Suess, E., von Huene, R., et al., 1990
Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 112

48. GEOCHEMICAL DATA REPORT FOR PERU MARGIN SEDIMENTS FROM SITES 680, 682, 685, AND 688[1]

Kay-Christian Emeis,[2] Paul N. Boothe,[3] Barry J. Katz,[4] John W. Morse,[3] Bob J. Presley,[3] and Marta T. von Breymann[2]

INTRODUCTION

This data report tabulates results of chemical analyses of sediments from four sites (680, 682, 685, and 688) drilled during Leg 112 offshore Peru. These sediments were recovered from the forearc basins underlying the Peru upwelling area. They are equivalent in facies and age to the Pisco and Monterey formations, both of which are of considerable economic and geological interest as hydrocarbon source rocks deposited under conditions of coastal upwelling. Sediments recovered from the shelf (Site 680) and slope (Sites 682, 685, and 688) during Leg 112 are unconsolidated and are thermally immature. A lack of consolidation and thermal catagenesis makes these deposits ideal targets for chemical investigation into effects of early diagenesis in organic-carbon-rich siliceous muds.

METHODS

Samples were obtained on board *JOIDES Resolution*, freeze-dried, ground, and stored in snap-cap glass bottles. Subsamples were used for analysis of calcium carbonate, opal, organic matter abundance and pyrolitic character, iron, and selected trace metal and rare earth elements (REE).

Carbonate

Carbon dioxide (CO_2) liberated by acid treatment (2N HCl) of the sample was determined in a Coulometrics CO_2 Analyzer and converted to calcium carbonate ($CaCO_3$) weight percentages.

Instrumental Neutron Activation Analysis

Instrumental neutron activation analysis (INAA) was performed in a TRIGA (Training Research Isotope-Production General Atomic) reactor at the Texas A&M University Nuclear Science Center at a flux of 10^{13} neutrons/s. The counting was performed using a germanium-lithium gamma-detector, coupled with a pulse-height multichannel analyzer. These data were reduced and standardized by computer.

Total Reduced Sulfur

The method employed for determining total reduced sulfur (TRS) is adapted from Zhabina and Volkov (1978) and Canfield et al. (1986). In brief, hydrogen sulfide (H_2S) from reductive decomposition of sulfide by a chromium(II) solution in concentrated hydrochloric acid is titrated with lead perchlorate and the end point determined with a silver sulfide reference electrode.

Opal

Opaline silica was determined using a wet alkaline leaching procedure after Eggimann et al. (1980), as modified by Mortlock and Froehlich (in press). After removing organic matter and carbonates that would interfere with the colorimetric determination of silicon, the sample was leached with 2N Na_2CO_3 and analyzed spectrophotometrically.

Organic Matter

Ground sediments were used to determine total organic carbon (TOC) by combustion at 600°C in the TOC module of a Delsi Nermag Rock Eval II after establishing the yields of hydrocarbons (S_1 and S_2) and CO_2 (S_3) per gram of sediment in a programmed pyrolysis run. The procedure is described in detail in Espitalié et al. (1985), who also gave guidelines for interpreting results. Some considerations as to the usefulness of pyrolysis in immature sediments and some pitfalls are outlined in Katz (1983) and Peters (1986). Samples of Holes 682A and 685A were not analyzed by pyrolysis. Here, we employed a Perkin Elmer Model 240C CHN analyzer to determine elemental carbon and nitrogen by combustion at 1000°C. Organic carbon was determined by subtracting carbonate carbon from total carbon.

RESULTS

Results of the chemical analyses are listed for individual sites in Tables 1 through 4. A composite data set of all analyses yielded average values that are compared with available literature data on sediments of other upwelling-related facies, of organic carbon-rich rocks from different depositional settings, and with "average shale" and "average carbonates" in Table 5. Analysis and interpretation of these results are included in Emeis and Morse (this volume) and von Breymann et al. (this volume).

[1] Suess, E., von Huene, R., et al., 1990. *Proc. ODP, Sci. Results*, 112: College Station, TX (Ocean Drilling Program).
[2] Ocean Drilling Program, Texas A&M University, College Station, TX 77840.
[3] Department of Oceanography, Texas A&M University, College Station, TX 77843.
[4] Texaco, 3901 Briarpark, Houston, TX 77042.

REFERENCES

Brumsack, H. J., and Gieskes, J. M., 1983. Interstitial water trace element chemistry of laminated sediments from the Gulf of California, Mexico. *Mar. Chem.*, 14:89–106.
Canfield, D. E., Raiswell, R., Westrich, J. T., Reaves, C. M., and Berner, R. A., 1986. The use of chromium reduction in the analysis of reduced inorganic sulfur in sediments and shales. *Chem. Geol.*, 54:149–155.
Eggimann, D. W., Manheim, F. T., and Betzer, P. R., 1980. Dissolution and analysis of amorphous silica in marine sediments. *J. Sediment. Petrol.*, 50:215–225.
Emeis, K.-C., 1985. Geochemie und Fazies von Schwarzschiefern und organischreichen Sedimenten des Südatlantik [PhD dissert.]. Hamburg Univ., Hamburg, F.R.G.

Espitalié, J., Deroo, G., and Marquis, F., 1985. La pyrolyse Rock-Eval et ses applications. *Rev. Inst. Français Pet.*, 40:563–579.

Katz, B. J., 1983. Limitations of 'Rock-Eval' pyrolysis for typing organic matter. *Org. Geochem.*, 4:195–199.

Peters, K. E., 1986. Guidelines for evaluating petroleum source rocks using programmed pyrolysis. *AAPG Bull.*, 70:318–329.

Mortlock, R. A., and Froehlich, P. N., in press. A simple method for the rapid determination of biogenic opal in marine sediments. *J. Sediment. Petrol.*

Turekian, K. K., and Wedepohl, K. H., 1961. Distribution of the elements in some major units of the earth's crust. *Geol. Soc. Am. Bull.*, 72:175–192.

Zhabina, N. N., and Volkov, I. I., 1978. A method of determination of various sulfur compounds in sea sediments and rocks. *In* Krumbein, W. E. (Ed.), *Environmental Biogeochemistry and Geomicrobiology, Vol. 3: Methods, Metals, and Assessment*: Ann Arbor (Ann Arbor Scientific Publ.), 735–746.

Date of initial receipt: 24 April 1989
Date of acceptance: 7 June 1989
Ms 112B-203

Table 1. Sediment chemistry at Hole 680.

