66	0.40	97.87	8.68
69	60.17	0.77	16.90	8.43	0.12	1.91	4.27	1.37	3.01	2.66	0.39	98.49	8.56
70	60.65	0.76	16.72	8.45	0.13	2.05	4.31	1.38	2.58	2.58	0.38	98.27	8.59
71	60.50	0.74	16.61	8.09	0.21	1.98	4.49	1.35	3.02	2.65	0.36	97.17	8.32

Table XII-3 (continued)

No.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Fe_3/ToFe	Tot Fe
72	64.59	0.71	15.79	7.36	0.21	0.74	2.89	1.18	3.26	2.96	0.29	96.94	7.60
73	60.02	0.81	18.23	8.48	0.13	1.62	3.39	1.26	2.71	3.02	0.32	98.31	8.63
74	61.75	0.54	15.31	6.30	0.15	1.87	3.68	2.28	3.39	2.98	1.16	97.70	7.06
75	59.27	0.87	19.18	9.20	0.16	2.26	3.74	1.30	0.74	2.95	0.34	98.08	9.38
76	56.90	0.83	18.96	8.98	0.18	1.69	4.14	1.25	3.99	2.78	0.30	97.88	9.17
77	56.47	0.85	19.03	9.20	0.13	1.97	4.08	1.43	3.63	2.77	0.44	98.45	9.35
78	58.91	0.81	18.17	9.00	0.16	0.75	3.97	1.40	3.65	2.78	0.39	98.03	9.18
79	57.87	0.74	18.35	8.66	0.17	1.05	4.34	1.49	4.32	2.51	0.48	97.92	8.84
80	56.33	0.70	17.14	8.13	0.16	3.52	4.56	1.74	3.93	3.00	0.79	97.92	8.31
82	57.70	0.59	15.43	7.06	0.14	1.97	3.46	2.96	4.77	4.25	1.67	97.88	7.22
83	59.07	0.56	15.19	6.56	0.15	2.08	4.23	2.83	4.09	3.67	1.58	97.49	6.72
84	58.47	0.55	14.45	6.61	0.12	1.57	4.60	3.13	4.95	3.80	1.74	97.98	6.75
85	56.04	0.44	10.58	6.25	0.17	0.91	3.80	14.16	2.75	3.30	1.59	97.13	6.44
87	60.16	0.63	16.86	7.73	0.13	1.14	3.36	1.86	4.41	2.92	0.80	98.15	7.88
88	61.18	0.67	16.25	7.54	0.13	1.21	3.34	1.64	4.61	2.84	0.59	98.13	7.69
89	60.79	0.67	16.36	7.59	0.13	1.06	3.34	1.66	4.91	2.86	0.65	98.14	7.73
90	61.66	0.73	16.02	7.43	0.23	1.16	3.17	1.42	4.93	2.87	0.39	96.69	7.69
91	62.00	0.75	16.54	7.61	0.22	1.11	3.11	1.51	3.78	2.96	0.40	96.88	7.86
92	63.34	0.63	15.53	7.20	0.22	0.78	3.08	1.62	4.19	2.81	0.60	96.72	7.45
93	61.01	0.69	16.67	7.65	0.14	1.17	3.50	1.71	3.80	2.55	0.61	97.96	7.80
94	62.02	0.71	16.30	7.55	0.17	1.03	3.14	1.45	4.28	2.96	0.39	97.57	7.74
95	61.01	0.71	17.11	7.82	0.14	1.26	3.30	1.55	3.63	2.95	0.51	98.00	7.98
96	63.22	0.72	16.08	7.50	0.21	1.23	3.06	1.39	3.28	2.96	0.34	96.93	7.73
97	63.46	0.72	15.46	7.34	0.24	1.10	3.15	1.44	3.82	2.90	0.36	96.46	7.61
98	64.16	0.71	15.43	7.03	0.33	0.95	3.02	1.44	3.70	2.90	0.33	95.05	7.39
99	62.50	0.72	16.01	7.41	0.18	1.17	3.36	1.36	4.02	2.94	0.32	97.32	7.61
100	62.09	0.73	16.19	7.65	0.10	1.72	3.21	1.34	3.71	2.93	0.32	98.58	7.76
101	62.28	0.72	16.03	7.51	0.16	1.30	3.24	1.33	4.22	2.90	0.32	97.70	7.69
102	62.06	0.71	15.80	7.33	0.17	1.13	3.29	1.31	4.99	2.89	0.32	97.44	7.52
103	63.19	0.73	16.51	7.45	0.18	1.29	2.27	1.33	3.03	2.99	0.32	97.32	7.66
104	61.35	0.71	16.05	7.27	0.15	1.81	3.19	1.33	4.94	2.87	0.34	97.82	7.43
105	61.15	0.71	15.70	7.34	0.10	1.70	3.19	1.41	5.52	2.82	0.36	98.51	7.45
106	61.88	0.69	15.83	7.30	0.16	1.24	3.19	1.39	5.07	2.86	0.38	97.61	7.48
107	61.16	0.71	16.20	7.70	0.13	1.81	3.20	1.41	4.40	2.87	0.40	98.10	7.85
108	60.49	0.69	15.83	7.37	0.16	1.68	3.20	1.31	4.42	2.88	1.97	97.68	7.54
109	61.72	0.68	16.02	7.35	0.13	1.43	3.15	1.30	4.97	2.92	0.34	98.14	7.49

