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XIV. MAJOR ELEMENT CHEMISTRY OF THE SEDIMENTS ON THE CENTRAL PACIFIC TRANSECT, WAKE TO TAHITI, GH80-1 CRUISE

Ryuichi Sugisaki and Takashi Kinoshita***

Introduction

One of the authors described major element chemistry of pelagic sediments which were sampled from the northern Central Pacific Basin, during GH79–1 cruise, Geological Survey of Japan (SUGISAKI, 1981a). In the present investigation, we analyzed 127 sediment samples collected during GH80–1 cruise. These samples were taken on paralled two traverses, about 2,000 km long each, which ran from NW to SE in the Central Pacific. The traverses are divided into three segments. The northwestern segment comprises the Mid-Pacific Mountains area and the northern and central parts of the Central Pacific Basin. The middle segment is represented by the North Tokelau Basin and a part of the southern part of Central Pacific Basin on the south of the Nova-Canton Trough. The southeastern segment includes the Manihiki Plateau, the Penrhyn Basin, and the Manihiki Northeastern Basin.

The main body of the present paper deals with chemical characteristics of these samples, comparison of their chemical features with those of other regions, and discussions of sediment sources.

Samples and analyses

The 127 samples for this study (Table XIV-1) were selected on the ship from 17 piston cores and 27 box cores, which were taken by shipboard members from 44 locations along the traverses.

The samples were dried at 70°C and ground. They were analyzed for their major chemical compositions according to the method of SUGISAKI (1981b). AppendixXIV-1 lists the analytical results. The results show that the samples contain various amounts of water, carbonates, organic matters, and others. In order to discuss comprehensively including the data from the other region, the analytical data were recalculated into the compositions on water, carbonate, and other free basis. The results were listed in Table XIV-2, and the recalculated data will be mostly used in the following discussions.

General characteristics of the sediments

$CaCO_3$ is found in some samples and not in the others. Sample Nos. 96, 99, 100, 102, 103, and 104, which contain $CaCO_3$, were collected from the box cores on the Manihiki Plateau. The water depths of the samples are 4,947 m, 4,650 m, 4,155 m, 4,561 m, 2,944 m, and 2,763 m, respectively. Clearly all the sites do not exceed the calcium carbonate compensation depth, and the presence of the carbonates in them is reasonable. On the

*Department of Earth Sciences, Nagoya University, Chikusa-ku, Nagoya 464.
**Tamano Consultants Co. Ltd., Higashi-ku, Nagoya 461.

Table XIV-1 Description of samples.

Sample No.	Station	Observ. No.	Latitude	Longitude	Depth (m)	Location (cm)	Sediments
1	1647	B32(C)	16°10.14′N	179°19.82′W	5292		Zeolitic mud
2	1590	B2(S)	15°23.31′N	178°43.79′E	5287	Surface	Zeolite rich clay
3	1590	B2(S)	15°23.31′N	178°43.79′E	5287	10–15	Zeolite rich clay
4	1646	B31(C)	15°22.48′N	178°45.46′W	5537		Zeolite rich clay
5	1645	B30(C)	14°06.61′N	177°47.28′W	5068		Zeolite rich clay
6	1644	P179	13°16.99′N	177°08.35′W	5027	5–15	Zeolitic mud
7	1644	P179	13°16.99′N	177°08.35′W	5027	115–125	Zeolitic mud
8	1644	P179	13°16.99′N	177°08.35′W	5027	195–205	Zeolitic mud
9	1644	P179	13°16.99′N	177°08.35′W	5027	300–310	Zeolitic mud
10	1642	P178	11°06.38′N	175°30.67′W	5441	20–30	Siliceous fossil rich clay
11	1642	P178	11°06.38′N	175°30.67′W	5441	90–100	Siliceous fossil rich clay
12	1642	P178	11°06.38′N	175°30.67′W	5441	215–225	Siliceous fossil rich clay
13	1642	P178	11°06.38′N	175°30.67′W	5441	320–330	Siliceous fossil rich clay
14	1642	P178	11°06.38′N	175°30.67′W	5441	415–425	Siliceous fossil rich clay
15	1642	P178	11°06.38′N	175°30.67′W	5441	515–525	Siliceous fossil rich clay
16	1642	P178	11°06.38′N	175°30.67′W	5441	620–630	Siliceous fossil rich clay
17	1642	P178	11°06.38′N	175°30.67′W	5441	680–690	Siliceous fossil rich clay
18	1642	P178	11°06.38′N	175°30.67′W	5441	725–735	Siliceous fossil rich clay
19	1641	B29(C)	9°46.81′N	174°31.04′W	5829		Siliceous fossil rich clay
20	1640	P177	8°57.86′N	173°53.91′W	5915	5–20	Siliceous mud
21	1640	P177	8°57.86′N	173°53.91′W	5915	125–135	Siliceous mud
22	1640	P177	8°57.86′N	173°53.91′W	5915	235–245	Siliceous mud
23	1640	P177	8°57.86′N	173°53.91′W	5915	290–300	Siliceous mud
24	1640	P177	8°57.86′N	173°53.91′W	5915	345–355	Siliceous mud
25	1640	P177	8°57.86′N	173°53.91′W	5915	425–435	Siliceous mud
26	1640	P177	8°57.86′N	173°53.91′W	5915	525–535	Siliceous mud
27	1640	P177	8°57.86′N	173°53.91′W	5915	625–635	Siliceous mud
28	1640	P177	8°57.86′N	173°53.91′W	5915	725–735	Siliceous mud
29	1639	B28	7°40.26′N	172°56.77′W	5926		Siliceous mud
30	1598	B4	6°49.67′N	174°47.63′W	5962	Surface	Siliceous fossil rich clay
32	1638	P176	6°48.65′N	172°15.46′W	5791	10–20	Siliceous mud
33	1638	P176	6°48.65′N	172°15.46′W	5791	125–135	Siliceous mud
34	1638	P176	6°48.65′N	172°15.46′W	5791	225–235	Siliceous mud
35	1638	P176	6°48.65′N	172°15.46′W	5791	325–335	Siliceous mud
36	1638	P176	6°48.65′N	172°15.46′W	5791	525–535	Siliceous mud
37	1637	B27(C)	5°31.51′N	171°18.84′W	5970		Siliceous mud
38	1600	B5	4°41.39′N	173°11.89′W	5584	Surface	Siliceous mud
39	1636	P175	4°43.37′N	170°42.88′W	5747	115–125	Siliceous mud
40	1636	P175	4°43.37′N	170°42.88′W	5747	225–235	Siliceous mud
41	1636	P175	4°43.37′N	170°42.88′W	5747	315–325	Siliceous mud
42	1636	P175	4°43.37′N	170°42.88′W	5747	515–525	Siliceous mud

Table XIV-1 (Continued)

Sample No.	Station	Observ. No.	Latitude	Longitude	Depth (m)	Location (cm)	Sediments
43	1636	P175	4°43.37′N	170°42.88′W	5747	625–635	Siliceous mud
44	1636	P175	4°43.37′N	170°42.88′W	5747	715–725	Siliceous mud
45	1601	B6	3°17.83′N	172°10.51′W	5350	Surface	Siliceous mud
46	1602	B7	2°33.26′N	171°37.69′W	5389	Surface	Siliceous mud
47	1635	B26	3°16.42′N	169°40.10′W	5351		Siliceous ooze
48	1635A	P174	3°16.31′N	169°40.25′W	5350	50–60	Siliceous ooze
49	1635A	P174	3°16.31′N	169°40.25′W	5350	335–345	Siliceous ooze
50	1635A	P174	3°16.31′N	169°40.25′W	5350	740–750	Siliceous ooze
51	1634	P173	2°32.13′N	169°06.07′W	5087	30–40	Siliceous calcareous marly ooze
52	1634	P173	2°32.13′N	169°06.07′W	5087	140–150	Siliceous calcareous marly ooze
53	1634	P173	2°32.13′N	169°06.07′W	5087	240–250	Siliceous calcareous marly ooze
54	1634	P173	2°32.13′N	169°06.07′W	5087	320–330	Siliceous calcareous marly ooze
55	1634	P173	2°32.13′N	169°06.07′W	5087	440–450	Siliceous calcareous marly ooze
56	1634	P173	2°32.13′N	169°06.07′W	5087	540–550	Siliceous calcareous marly ooze
57	1634	P173	2°32.13′N	169°06.07′W	5087	640–650	Siliceous calcareous marly ooze
58	1634	P173	2°32.13′N	169°06.07′W	5087	740–750	Siliceous calcareous marly ooze
59	1603	P159	1°17.22′N	170°42.28′W	5479	0–15	Siliceous mud
60	1603	P159	1°17.22′N	170°42.28′W	5479	55–65	Siliceous mud
61	1603	P159	1°17.22′N	170°42.28′W	5479	240–250	Siliceous mud
62	1603	P159	1°17.22′N	170°42.28′W	5479	440–450	Siliceous mud
63	1603	P159	1°17.22′N	170°42.28′W	5479	640–650	Siliceous mud
64	1633	B25(C)	1°16.04′N	168°09.97′W	5359		Siliceous ooze
65	1604	B8	0°24.23′N	170°02.51′W	5457		Siliceous mud
66	1632	P172	0°26.16′N	167°33.83′W	5255	20–30	Siliceous nanno mud
67	1632	P172	0°26.16′N	167°33.83′W	5255	310–320	Siliceous nanno mud
68	1632	P172	0°26.16′N	167°33.83′W	5255	420–430	Siliceous nanno mud
69	1632	P172	0°26.16′N	167°33.83′W	5255	520–530	Siliceous nanno mud
70	1632	P172	0°26.16′N	167°33.83′W	5255	600–610	Siliceous nanno mud
72	1605	P160	0°57.91′S	169°01.69′W	5455	6–16	$CaCO_3$ rich siliceous mud
73	1605	P160	0°57.91′S	169°01.69′W	5455	165–175	$CaCO_3$ rich siliceous mud
74	1605	P160	0°57.91′S	169°01.69′W	5455	365–375	$CaCO_3$ rich siliceous mud
75	1605	P160	0°57.91′S	169°01.69′W	5455	565–575	$CaCO_3$ rich siliceous mud
76	1605	P160	0°57.91′S	169°01.69′W	5455	744–749	$CaCO_3$ rich siliceous mud
78	1630	P171	1°30.45′S	165°52.52′W	5537	15–34	Siliceous mud
79	1630	P171	1°30.45′S	165°52.52′W	5537	35–45	Siliceous mud
80	1630	P171	1°30.45′S	165°52.52′W	5537	135–145	Siliceous mud