Core, section, interval (cm)	Depth (mbsf)	Opal-Si	$CaCO_3$ (%)	T_{max} (°C)	S_1 (mg/g)	S_2 (mg/g)	S_3 (mg/g)	TOC (%)	TRS (%)	La (ppm)	Ce (ppm)	Sm (ppm)
680A-01H-2, 88–90	2.40	4.2	0.75	399	25.30	92.20	34.10	12.42	0.77	21	36	5.1
01H-2, 104–106	2.60	n.d.	0.83	405	5.10	28.40	5.40	5.31	1.03	22	38	5.0
01H-4, 7779	5.30	6.8	0.50	394	6.10	25.60	6.10	6.89	0.63	22	37	4.8
01H-6, 37–39	7.90	5.9	1.83	n.d.	n.d.	n.d.	n.d.	n.d.	0.78	13	23	3.8
02H-1, 86–88	9.20	13.6	12.00	406	4.80	26.40	6.40	5.01	0.84	21	34	4.6
02H-2, 96–98	10.80	5.4	31.99	401	1.90	12.40	3.00	3.38	1.14	39	69	8.0
02H-3, 51–53	11.80	8.2	0.58	390	6.60	34.50	6.00	6.86	0.94	26	43	6.3
02H-4, 25–26	13.10	2.8	0.00	385	4.70	30.40	5.10	7.12	1.07	24	40	5.3
02H-5, 25–27	14.60	3.9	11.83	397	2.00	13.90	3.60	1.95	0.92	22	43	5.3
02H-6, 25–26	16.10	5.4	0.08	402	3.50	24.70	3.80	3.47	0.96	23	40	5.3
02H-6, 68–70	16.40	n.d.	0.33	406	2.60	23.90	3.50	3.16	1.21	27	46	5.8
02H-7, 44–46	17.70	7.9	15.25	390	8.50	42.60	7.00	4.54	1.00	26	41	6.6
03H-1, 93–95	18.80	n.d.	14.74	n.d.	n.d.	n.d.	n.d.	n.d.	0.94	25	47	5.9
03H-2, 25–27	19.60	3.4	3.76	412	4.30	28.60	5.60	3.77	0.75	14	25	3.4
03H-3, 116–118	22.00	6.4	10.75	400	8.50	42.10	8.70	7.26	0.96	20	33	5.0
03H-4, 25–27	22.60	7.3	1.00	413	5.40	40.40	7.40	5.80	0.84	11	19	2.5
03H-5, 32–34	24.10	2.9	3.17	404	1.20	8.80	2.80	4.07	1.01	28	52	6.1
03H-6, 25–27	25.60	n.d.	26.49	425	0.20	2.30	1.30	2.00	0.18	31	55	6.8
03H-7, 25–27	27.10	n.d.	18.16	403	4.20	28.50	6.40	4.17	0.77	21	33	5.2
04H-1, 25–26	27.60	6.0	29.82	411	2.00	15.60	4.10	3.89	0.41	19	30	4.3
04H-2, 25–26	29.10	n.d.	27.66	407	5.00	42.30	4.50	5.70	0.63	22	34	7.1
04H-3, 25–26	30.60	n.d.	0.17	401	6.00	43.10	4.50	10.09	1.07	25	43	5.7
04H-4, 25–26	32.10	6.5	0.67	399	5.50	35.60	4.80	7.35	0.92	21	36	5.6
04H-5, 25–26	33.60	2.7	7.25	421	0.60	7.50	2.20	2.24	0.41	26	45	5.7
04H-6, 25–26	35.10	n.d.	20.66	413	1.80	15.40	3.30	2.88	0.62	26	45	5.9
04H-7, 25–25	36.60	1.9	0.00	405	2.40	21.40	2.90	3.71	0.94	28	51	6.3
05H-1, 18–19	37.00	4.2	4.83	398	3.10	22.70	3.10	4.72	0.91	25	44	6.0
05H-2, 18–19	38.50	10.0	2.50	387	6.20	33.60	4.50	8.23	1.05	31	45	5.9
05H-3, 57–59	40.40	2.4	7.33	n.d.	n.d.	n.d.	n.d.	n.d.	1.29	31	59	6.6
05H-4, 17–18	41.50	7.3	0.17	388	4.70	27.40	4.30	6.24	0.99	19	32	4.2
05H-5, 17–18	43.00	n.d.	2.17	396	3.00	26.40	4.40	5.44	0.98	38	61	7.9
06H–1, 18–19	46.40	7.3	3.84	385	3.80	20.10	2.60	4.40	1.23	22	43	4.9
07H-1, 35–36	56.20	12.3	0.42	387	3.30	16.70	2.40	3.68	0.67	16	27	4.2
07H-2, 80–82	58.10	2.1	1.75	n.d.	n.d.	n.d.	n.d.	n.d.	1.60	30	54	5.8
07H-3, 34–36	59.10	1.2	6.75	329	0.00	0.10	0.70	0.18	1.81	31	57	6.0
07H-4, 33–34	60.60	1.8	4.42	385	0.10	0.30	1.00	0.03	1.94	29	55	5.9
07H-5, 34–36	62.10	1.4	3.67	335	0.10	0.40	0.90	2.74	1.94	30	55	5.9
07H-6, 27–29	63.60	3.3	2.00	384	0.10	0.70	0.60	2.16	1.93	26	51	5.6
08H-1, 34–36	65.70	1.5	2.45	389	0.20	1.10	1.30	2.71	1.83	28	52	5.5
08H-2, 35–37	67.20	3.6	4.83	377	0.60	1.90	0.90	4.20	1.56	23	46	4.7
08H-3, 34–36	68.70	3.4	1.36	387	1.20	4.80	1.30	5.02	1.81	27	49	5.5
08H-4, 34–36	70.10	3.6	1.25	381	1.30	5.00	1.40	5.04	1.66	22	40	4.5
08H-5, 34–36	71.70	6.8	0.42	383	1.80	6.40	1.40	6.13	n.d.	18	34	3.8
08H-6, 34–36	73.20	1.1	5.50	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	24	45	4.8
08H-7, 34–36	74.70	3.7	1.07	n.d.	n.d.	n.d.	n.d.	6.01	n.d.	23	42	4.9
09H-1, 34–36	75.10	1.3	1.33	n.d.	n.d.	n.d.	n.d.	3.13	n.d.	32	58	6.6
09H-2, 34–36	76.60	3.1	0.25	n.d.	n.d.	n.d.	n.d.	3.65	n.d.	27	53	5.8
09H-3, 34–36	78.10	3.1	0.83	n.d.	n.d.	n.d.	n.d.	6.97	n.d.	21	37	4.4

Table 1 (continued).

