Geological Survey of Japan Cruise Report No. 23, p. 79-85, 1994

VII. CHEMICAL COMPOSITION OF DEEP-SEA SEDIMENTS IN THE PENRHYN BASIN, SOUTH PACIFIC (GH83-3 AREA)

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Introduction

Characteristics of areal and vertical distributions of element concentrations in the Penrhyn Basin sediments are discussed. The concentrations of major elements (SiO_2, TiO_2, Al_2O_3, Fe_2O_3, FeO, MgO, CaO, K_2O, MnO, P_2O_5, and H_2O+) and minor elements (Co, Ni, Cu, Zn, and Pb) were determined for 16 sediment samples.

Sampling method and sample locations

Deep-sea sediments were collected in the western part of the Penrhyn Basin during the Cruise GH83-3 using a box corer and a piston corer (Figs. VII-1 and VII-2). Surficial sediments of 7 box cores from B86 to B100 (up to 33 cm long) and a piston core P399 (68 cm long) were selected for chemical analysis. 2 to 3 cm surficial sediment and 3-cm long subsamples were taken on board.

Preparation and analytical method

To determine the heavy metal elements (Co, Ni, Cu, Zn, and Pb), 110°C-dried sediments were decomposed by hydrofluoric acid, hydrochloric acid and perchloric acid without removing sea-salt. The solutions were evaporated to dryness and finally adjusted to 0.3-N hydrochloric acid and determined by atomic absorption spectrometry.

To determine the major elements (SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, Na_2O, K_2O, and H_2O+), wet sediments were rinsed by distilled water several times until sea-salt was removed. Then the rinsed sample was dried at 110°C for 3 hours. The analytical values were presented to 110°C dried basis. The concentration of SiO_2 was determined by gravimetric and spectrophotometric method, P_2O_5, TiO_2 and FeO by spectrophotometric method. Al_2O_3 by volumetric method. Mg, Ca, Na, K, Mn, total Fe by atomic absorption spectrometry, and H_2O+ by gravimetry. The concentration of Fe_2O_3 was calculated by subtracting FeO from total Fe.

Results and discussions

Concentrations of SiO_2, TiO_2, Al_2O_3, FeO, MgO, CaO, Na_2O, MnO, P_2O_5, H_2O+ in sediments are shown in Table VII-1. Those of Co, Ni, Cu, Zn, and Pb in sediments

Keywords: surface sediment, core sediment, atomic absorption, metal element, Manihiki Plateau, Hakurei-Maru, Penrhyn Basin