Table XIV-1 (Continued)

Sample No.	Station	Observ. No.	Latitude	Longitude	Depth (m)	Location (cm)	Sediments
81	1630	P171	1°30.45′S	165°52.52′W	5537	235–245	Siliceous mud
82	1630	P171	1°30.45′S	165°52.52′W	5537	345–355	Siliceous mud
83	1630	P171	1°30.45′S	165°52.52′W	5537	435–445	Siliceous mud
84	1630	P171	1°30.45′S	165°52.52′W	5537	535–545	Siliceous mud
85	1630	P171	1°30.45′S	165°52.52′W	5537	625–635	Siliceous mud
86	1630	P171	1°30.45′S	165°52.52′W	5537	735–745	Siliceous mud
88	1607	P161	3°02.12′S	167°29.91′W	5698	25–35	Siliceous mud
89	1607	P161	3°02.12′S	167°29.91′W	5698	225–235	Siliceous mud
90	1607	P161	3°02.12′S	167°29.91′W	5698	515–525	Siliceous mud
91	1607	P161	3°02.12′S	167°29.91′W	5698	715–725	Siliceous mud
92	1629	B23(C)	2°53.00′S	164°57.31′W	5261	Surface	Siliceous mud
93	1628	P170	3°30.50′S	164°09.94′W	4947	10–25	Siliceous fossil rich clayey nanno ooze
94	1628	P170	3°30.50′S	164°09.94′W	4947	55–65	Siliceous fossil rich clayey nanno ooze
95	1628	P170	3°30.50′S	164°09.94′W	4947	150–160	Siliceous fossil rich clayey nanno ooze
96	1628	P170	3°30.50′S	164°09.94′W	4947	245–255	Siliceous fossil rich clayey nanno ooze
97	1628	P170	3°30.50′S	164°09.94′W	4947	345–355	Siliceous fossil rich clayey nanno ooze
98	1627	B22(C)	5°27.32′S	163°46.01′W	4995		Siliceous calcareous fossil rich mud
99	1625	B21	7°06.72′S	161°56.68′W	4650	Surface	Clayey nanno ooze
100	1611	B11	7°28.88′S	164°17.60′W	4155		Clayey nanno ooze
101	1612	P163	8°01.08′S	163°48.40′W	4808	60–65	Calcareous mud
102	1623	B20(C)	9°26.14′S	160°14.83′W	4561		Calcareous marly ooze
103	1613	B12	9°29.32′S	162°41.40′W	2944	Surface	Foraminifera ooze
104	1614	B13(C)	10°16.67′S	162°04.76′W	2763		Clayey nanno foraminifera ooze
105	1622	P167	10°16.35′S	159°35.57′W	5235	5–20	Zeolite rich mud
106	1622	P167	10°16.35′S	159°35.57′W	5235	35–45	Zeolite rich mud
107	1622	P167	10°16.35′S	159°35.57′W	5235	180–190	Zeolite rich mud
108	1622	P167	10°16.35′S	159°35.57′W	5235	380–390	Zeolite rich mud
109	1622	P167	10°16.35′S	159°35.57′W	5235	580–590	Zeolite rich mud
110	1621	B19(C)	11°35.38′S	158°34.91′W	5312	Surface	Zeolite rich mud
111	1621	B19(C)	11°35.38′S	158°34.91′W	5312	10–20	Zeolite rich mud
112	1616	B14	12°20.07′S	160°30.89′W	5690		Pelagic clay
113	1620	B18(C)	12°26.44′S	157°57.20′W	5285		Zeolitic mud
114	1620	B18(C)	12°26.44′S	157°57.20′W	5285	10–20	Zeolitic mud
115	1620	B18(C)	12°26.44′S	157°57.20′W	5285	Bottom	Zeolitic mud
116	1617	B15	13°47.40′S	159°28.35′W	5162	Surface	Pelagic clay
117	1617	B15	13°47.40′S	159°28.35′W	5162	20–30	Pelagic clay
118	1619	P166	13°34.03′S	157°06.01′W	5131	Surface	Zeolitic mud
119	1618	B16(C)	14°29.61′S	158°52.98′W	5453	Surface	Pelagic clay
120	1618	B16(C)	14°29.61′S	158°52.98′W	5453	17–24	Pelagic clay
121	1618A	P165	14°28.86′S	158°52.66′W	5530	10–26	Pelagic clay
122	1618A	P165	14°28.86′S	158°52.66′W	5530	70–80	Pelagic clay
123	1618A	P165	14°28.86′S	158°52.66′W	5530	150–160	Pelagic clay
124	1618A	P165	14°28.86′S	158°52.66′W	5530	370–380	Pelagic clay
125	1618A	P165	14°28.86′S	158°52.66′W	5530	470–480	Pelagic clay
126	1618A	P165	14°28.86′S	158°52.66′W	5530	570–580	Pelagic clay
127	1618A	P165	14°28.86′S	158°52.66′W	5530	670–680	Pelagic clay

Table XIV-2 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+}/To. Fe*	Tot Fe**
1	60.93	0.95	17.95	7.76	0.72	0.98	2.88	1.89	1.62	3.69	0.63	90.65	8.56
2	58.28	0.84	17.09	8.01	0.07	2.02	2.66	2.86	2.68	4.00	1.49	99.01	8.09
3	58.30	0.84	18.08	7.99	0.11	1.22	2.68	2.89	2.19	4.12	1.58	98.50	8.11
4	60.15	0.82	17.55	7.80	0.10	1.27	2.20	2.76	1.91	3.99	1.44	98.55	7.91
5	61.36	0.92	17.83	7.82	0.51	0.96	2.56	2.00	1.56	3.70	0.78	93.30	8.38
6	58.24	0.71	17.05	6.72	0.07	1.31	2.14	3.67	2.97	4.81	2.30	98.85	6.80
7	55.59	0.62	15.62	6.38	0.08	2.66	1.68	4.61	5.20	4.46	3.10	98.54	6.47
8	54.33	0.58	14.40	5.72	0.06	2.09	2.01	8.07	2.58	4.57	5.60	98.89	5.78
9	57.08	0.46	13.39	5.40	0.05	2.18	4.01	7.21	1.84	3.30	5.08	99.05	5.46
10	60.20	0.88	19.12	8.61	0.23	1.06	2.85	1.38	1.88	3.42	0.37	97.09	8.87
11	60.14	0.86	18.94	8.87	0.07	1.16	2.98	1.43	1.75	3.38	0.42	99.19	8.94
12	59.48	0.89	18.27	9.11	0.03	1.37	3.24	1.61	2.05	3.40	0.54	99.59	9.15
13	60.31	0.84	18.20	8.59	0.11	1.22	3.32	1.65	1.95	3.28	0.53	98.62	8.71
14	60.18	0.78	18.13	8.66	0.01	1.40	3.50	1.77	1.79	3.10	0.69	99.93	8.66
15	59.99	0.77	17.77	8.73	0.06	1.66	3.38	1.98	1.68	3.08	0.90	99.27	8.80
16	60.16	0.68	17.70	7.75	0.01	1.40	3.67	2.23	2.25	3.07	1.07	99.86	7.76
17	60.19	0.67	17.45	7.58	0.02	1.56	3.15	2.36	2.27	3.47	1.28	99.71	7.60
18	58.32	0.67	16.93	7.79	0.05	2.07	2.49	3.29	2.53	4.09	1.78	99.29	7.84
19	63.91	0.69	16.64	8.09	0.24	1.07	2.25	1.67	1.90	3.00	0.55	96.80	8.35
20	58.36	0.74	16.47	7.87	0.06	1.21	2.29	1.25	1.56	2.89	0.32	99.19	7.94
21	60.40	0.86	18.34	9.22	0.11	1.87	2.89	1.54	1.36	2.93	0.47	98.74	9.34
22	60.28	0.83	18.08	9.36	0.08	2.01	3.12	1.56	1.37	2.81	0.49	99.07	9.45
23	61.24	0.81	18.25	9.13	0.10	0.81	3.06	1.54	1.86	2.79	0.43	98.84	9.24
24	60.30	0.77	17.94	8.82	0.08	2.67	2.95	1.69	1.65	2.57	0.57	98.96	8.91
25	58.36	0.77	17.67	8.99	0.06	2.61	5.41	1.66	1.40	2.52	0.56	99.30	9.05
26	59.39	0.74	17.64	8.59	0.02	1.90	6.06	1.75	0.85	2.46	0.62	99.71	8.61
27	59.37	0.66	17.23	7.68	0.10	1.96	6.67	1.78	1.51	2.34	0.72	98.64	7.78
28	62.34	0.68	17.28	7.70	0.05	1.51	3.71	1.99	1.58	2.39	0.78	99.32	7.75
29	58.78	0.63	14.39	7.00	0.13	10.40	2.37	1.39	1.94	2.50	0.47	98.00	7.14
30	67.14	0.71	15.78	7.75	0.18	1.12	0.57	1.63	1.76	2.84	0.53	97.47	7.95
32	61.16	0.82	18.27	9.21	0.10	1.86	2.70	1.51	1.37	2.57	0.43	98.76	9.33
33	62.17	0.71	16.95	8.75	0.11	2.04	3.39	1.68	1.34	2.27	0.58	98.65	8.87
34	64.01	0.63	15.68	7.75	0.03	1.67	3.68	1.77	2.03	2.07	0.69	99.57	7.78
35	68.19	0.50	14.25	6.30	0.03	1.26	3.40	1.68	1.90	1.79	0.69	99.49	6.34