Eu (ppm)	Yb (ppm)	Lu (ppm)	Ba (ppm)	Cr (ppm)	Fe (%)	Cs (ppm)	Co (ppm)	Hf (ppm)	Rb (ppm)	Sc (ppm)	Th (ppm)	Sb (ppm)	Br (ppm)
0.73	0.1	0.50	401	116	1.93	5.1	6.0	4.4	53	8.4	6.6	2.8	331
0.76	2.0	0.49	396	118	2.12	6.8	6.4	4.5	61	8.8	6.8	2.7	307
0.72	2.0	0.46	332	90	2.17	7.2	5.9	4.1	61	8.9	6.8	2.4	196
0.48	1.3	0.42	374	127	1.59	4.2	5.5	2.1	40	6.8	4.2	1.7	375
0.70	1.9	0.40	463	116	1.89	6.7	6.5	3.1	58	8.3	6.0	1.4	275
1.31	3.3	0.71	568	130	3.96	14.7	11.8	7.6	121	16.3	13.1	4.0	208
0.84	1.7	0.55	374	139	2.30	10.4	6.7	3.1	79	10.9	7.0	2.1	215
0.76	2.1	0.51	362	127	2.52	9.4	7.2	3.3	72	11.2	7.3	2.4	231
0.95	2.5	0.46	427	93	2.50	6.6	6.2	5.2	67	10.4	7.7	2.4	140
0.70	1.8	0.51	337	124	2.07	9.4	6.6	3.8	67	9.0	6.7	2.3	247
0.87	2.4	0.49	344	104	2.41	11.4	7.3	4.2	84	11.1	8.1	1.4	171
0.78	2.3	0.55	457	163	2.35	9.9	7.5	3.5	80	10.2	7.2	2.6	318
0.92	2.6	0.53	375	126	2.29	8.4	6.1	4.7	72	9.9	7.8	2.2	248
0.44	1.3	0.37	204	96	1.42	5.2	4.2	1.9	43	6.2	4.4	1.9	258
0.64	1.9	0.45	388	154	2.06	5.9	6.3	3.1	59	8.9	6.0	2.6	251
0.45	1.1	0.27	182	105	1.36	4.1	4.6	1.7	38	5.3	3.6	1.8	280
1.05	2.6	0.53	431	85	2.57	7.3	9.9	1.1	95	11.0	8.9	2.5	82
1.22	3.4	0.67	574	58	1.82	4.7	5.1	10.0	76	9.5	8.4	2.2	52
0.67	1.9	0.48	228	122	1.93	6.8	5.5	3.2	58	8.1	6.1	2.1	187
0.66	2.2	0.39	295	83	1.19	3.9	3.5	3.9	44	5.8	5.3	1.9	166
0.66	2.0	0.99	413	200	1.71	5.9	6.0	2.2	47	8.1	5.2	2.2	540
0.83	2.3	0.53	396	174	2.56	11.7	8.5	4.3	78	11.3	8.4	2.2	352
0.71	1.9	0.52	347	130	1.93	7.3	6.3	3.0	60	8.5	6.3	1.7	267
0.96	3.0	0.56	429	64	1.27	3.1	4.1	10.0	45	7.1	7.0	2.0	103
1.02	3.0	0.62	367	97	1.84	5.8	5.0	6.7	68	8.8	7.6	2.5	130
1.02	2.8	0.57	420	126	2.33	9.0	7.2	6.6	74	11.1	8.9	2.0	199
0.88	2.6	0.55	409	112	2.10	9.5	6.8	5.3	64	9.6	7.5	2.2	246
1.02	3.0	0.62	326	129	2.10	8.0	7.0	3.0	59	8.0	6.0	2.0	234
1.13	2.8	0.51	402	122	2.93	13.8	9.2	4.5	87	13.9	9.8	2.8	179
0.63	1.5	0.37	270	96	1.85	10.0	8.2	2.5	61	7.1	5.4	2.0	172
1.26	3.4	0.72	595	164	3.39	10.3	12.0	6.3	88	13.4	10.6	2.4	338
0.87	2.3	0.43	452	117	2.50	12.6	7.4	4.5	76	10.4	8.0	2.3	202
0.55	1.4	0.40	309	85	1.35	5.4	4.4	2.1	38	5.3	4.3	1.1	210
1.23	2.9	0.47	391	43	3.81	12.4	11.6	5.0	109	13.9	10.2	3.7	37
1.12	2.6	0.48	426	45	4.11	9.8	11.9	5.1	110	14.2	10.3	4.5	31
1.15	2.6	0.48	430	48	3.86	11.5	11.0	4.6	102	12.8	10.1	2.2	44
1.17	2.5	0.45	424	48	4.17	12.2	12.2	4.4	122	14.3	10.4	3.6	43
0.97	2.4	0.41	418	51	3.72	11.7	9.9	4.3	89	12.9	9.9	1.9	56
1.08	2.3	0.44	432	59	3.59	10.2	9.4	4.4	108	12.7	10.1	2.7	59
0.88	2.1	0.36	318	57	2.87	10.9	8.8	3.6	85	11.0	8.5	1.3	116
0.96	2.2	0.44	373	90	3.40	10.4	9.2	3.8	104	12.2	8.4	2.7	69
0.84	1.9	0.33	320	83	3.16	10.6	9.0	3.7	76	11.9	8.3	1.4	113
0.71	1.6	0.30	272	86	2.63	7.4	7.0	2.8	72	8.5	6.4	1.6	124
0.89	2.0	0.37	478	49	2.68	7.2	7.4	4.5	74	9.9	8.6	1.5	53
0.85	2.0	0.38	360	119	3.46	9.8	8.5	3.9	97	11.0	8.7	2.1	89
1.21	3.0	0.55	451	74	4.38	11.6	11.3	4.4	120	15.4	10.6	3.0	54
1.05	2.9	0.48	418	77	3.86	12.4	10.3	4.1	98	14.5	10.0	1.8	68
0.78	1.8	0.33	343	124	3.73	9.7	9.2	3.4	95	11.8	8.5	2.3	90

Table 2. Sediment chemistry at Site 682.

