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Article

Geochemical compositions of sediment core sample from brackish Lake Shinji, southwest Japan

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Abstract

Geochemical analysis was carried out for sediment core samples from western side of Lake Shinji to evaluate historic changes of brackish lake environment. Concentrations of Zn significantly increased from the horizon correlative to 1950 year. Contents of Pb, MnO, P_2O_5, and TS (total sulfur) with Zn showed considerable increase from 1980 year horizon. Abundances of MnO and P_2O_5 are notable above the horizon of 2000 year suggestive of increment of plankton blooming and decline of sedimentation rate.

Key words: Lake Shinji, brackish lake, estuary, core sediment, geochemistry, human activities

Introduction

Geologic core sample from the lake can reveal a seamless vertical profile of environmental changes. Application of geochemical analysis to such core samples is useful for understanding impact of human activities, changes of sedimentary environment and provenance signature. A short core was collected in brackish lake, Lake Shinji which demonstrated considerable variation of geochemical compositions. Description of this vertical profile can be used for assessment of characteristic feature within brackish lake and for evaluation of ubiquity of depositional basin.

Environment of Lake Shinji

The Lake Sinji (79.2 km^2, average water depth of 4.5 m, maximum 6 m) is a brackish lake of which environment is controlled by mixing of fresh water from Hii River from west and brackish water from the Ohashi River from the west (Tokuoka *et al*., 1990). Clastic sediments are transported mainly from the Hii River, and coarse material deposited coastal area which provides good fishery area of bivalve *Corbicula japonica* for representative production in Japan. Mixing of fresh water and brackish water is not sufficient, for both water mass may form halocline and stratified water column (Tokuoka *et al*., 2002). This tendency is significant in summer season which are enhanced by formation of warmer upper water mass. The transitional boundary has been measured to be about 3 m deep. Salinity of bottom water is 5~10 psu (0.5~1.0%) and that of surface water is 1~5 psu (0.1~0.5%) referred from Shimane Prefecture (2018). Bottom water may become stagnant and disoxic to anoxic in summer time (Kamiya *et al*., 1996). And planktonic blooming and decomposition of their organic matter may consume dissolved oxygen, which can generate anoxic water environment in the bottom water (Tokuoka *et al*., 2002).

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Material and Analytical Procedure

Core sample was collected western side of Lake Shinji (N 35˚26.84′, E 132˚54.96′; Fig. 1) in 2010, using acrylic pipe (length 1 m, diameter 76 mm). Core was cut into 2-cm thick sections. Each sample was dried in an oven at 160˚C for 48 hrs to remove weakly-bound volatiles. The dried samples were then ground for 20 min in an automatic agate pestle and mortar grinder.

Abundances of selected major elements (TiO_2, Fe_2O_3* (total iron expressed as Fe_2O_3), MnO, CaO and P_2O_5) and the trace elements As, Pb, Zn, Cu, Ni, Cr, V, Sr, Y, Nb, Zr, Th, Sc, F, Br, I and TS (total sulfur) were determined by X-ray fluorescence analysis (XRF) in the Department of Geoscience, Shimane University, using a Rigaku Co. Ltd. RIX-2000 spectrometer. The XRF analyses were made on pressed powder briquettes (about 5 g sample by a force of 200 kN for 60s), following the method of Ogasawara (1987). Average errors for all elements are less than ± 10% relatively. Analytical results for GSJ standard JSl-1 were acceptable compared to the proposed values of Imai *et al*. (1996).

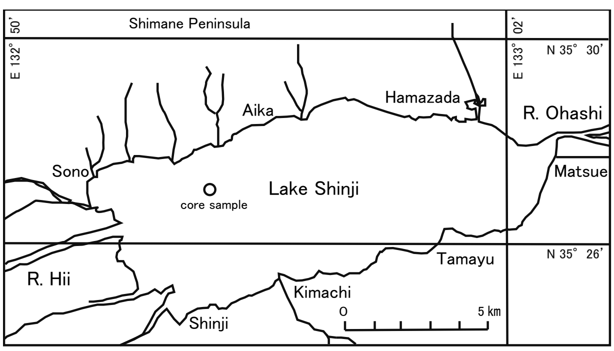

Fig. 1. Index map of Lake Shinji showing core sampling site.

Table 1. Analytical results (XRF) of core samples from western side of the Lake Shinji, southwest Japan.