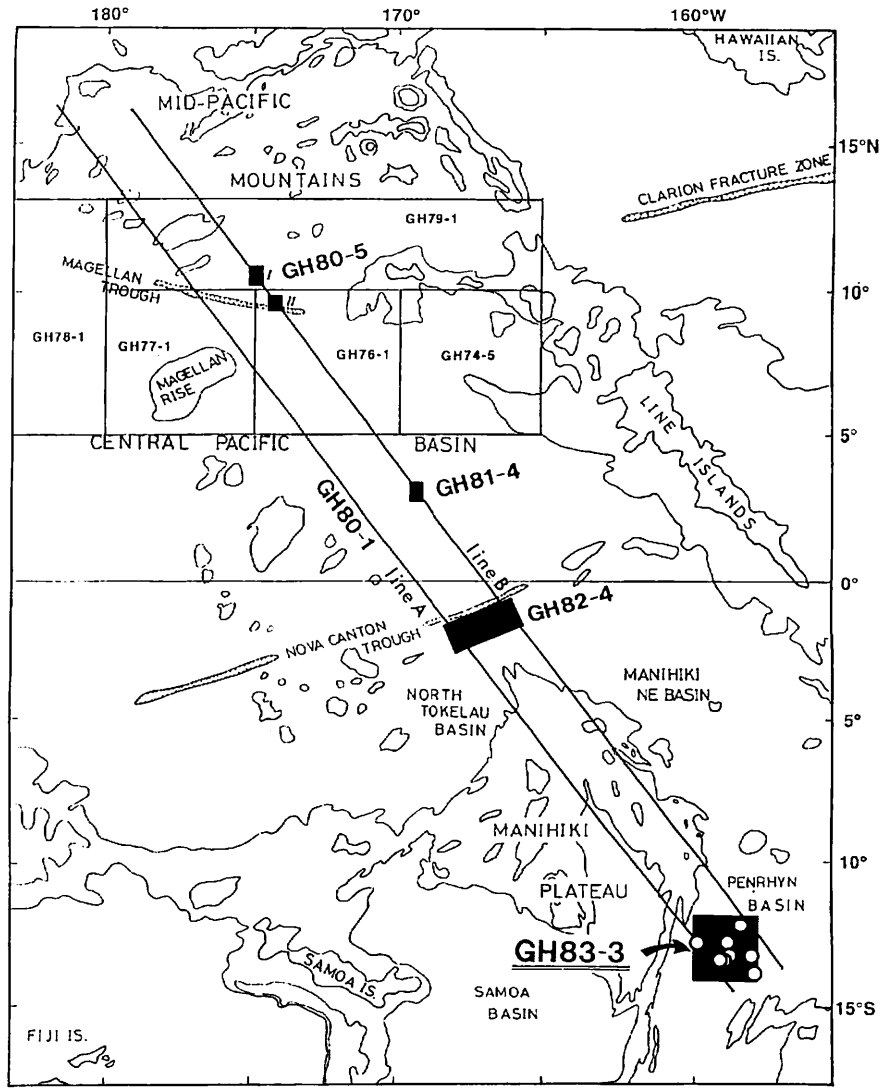

Fig. VII-1 Sample locations of GH83-3 sediments together with the previous study areas by GSJ.

are shown in Table VII-2. Sediment lithology is described by Nishimura and Saito (Chapter IV, this volume).

Characteristics of areal variation

Lisitzin (1978) reported that the average of Al/Ti is 32 in granite, 22 in andesite, and 11 in oceanic basalt. The values for andesite and oceanic basalt are shown in Fig. VII-3. The areal distribution of Al/Ti ratio, Fe, Mn, Fe/Mn ratio. Cu, Ni, and Cu/Ni ratio in the Penrhyn Basin sediments are shown in Fig. VII-3. The highest Al/Ti ratio in the sediments is 18.6 in P399-VIII45 (45 cm from sea floor). The ratios are generally lower than 20 for the Central Pacific Basin sediments (Mita and Nakao, 1990

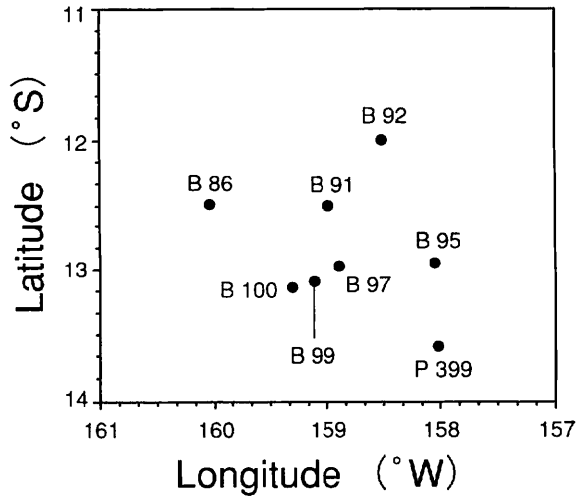

Fig. VII-2 Detail locations of sampling site in GH83-3 area. See in Chapter I for topography.

and 1992). Next higher value is 15 for the surficial sediment from B95 (27-30 cm). The ratios of 8.83 (B97), 8.05 (B99), and 8.48 (B100) are significantly lower than oceanic basalt. These three sediments are likely to be derived from weathered oceanic basalt. The ratios in other 11 samples (between 10.03 and 10.76) are close to that of oceanic basalt.

The Mn concentration (1.74 to 2.20%) of surficial sediments is generally high as compared with that of Central Pacific Basin sediments (Mita and Nakao, 1990 and 1992). The sediment from Unit II (Oligocene or older: Nishimura and Saito, Chapter IV) is significantly low (0.41% at P399-VIII45).