Sample ID	Depth (mbsf)	Opal-Si (%)	$CaCO_3$ (%)	TOC (%)	TN (%)	TRS (%)	C/N	La (ppm)	Ce (ppm)	Sm (ppm)	Eu (ppm)	Yb (ppm)	Lu (ppm)	Ba (ppm)	Cr (ppm)
01H-3, 76–78	3.76	3.1	12.75	5.94	0.35	0.54	16.97	31	52	6.0	0.99	2.8	0.49	1035	74
01H-6, 56–58	8.06	3.2	0.92	6.86	0.62	0.58	11.06	32	52	6.5	1.07	3.2	0.66	2245	108
02H-3, 45–47	13.25	3.4	1.50	15.71	0.78	0.84	20.14	24	37	5.0	0.80	2.5	0.53	1755	77
03H-2, 55–57	21.35	4.2	3.83	9.69	0.53	1.03	18.28	24	40	4.6	0.79	2.2	0.40	1718	102
03H-5, 67–77	25.97	4.7	0.83	8.25	n.d.	1.27	n.d.	26	46	5.2	0.90	2.4	0.47	1391	125
04H-1, 127–128	30.07	12.6	0.25	17.94	1.18	n.d.	n.d.	15	25	3.3	0.50	1.4	0.31	1198	90
05H-1, 48–49	38.88	12.1	n.d.	11.41	0.73	0.80	15.63	16	26	3.3	0.49	1.3	0.29	989	74
06H-3, 140–150	52.30	10.9	7.01	8.10	n.d.	1.17	n.d.	16	27	3.4	0.57	1.7	0.44	670	114
07H-2, 79–81	58.09	5.6	0.00	10.35	0.77	1.46	13.44	21	38	3.8	0.75	1.7	0.36	3208	114
08H-1, 46–48	67.26	13.2	2.75	15.22	0.98	0.81	15.53	12	21	2.6	0.39	1.2	0.26	432	120
09H-1, 106–116	77.50	15.7	2.08	7.14	1.12	1.02	6.38	11	20	2.5	0.44	1.0	0.27	385	138
10H-1, 94–96	86.74	17.6	1.42	13.61	1.40	0.19	9.72	7	11	1.9	0.24	n.d.	0.26	307	91
12X-1, 140–150	106.30	6.2	1.67	2.25	n.d.	1.80	n.d.	18	34	3.8	0.74	1.5	0.32	585	130
14X-CC, 2–3	126.58	12.2	3.00	7.88	0.57	0.98	13.82	11	19	2.5	0.50	0.9	0.22	471	117
15X-1, 134–139	134.70	11.4	4.50	3.65	0.66	0.83	5.53	11	19	2.4	0.41	1.0	0.22	366	146
17H-1, 146–147	153.76	n.d.	9.50	11.05	0.61	1.06	18.11	17	29	3.8	0.63	1.4	0.30	533	149
18X-1, 145–150	163.30	12.7	6.25	9.56	0.53	n.d.	18.04	11	18	2.7	0.44	1.0	0.26	376	122
18X-2, 84–86	164.14	13.6	7.58	10.01	0.55	0.81	18.20	11	20	3.0	0.42	1.0	0.53	415	121
20X-1, 59–61	181.39	12.9	5.17	8.82	0.49	0.94	18.00	11	18	2.6	0.43	0.9	0.18	379	106
20X-2, 44–46	182.74	12.9	6.08	9.66	0.74	1.22	13.05	10	16	2.3	0.41	0.9	0.19	385	116
21X-1, 93–95	191.23	n.d.	8.25	8.88	0.57	0.90	15.58	10	16	2.4	0.39	0.9	0.19	429	100
22X-2, 63–64	201.93	n.d.	4.67	7.88	0.54	0.86	14.59	16	25	3.6	0.63	1.6	0.27	538	109
24X-1, 117–120	219.97	11.0	7.08	8.31	0.48	0.87	17.31	18	25	3.7	0.62	1.5	0.31	527	111
25X-CC, 18–20	229.17	n.d.	7.92	8.72	0.47	0.70	18.55	15	24	3.9	0.56	1.4	0.35	537	107
26X-CC, 11–13	238.80	14.4	7.83	9.21	0.63	0.80	14.62	13	18	2.8	0.39	0.9	0.24	437	98
27X-1, 106–113	248.40	14.8	5.39	3.19	n.d.	0.77	n.d.	12	18	2.6	0.39	0.8	0.24	383	97
28X-1, 6–7	256.86	n.d.	6.42	8.02	0.30	0.45	26.73	14	19	2.9	0.44	1.0	0.25	466	84
29X-1, 16–17	266.46	n.d.	5.92	10.02	0.43	0.57	23.30	8	11	2.1	0.29	0.5	0.13	304	76
33X-1, 16–17	295.26	n.d.	3.42	11.89	0.92	n.d.	12.92	18	26	4.4	0.55	1.3	0.36	537	146
34X-2, 140–150	307.60	4.2	13.20	3.72	n.d.	1.82	n.d.	23	34	4.9	1.01	2.4	0.58	755	202
34X-3, 30–32	307.90	n.d.	7.42	6.14	0.51	2.05	12.04	19	33	4.4	0.81	2.0	0.45	584	186
35X-2, 97–98	313.67	n.d.	2.83	4.27	0.46	2.63	9.28	19	32	4.4	0.85	2.0	0.40	608	138
36X-1, 80–85	321.46	n.d.	3.58	5.16	0.39	1.74	13.23	20	36	4.5	0.92	1.7	0.43	725	120
37X-2, 83–84	332.52	n.d.	7.83	6.78	0.48	1.29	14.13	19	32	4.5	0.73	1.6	0.37	643	134
39X-2, 131–141	352.20	n.d.	7.59	2.97	n.d.	1.72	n.d.	17	25	5.0	0.67	1.3	0.55	666	149
40X-2, 9–11	360.29	4.7	5.50	6.09	0.43	1.72	14.16	19	34	4.4	0.90	1.8	0.49	725	136
41X-CC, 10–11	368.30	n.d.	3.17	12.92	0.65	2.13	19.88	15	24	4.4	0.66	1.7	0.49	474	203
42X-CC, 12–13	378.00	n.d.	0.75	7.37	0.4B	0.95	15.35	9	13	2.4	0.36	1.0	0.02	322	121
44X-CC, 10–11	397.13	n.d.	3.74	4.59	0.31	1.99	14.81	16	30	3.5	0.60	1.5	0.30	575	80
45X-1, 29–30	403.99	n.d.	1.00	2.28	0.24	n.d.	9.50	15	27	3.7	0.77	1.7	0.36	423	60
46X-1, 40–42	408.60	2.8	11.16	4.73	0.25	1.35	18.92	25	45	5.4	1.01	2.6	0.49	539	83
46X-1, 140–150	409.70	n.d.	8.08	1.39	n.d.	0.90	n.d.	17	30	3.8	0.74	2.1	0.41	448	70
47X-1, 51–52	418.21	n.d.	2.75	2.24	0.25	1.11	8.96	17	30	3.9	0.79	1.9	0.38	558	69
48X-CC, 18–19	427.31	n.d.	3.49	2.33	0.26	1.14	8.97	16	26	3.7	0.80	1.8	0.37	497	63

Table 2 (continued).

Sample ID	Fe (%)	Cs (ppm)	Co (ppm)	Hf (ppm)	Rb (ppm)	Sc (ppm)	Th (ppm)	Sb (ppm)	Br (ppm)
01H-3, 76–78	3.36	9.5	8.0	6.0	99	12.88	9.32	2.3	135
01H-6, 56–58	3.65	10.8	9.2	4.3	101	14.94	9.35	2.0	171
02H-3, 45–47	2.64	8.2	7.3	3.0	80	10.92	6.45	1.6	180
03H-2, 55–57	3.32	8.9	8.2	3.4	81	12.55	7.43	1.8	169
03H-5, 67–77	3.71	10.0	8.9	3.3	95	14.05	8.73	3.0	154
04H-1, 127–128	1.58	4.7	4.4	1.6	38	6.47	4.13	1.6	223
05H-1, 48–49	1.81	6.2	4.9	1.9	55	7.20	4.83	1.4	184
06H-3, 140–150	2.18	6.4	4.4	2.2	51	7.61	4.80	2.4	234
07H-2, 79–81	3.09	9.5	7.2	2.9	85	11.40	7.35	3.1	168
08H-1, 46–48	1.50	4.5	3.4	1.8	42	5.74	3.88	1.9	272
09H-1, 106–116	1.80	4.9	3.7	1.4	42	6.40	3.36	1.6	208
10H-1, 94–96	0.93	2.6	2.3	0.9	23	3.57	2.03	1.0	219
12X-1, 140–150	3.16	7.5	6.8	3.1	80	11.72	6.83	2.3	47
14X-CC, 2–3	1.57	3.7	2.9	1.9	48	6.32	3.69	0.9	112
15X-1, 134–139	1.74	4.8	3.4	1.6	45	7.48	3.82	1.6	79
17H-1, 146–147	2.00	4.7	3.3	2.6	58	8.94	4.84	1.2	54
18X-1, 145–150	1.57	4.0	2.5	1.5	43	6.28	3.37	1.0	42
18X-2, 84–86	1.48	3.3	2.4	1.9	39	6.29	3.33	0.7	87
20X-1, 59–61	1.39	3.8	2.4	1.4	46	5.63	3.40	0.7	65
20X-2, 44–46	1.38	3.4	2.2	1.4	42	5.73	3.03	0.9	72
21X-1, 93–95	1.51	3.7	2.4	1.5	42	5.62	3.16	0.7	61
22X-2, 63–64	1.53	3.5	2.3	2.1	51	7.38	4.08	1.0	52
24X-1, 117–120	1.51	3.0	2.6	2.0	45	7.66	4.13	0.6	41
25X-CC, 18–20	1.36	2.9	2.3	1.7	42	7.00	3.76	0.7	45
26X-CC, 11–13	1.24	2.6	2.0	1.4	34	5.41	3.18	0.7	52
27X-1, 106–113	1.20	2.7	1.9	1.5	33	5.52	3.29	0.8	34
28X-1, 6–7	1.01	2.0	1.7	1.6	30	4.98	3.08	0.6	55
29X-1, 16–17	0.76	1.7	1.9	0.7	20	3.13	1.70	0.9	66
33X-1, 16–17	2.86	5.9	6.8	2.2	67	10.77	5.11	1.9	37
34X-2, 140–150	4.93	8.1	9.2	3.0	99	17.32	6.61	2.9	38
34X-3, 30–32	4.24	8.8	9.7	3.1	103	15.60	6.86	3.2	47
35X-2, 97–98	4.47	6.5	10.1	3.1	82	16.11	6.07	1.6	33
36X-1, 80–85	3.56	5.8	8.7	3.6	69	14.86	5.77	1.6	28
37X-2, 83–84	3.29	4.6	7.2	3.1	66	12.62	5.09	1.7	35
39X-2, 131–141	3.20	4.7	6.4	2.4	58	11.19	4.11	1.5	22
40X-2, 9–11	4.33	4.7	7.9	3.4	76	14.41	5.08	1.6	26
41X-CC, 10–11	3.02	3.5	6.4	2.1	48	10.62	3.89	2.8	24
42X-CC, 12–13	1.28	2.1	3.0	1.2	26	5.63	1.72	1.3	21
44X-CC, 10–11	2.96	4.6	6.9	2.5	72	11.68	4.47	3.0	16
45X-1, 29–30	5.83	5.7	9.4	3.5	61	14.33	4.36	1.1	14
46X-1, 40–42	4.36	4.6	9.9	4.7	85	17.99	7.27	1.5	14
46X-1, 140–150	2.70	3.1	6.4	2.9	56	12.64	4.60	1.6	22
47X-1, 51–52	3.86	4.5	8.4	3.7	73	16.01	4.96	0.9	17
48X-CC, 18–19	3.43	4.3	8.5	3.6	66	17.27	4.50	0.8	22