Depth	Trace elements (ppm)											Major elements (wt%)					wt%
cm	As	Pb	Zn	Cu	Ni	Cr	V	Sr	Zr	Th	Sc	TiO_2	Fe_2O_3	MnO	CaO	P_2O_5	TS
2	13	38	188	36	19	44	171	134	101	15	17	0.66	9.66	0.31	1.41	0.26	0.51
4	12	38	182	38	21	41	170	136	103	14	17	0.67	9.64	0.23	1.42	0.19	0.82
6	13	37	177	36	20	42	170	131	105	16	16	0.69	9.62	0.20	1.33	0.17	0.95
8	12	37	178	35	22	42	171	125	104	16	19	0.67	9.50	0.18	1.27	0.16	0.94
10	12	38	177	35	22	41	167	124	106	16	18	0.71	9.39	0.17	1.25	0.15	0.92
12	12	38	171	35	20	42	177	121	104	15	18	0.68	9.38	0.17	1.26	0.15	1.01
14	12	37	168	36	21	43	175	122	106	16	20	0.68	8.94	0.15	1.29	0.14	0.97
16	14	35	158	36	19	44	175	128	106	14	19	0.67	8.94	0.14	1.27	0.14	0.97
18	11	32	148	31	18	31	175	144	112	15	21	0.71	8.18	0.13	1.47	0.14	0.79
20	10	31	140	32	15	33	157	142	109	15	21	0.71	8.08	0.13	1.45	0.13	0.66
22	11	30	143	35	15	29	157	133	101	14	22	0.69	8.18	0.12	1.36	0.13	0.73
24	12	29	139	34	16	33	163	125	97	14	22	0.68	8.72	0.13	1.28	0.12	1.05
26	10	30	133	34	17	34	164	125	98	16	22	0.72	8.58	0.14	1.25	0.13	0.77
28	9	29	134	34	16	32	167	123	97	15	22	0.73	8.56	0.14	1.24	0.13	0.72
30	9	29	132	34	17	30	172	118	95	16	23	0.70	8.70	0.14	1.19	0.13	0.73
32	9	29	131	33	17	31	164	118	96	16	22	0.71	8.70	0.14	1.20	0.13	0.74
34	12	30	132	31	18	36	167	111	98	17	22	0.68	8.57	0.15	1.13	0.12	0.71
36	11	30	128	31	17	34	167	115	99	17	21	0.68	8.57	0.15	1.14	0.12	0.74
38	12	29	124	28	16	33	159	119	101	18	19	0.68	8.47	0.15	1.20	0.13	0.70
40	11	30	119	27	21	32	167	112	96	19	19	0.67	8.63	0.15	1.11	0.13	0.56
42	12	28	121	27	17	37	162	109	96	20	19	0.68	8.77	0.15	1.07	0.13	0.46
44	12	28	115	25	18	34	161	105	96	20	19	0.68	8.84	0.15	1.04	0.13	0.40
46	10	29	118	24	19	34	162	99	92	22	20	0.69	8.75	0.15	1.00	0.13	0.30
48	9	29	113	24	17	31	152	97	91	21	19	0.71	8.64	0.16	0.99	0.13	0.22
50	12	29	111	23	20	34	161	97	91	21	19	0.66	8.39	0.16	0.97	0.13	0.24
52	13	28	113	24	19	30	157	97	92	24	20	0.69	8.54	0.17	0.98	0.13	0.26
54	11	28	115	25	18	30	155	98	94	23	18	0.68	8.52	0.16	0.98	0.13	0.23
56	12	29	111	24	19	32	160	100	94	24	19	0.66	8.65	0.16	0.98	0.12	0.32
58	12	28	113	24	19	33	157	97	93	23	22	0.64	8.56	0.17	0.96	0.12	0.36
60	11	27	111	24	17	31	153	95	94	23	19	0.67	8.52	0.17	0.95	0.12	0.35
62	11	28	110	23	18	34	154	93	95	24	20	0.68	8.39	0.16	0.93	0.12	0.32
64	10	28	110	23	20	36	158	91	96	23	21	0.65	8.29	0.15	0.91	0.12	0.28
66	12	26	109	21	20	36	162	92	96	26	20	0.69	8.31	0.15	0.92	0.12	0.30
68	12	27	107	23	19	35	162	92	96	26	18	0.67	8.32	0.15	0.92	0.12	0.31
70	12	27	108	25	20	34	149	92	96	25	18	0.67	8.18	0.15	0.92	0.12	0.30
72	12	28	107	22	19	41	156	91	97	25	19	0.69	8.20	0.14	0.92	0.12	0.27
74	12	27	108	23	20	38	160	90	96	25	20	0.66	8.33	0.14	0.91	0.12	0.28