Fe_3/ToFe: Fe_2O_3/Total Fe as Fe_2O_3 Tot Fe: Total Fe as Fe_2O_3.

Table XII-4 Average chemical compositions (%) and standard deviations of sediments

	GH80-5	GH80-1[1]	GH79-1[2]	Izu-Ogasawara Trench[3]	Nankai Trough[4]	Japan Trench Site 434[5]	Pelagic sediments[6]
Number of Samples	106	111	34	48	29	54	35
SiO_2	60.75±5.37	62.88±8.47	62.83±6.34	65.60±3.24	66.88±1.99	73.38±4.22	61.52
TiO_2	0.68±0.15	0.88±0.52	0.84±0.26	0.74±0.09	0.72±0.06	0.51±0.074	0.90
Al_2O_3	16.28±2.72	14.44±3.16	15.91±1.53	16.06±0.91	16.51±0.64	12.11±1.54	18.12
Total Fe as Fe_3O_2	7.80±1.33	8.72±2.94	8.26±2.64	7.69±1.39	6.01±0.65	6.03±0.26	9.09
MnO	1.77±0.57	2.09±1.54	0.85±0.24	0.84±1.15	0.09±0.06	0.12±0.10	0.64
MgO	3.76±0.66	2.48±1.04	3.25±0.41	2.15±0.64	2.29±0.36	2.03±0.44	1.00
CaO	1.97±1.50	2.79±1.55	2.19±1.29	3.24±1.22	1.51±0.93	1.15±0.65	3.19
Na_2O	3.63±0.92	1.81±0.72	1.38±0.64	1.54±0.47	3.29±0.36	2.72±0.54	1.98
K_2O	2.86±0.48	2.73±0.77	3.48±0.71	2.22±0.51	3.09±0.41	2.05±0.30	3.23
P_2O_5	0.79±0.69	1.19±1.05	1.05±0.70	0.16±0.15	0.14±0.01	0.088±0.028	0.33

1) SUGISAKI and KINOSHITA (1982)
2) SUGISAKI (1981a)
3) SUGISAKI and KINOSHITA (1981)
4) SUGISAKI (1978)
5) SUGISAKI (1980)
6) EL WAKEEL and RILEY (1961)

Table XII-5 Correlation coefficients between TiO_2 and other oxides

SiO_2	0.033
Al_2O_3	0.886
Fe_2O_3	0.950
FeO	−0.147
MnO	−0.260
MgO	−0.179
CaO	−0.831
Na_2O	−0.615
K_2O	−0.089
P_2O_5	−0.851

present samples from the central Pacific displays the highest sodium content exhibited in the table.