Table 3. Sediment chemistry Site 685.

Sample ID	Depth (mbsf)	Opal-Si (%)	$CaCO_3$ (%)	TOC (%)	TN (%)	TRS (%)	C/N	La (ppm)	Ce (ppm)	Sm (ppm)	Eu (ppm)	Yb (ppm)	Lu (ppm)	Ba (ppm)	Cr (ppm)
01H-2, 40–41	1.90	n.d.	0.58	7.72	1.76	1.13	4.4	25	45	5.3	1.06	1.8	0.46	874	84
02H-3, 44–45	7.54	4.3	1.25	6.05	0.71	0.95	8.5	27	45	5.1	0.91	2.0	0.42	2002	77
03H-3, 35–36	16.95	n.d.	3.25	7.41	0.92	1.05	8.1	26	45	5.1	0.96	2.1	0.41	702	74
04H-2, 19–20	24.69	n.d.	1.09	4.73	0.86	0.87	5.5	22	38	4.5	0.83	1.8	0.49	1151	83
05H-2, 41–42	34.51	4.1	0.75	5.63	0.78	1.08	7.2	29	50	5.5	1.04	2.3	0.51	1055	81
06H-2, 22–23	43.82	n.d.	0.33	7.37	0.80	0.77	9.2	28	47	5.3	0.99	2.2	0.46	1227	87
07H-2, 33–34	53.43	n.d.	1.33	6.74	0.82	0.89	8.2	24	40	4.7	0.95	2.3	0.47	929	86
08H-3, 55–56	64.65	n.d.	1.42	4.94	1.30	0.37	3.8	26	43	5.1	0.95	2.4	0.53	1427	99
09H-5, 70–71	76.17	6.4	5.25	8.08	0.78	2.20	10.4	22	36	3.9	0.72	2.2	0.42	876	77
10X-2, 30–31	81.90	n.d.	1.75	5.89	0.76	0.52	7.7	23	39	4.2	0.78	2.3	0.41	919	87
11X-3, 10–11	92.70	7.9	4.92	9.09	0.97	0.37	9.4	20	32	3.5	0.69	1.7	0.36	935	76
12X-5, 30–31	105.40	n.d.	6.26	8.33	1.02	0.62	8.2	22	38	4.3	0.78	2.3	0.42	1036	78
13X-2, 65–66	110.75	n.d.	2.84	8.24	1.02	0.55	8.1	23	40	4.3	0.84	2.2	0.41	1029	77
14X-2, 71–72	120.31	4.7	2.00	7.35	0.80	1.07	9.2	27	46	5.2	0.94	2.5	0.44	1160	86
15X-3, 47–48	129.87	n.d.	2.00	2.94	0.30	1.21	9.8	18	30	3.4	0.59	1.6	0.32	610	61
16X-2, 19–20	138.79	n.d.	4.59	7.85	0.95	0.99	8.3	16	27	3.2	0.55	1.4	0.27	717	56
17X-4, 45–46	151.05	7.6	2.42	6.09	0.67	0.52	9.1	21	36	3.9	0.75	1.6	0.26	913	69
18X-1, 31–32	156.41	n.d.	4.25	7.63	0.79	n.d.	9.7	25	44	4.5	0.88	2.0	0.38	827	68
19X-1, 23–24	165.83	n.d.	2.67	7.18	0.70	1.50	10.3	24	41	4.3	0.83	1.9	0.38	985	69
20X-4, 72–73	180.04	5.2	1.92	8.66	0.96	0.60	9.0	23	39	4.3	0.82	1.9	0.34	1124	72
22X-2, 91–92	196.51	n.d.	2.59	6.49	1.28	0.49	5.1	23	38	4.2	0.79	2.0	0.37	1035	86
25X-CC, 0–1	223.00	4.3	1.33	10.07	1.01	n.d.	10.0	22	35	4.0	0.73	1.9	0.39	1079	138
27X-1, 49–50	234.09	n.d.	0.92	12.86	1.06	n.d.	12.1	19	28	3.4	0.58	1.5	0.36	1049	136
28X-3, 48–49	246.58	5.5	0.83	3.88	0.53	0.50	7.3	24	42	4.9	0.86	2.1	0.40	1007	138
29X-2, 14–15	254.24	n.d.	1.33	6.57	0.75	n.d.	8.8	19	28	3.4	0.66	1.8	0.35	1035	131
30X-2, 49–50	264.09	n.d.	1.42	4.88	0.60	1.00	8.1	19	28	3.4	0.59	1.9	0.29	917	105
34X-2, 26–27	301.86	7.0	0.75	2.90	0.88	n.d.	3.3	19	32	3.6	0.66	1.5	0.27	876	78
35X-6, 29–30	316.13	n.d.	8.99	2.84	0.94	1.44	3.0	12	20	2.2	0.48	1.1	0.27	904	87
36X-3, 140–150	326.90	n.d.	0.29	2.40	n.d.	n.d.	n.d.	25	42	4.9	0.91	2.8	0.47	862	158
36X-7, 40–41	327.40	n.d.	0.58	4.67	1.08	n.d.	4.3	10	14	1.6	0.30	0.7	0.19	644	58
37X-1, 146–147	330.06	7.9	1.00	6.60	0.59	1.20	11.2	16	25	2.9	0.58	1.4	0.32	882	89
38X-CC, 20–21	338.82	n.d.	42.10	12.45	0.79	0.73	15.8	17	26	2.9	0.52	2.0	0.45	1108	112
39X-3, 140–150	352.00	n.d.	0.25	1.72	n.d.	n.d.	n.d.	24	41	4.4	0.79	1.9	0.37	1100	136
40X-1, 1–2	357.11	6.7	1.50	5.09	0.52	0.68	9.8	19	30	3.4	0.73	1.9	0.42	941	126
42X-CC, 9–10	378.79	n.d.	2.00	4.83	0.56	1.56	8.6	20	33	3.7	0.74	1.9	0.45	864	139
43X-1, 30–31	385.90	8.2	0.42	4.70	0.79	0.77	5.9	7	10	1.7	0.33	0.9	0.18	401	62
44X-3, 40–50	396.00	n.d.	6.25	1.61	n.d.	n.d.	n.d.	19	34	4.2	0.74	2.2	0.39	920	123
47X-1, 39–40	421.49	3.5	3.58	3.80	0.96	n.d.	4.0	14	24	2.6	0.48	1.0	0.24	519	57
48X-1, 61–62	431.21	n.d.	4.75	5.09	0.93	0.49	5.5	21	36	3.9	0.73	1.8	0.36	696	123
49X-CC, 9–10	440.59	n.d.	4.75	4.95	0.44	n.d.	11.2	20	36	3.7	0.69	1.8	0.33	662	126
50X-1, 52–53	450.12	6.5	4.75	5.30	0.83	n.d.	6.4	18	30	3.9	0.72	1.8	0.34	728	122
50X-1, 92–102	450.52	n.d.	3.25	2.33	n.d.	1.31	n.d.	15	27	3.6	0.65	2.0	0.38	621	112