Results and Discussion

Geochemical compositions of core sediments are indicated in Table 1. Based on vertical variation of abundances of each element, three groups can be recognized, namely increasing up ward, decreasing up ward and less changed. Elements increasing up ward are Pb, Zn, Cu, Sr, Fe_2O_3, MnO CaO, P_2O_5 and TS. To evaluate increasing rate, abundances between top and bottom samples are given. Significantly increased elements are Pb (40.8%), Zn (70.5%), Cu (57.8%), Sr (48.8), MnO (124.3%), CaO (54.9%), P_2O_5 (119.5%) and TS (82.1%). Slightly increased elements are As (5.0%), Cr (16.2%), V (6.7%), Zr (5.3%) and Fe_2O_3 (16.0%). Decreased elements are Ni (-4.5%), Th (-40.9%) and Sc (-14.1%). Abundances of Th decreasing rate is significant. Abundances of TiO_2 (0.0%) showed some variation within vertical profile but did not show significant changes suggesting source material related to TiO_2 was homogeneous and grain sized was also well sorted (McLennan *et al*., 1993).

To describe vertical variation with age determination, previously reported core samples (Tamura *et al*., 1996) was adopted. This work presented the age of the cores collected from western, central and eastern sides of the Lake Shinji. Concentrations of TS were measured, and its decreasing horizon was noted to be environmental change of the lake. It is well known that Hii River flowed to the west into Japan Sea, before the huge scale flooding occurred in 1635 or 1639 (Tokuoka *et al*., 1990). After this event the river changed the way of flow towards east into Lake Shinji which marked as beginning of fresh water lake. Supposed age for the core samples was indicated with vertical profile of the abundances of selected elements with considerable increase (Fig. 2).

Contents of Zn showed little change from horizon of correlative to 1910 year, and slightly increased its abundances from 1950. Above the horizon of 1980 year, contents of Zn significantly increased to the top. Contents of Pb showed similar variation to those of Zn, but with less variation during 1950 to 1980 year horizons. Characteristic increasing feature above the horizon of 1980 year may be caused by increments of human activities of surrounding areas (Ahmed *et al*., 2011). Contents of MnO and P_2O_5 did not show significant changes below the horizon of 1980 year, but changed to increasing curves towards

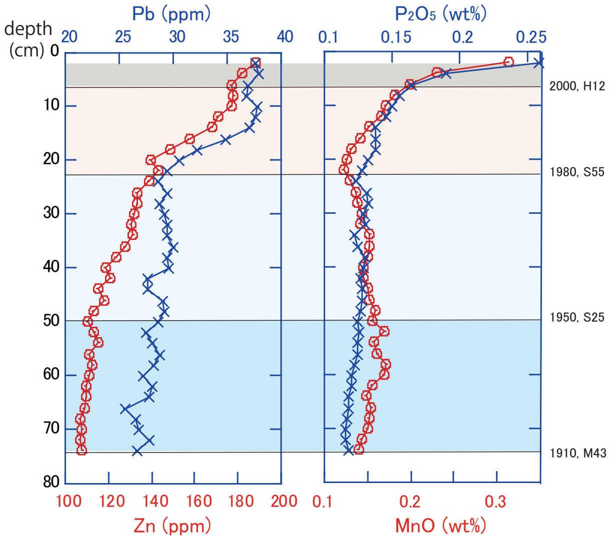

Fig. 2. Vertical profile of variation of abundances of selected elements, Zn, Pb, MnO and P_2O_5 which showing significant increase. For detail see text.

top horizon. Especially from the horizon of 2000 year, increasing tendency became considerable. Manganese may be soluble in reductive water condition but cannot react with sulfide comparing to that of iron (FeS_2). This is because of difference of solubility products, FeS ($1x10^{-16}$) and MnS ($1x10^{-10}$) (Physics and Chemistry Chronological Table, 2015). Increased Mn contents in sediments is suggestive of manganese oxide precipitation from reductive bottom water with higher content of manganese in the Lake Shinji. Increased abundances of P_2O_5 may be related to strong eutrophication in the lake. The accelerated addition from the horizon of 2000 year is to be considered from recent decline of sedimentation rate in Lake Shinji (Nomura, 2015).

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（要　旨）

石賀裕明・Faruque Ahmed・瀬戸浩二，2018．西南日本の汽水湖，宍道湖の堆積物コア試料の地球化学的分析．島根大学地球資源環境学研究報告，36，39-41.

汽水湖の歴史的環境変化を評価するために，宍道湖の西部において採取されたコア試料について地球化学分析を行った．Zn 含有率は 1950 年の層準から有意に増加する．Pb, MnO, P_2O_5 と TS（全イオウ）の含有率も Zn とともに 1980 年の層準から増加する．MnO, P_2O_5 についての 2000 年からの目立った増加は，プランクトンのブルーミングと堆積速度の低下によるかもしれない．