Sediments from the cruises of GH79-1 and GH80-1 showed high concentration of P_2O_5. The present samples are also characterized by high P_2O_5 content. The sampling area under consideration is adjacent to the above two cruise areas and this feature is naturally accepted, which will be discussed later.

Table XII-5 shows the correlation coefficients of TiO_2 against other oxides. Titanium is called resistrates in the geochemical classification of elements and it appears that it neither precipitates nor dissolves in sea water. In the table, titania is positively correlated with Al_2O_3, Fe_2O_3 and reversely done with Na_2O, CaO and P_2O_5. This suggests that Ti, Al and Fe are terrigenous whereas Na, Ca and P tend to precipitate in the ocean; consequently, the former group is diluted by the latter.

Chemical Features of Zeolitic Sediments

The sample description (Table XII–1) indicates that the several types of sediments are discriminated in this area. For example, vertical variations of some oxide concentrations along with the lithological description of core P194 are depicted in Fig. XII–2. This core consists of three lithologic units—pelagic clay, zeolitic clay and siliceous ooze. A clear correlation between lithology and chemistry emerges in the figure. The average compositions of three lithological unites for all the samples are compared with each others in Table XII–6. It should be noted that Na_2O as a major component of zeolite is enriched in zeolitic clay.

If we assume that (1) zeolite does not contain Ti, (2) zeolitic clay is composed of zeolite and pelagic clay, and (3) the compositions of pelagic clay and zeolitic clay are represented by the averages of Table XII–6, we can get the following equations pertaining to TiO_2 content

$$0.778\,V_p + 0.0\,V_z = 0.571$$

$$V_p + V_z = 1$$

where V_p and V_z are fraction of pelagic clay and that of zeolite, in zeolitic clay, respectively: 0.778 and 0.571 are the averaged TiO_2 concentration of pelagic clay

Table XII-6 Average and their standard deviation of major constituents of sediments of the three types

	Pelagic sediments	Zeolitic sediments	Siliceous sediments
Number of Samples	49	28	27
SiO_2	59.39±1.27	58.70±1.25	64.88±9.30
TiO_2	0.78±0.077	0.57±0.092	0.62±0.20
Al_2O_3	17.65±0.89	15.75±1.31	14.60±4.33
Fe_2O_3	8.37±0.59	7.17±0.69	6.67±1.96
FeO	0.17±0.039	0.19±0.10	0.16±0.06
MnO	1.78±0.55	1.99±0.39	1.23±0.50
MgO	3.93±0.43	4.16±0.33	3.03±0.72
CaO	1.47±0.36	2.84±1.15	1.50±0.49
Na_2O	3.08±0.69	4.20±0.56	4.00±1.04
K_2O	2.92±0.29	2.90±0.39	2.66±0.74
P_2O_5	0.47±0.28	1.52±0.82	0.55±0.45
Fe_2O_3/FeO	97.84±0.56	97.12±1.52	97.14±1.57
Tot·Fe_2O_3	8.56±0.59	7.39±0.70	6.96±2.00

Table XII-7 Comparison of calculated composition of zeolite in the present sediments and an analytical example of deep sea phillipsite

	Calculated composition of zeolite	Deep sea phillipsite*
SiO_2	56.8	60.4
Al_2O_3	10.51	19.2
Fe_2O_3	4.16	1.90
MgO	4.79	0.70
CaO	6.62	0.56
Na_2O	7.29	4.71
K_2O	2.84	7.08

*Quoted from Table 2 of SHEPPARD *et al.* (1970).