Table XIV-2 (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+}/To. Fe*	Tot Fe**
36	80.66	0.31	7.93	3.77	0.08	0.99	1.37	1.28	1.78	1.35	0.48	97.65	3.86
37	67.82	0.63	14.38	7.25	0.07	0.92	2.07	1.49	2.30	2.57	0.49	98.88	7.33
38	67.44	0.64	14.00	7.32	0.05	1.14	1.97	1.96	2.30	2.43	0.75	99.18	7.38
39	65.69	0.66	15.53	7.84	0.20	1.34	1.93	1.38	2.48	2.58	0.36	97.20	8.07
40	65.52	0.64	15.47	7.82	0.09	1.67	1.94	1.40	2.60	2.49	0.37	98.79	7.92
41	62.33	0.76	16.61	9.01	0.01	1.55	2.57	1.57	2.73	2.42	0.43	99.82	9.03
42	64.38	0.68	15.81	8.20	0.10	1.67	2.26	1.76	2.15	2.38	0.63	98.73	8.30
43	68.13	0.58	14.21	7.22	0.07	1.33	1.88	1.59	2.22	2.29	0.49	98.99	7.29
44	70.15	0.55	13.67	6.67	0.01	1.03	1.85	1.56	1.67	2.39	0.44	99.86	6.68
45	70.11	0.52	12.10	6.47	0.01	1.34	1.87	2.54	1.78	2.05	1.20	99.89	6.48
46	68.50	0.62	14.19	7.53	0.12	1.14	1.64	1.85	1.39	2.43	0.61	98.32	7.66
47	71.85	0.50	12.05	6.23	0.08	1.69	1.75	2.02	0.99	2.01	0.84	98.67	6.32
48	82.79	0.24	7.56	3.33	0.07	0.54	0.92	1.54	0.95	1.36	0.71	97.72	3.41
49	85.39	0.19	6.51	2.61	0.09	0.38	0.47	1.44	1.00	1.36	0.57	96.49	2.70
50	82.37	0.21	8.08	3.09	0.07	0.54	0.68	1.41	1.17	1.70	0.67	97.65	3.17
51	68.75	0.60	14.69	7.60	0.10	1.18	2.77	0.21	0.89	2.69	0.52	98.56	7.71
52	66.86	0.63	14.84	7.63	0.07	1.34	1.89	1.84	1.68	2.61	0.60	98.97	7.71
53	66.21	0.63	14.56	7.69	0.11	1.23	2.38	2.06	1.86	2.57	0.70	98.41	7.81
54	68.83	0.52	12.97	6.43	0.11	1.63	2.17	2.12	2.04	2.40	0.76	98.06	6.56
55	84.71	0.18	4.74	2.51	0.06	0.44	1.03	2.82	0.97	0.99	1.55	97.45	2.58
56	80.47	0.24	5.16	2.89	0.05	0.55	1.44	4.24	1.48	1.02	2.46	98.21	2.95
57	86.96	0.17	3.95	2.23	0.02	0.29	1.01	1.81	1.80	0.88	0.87	98.98	2.25
58	90.29	0.15	2.55	2.07	0.0	0.23	1.75	0.39	1.22	0.72	0.62	100.00	2.07
59	69.85	0.56	12.84	6.90	0.03	1.27	1.80	1.69	2.31	2.29	0.45	99.45	6.94
60	74.90	0.40	10.63	5.21	0.04	0.92	1.45	1.26	2.81	2.07	0.32	99.19	5.25
61	79.95	0.30	8.50	4.07	0.02	0.66	1.02	1.04	2.42	1.79	0.24	99.59	4.09
62	74.61	0.41	10.85	5.11	0.10	0.82	1.44	1.25	2.99	2.12	0.30	97.95	5.21
63	84.67	0.25	7.19	3.22	0.10	0.48	0.46	0.91	0.96	1.56	0.21	96.71	3.33
64	70.80	0.53	13.25	6.73	0.10	1.22	1.64	1.75	1.16	2.27	0.53	98.36	6.84
65	69.93	0.58	13.42	6.89	0.10	1.10	1.78	1.97	1.28	2.29	0.65	98.38	7.00
66	62.14	0.61	13.67	7.88	0.0	1.06	4.42	5.22	1.68	2.66	0.66	100.00	7.88
67	66.48	0.67	14.43	7.90	0.08	1.62	1.92	2.27	1.59	2.52	0.53	98.91	7.99
68	66.44	0.67	14.24	8.06	0.0	1.55	2.10	1.99	1.86	2.55	0.55	100.00	8.06
69	69.28	0.55	13.13	6.62	0.17	1.27	1.46	1.82	2.63	2.49	0.58	97.27	6.80

Table XIV-2 (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+}/To. Fe*	Tot Fe**
70	71.04	0.52	12.58	6.30	0.24	1.28	1.68	1.75	1.66	2.45	0.52	95.97	6.57
72	62.45	0.75	13.50	8.07	0.12	0.95	3.34	5.88	1.95	2.44	0.56	98.42	8.20
73	66.62	0.77	14.58	8.33	0.11	1.09	1.81	2.01	1.65	2.57	0.45	98.58	8.45
74	66.76	0.75	13.91	8.20	0.12	1.06	1.99	1.98	2.17	2.54	0.51	98.41	8.34
75	64.73	0.86	14.56	8.93	0.15	1.57	2.48	2.26	1.39	2.41	0.65	98.11	9.10
76	70.93	0.61	12.44	6.46	0.12	0.87	1.40	1.76	2.77	2.21	0.43	97.96	6.59
78	66.02	1.01	13.70	8.71	0.20	1.33	2.19	2.48	1.24	2.47	0.65	97.53	8.94
79	64.87	1.00	14.25	9.18	0.11	1.50	2.65	2.47	0.94	2.44	0.60	98.70	9.30
80	64.06	0.96	14.55	8.84	0.15	1.22	2.61	2.45	1.97	2.53	0.65	98.17	9.01
82	83.72	1.12	13.79	9.50	0.09	1.91	2.64	2.79	1.35	2.28	0.81	98.92	9.60
83	65.55	1.08	13.16	9.02	0.04	1.65	2.37	2.74	1.40	2.28	0.70	99.47	9.06
84	67.87	1.03	12.84	8.50	0.05	1.46	2.14	2.49	0.75	2.33	0.54	99.33	8.55
85	66.27	1.08	12.75	8.49	0.03	1.80	2.14	2.86	1.54	2.33	0.71	99.60	8.52
86	65.31	1.24	12.95	8.84	0.06	1.46	2.18	3.13	1.82	2.29	0.72	99.29	8.90
88	58.36	1.68	15.99	12.01	0.03	1.80	3.81	3.70	1.42	2.29	0.93	99.75	12.03
89	57.32	1.94	16.30	11.33	0.09	1.51	3.51	4.06	0.76	2.21	0.96	99.13	11.43
90	52.44	3.46	12.70	12.45	0.05	1.82	3.54	5.64	0.36	3.71	3.83	99.58	12.51
91	55.98	0.55	12.63	5.67	0.09	1.99	3.81	8.64	1.45	3.19	6.00	98.29	5.77
92	67.28	0.79	12.57	7.37	0.07	1.54	1.91	2.81	2.46	2.27	0.93	98.98	7.45
93	58.72	0.78	12.42	8.69	0.07	1.33	7.04	4.83	2.51	2.48	1.13	99.12	8.77
94	61.64	0.87	14.65	9.10	0.0	2.00	2.44	3.35	2.13	2.50	1.32	100.00	9.10
95	59.62	0.86	15.71	9.35	0.16	2.19	2.99	3.26	2.27	2.44	1.15	98.17	9.52
96	59.05	0.93	15.49	9.66	0.16	2.57	3.06	3.58	1.80	2.23	1.48	98.22	9.83
97	56.99	0.85	15.30	9.01	0.15	3.39	3.23	3.63	2.67	3.03	1.74	98.13	9.18
98	60.81	0.69	12.92	8.22	0.13	2.18	2.00	6.33	3.02	2.10	1.58	98.23	8.37
99	56.14	0.94	12.39	10.04	0.13	2.03	6.55	4.94	1.67	2.41	2.75	98.58	10.19
100	40.72	0.45	5.56	6.11	0.35	1.05	22.07	20.49	0.43	1.31	1.47	93.99	6.50
101	51.68	0.98	15.24	11.28	0.08	3.59	2.86	6.02	3.28	2.10	2.89	99.20	11.38
102	41.75	0.95	9.66	9.81	0.12	1.69	12.81	18.18	0.96	2.02	2.06	98.70	9.94
103	12.66	0.10	0.0	1.36	0.10	0.14	20.09	64.89	0.01	0.21	0.44	92.78	1.47
104	14.86	0.16	0.0	1.61	0.15	0.15	24.32	57.18	0.83	0.22	0.52	90.51	1.78
105	56.91	1.06	17.07	10.37	0.07	1.10	2.14	3.37	2.44	3.71	1.76	99.25	10.45
106	54.61	0.96	15.77	9.35	0.13	2.33	2.23	4.76	2.83	4.02	3.02	98.52	9.49
107	53.30	0.81	14.39	10.44	0.21	5.19	1.74	4.24	3.08	4.11	2.48	97.77	10.68