Table 3 (continued).

Sample ID	Fe (%)	Cs (ppm)	Co (ppm)	Hf (ppm)	Rb (ppm)	Sc (ppm)	Th (ppm)	Sb (ppm)	Br (ppm)
01H-2, 40–41	3.84	10.5	10.1	3.2	99	14.0	8.7	2.5	213
02H-3, 44–45	3.58	10.9	8.6	3.7	95	12.9	9.1	2.3	131
03H-3, 35–36	3.37	9.4	8.1	3.7	91	11.6	8.4	2.1	181
04H-2, 19–20	3.45	7.3	9.1	3.0	75	14.2	6.7	2.2	139
05H-2, 41–42	3.77	11.9	9.2	3.9	110	14.5	9.6	2.4	127
06H-2, 22–23	3.59	9.8	8.4	3.7	92	14.1	8.6	2.1	200
07H-2, 33–34	3.74	9.2	8.9	3.3	87	13.8	7.7	1.7	163
08H-3, 55–56	3.67	9.1	7.5	3.9	84	14.5	8.1	1.7	131
09H-5, 70–71	4.45	8.6	7.1	3.1	67	13.0	6.9	1.6	148
10X-2, 30–31	3.63	10.7	9.4	3.5	82	13.7	7.7	1.6	128
11X-3, 10–11	2.76	8.9	6.3	2.8	64	10.8	6.0	1.5	196
12X-5, 30–31	3.26	9.6	7.6	3.3	68	12.2	7.0	1.7	178
13X-2, 65–66	3.39	11.4	8.4	3.4	86	12.8	7.6	2.0	155
14X-2, 71–72	3.62	12.4	8.6	3.9	85	13.8	8.8	2.0	136
15X-3, 47–48	2.37	8.7	5.6	2.7	57	9.2	5.4	1.3	211
16X-2, 19–20	2.23	7.2	5.0	2.3	53	8.3	4.8	1.4	199
17X-4, 45–46	2.90	8.4	7.2	3.1	66	11.3	6.6	1.9	135
18X-1, 31–32	2.88	10.8	6.8	3.5	95	11.5	7.8	2.3	148
19X-1, 23–24	2.71	10.1	6.7	3.7	76	11.3	7.5	2.1	107
20X-4, 72–73	2.79	9.3	6.2	3.2	73	11.0	7.1	2.3	127
22X-2, 91–92	3.21	8.5	6.8	3.2	71	12.1	6.9	2.0	111
25X-CC, 0–1	2.63	7.7	6.5	2.9	81	11.3	6.2	1.9	142
27X-1, 49–50	2.86	7.2	6.4	2.5	70	10.6	5.2	1.8	136
28X-3, 48–49	2.95	8.0	7.3	3.2	75	13.9	7.1	2.1	45
29X-2, 14–15	3.03	7.1	7.2	2.8	80	12.1	5.7	1.6.	86
30X-2, 49–50	3.10	6.7	7.4	2.5	60	11.0	5.9	1.7	63
34X-2, 26–27	2.57	6.8	6.0	3.0	77	8.5	6.6	2.6	44
35X-6, 29–30	2.79	4.7	5.4	1.8	62	7.7	3.9	1.9	73
36X-3, 140–150	4.44	9.7	9.2	3.4	93	17.0	8.1	1.6	42
36X-7, 40–41	1.89	2.9	3.9	1.1	40	5.1	2.6	1.3	67
37X-1, 146–147	2.75	5.3	5.6	2.2	70	9.4	4.8	1.5	52
38X-CC, 20–21	5.32	5.2	5.5	2.2	73	12.5	4.7	1.9	70
39X-3, 140–150	2.79	7.9	6.4	3.2	84	10.3	7.6	1.3	51
40X-1, 1–2	3.06	7.4	6.7	2.8	91	12.3	6.1	1.9	49
42X-CC, 9–10	4.03	7.5	7.5	2.8	90	12.5	6.5	2.0	39
43X-1, 30–31	1.37	1.8	2.9	1.1	28	5.8	1.6	1.0	67
44X-3, 40–50	4.06	7.2	9.1	3.1	76	15.3	6.2	1.8	43
47X-1, 39–40	2.32	4.0	4.6	2.1	55	7.6	4.0	1.3	36
48X-1, 61–62	3.98	7.3	7.1	2.8	90	13.1	6.7	1.6	78
49X-CC, 9–10	3.56	7.1	7.3	2.8	86	12.6	6.5	1.5	91
50X-1, 52–53	3.60	5.1	7.7	2.9	74	13.9	5.3	1.9	60
50X-1, 92–102	3.28	4.8	7.2	2.6	53	12.6	4.7	1.9	68

Table 4. Sediment chemistry at Site 688.