and zeolitic clay, respectively. From the equations, we get $V_p = 0.734$ and $V_z = 0.266$. With this volume ratio and the average composition for pelagic clay and zeolitic clay (Table XII–5), the averaged chemical composition of zeolite can be calculated by the same way. The calculated results are shown in Table XII–7. For comparison, the chemical composition of a deep sea phillipsite analyzed by SHEPPARD *et al.* (1970) is listed in the table. Both are not identical. This discrepancy suggests that the above assumption for estimation is incorrect and the amount of zeolite is overestimated. Furthermore, sediments designated as normal pelagic clay in Table XII–1 show also high Na_2O content, comparing with other deep ocean (Table XII–5). The evidence infers that (1) the present sediments were originally enriched in Na_2O; The high content of Na_2O could be ascribed to montmorillonites which abundantly occur in the south Pacific sediments (GRIFFIN *et al.* 1968): (2) zeolites have formed in sediments where sodium is conspicously abundant; the ocean floor in this area inherently gives an environment favorable for the genesis of zeolite. Diagensis, hydrothermal process and metamorphism have been accepted to be responsible for the formation of zeolite. Zeolites in the present area occur in young sediments near surface of the ocean floor and they are likely to have formed as a result of diagenesis in sodium rich environment.

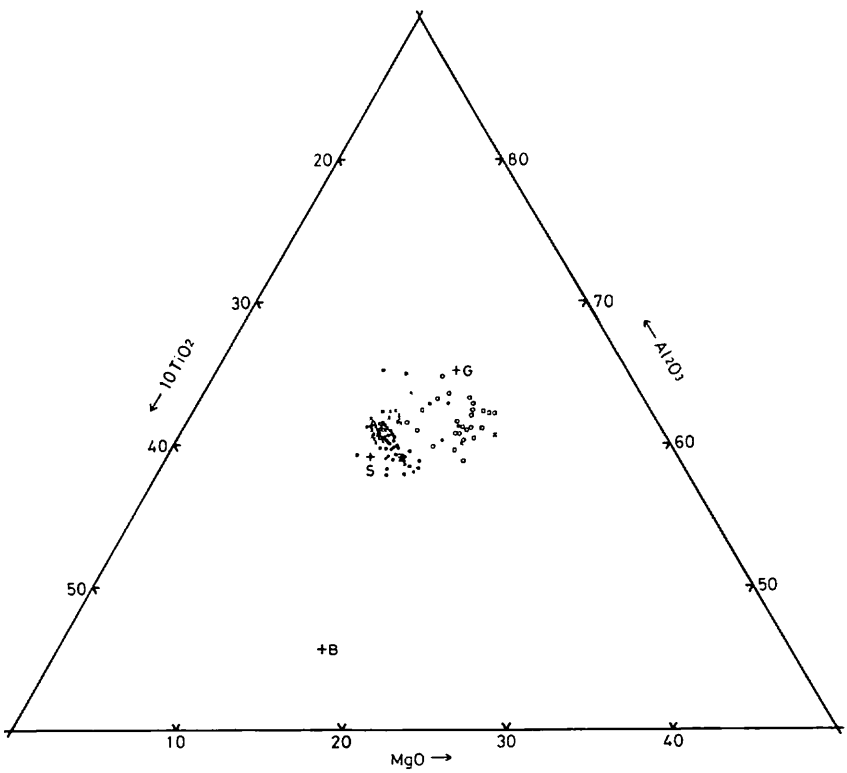

Fig. XII–1 Relationship among TiO_2–Al_2O_3–MgO. Open circles, closed circles and Xs represent zeolitic clay, pelagic clay and siliceous clay, respectively. Crosses represent averaged rocks. G: granites, B: basalts (DALY 1933), S: sediments of GH79–1 (SUGISAKI 1981).