Table XIV-2 (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+}/To. Fe*	Tot Fe**
108	54.53	0.74	15.33	9.86	0.06	3.87	2.05	4.01	2.74	4.41	2.40	99.36	9.92
109	54.22	0.77	14.57	10.57	0.29	4.47	2.17	4.21	1.86	4.27	2.60	97.07	10.89
110	52.78	1.40	15.51	12.60	0.14	4.14	2.55	4.13	1.65	3.22	1.88	98.75	12.76
111	53.35	1.46	16.26	11.85	0.09	2.73	2.58	4.25	1.91	3.58	1.95	99.14	11.96
112	52.53	1.62	16.39	13.95	0.12	3.32	2.54	4.12	1.30	2.71	1.40	99.03	14.08
113	53.20	1.36	15.35	11.91	0.17	4.10	2.22	4.45	1.78	3.35	2.12	98.44	12.10
114	51.74	1.39	15.75	11.04	0.10	3.23	1.96	7.71	1.67	3.29	2.13	99.01	11.15
115	52.93	1.25	14.19	13.11	0.25	4.20	2.52	4.26	1.67	3.30	2.33	97.95	13.38
116	50.59	2.13	16.24	15.94	0.21	4.38	1.96	4.05	0.87	2.45	1.20	98.55	16.17
117	51.11	2.16	16.66	14.00	0.09	3.74	3.97	4.45	0.08	2.66	1.10	99.33	14.10
118	50.36	1.98	15.86	14.37	0.10	3.17	5.24	4.46	0.16	2.79	1.50	99.20	14.49
119	50.09	2.26	16.06	15.71	0.12	3.68	3.15	4.24	1.12	2.44	1.13	99.18	15.84
120	51.30	2.14	15.42	14.62	0.07	3.69	3.71	4.61	0.60	2.58	1.26	99.44	14.70
121	49.29	2.33	16.01	15.40	0.12	3.82	4.38	4.30	0.73	2.50	1.13	99.16	15.53
122	52.32	2.04	15.10	14.48	0.13	3.39	2.52	4.24	1.28	2.92	1.58	99.00	14.62
123	54.37	1.15	14.25	10.91	0.12	4.01	2.49	4.39	2.22	3.77	2.31	98.79	11.04
124	58.04	0.69	10.74	13.06	0.28	6.68	1.72	2.32	2.15	3.31	1.01	97.71	13.37
125	58.68	0.75	10.04	14.19	0.22	6.33	2.13	2.24	1.46	2.97	1.01	98.33	14.43
126	58.17	0.76	9.67	13.32	0.09	6.80	2.03	2.90	1.83	2.98	1.46	99.25	13.42
127	59.18	0.86	9.69	12.39	0.23	5.10	2.46	3.47	1.85	2.98	1.79	97.97	12.65

*Fe_2O_3/Total Fe as Fe_2O_3.
**Total Fe as Fe_2O_3.

Table XIV-3 Average chemical compositions (%) and standard deviations of sediments.

Area	GH80–1	GH79–1*	Izu–Ogasawara** Trench	Nankai Trough***
Number of samples	111****	34	48	29
SiO_2	62.88±8.47	62.83±6.34	65.60±3.24	66.88±1.99
TiO_2	0.88±0.52	0.84±0.26	0.74±0.09	0.72±0.06
Al_2O_3	14.44±3.16	15.91±1.53	16.06±0.91	16.51±0.64
Total Fe as Fe_2O_3	8.72±2.94	8.26±2.64	7.69±1.39	6.01±0.65
MnO	2.09±1.54	0.85±0.24	0.84±1.15	0.09±0.06
MgO	2.48±1.04	3.25±0.41	2.15±0.64	2.29±0.36
CaO	2.79±1.55	2.19±1.29	3.24±1.22	1.51±0.93
Na_2O	1.81±0.72	1.38±0.64	1.54±0.47	3.29±0.36
K_2O	2.73±0.77	3.48±0.71	2.22±0.51	3.09±0.41
P_2O_5	1.19±1.05	1.05±0.70	0.16±0.15	0.14±0.01

*Sugisaki (1981a).
**Sugisaki and Kinoshita (1981).
***Sugisaki (1978).
****Samples containing $CaCO_3$ were excluded from the average.

other hand, the presence of the calcium carbonates in sample, Nos. 51, 58, 66, 72, 78, and 93 is noticeable. Their water depths mostly exceed 5,000 m; moreover, these samples are all situated within 60 cm from the top of the cores, except for No 58. The samples in deeper parts of these cores do not contain $CaCO_3$. The presence of $CaCO_3$ at the top of cores may be attributed to the higher biological activity, which is suggested by the precipitation of much calcium phosphates, probably of biological origin, as stated later. If the deposition rate of calcium carbonate should exceed the dissolution rate, $CaCO_3$ would remain unsolved in the upper part of the cores, whereas, in the lower, it would solve during a long duration. $CaCO_3$ distribution similar to this case was reported for piston core P60 in the Shikoku Basin during GH75–4 (Sugisaki, 1978).

Table XIV-3 shows the comparison of sediment chemistry from various regions in the Pacific Ocean——continental slope, trench, and deep ocean basin, exemplified by the Nankai Trough, the Izu-Ogasawara Trench, and the northern Central Pacific Basin, respectively. This comparison indicates a tendency of chemical variation of sediments that Mn, Fe, and P increase with the distance from lands. This was partly discussed in our previous papers (Sugisaki, 1978; Sugisaki and Kinoshita, 1981; Kinoshita, 1981). Another aspect is a marked difference of the sediment chemistry between GH79–1 and GH80–1 areas. As shown in Table XIV-3, the concentrations of MnO, Fe_2O_3, and P_2O_5 in samples from the GH80–1 area are generally higher than those from GH79–1 area. The higher concentration of P_2O_5 implies a higher biological activity in this region, as stated later. The high concentrations of MnO and Fe_2O_3 in GH80–1 samples might be attributed to a lower sedimentation rate.

Precipitation of biological silica

The survey tracks cross the Nova Canton Trough and the Manihiki Plateau. For convenience of discussion, we classify the sediment samples into three groups as follows; the first collected from the northwestern segment (Sample Nos. 1–76), the second from the middle (Nos. 78–91), and the third from the southeastern (Nos. 92–127). The first seg-

Table XIV-4 Average and their standard deviation of major constituents of sediments in the three segments*.

	North area	Middle area	South area
Sample No.	1–76	78–92	95–127
SiO_2	66.39±7.96	62.54±5.11	54.35±3.32
TiO_2	0.63±0.30	1.30±0.74	1.30±0.56
Al_2O_3	14.49±3.72	13.71±1.26	14.68±2.11
Total Fe as Fe_2O_3	7.18±1.86	9.22±1.83	12.18±2.22
MnO	1.47±1.20	1.61±0.23	3.84±1.32
MgO	2.37±1.15	2.73±0.69	2.66±0.83
CaO	2.07±1.16	3.56±1.77	4.21±1.10
Na_2O	1.90±0.66	1.34±0.56	1.80±0.85
K_2O	2.63±0.82	2.51±0.44	3.08±0.65
P_2O_5	0.88±0.93	1.39±1.63	1.76±0.58

*Samples containing $CaCO_3$ were excluded from the average.

ment ends at the Nova Canton Trough in the south; the third includes the Manihiki Plateau and the Penrhyn Basin.