Downcore variations

The vertical distribution of major and minor elements in cores (B92 and B95) are shown in Figures VII-4 and VII-5. The concentrations of SiO_2 and Cu increase but those of Mn and Co decrease with depth from the sediment surface in B92. There is no significant downcore variations for other elements in the core. In the box core B95, SiO_2, CaO, Na_2O, K_2O, P_2O_5, Ni, and Cu increase with depth but Mn, Fe_2O_3, Zn, TiO_2, and Al_2O_3 decrease. Murray and Irvine (1895) first pointed out that Mn oxide (IV) is dissolved to soluble Mn (II) ion by microbial reduction in the deeper zone of sediments and mobilized in pore water to the upper zone by the compaction, and then eventually precipitated in oxidizing environment at the surface. Lynn and Bonatti (1965) and Li *et al.* (1969) assumed similar inorganic process of upward migration of manganese in deep-sea sediments. The downcore decrease of manganese in the core B95 may be caused by the process, although interstitial water chemistry and a comparative sediment chemistry data are needed to ascertain this process.

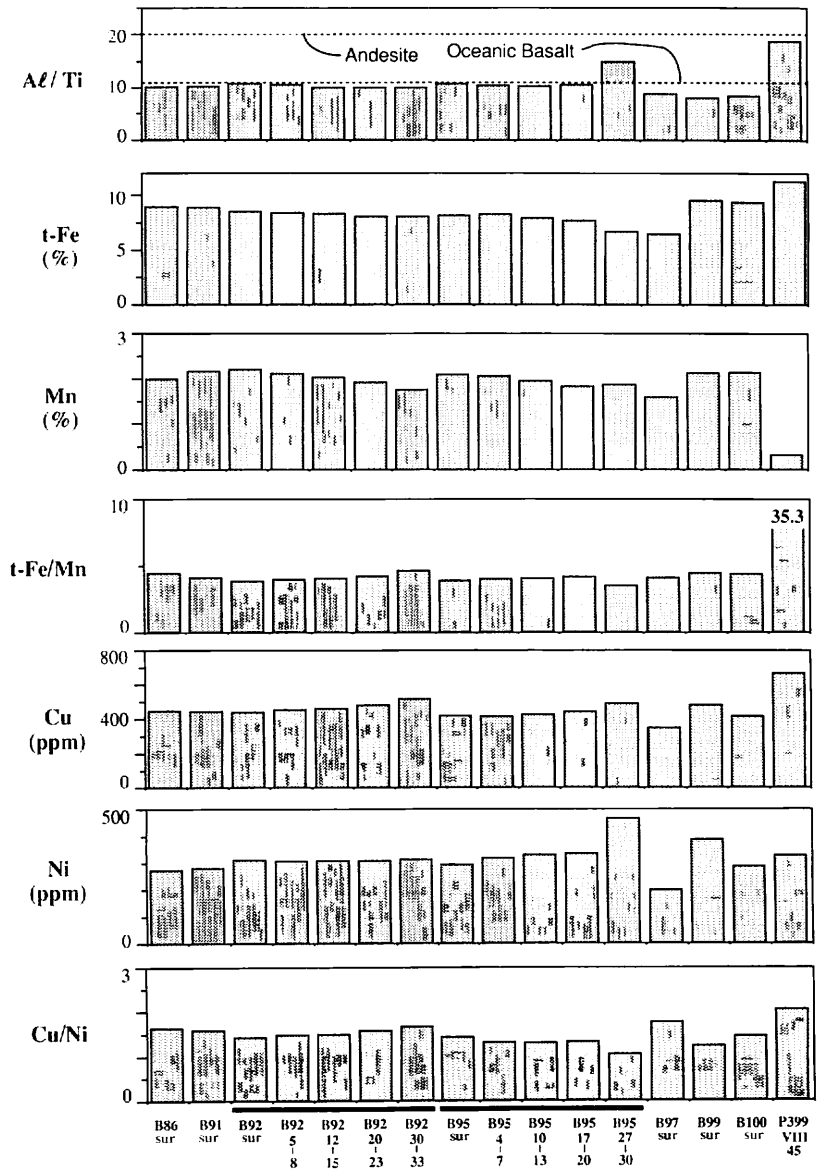

Fig. VII-3 Areal distribution of Al/Ti, Fe, Mn, Fe/Mn, Cu, Ni, and Cu/Ni in the sediments. "t-Fe" denotes total Fe (II+III).