Core, section, interval (cm)	Depth (mbsf)	Opal-Si	$CaCO_3$ (%)	T_{max} (°C)	S_1 (mg/g)	S_2 (mg/g)	S_3 (mg/g)	TOC (%)	TRS (%)	La (ppm)	Ce (ppm)	Sm (ppm)
688A-01H-5, 82–83	6.8	n.d.	1.33	n.d.	n.d.	n.d.	n.d.	3.02	0.66	30	48	6.1
02H-1, 44–45	8.7	3.5	1.00	n.d.	n.d.	n.d.	n.d.	2.77	1.00	28	43	5.7
02H-3, 44–45	11.7	n.d.	1.33	n.d.	n.d.	n.d.	n.d.	1.85	0.39	29	48	6.1
02H-5, 44–45	14.7	n.d.	1.75	423	1.15	4.48	1.97	1.56	0.56	30	48	6.2
02H-7, 44–45	17.7	n.d.	10.34	418	2.59	13.58	5.32	3.73	0.87	24	43	4.9
03H-2, 42–43	19.7	6.6	10.68	406	3.24	10.77	4.59	3.28	116	23	40	4.7
03H-4, 42–43	22.7	n.d.	10.89	422	1.79	9.10	4.51	2.72	118	25	44	5.1
03H-4, 140–150	23.7	n.d.	n.d.	424	0.68	5.07	2.58	1.99	1.14	n.d.	n.d.	n.d.
04H-3, 44–45	30.7	n.d.	6.51	n.d.	n.d.	n.d.	n.d.	2.70	0.88	31	51	6.4
05H-3, 64–65	40.4	4.8	49.87	423	0.90	5.17	2.49	1.55	0.84	31	55	6.0
06H-2, 63–64	48.5	n.d.	13.76	422	1.20	5.87	3.13	1.91	0.93	25	44	5.5
06H-3, 145–150	50.8	n.d.	8.48	424	0.68	5.07	2.58	2.14	0.81	26	46	5.6
08X-1, 57–58	65.9	3.2	21.35	n.d.	n.d.	n.d.	n.d.	3.67	1.08	25	42	5.3
09X-5, 100–111	81.9	n.d.	9.17	413	3.50	16.41	5.12	3.87	1.06	25	47	5.1
09X-5, 140–150	82.2	n.d.	n.d.	418	2.16	16.37	3.94	4.73	1.34	n.d.	n.d.	n.d.
09X-6, 110–111	83.4	n.d.	1.50	405	2.98	12.39	5.20	3.32	0.80	23	45	4.7
10X-2, 32–33	86.1	4.5	8.76	404	2.28	8.73	6.14	3.55	1.32	24	44	4.7
11X-2, 28–29	95.6	n.d.	8.09	n.d.	n.d.	n.d.	n.d.	3.76	0.86	27	49	5.3
12X-1, 55–56	103.9	2.8	8.59	414	3.50	17.37	6.04	4.24	0.68	25	43	4.7
13X-2, 66–67	115.0	n.d.	5.34	420	2.28	13.60	4.77	3.67	0.55	29	51	5.6
13X-6, 66–67	121.0	n.d.	11.84	419	2.29	12.94	5.41	3.56	0.73	27		
14X-2, 85–86	124.7	n.d.	8.84	414	2.46	12.79	7.37	3.76	0.73	27	48	5.3
14X-6, 85–86	130.7	2.8	4.34	417	2.82	15.56	6.24	4.08	0.32	28	47	5.1
16X-2, 11–12	142.9	n.d.	0.32	413	3.18	15.23	5.83	4.40	0.68	23	35	4.4
16X-6, 12–13	148.9	n.d.	2.50	419	3.48	19.87	5.94	4.87	0.52	26	42	5.2
17X-1, 58–59	151.4	n.d.	3.50	416	2.50	13.38	5.95	3.36	0.79	27	44	5.1
17X-6, 58–59	158.9	n.d.	2.75	421	2.24	13.88	4.79	3.53	0.52	28	46	5.1
18X-1, 133–135	161.6	5.6	4.17	413	3.88	18.65	6.30	4.78	0.67	25	39	4.9
19X-1, 58–59	170.4	n.d.	8.59	419	2.27	14.67	5.71	3.71	n.d.	27	45	5.2
19X-3, 140–150	174.2	n.d.	n.d.	424	0.88	10.35	3.51	3.24	0.48	n.d.	n.d.	n.d.
19X-5, 58–59	176.4	n.d.	7.26	416	1.49	9.91	4.65	2.80	0.90	29	52	5.7
21X-1, 63–64	189.4	n.d.	14.68	409	2.47	12.21	6.86	3.53	0.68	23	37	4.4
21X-3, 63–64	192.4	n.d.	8.17	410	1.90	9.86	5.27	3.09	1.00	24	43	4.7
21X-3, 108–118	192.9	n.d.	n.d.	417	1.05	9.86	3.33	3.41	1.01	n.d.	n.d.	n.d.
22X-1, 20–21	198.5	4.6	9.67	415	4.43	24.28	7.19	5.75	0.89	25	42	5.1
23X-1, 69–70	208.5	n.d.	2.92	418	2.36	14.34	4.72	3.38	0.69	23	40	4.8
24X-1, 50–51	217.8	n.d.	2.00	416	3.45	19.57	4.99	4.79	1.06	24	43	4.8
25X-1, 62–63	227.4	n.d.	1.83	408	7.74	35.38	7.38	8.00	0.95	21	34	4.2
26X-1, 33–34	236.6	5.3	1.42	409	4.20	21.03	5.21	5.17	0.85	24	43	4.6
27X-1, 25–26	246.1	n.d.	1.08	414	2.57	12.73	3.71	3.24	1.04	27	47	5.8
27X-4, 140–150	251.7	n.d.	n.d.	413	1.36	16.66	3.27	2.71	1.60	n.d.	n.d.	n.d.
28X-1, 55–56	255.9	n.d.	1.92	423	2.36	17.36	7.00	4.99	1.26	27	46	5.6
29X-2, 38–39	269.7	n.d.	1.10	410	4.15	23.64	4.91	5.44	1.00	26	47	5.7
30X-1, 39–40	277.8	4.8	1.85	410	3.61	18.68	5.01	4.78	1.14	27	48	5.4
31X-1, 39–40	287.4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	4.49	0.75	24	43	5.0
32X-1, 37–38	297.0	n.d.	3.76	417	2.10	13.20	4.90	3.38	0.95	28	54	5.7
33X-1, 86–87	303.7	n.d.	3.43	415	2.91	18.68	5.58	4.64	0.71	23	40	4.6
34X-1, 68–69	313.0	4.2	1.75	407	4.17	20.46	4.25	4.51	0.27	26	46	5.1
36X-1, 85–86	332.2	n.d.	1.75	416	2.69	15.85	3.50	3.75	1.12	26	47	5.9
36X-6, 140–150	339.9	n.d.	n.d.	427	1.15	15.81	2.78	3.72	1.04	n.d.	n.d.	n.d.
37X-2, 59–61	342.9	n.d.	1.00	402	7.07	31.54	5.93	6.93	0.11	21	37	4.6

Table 4 (continued).