Average compositions of each group are listed in Table XIV-4. The classification is tentative and artificial; the middle segment could be discussed together with the southeastern segment. Some samples of the third group are collected from the Penrhyn Basin: they are characterized by high MnO content. The averages listed in the table are also tentative.

The comparison shows that the average SiO_2 in the first group is higher than those of the others. Sample descriptions (Table XIV-1) also show that siliceous mud or siliceous clay occurs in the first group. A clear relation between SiO_2 and Al_2O_3 in marine sediments from several regions was reported by SUGISAKI (1980; 1981a). The regression line calculated for the first group is $SiO_2=97.51-2.15Al_2O_3$ with a correlation coefficient of 0.915. The formula implies the precipitation of nearly pure silica. The evidence was observed also in the GH79–1 area adjacent to the present region. The pure silica was interpreted to have been derived from siliceous organisms such as diatom, sponge, radiolaria, and others (SUGISAKI, 1981a). In the GH80–1 samples, the biological contribution of silica to the sediments is similarly postulated. On the other hand, other two segments hardly show such a relation between Al_2O_3 and SiO_2, suggesting no precipitation of biogenic silica.

The core samples from the southern part of the first group, namely 159, 160, 172, 175, and 176, are responsible for the high SiO_2 content. Figure XIV-1 shows vertical variations of silica in some piston cores. This shows an increase of SiO_2 content with increasing depth of the samples in each core. For comparison, the figure contains also a core (piston core P178) located at the northern end of the survey area, which hardly shows any vertical trend of SiO_2 variation. In the southern part of the first group, samples deeper than 500 cm in some cores show SiO_2 content as high as 85–90%. This indicates that the productivity of siliceous organisms had been high when the sediments at these depth deposited in this area. These samples may be transformed into cherts during crystallization.

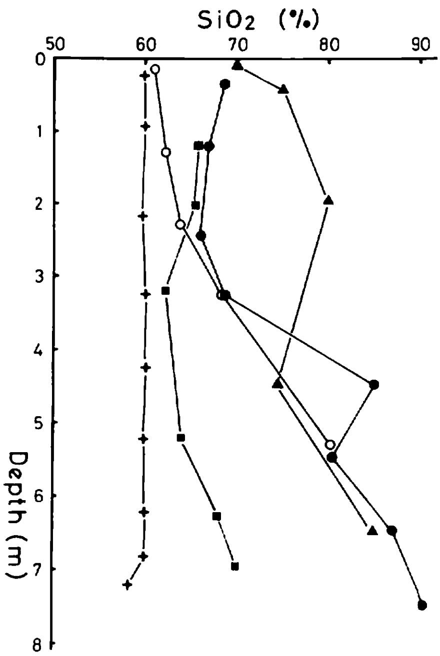

Fig. XIV-1 Vertical variations of SiO_2 content in several piston cores. Triangles; P159, solid circles; P173, squares; P175; open circles; P176; crosses; P178.

Precipitation of phosphates

The present samples generally contain much P_2O_5. For example, the P_2O_5 content of sample No. 91 amounts to 6.00% (Table XIV-2). Each average of P_2O_5 listed in Table XIV-4 mostly exceeds 1%, which is much larger than the world wide average of pelagic sediments (0.33%; WAKEEL and REILEY, 1961) and those of the sediments from the regions around the Japanese Islands (0.1 to 0.2%; Table XIV-3). The average observed for the sediments from GH79–1 cruise is also large as much as 1.05%; the phosphorus was interpreted to have been precipitated as calcium phosphates, because P_2O_5 positively correlated with CaO and the slope of the regression line gives atomic ratio of 5 to 3 for Ca to P (SUGISAKI, 1981a). These calcium phosphates also probably formed under the condition of high organic productivity. Figure XIV-2 shows the relationship between P_2O_5 and CaO in the present samples. A clear correlation on the plot emerges for the samples from the northwestern segment. The regression line for the northwestern samples gives atomic ratio of 5: 2.93 for Ca: P. This shows the formation of calcium phosphate, which results from chemical precipitation or inorganic replacement of carbonate materials. On the other hand, a correlation was hardly observed for the sediments in the other segments, and the compositional points in Fig. XIV-2 for the other segments are all located in the field above the correlation line for the northwestern segment.

From the above evidence, it seems that the source of phosphates in the southeastern segment of the survey lines is different from that of the rest. This difference will be discussed in the following lines.

Origin of the sediments

Several papers published by the authors (SUGISAKI, 1980; 1981a) show that the oceanic sediments around the Japanese Islands were derived from the rocks of the Islands and

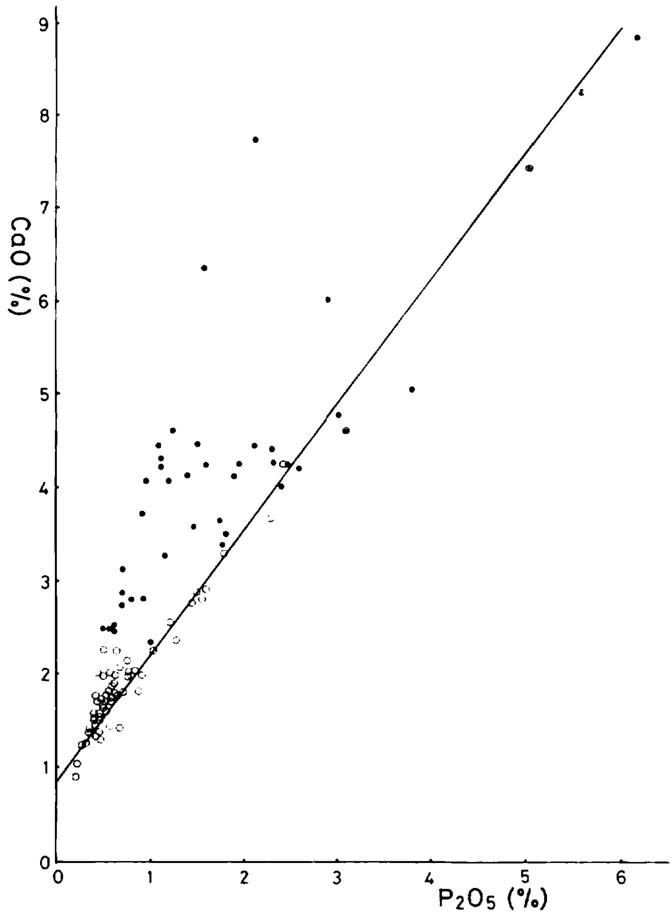

Fig. XIV-2 CaO versus P_2O_5 plots. Open and double circles represent samples from the northwestern segment. Solid circles do the others. The regression line was calculated on the basis of the data of the open circles and show the atomic ratio of 5: 2.93 for Ca: P.

the rock fragments become chemically homogeneous during sedimentation processes. The contribution from small islands such as the Izu-Ogasawara Islands to the marine sediments is not large in volume and is limited in a small local area around the islands (SUGISAKI and KINOSHITA, 1981). Figure XIV-3 shows the relationship among K_2O, Al_2O_3, and MgO in the present samples. The mutual ratio among these elements remains stationary during weathering or deposition, and the diagram is expected to be helpful in the examination of the sediment source.

The compositional points on the diagram are mostly located in a field between points of the world wide averages for granites and basalts. This suggests that main part of the sediments are derived from the continental rocks.

The compositional points of the samples from the southeastern segment more diverge than do those from the others. It seems therefore highly probable that some source