Origin of High Phosphorus Sediments

The sediments from the cruises of GH79–1 and GH80–1 are enriched in phosphates. Chemical inspection disclosed that the phosphorus is derived from (1) deposition of calcium phosphates such as francolite and/or (2) alkaline series volcanic rocks of submerged volcanic islands. The origin of phosphorus in GH79–1 sediments can be assigned to the first case (SUGISAKI 1981a), whereas that of GH80–1 to both

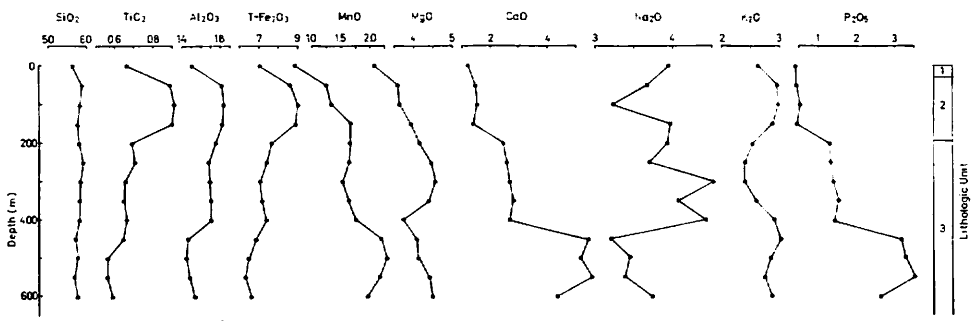

Fig. XII–2 Vertical variation of oxides (in wt.%) and the lithologic unit of core P194. 1: siliceous clay, 2: pelagic clay, 3: zeolitic clay.

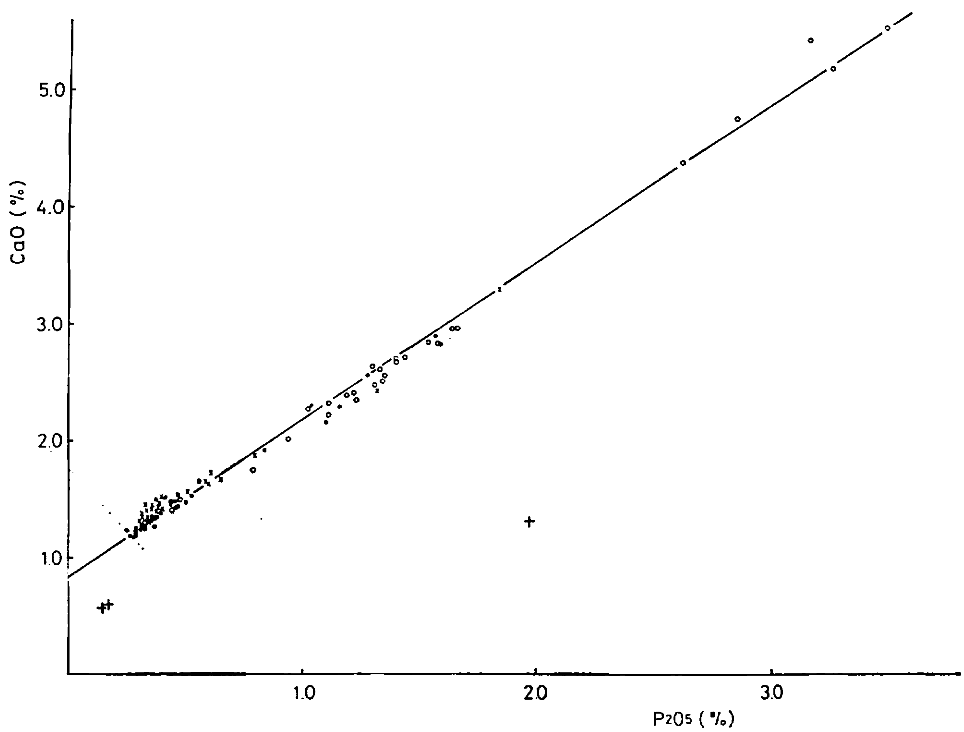

Fig. XII–3 Relationship between CaO and P_2O_5. The symbols are the same as those in Fig. 1. Crosses showing high silica samples are excluded from the calculation of the regression line: $CaO = 1.328P_2O_5 + 0.848$ with a correlation coefficient of 0.997.

(SUGISAKI and KINOSHITA, 1982).