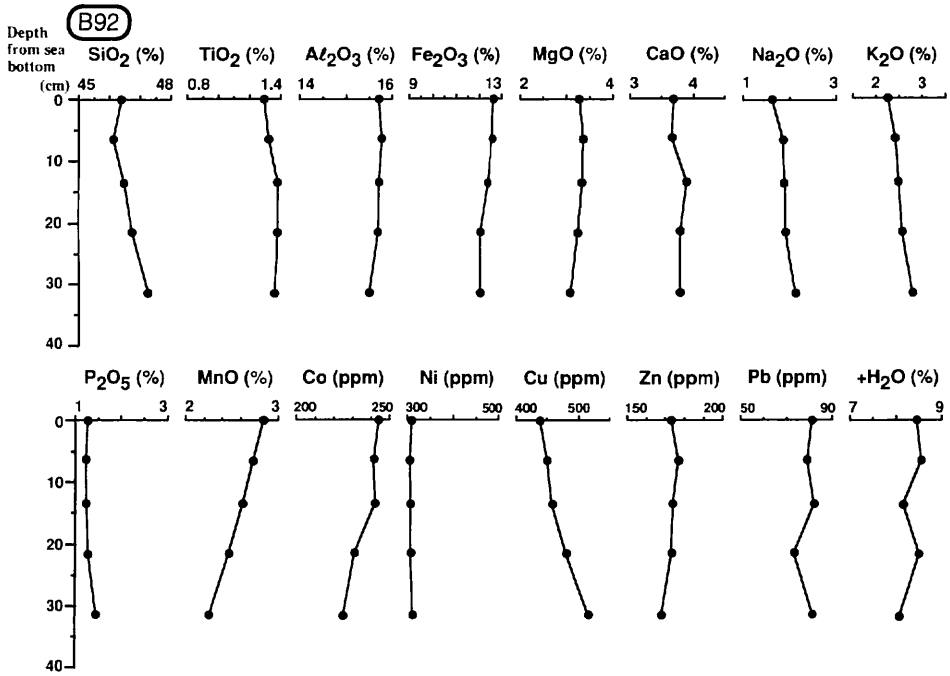

Fig. VII-4 Vertical distribution of concentration of major and minor components in core B92.

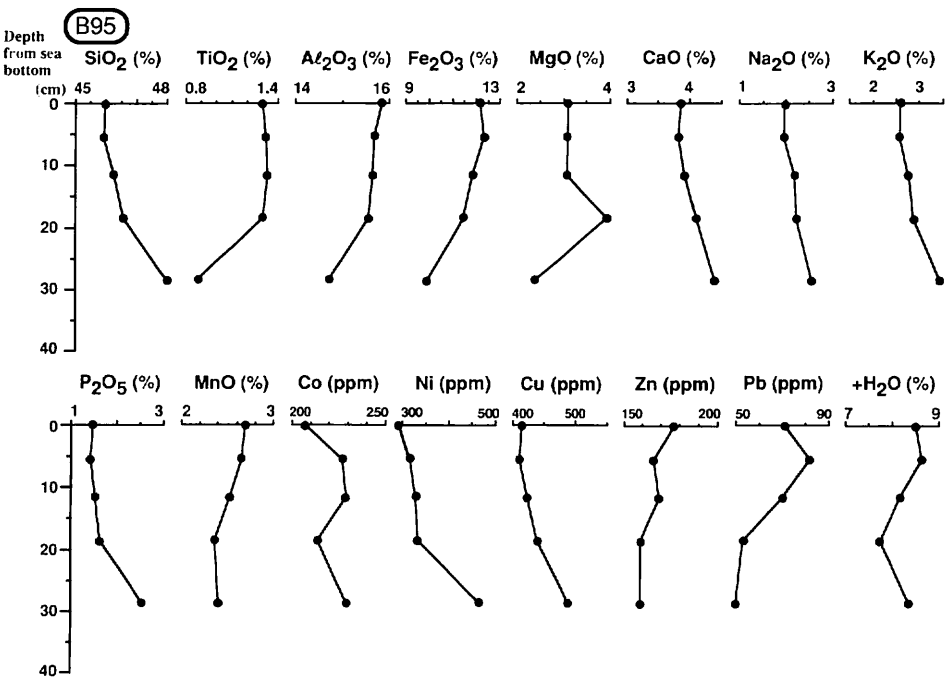

Fig. VII-5 Vertical distribution of concentration of major and minor components in core B95.