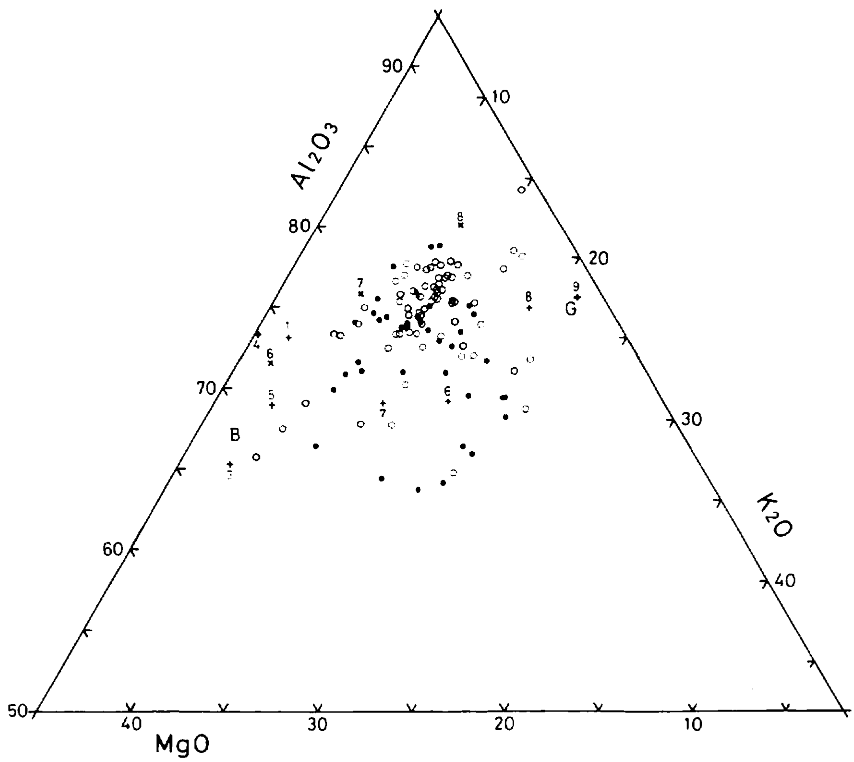

Fig. XIV-3 Al_2O_3–MgO–K_2O relation. All symbols are common to Fig. XIV-4. Open circles; samples from the northwestern segment, solid circles; samples from the other segments. G and B; the averaged granites and basalts, respectively (DALY, 1933). Crosses; the volcanics of Tahiti (MCBIRNEY and AOKI, 1968) (1; aphyric basalt, 2; olivine augite basalt; 3, alkali basalt, 4; basanite, 5; basanite, 6; aphyric tahitite, 7; tahitite, 8; trachyte, 9; trachyte). Xs; the volcanics of Hawaii (MACDONALD, 1968) (1; oceanite, 2; tholeiite and olivine tholeiite, 3; ankaramite, 4; alkali olivine basalt, 5; feldspar-phyric basalt, 6; hawaiite, 7; mugearite, 8; benmoreite, 9; basanitoid, 10; basanite.

other than the continental rocks is involved in the sediments.

The samples under consideration were collected from the survey lines which cross the Manihiki Plateau. The plateau is composed of early Cretaceous basalt of oceanic ridge tholeiite type overlain by thick sedimentary sequence of the early Cretaceous-Quaternary (SCHLANGER, JACKSON, *et al.*, 1976). For reference, several points of volcanic rocks from Tahiti and Hawaii are plotted in the figure. The points for the sediments on the Manihiki Plateau cluster around some points of the volcanic rocks from the island of Tahiti. The island of Tahiti and the Manihiki Plateau are both located between two island chains, viz., Tuamotu-Line and Austral-Gilbert-Marshall. According to the hypothesis by MORGAN (1971), these island chains were resulted from volcanisms due to mantle plumes when the Pacific plate moved. Symbols 6, 7, and 8 of Tahiti volcanics on the diagram, represent aphyric tahitite, tahitite, and trachyte, respectively, which are characteristic of Tahiti volcanics. The compositional similarity suggests that some

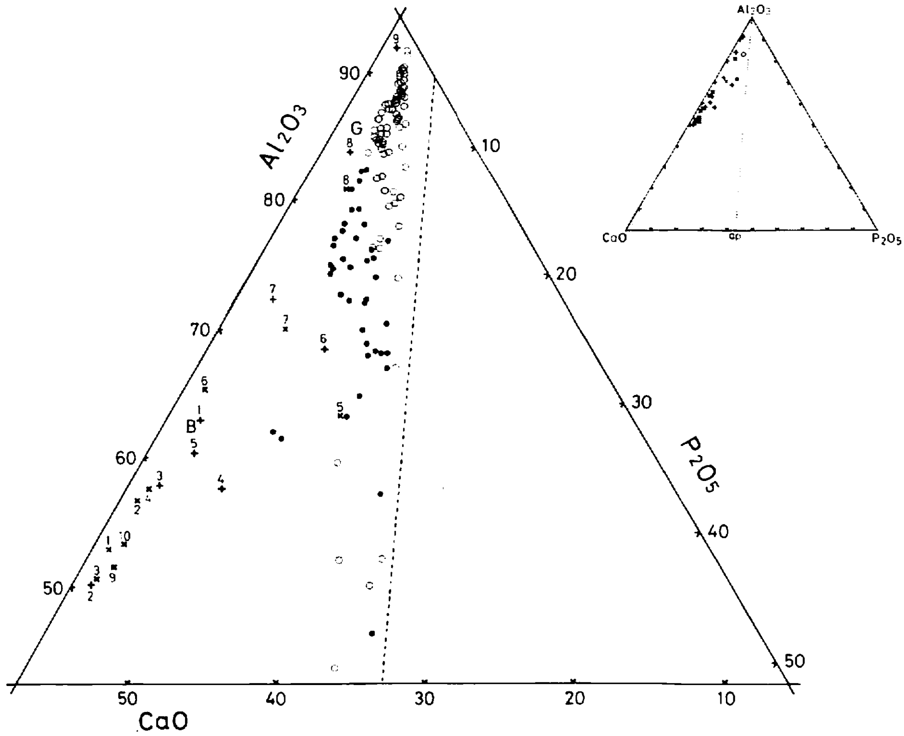

Fig. XIV-4 Al_2O_3–CaO–P_2O_5 relation. The symbols are common to those in Fig. XIV-3. Dotted line connects Al_2O_3 and apatite components. The upper right is index figure: open and solid circles represent the average compositions of the samples from the northwestern and the other segments, respectively.

volcanisms of Tahiti type have been active on the Manihiki Plateau and have contributed to the chemical composition of sediments, as postulated by DONNELLY and WALLACE (1976) on the basis of high Ti content in the Manihiki DSDP hole. The concentration of TiO_2 from the middle and southeastern segments is higher than that of the northwestern segment (Table XIV-3). This is not inconsistent with DONNELLY and WALLACE (1976)'s data.

The relationship among CaO, P_2O_5, and Al_2O_3 plotted in Fig. XIV-4 also shows the chemical resemblance between some Tahiti volcanics and the sediments on the Manihiki Plateau. These oceanic island volcanics are inherently enriched in P_2O_5: for example, aphyric tahitite contains 1.74% P_2O_5. In Fig. XIV-2, samples from the southeastern segment do not show a clear correlation between P_2O_5 and CaO. These points, on the plot of P_2O_5 versus CaO, are all located above the regression line for the northwestern samples. This evidence shows that P_2O_5 was partly derived from the volcanics of the Manihiki Plateau, although a part of phosphorus may precipitates as calcium phosphates. It can be concluded that the source of the phosphorus in sediments for the northwestern segment in the survey area is not identical to the southeastern one.

Summary

The analytical results of 127 sediments on the survey lines of GH80–1 cruise about 2,000 km long each, Wake to Tahiti, show several aspects of the sediments as follows.

Some samples within 60 cm from the core top contain $CaCO_3$, although the water depths of these sampling sites exceed the calcium carbonate compensation depth. This suggests the high biological activity. Concentrations of MnO, Fe_2O_3, and P_2O_5 in the present samples are higher than those from the GH79–1 area, suggesting the slow sedimentation rate and high biological activity in the present region. Sediments from the northwestern part of the survey lines show high SiO_2 content, suggesting the precipitation of pure silica as organisms. Much calcium phosphates also precipitate. Chemical compositions of these sediments suggest that the sediments are mostly terrigenous but some sediments on the Manihiki Plateau are derived from volcanics of the plateau.

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We would like to thank Miss Yumiko ISOBE for her technical assistance.