P_2O_5 content was plotted against CaO for the present samples (Fig. XII–3). A clear correlation with the correlation coefficient of 0.997 gives 5 : 2.97 for the atomic ratio of Ca : P and the calculated ratio can be regarded as 5 : 3. This indicates the formation of calcium phosphates resulted from chemical precipitation and/or inorganic replacement of carbonate materials; a contribution of phosphorus from volcanic rocks which was observed on the Manihiki Plateau (SUGISAKI and KINOSHITA, 1982) is not recognized in this area. Figure XII–3 and Table XII–6 clearly show that the calcium and phosphorus contents are higher in zeolitic clay than in other types of sediments. Although a genetic relation between zeolite and calcium phosphates may not be possible, a chemical and biological environment in the zeolitic clay would have been unique.

Summary

The major-element chemistry of 106 marine sediments from the GH80–5 area showed aspects as follows.

(1) Calcium carbonates do not occur in this area where the water depths exceed the calcium carbonate compensation depth.

(2) The present samples tend to be riched in Na_2O and P_2O_5 and impoverished in SiO_2, comparing with other oceanic sediments.

(3) SiO_2 has no relation with other oxides in their concentration. This suggests that a biological activity pertaining to SiO_2 is low in this area.

(4) Al_2O_3–TiO_2–MgO relation reflects dominantly derived detritus with minimal secondary modification.

(5) Zeolitic clay shows high content of Na_2O which is a major component of zeolite. Whereas the Na_2O content of pelagic clay is also higher than that in other regions. The enrichment of Na_2O can be related with montmorillonite-rich sediments which are abundant in the central Pacific. The sediments likely afford a favorable environment for zeolite formation.

Acknowledgment

The authors gratefully acknowledge the technical assistance of Mrs. Yumiko HASHIMOTO.

References

DALY, R. A. (1933) *Igneous rocks and the depths of the earth.* McGraw-Hill Book Company, N.Y., 598p.

EL WAKEEL, S. K. and RILEY, J. P. (1961) Chemical and mineralogical studies of deep-sea sediments. *Geochim. Cosmochim. Acta*, vol. 25, p. 110–146.

GRIFFIN, J. J., WINDOM, H. and GOLDBERG, E. D. (1968) The distribution of clay minerals in the world ocean. *Deep-Sea Res.*, vol. 15, p. 433–459.

SHEPPARD, R. A., GUDE, III, A. J. and GRIFFIN, J. J. (1970) Chemical composition and physical properties of phillipsite from the Pacific and Indian Oceans. *Am. Mineral.*, vol. 55, p. 2053–2062.

SUGISAKI, R. (1978) Chemical composition of argillaceous sediments on the Pacific margin of southwest Japan. *Geol. Surv. Japan Cruise Rept.*, no. 6, p. 65–73.
SUGISAKI, R. (1980) Major element chemistry of the Japan Trench sediments, Legs 56 and 57, Deep-Sea Drilling Project. *In* Scientific Party, *Initial Reports of DSDP*, vol. 56–57, Washington (U.S. Government Printing Office), pt. 2, p. 1233–1249.
SUGISAKI, R. (1981a) Major-element chemistry of Bottom sediments from the GH79–1 area, the northern central Pacific Basin. *Geol. Surv. Japan Cruise Rept.*, no. 15, p. 236–244.
SUGISAKI, R. (1981b) A modified method of analysis of bulk chemical composition of agrillaceous sediments and data display with special reference to marine sediments. *Jour. Geol. Soc. Japan*, vol. 87, p. 77–85.
SUGISAKI, R. and KINOSHITA, T. (1981) Chemical composition of marine agrillaceous sediments around the Izu-Ogasawara Islands. *Geol. Surv. Japan Cruise Rept.*, no. 14, p. 146–158.
SUGISAKI, R. and KINOSHITA, T. (1982) Major element chemistry of the sediments on the central Pacific transect, Wake to Tahiti, GH80–1 Cruise. *Geol. Surv. Japan Cruise Rept.*, no. 18, p. 293–312.