Eu (ppm)	Yb (ppm)	Lu (ppm)	Ba (ppm)	Cr (ppm)	Fe (%)	Cs (ppm)	Co (ppm)	Hf (ppm)	Rb (ppm)	Sc (ppm)	Th (ppm)	Sb (ppm)	Br (ppm)
1.30	3.39	0.72	1819	92	3.58	13.2	9.6	3.8	117	15.0	8.9	2.5	211
1.14	3.17	0.66	2060	102	4.03	11.6	9.3	3.4	111	15.3	8.3	0.9	185
1.14	3.44	0.64	2576	94	2.96	10.5	7.9	3.7	93	14.3	8.7	2.1	175
1.07	3.83	0.75	3310	91	3.22	9.0	8.0	4.4	99	13.4	8.8	2.0	117
1.01	2.47	0.47	868	127	3.69	43.4	9.5	3.3	114	14.3	8.5	2.7	256
1.03	2.44	0.47	944	88	3.36	12.3	7.8	3.1	98	11.7	7.4	2.6	222
1.04	2.46	0.46	1050	73	3.27	12.5	7.8	3.5	100	11.6	8.0	1.8	180
n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1.09	2.93	0.64	1754	83	3.49	13.8	9.2	4.2	124	14.5	9.4	2.5	170
1.32	2.57	0.57	4684	84	4.19	15.1	10.1	4.3	106	14.3	10.1	3.5	190
0.93	2.56	0.63	1376	80	3.41	12.1	8.7	3.6	97	12.9	8.3	2.6	150
1.09	3.20	0.66	1321	89	3.19	10.5	8.3	3.9	89	13.7	8.2	2.2	70
0.89	2.98	0.62	1509	92	3.19	12.4	8.4	3.4	91	13.1	7.6	2.6	230
1.03	2.62	0.53	1006	107	3.08	13.4	8.1	3.9	93	12.7	8.7	2.4	278
n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
0.96	2.21	0.46	986	86	2.70	13.3	6.9	3.5	91	12.4	8.1	2.6	184
0.88	2.17	0.41	1036	75	3.66	12.8	7.7	3.5	94	11.1	8.2	2.6	187
0.90	2.64	0.53	12	90	3.23	14.0	8.4	3.9	107	13.9	9.1	2.4	217
0.92	2.60	0.50	1404	98	2.95	13.2	7.3	3.5	96	11.6	7.7	2.3	275
1.06	2.75	0.51	1441	100	3.58	15.3	9.2	4.5	112	13.4	9.9	3.0	239
1.01	2.71	0.52	1348	84	3.54	14.3	8.9	3.8	112	13.7	9.3	2.5	230
0.95	2.93	0.56	1590	97	4.17	15.6	9.3	3.9	101	15.1	9.2	2.6	242
1.02	2.93	0.54	1422	101	3.35	12.8	8.0	3.8	100	13.3	8.7	2.3	264
0.80	2.63	0.51	1957	101	3.12	10.3	7.3	2.9	79	11.9	6.6	2.3	264
0.90	2.98	0.60	1899	117	3.30	11.6	8.4	3.5	89	13.7	8.0	2.7	287
0.92	3.10	0.56	1729	108	3.79	12.0	8.3	3.7	103	14.2	8.5	2.5	237
0.98	3.17	0.53	1883	115	3.48	12.1	8.3	3.6	100	13.9	8.5	2.5	249
0.81	2.99	0.54	1857	107	3.10	10.3	7.6	3.6	88	12.1	7.6	2.3	301
0.91	3.01	0.54	1406	113	3.88	12.5	9.2	3.9	112	14.8	9.0	2.3	225
n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
1.11	3.06	0.56	1270	87	4.12	14.7	9.7	4.2	118	14.7	10.2	3.1	163
0.77	2.19	0.46	1452	100	3.35	10.7	4.1	3.2	82	13.5	7.3	1.9	210
0.76	2.59	0.48	1265	101	3.63	11.9	8.3	3.5	92	13.3	8.5	2.0	219
n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
0.89	3.11	0.62	1472	110	3.16	11.0	7.6	3.4	85	13.2	7.7	2.6	279
0.83	2.70	0.53	1518	102	3.05	9.1	7.0	3.0	78	11.7	7.1	2.0	234
0.81	2.49	0.49	1511	128	3.33	11.3	9.1	3.3	92	13.6	8.2	2.2	262
0.66	2.18	0.46	1650	123	2.56	8.8	6.3	3.0	70	10.1	6.2	1.9	301
0.78	2.11	0.45	1589	103	2.91	11.7	7.2	3.6	86	11.4	7.9	2.4	234
0.92	3.02	0.64	1808	149	3.55	10.1	8.4	3.8	90	14.2	8.2	2.3	179
n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
0.93	2.78	0.52	1083	103	3.12	12.0	7.9	3.6	96	12.0	8.3	2.2	221
0.99	2.79	0.63	1294	137	3.02	12.8	8.1	3.3	88	13.6	8.6	2.8	247
0.97	2.48	0.57	1311	109	3.45	13.2	9.5	3.6	92	12.9	8.9	2.7	204
1.07	2.56	0.54	1518	127	3.03	10.9	7.7	3.3	86	12.6	7.9	2.6	201
0.98	2.57	0.57	1180	120	4.13	13.7	9.9	3.9	96	15.8	9.6	2.6	166
0.74	2.39	0.49	1258	103	2.74	11.1	7.8	3.1	77	10.9	7.8	1.9	170
0.88	2.60	0.52	1858	133	3.51	12.8	8.6	3.5	97	13.4	8.5	2.8	187
0.87	2.77	0.68	1770	146	3.73	13.0	9.9	3.7	87	14.5	8.6	2.5	366
n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
0.72	2.05	0.51	1521	125	2.75	10.4	7.4	2.8	72	10.3	7.0	2.5	261

Table 5. Average sediment composition of Peru margin sediments and comparison with data from other upwelling sediments.

	Opal	$CaCO_3$	TOC	TRS	La	Ce	Sm	Eu	Yb	Lu	Ba	Cr
Number of Cases	91	177	170	156	179	179	179	179	178	179	179	179
Minimum	1.1	0.00	0.03	0.11	7	10	1.59	0.2	0.1	0.02	11	42
Maximum	17.6	49.87	17.94	2.63	37	60	7.70	1.3	3.8	0.74	3252	196
Mean	6.3	5.37	5.48	0.99	21	36	4.35	0.8	2.0	0.42	841	98
Standard Dev.	3.8	7.04	3.19	0.44	6	11	1.12	0.2	0.6	1.22	567	29

	Fe	Cs	Co	Hf	Rb	Sc	Th	Sb	Br
Number of Cases	179	179	179	179	179	179	179	179	179
Minimum	0.72	1.6	1.6	0.66	18.8	2.9	1.6	0.6	12
Maximum	5.77	14.5	11.75	9.28	118.4	16.9	10.5	4.2	390
Mean	2.77	8.1	6.77	3.13	72.5	10.7	6.5	1.9	143
Standard Dev.	0.89	3.2	2.26	1.15	22.1	3.1	2.1	0.6	88

Component	n	TOC	La	Ce	Ba	Cr	Fe	Co	Rb	Sc	Th	Br
[1]Peru upwelling	179	5.5	21	36	840	98	2.8	6.7	72.5	10.7	6.5	143
[2]Gulf of California	50	4.4	n.g.	n.g.	566	44	7	n.g.	n.g.	n.g.	n.g.	n.g.
[3]Benguela upwelling	44	6.1	14	30	2927	101	3.2	11	63	22	6	104
[4]Average clay	n.g.	0.3	115	345	2300	90	6.5	74	110	19	7	70
[5]Average carbonates	n.g.	n.g.	10	35	190	11	0.9	1	10	2	1	70

[1] This study.
[2] Brumsack, 1986.
[3] Emeis, 1985.
[4] Turekian and Wedepohl, 1961.
[5] Turekian and Wedepohl, 1961.