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Appendix XIV-1 Analyses of samples (Dried at 110°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	53.28	0.83	15.70	6.79	0.63	0.86	2.52	1.65	1.41	3.23	0.55	5.60	0.0	2.83	3.69	99.57
2	51.63	0.74	15.14	7.10	0.06	1.79	2.36	2.53	2.37	3.54	1.31	5.63	0.0	2.55	2.21	98.96
3	51.62	0.74	16.01	7.07	0.10	1.08	2.37	2.56	1.94	3.65	1.40	4.37	0.0	3.63	2.75	99.29
4	52.55	0.72	15.33	6.81	0.09	1.11	1.93	2.41	1.67	3.49	1.26	6.21	0.0	2.39	2.82	98.78
5	53.45	0.80	15.53	6.81	0.44	0.84	2.23	1.74	1.36	3.22	0.68	6.07	0.0	2.40	3.63	99.20
6	51.42	0.63	15.05	5.93	0.06	1.16	1.89	3.24	2.63	4.25	2.03	5.45	0.0	3.05	2.08	98.88
7	50.44	0.56	14.17	5.78	0.08	2.41	1.53	4.18	4.72	4.05	2.81	5.63	0.0	0.61	2.35	99.32
8	48.02	0.51	12.73	5.05	0.05	1.85	1.77	7.13	2.28	4.04	4.95	5.91	0.0	2.24	1.95	98.49
9	50.12	0.40	11.76	4.74	0.04	1.91	3.52	6.33	1.62	2.90	4.46	3.58	0.0	4.26	3.21	98.86
10	49.28	0.72	15.65	7.05	0.19	0.87	2.34	1.13	1.54	2.80	0.30	7.19	0.0	3.52	5.90	98.47
11	47.09	0.67	14.83	6.94	0.05	0.91	2.33	1.12	1.37	2.65	0.33	7.53	0.0	6.83	5.59	98.25
12	45.90	0.69	14.10	7.03	0.03	1.06	2.50	1.24	1.59	2.62	0.42	15.03	0.0	1.73	4.77	98.70
13	46.85	0.65	14.14	6.68	0.08	0.95	2.58	1.28	1.52	2.55	0.41	12.44	0.0	3.72	5.12	98.97
14	46.97	0.61	14.15	6.76	0.00	1.09	2.73	1.38	1.40	2.42	0.54	12.42	0.0	2.64	5.32	98.42
15	48.49	0.62	14.36	7.06	0.05	1.34	2.74	1.60	1.36	2.49	0.73	8.44	0.0	4.85	4.92	99.03
16	50.37	0.57	14.82	6.49	0.01	1.17	3.07	1.87	1.89	2.57	0.90	7.73	0.0	3.58	4.05	99.09
17	48.77	0.54	14.14	6.14	0.02	1.26	2.55	1.91	1.84	2.81	1.04	13.41	0.0	1.57	3.09	99.09
18	51.09	0.59	14.83	6.82	0.04	1.81	2.18	2.88	2.22	3.58	1.56	7.08	0.0	1.47	2.05	98.21
19	53.09	0.57	13.82	6.72	0.20	0.89	1.87	1.39	1.57	2.49	0.46	7.54	0.0	1.02	6.67	98.30
20	52.43	0.66	14.80	7.07	0.05	1.09	2.06	1.12	1.40	2.60	0.29	6.26	0.0	2.27	6.33	98.44
21	45.80	0.65	13.91	6.99	0.08	1.42	2.19	1.17	1.03	2.22	0.36	9.08	0.0	6.40	7.49	98.79
22	45.87	0.63	13.76	7.12	0.06	1.53	2.37	1.19	1.05	2.14	0.37	9.29	0.0	4.83	7.94	98.15
23	47.01	0.62	14.01	7.01	0.07	0.62	2.35	1.18	1.43	2.14	0.33	8.25	0.0	5.56	8.10	98.68
24	47.72	0.61	14.20	6.98	0.07	2.11	2.33	1.34	1.30	2.03	0.45	9.63	0.0	1.99	7.59	98.35
25	47.90	0.63	14.50	7.38	0.05	2.14	4.44	1.36	1.15	2.07	0.46	7.54	0.0	5.20	6.19	101.00
26	47.30	0.59	14.05	6.84	0.02	1.51	4.82	1.39	0.67	1.96	0.49	10.75	0.0	2.32	7.60	100.31
27	46.76	0.52	13.57	6.05	0.07	1.54	5.25	1.40	1.19	1.84	0.57	10.38	0.0	3.62	6.94	99.70
28	45.82	0.50	12.70	5.66	0.04	1.11	2.73	1.46	1.16	1.76	0.57	16.22	0.0	0.96	7.79	98.47
29	50.40	0.54	12.34	6.00	0.11	8.92	2.03	1.19	1.67	2.14	0.40	8.21	0.0	0.01	7.61	101.57
30	52.05	0.55	12.23	6.00	0.14	0.87	0.44	1.26	1.36	2.20	0.41	10.33	0.0	3.10	7.06	98.01
32	47.08	0.63	14.06	7.09	0.08	1.43	2.08	1.16	1.05	1.98	0.33	11.23	0.0	2.30	7.41	97.91
33	46.21	0.53	12.60	6.50	0.08	1.52	2.52	1.25	1.00	1.69	0.43	11.04	0.0	5.94	7.71	99.03
34	48.95	0.48	11.99	5.92	0.02	1.28	2.81	1.35	1.55	1.58	0.53	6.95	0.0	6.40	7.59	97.42
35	54.03	0.40	11.29	4.99	0.02	1.00	2.69	1.33	1.51	1.42	0.55	4.81	0.0	7.12	7.61	98.78

Appendix XIV-1 (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
36	65.12	0.25	6.40	3.05	0.07	0.80	1.11	1.03	1.44	1.09	0.39	6.62	0.0	4.12	6.79	98.27
37	54.00	0.50	11.45	5.77	0.06	0.73	1.65	1.19	1.83	2.05	0.39	7.66	0.0	5.50	6.91	99.69
38	53.37	0.51	11.08	5.79	0.04	0.90	1.56	1.55	1.82	1.92	0.59	6.23	0.0	6.35	7.79	99.50
39	51.78	0.52	12.24	6.18	0.16	1.06	1.52	1.09	1.96	2.03	0.28	10.24	0.0	1.30	7.71	98.08
40	49.97	0.49	11.80	5.97	0.07	1.27	1.48	1.07	1.98	1.90	0.28	10.12	0.0	3.31	8.23	97.93
41	50.31	0.61	13.41	7.28	0.01	1.25	2.08	1.27	2.20	1.95	0.35	7.66	0.0	4.12	6.56	99.06
42	50.10	0.53	12.30	6.33	0.07	1.30	1.76	1.37	1.67	1.85	0.49	8.09	0.0	4.38	7.77	98.06
43	52.44	0.45	10.94	5.55	0.05	1.02	1.45	1.22	1.71	1.76	0.38	10.11	0.0	1.98	8.24	97.29
44	53.66	0.42	10.46	5.10	0.01	0.79	1.42	1.19	1.28	1.83	0.34	11.43	0.0	2.71	8.43	99.07
45	52.38	0.39	9.04	4.83	0.00	1.00	1.40	1.90	1.33	1.53	0.90	11.39	0.0	6.03	7.87	100.00
46	47.42	0.43	9.82	5.21	0.08	0.79	1.13	1.28	0.96	1.68	0.42	18.84	0.0	3.91	8.36	100.34
47	56.18	0.39	9.42	4.87	0.06	1.32	1.37	1.58	0.77	1.57	0.66	12.45	0.0	0.64	7.98	99.26
48	66.29	0.19	6.05	2.67	0.06	0.43	0.74	1.23	0.76	1.09	0.57	10.32	0.0	2.85	6.20	99.45
49	65.98	0.15	5.03	2.02	0.07	0.29	0.37	1.11	0.77	1.05	0.44	11.08	0.0	4.33	7.34	100.03
50	65.26	0.17	6.40	2.45	0.05	0.43	0.54	1.12	0.93	1.35	0.53	8.98	0.0	4.67	6.78	99.66
51	46.18	0.40	9.87	5.11	0.07	0.79	1.86	0.14	0.60	1.81	0.35	11.00	12.71	0.10	7.32	98.30
52	52.26	0.49	11.60	5.97	0.06	1.05	1.48	1.44	1.31	2.04	0.47	9.79	0.0	3.91	7.21	99.08
53	52.31	0.50	11.50	6.07	0.09	0.97	1.88	1.63	1.47	2.03	0.55	9.34	0.0	4.21	6.85	99.41
54	55.28	0.42	10.42	5.17	0.09	1.31	1.74	1.70	1.64	1.93	0.61	11.40	0.0	0.12	6.39	98.22
55	68.68	0.15	3.84	2.04	0.05	0.36	0.83	2.29	0.78	0.80	1.26	5.50	0.0	4.83	7.59	99.00
56	66.07	0.20	4.24	2.38	0.04	0.45	1.18	3.48	1.21	0.84	2.02	5.10	0.0	5.46	6.87	99.54
57	71.92	0.14	3.27	1.84	0.02	0.24	0.83	1.50	1.49	0.73	0.72	6.48	0.0	5.55	4.94	99.68
58	58.00	0.10	1.64	1.33	0.0	0.15	1.12	0.25	0.78	0.46	0.40	5.43	22.00	0.57	7.26	99.49
59	52.44	0.42	9.64	5.18	0.03	0.95	1.35	1.27	1.73	1.72	0.34	10.11	0.0	2.68	10.48	98.34
60	56.44	0.30	8.01	3.93	0.03	0.69	1.09	0.95	2.12	1.56	0.24	11.83	0.0	2.05	8.85	98.09
61	63.01	0.24	6.70	3.21	0.01	0.52	0.80	0.82	1.91	1.41	0.19	7.50	0.0	5.54	8.73	100.59
62	59.81	0.33	8.70	4.09	0.08	0.66	1.16	1.00	2.40	1.70	0.24	8.85	0.0	3.70	7.47	100.18
63	65.28	0.19	5.54	2.49	0.08	0.37	0.36	0.70	0.74	1.20	0.16	8.17	0.0	5.00	8.12	98.38
64	52.05	0.39	9.74	4.95	0.07	0.90	1.21	1.29	0.86	1.67	0.39	8.44	0.0	6.51	9.12	97.58
65	51.53	0.43	9.89	5.08	0.07	0.81	1.31	1.45	0.94	1.69	0.48	6.02	0.0	7.87	10.09	97.67
66	35.74	0.35	7.86	4.53	0.0	0.61	2.54	3.00	0.97	1.53	0.38	3.78	30.77	3.49	5.75	101.31
67	52.67	0.53	11.43	6.26	0.06	1.28	1.52	1.80	1.26	2.00	0.42	6.64	0.0	6.79	6.64	99.31
68	51.79	0.52	11.10	6.28	0.0	1.21	1.64	1.55	1.45	1.99	0.43	6.27	0.0	8.83	6.68	99.74
69	53.98	0.43	10.23	5.16	0.13	0.99	1.14	1.42	2.05	1.94	0.45	8.25	0.0	2.35	7.34	95.86