Table VII-1 Concentrations of major elements of sediments in GH83-3 area (to 110°C dry basis).

Sample Name	SiO_2 (%)	TiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	FeO (%)	MnO (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	P_2O_5 (%)	CO_2 (%)	S (%)	$+H_2O$ (%)	Total (%)
B 86 surface	45.92	1.38	15.82	13.30	0.00	2.57	3.48	3.34	1.52	2.04	0.95	0.32	0.11	8.82	99.71
B 91 surface	45.82	1.37	15.85	13.23	0.00	2.78	3.39	3.28	1.50	2.08	1.01	0.25	0.08	8.94	99.72
B 92 surface	46.40	1.29	15.70	12.64	0.00	2.84	3.28	3.69	1.63	2.26	1.27	0.18	0.06	8.44	99.83
B 92 5 - 8	46.12	1.32	15.77	12.56	0.00	2.73	3.35	3.66	1.85	2.41	1.23	0.07	0.06	8.54	99.81
B 92 12 - 15	46.50	1.38	15.70	12.35	0.00	2.62	3.33	3.89	1.89	2.48	1.24	0.02	0.03	8.14	99.71
B 92 20 - 23	46.76	1.38	15.68	12.01	0.00	2.47	3.24	3.79	1.90	2.55	1.27	0.04	0.03	8.48	99.73
B 92 30 - 33	47.26	1.36	15.49	12.01	0.00	2.25	3.09	3.79	2.12	2.78	1.44	0.05	0.03	8.06	99.87
B 95 surface	46.00	1.30	15.84	12.16	0.00	2.69	3.10	3.86	1.97	2.59	1.49	0.08	0.03	8.52	99.76
B 95 4 - 7	45.94	1.32	15.67	12.33	0.00	2.65	3.08	3.82	1.95	2.57	1.44	0.15	0.04	8.64	99.73
B 95 10 - 13	46.28	1.33	15.64	11.84	0.00	2.52	3.07	3.92	2.18	2.76	1.54	0.32	0.03	8.16	99.72
B 95 17 - 20	46.56	1.30	15.55	11.45	0.00	2.37	3.93	4.10	2.22	2.88	1.65	0.02	0.02	7.74	99.92
B 95 27 - 30	47.96	0.88	14.71	9.91	0.00	2.41	2.40	4.39	2.56	3.45	2.53	0.06	0.03	8.38	99.80
B 97 surface	31.50	1.09	10.90	9.64	0.00	2.04	2.21	18.67	0.94	1.30	0.90	13.17	0.13	7.22	99.82
B 99 surface	45.10	1.69	15.40	14.16	0.00	2.74	3.43	3.87	1.61	2.17	1.25	0.12	0.05	8.02	99.74
B100 surface	45.36	1.65	15.85	13.99	0.00	2.76	3.45	3.43	1.47	2.03	0.98	0.02	0.06	8.55	99.73
P 399 VIII 45	50.38	0.74	15.60	16.75	0.00	0.41	3.81	0.42	1.38	2.21	0.23	0.00	0.00	7.92	99.99

Table VII-2 Concentrations of minor elements of sediments in GH83-3 area (to 110°C dry basis).

Sample Name	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Pb (ppm)	Total (ppm)
B 86 surface	250	272	443	187	83	1235
B 91 surface	234	279	441	176	85	1215
B 92 surface	244	309	438	173	81	1245
B 92 5 - 8	241	306	450	177	79	1253
B 92 12 - 15	242	308	457	174	82	1263
B 92 20 - 23	231	307	479	173	73	1263
B 92 30 - 33	225	312	514	168	81	1300
B 95 surface	207	291	415	177	71	1161
B 95 4 - 7	227	317	411	166	82	1203
B 95 10 - 13	229	329	424	169	70	1221
B 95 17 - 20	214	335	440	159	53	1201
B 95 27 - 30	229	465	488	159	50	1391
B 97 surface	171	198	347	134	43	893
B 99 surface	257	388	478	180	79	1382
B100 surface	244	286	411	180	67	1188
P 399 VIII 45	33	327	666	413	0	1439

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