Appendix XIV-1 (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
70	53.66	0.39	9.50	4.76	0.18	0.97	1.27	1.32	1.25	1.85	0.39	10.37	0.0	5.82	8.13	99.86
72	42.28	0.51	9.14	5.46	0.08	0.64	2.26	3.98	1.32	1.65	0.38	6.93	16.01	3.84	5.10	99.59
73	51.25	0.59	11.22	6.41	0.08	0.84	1.39	1.55	1.27	1.98	0.35	9.81	0.0	4.52	7.71	98.98
74	51.49	0.58	10.73	6.33	0.09	0.82	1.54	1.53	1.67	1.96	0.39	12.17	0.0	1.42	7.45	98.18
75	50.16	0.67	11.28	6.92	0.12	1.22	1.92	1.75	1.08	1.87	0.50	8.57	0.0	6.48	7.18	99.72
76	56.15	0.48	9.85	5.11	0.10	0.69	1.11	1.39	2.19	1.75	0.34	8.84	0.0	1.19	8.31	97.50
78	53.20	0.81	11.04	7.02	0.16	1.07	1.76	2.00	1.00	1.99	0.52	5.65	0.0	5.78	7.05	99.05
79	53.09	0.82	11.66	7.51	0.09	1.23	2.17	2.02	0.77	2.00	0.49	6.34	0.0	3.50	8.73	100.42
80	51.85	0.78	11.78	7.16	0.12	0.99	2.11	1.98	1.59	2.05	0.53	4.36	0.0	7.01	6.17	98.48
82	50.50	0.89	10.93	7.53	0.07	1.51	2.09	2.21	1.07	1.81	0.64	7.09	0.0	6.54	6.30	99.18
83	51.64	0.85	10.37	7.10	0.03	1.30	1.87	2.16	1.10	1.80	0.55	8.35	0.0	6.24	6.13	99.49
84	53.87	0.82	10.19	6.74	0.04	1.16	1.70	1.98	0.59	1.85	0.43	8.32	0.0	4.77	7.00	99.47
85	53.80	0.88	10.35	6.89	0.02	1.46	1.74	2.32	1.25	1.89	0.58	8.90	0.0	2.24	6.69	99.01
86	52.74	1.00	10.46	7.14	0.05	1.18	1.76	2.53	1.47	1.85	0.58	6.70	0.0	6.15	5.76	99.37
88	46.03	1.37	13.06	9.81	0.02	1.47	3.11	3.02	1.16	1.87	0.76	6.72	0.0	6.47	5.09	99.95
89	45.99	1.56	13.08	9.09	0.07	1.21	2.82	3.26	0.61	1.77	0.77	6.32	0.0	4.82	7.43	98.80
90	45.28	2.99	10.97	10.75	0.04	1.57	3.06	4.87	0.31	3.20	3.31	7.15	0.0	2.98	2.88	99.37
91	49.07	0.48	11.07	4.97	0.08	1.74	3.34	7.57	1.27	2.80	5.26	6.35	0.0	2.54	2.76	99.31
92	51.93	0.61	9.70	5.69	0.05	1.19	1.48	2.17	1.90	1.75	0.72	7.89	0.0	5.61	8.10	98.79
93	26.99	0.36	5.71	3.99	0.03	0.61	3.23	2.22	1.16	1.14	0.52	4.46	46.45	0.95	4.38	102.20
94	48.73	0.69	11.58	7.19	0.0	1.58	1.93	2.65	1.68	1.98	1.04	8.14	1.34	3.06	6.96	98.56
95	45.51	0.66	11.99	7.14	0.12	1.67	2.28	2.49	1.73	1.86	0.88	8.64	0.0	5.39	8.18	98.53
96	45.03	0.71	11.81	7.37	0.12	1.96	2.33	2.73	1.37	1.70	1.13	7.35	0.0	6.84	7.38	97.83
97	44.24	0.66	11.88	7.00	0.12	2.63	2.51	2.82	2.07	2.35	1.35	7.16	0.0	6.86	7.41	99.06
98	45.70	0.52	9.71	6.18	0.10	1.64	1.50	4.76	2.27	1.58	1.19	8.21	0.0	5.76	8.62	97.75
99	26.78	0.45	5.91	4.79	0.06	0.97	3.12	2.35	0.80	1.15	1.31	2.84	44.09	1.67	4.49	100.79
100	7.77	0.09	1.06	1.17	0.07	0.20	4.21	3.91	0.08	0.25	0.28	1.41	76.16	0.35	3.09	100.09
101	39.16	0.74	11.55	8.55	0.06	2.72	2.17	4.56	2.48	1.59	2.19	7.80	0.0	8.48	7.21	99.27
102	13.61	0.31	3.15	3.20	0.04	0.55	4.18	5.93	0.31	0.66	0.67	2.55	61.01	0.06	3.68	99.90
103	3.45	0.03	0.0	0.37	0.03	0.04	5.47	17.68	0.00	0.06	0.12	0.79	63.46	4.62	3.83	99.95
104	3.43	0.04	0.0	0.37	0.04	0.04	5.61	13.20	0.19	0.05	0.12	0.85	71.52	1.02	2.06	98.54
105	50.04	0.93	15.01	9.12	0.06	0.97	1.88	2.96	2.14	3.26	1.55	8.39	0.0	1.58	2.66	100.56
106	42.69	0.75	12.33	7.31	0.10	1.82	1.74	3.72	2.21	3.14	2.36	8.37	0.0	8.94	3.54	99.03
107	44.89	0.68	12.12	8.79	0.18	4.37	1.47	3.57	2.60	3.46	2.09	7.38	0.0	2.54	4.77	98.90

Appendix XIV-1 (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
108	45.88	0.62	12.90	8.30	0.05	3.26	1.73	3.37	2.31	3.71	2.02	6.60	0.0	4.86	4.00	99.60
109	45.24	0.64	12.16	8.82	0.24	3.73	1.81	3.51	1.55	3.56	2.17	8.09	0.0	3.71	4.66	99.89
110	44.11	1.17	12.96	10.53	0.12	3.46	2.13	3.45	1.38	2.69	1.57	8.61	0.0	2.61	4.61	99.41
111	45.78	1.25	13.95	10.17	0.08	2.34	2.21	3.65	1.63	3.07	1.67	5.07	0.0	5.22	3.40	99.49
112	42.71	1.32	13.33	11.34	0.10	2.70	2.07	3.35	1.05	2.20	1.14	4.38	0.0	7.05	7.11	99.85
113	43.88	1.12	12.66	9.82	0.14	3.38	1.83	3.67	1.47	2.76	1.75	7.45	0.0	4.70	4.52	99.15
114	46.61	1.25	14.19	9.94	0.09	2.91	1.76	6.95	1.50	2.96	1.92	7.69	0.0	0.10	3.63	101.50
115	45.14	1.07	12.10	11.18	0.21	3.58	2.15	3.63	1.42	2.81	1.99	4.45	0.0	5.02	4.30	99.05
116	38.48	1.62	12.35	12.12	0.16	3.33	1.49	3.08	0.66	1.86	0.91	7.09	0.0	8.65	7.43	99.23
117	41.94	1.77	13.67	11.49	0.07	3.07	3.26	3.65	0.07	2.18	0.90	6.28	0.0	6.21	5.46	100.01
118	40.40	1.59	12.72	11.53	0.08	2.54	4.20	3.58	0.13	2.24	1.20	6.87	0.0	6.55	6.71	100.34
119	40.65	1.83	13.03	12.74	0.10	2.99	2.56	3.44	0.91	1.98	0.92	7.32	0.0	5.15	6.20	99.82
120	42.60	1.78	12.80	12.14	0.06	3.06	3.08	3.83	0.50	2.14	1.05	9.01	0.0	2.67	4.13	98.85
121	40.24	1.90	13.07	12.57	0.10	3.12	3.58	3.51	0.60	2.04	0.92	8.85	0.0	4.13	4.87	99.49
122	43.58	1.70	12.58	12.06	0.11	2.82	2.10	3.53	1.06	2.43	1.32	7.25	0.0	3.56	4.76	98.85
123	43.38	0.92	11.37	8.70	0.10	3.20	1.99	3.50	1.77	3.01	1.84	14.57	0.0	1.04	3.54	98.94
124	48.46	0.58	8.97	10.90	0.23	5.58	1.43	1.94	1.80	2.76	0.84	8.02	0.0	2.16	5.62	99.29
125	48.76	0.62	8.34	11.79	0.18	5.26	1.77	1.86	1.21	2.47	0.84	10.06	0.0	1.13	4.79	99.08
126	47.42	0.62	7.88	10.86	0.07	5.54	1.66	2.36	1.49	2.43	1.19	10.71	0.0	1.12	4.78	98.13
127	48.65	0.71	7.97	10.19	0.19	4.19	2.02	2.85	1.52	2.45	1.47	10.15	0.0	2.86	4.21	99.42

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