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11. Data Report: Major Cation Concentrations of Interstitial Waters Collected from Deep Sediments of Eastern Equatorial Pacific and Peru Margin (ODP Leg 201)[1]

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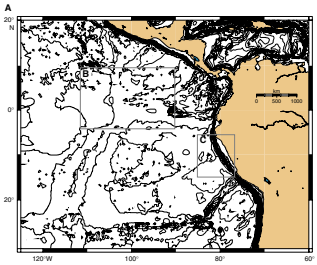
INTRODUCTION

Leg 201 of the Ocean Drilling Program (ODP) focused on understanding subsurface microbial communities and their influence on the chemistry of the surrounding environment (D'Hondt, Jørgensen, Miller, et al., 2003). During the cruise, sediment cores were collected from four different marine environments of the eastern Pacific Ocean (Fig. **F1**): deep open ocean beneath the moderately productive upwelling regime of the equator (Sites 1225 and 1226), shallow waters of the highly productive Peru shelf (Sites 1227–1229), a deepwater gas-charged zone in the Peru Trench (Site 1230), and a deep open-ocean area under oligotrophic waters (Site 1231). Each of these sites had been drilled previously (during either Deep Sea Drilling Project [DSDP] Leg 34, ODP Leg 112, or ODP Leg 138), although not for detailed microbiological or geochemical investigations.

Interstitial waters are routinely analyzed for major cations aboard the *JOIDES Resolution* drillship. An exception was made during Leg 201 because other dissolved species (e.g., Fe^{2+}, Mn^{2+}, Ba^{2+}, and acetate) were of more immediate interest and because low-resolution profiles of major cations already existed from the earlier cruises (D'Hondt, Jørgensen, Miller, et al., 2003). Consequently, major cation analyses were withheld for shore-based work. We present here the Ca^{2+}, Mg^{2+}, K^+, Na^+, and Sr^{2+} concentrations for pore waters from six of the sites, Sites 1225–1230. Pore waters from Site 1231 are not included in this report because of data inconsistencies.

F1. Leg 201 drill sites and Sites 1225 and 1226, p. 6.



[1] Donohue, C.M., Snyder, G.T., and Dickens, G.R., 2005. Data report: Major cation concentrations of interstitial waters collected from deep sediments of eastern equatorial Pacific and Peru margin (ODP Leg 201). *In* Jørgensen, B.B., D'Hondt, S.L., and Miller, D.J. (Eds.), *Proc. ODP, Sci. Results,* 201, 1–19 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/201_SR/VOLUME/CHAPTERS/104.PDF>. [Cited YYYY-MM-DD]
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METHODS

Pore waters taken for all shipboard and shore-based chemical analyses were collected from whole-round intervals in accordance with standard procedures used on the *JOIDES Resolution* (Gieskes et al., 1991). For major ion analyses, splits of these samples were acidified with 5 µL of ultrapure HNO_3, sealed in plastic tubes, and shipped to Rice University in Houston, Texas (USA). Each tube was cut, and the sample was transferred to a prewashed plastic 15-mL centrifuge tube. Aliquots of each sample were prepared by diluting 0.1 mL of pore water with 9.9 mL of deionized water. The sample was then spiked with 0.1 µL of a 1-ppm yttrium standard (for peak calibration) and further acidified with 0.1 µL of 1% ultra pure HNO_3 to inhibit possible precipitation.

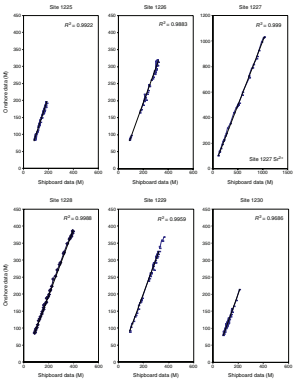
Samples were then analyzed for Ca^{2+}, Mg^{2+}, Na^{+}, Sr^{2+}, K^{+}, and Y^{+} concentrations using a Varian Vista Pro inductively coupled plasma–atomic emission spectrometer at Rice University. The wavelengths used for analyses were: 370.602 and 396.000 nm for Ca^{2+}, 383.829 and 279.800 nm for Mg^{2+}, 766.491 and 769.000 nm for K^{+}, 589.592 and 330.237 nm for Na^{+}, and 430.544 and 407.771 nm for Sr^{2+}. The wavelength that provided the least error from each pair was used to determine the analyte concentration. Concentrations were obtained by comparing peak areas to those generated from analyses of International Association for the Physical Sciences of the Ocean and standards prepared by diluting (1:10, 1:50, 1:100, and 1:500) artificial seawater of known concentrations (Gieskes et al., 1991). Ten samples were prepared and analyzed a second time to assess precision. Repeated analyses of these true replicates are within 3% for all major cations (Table **T1**).

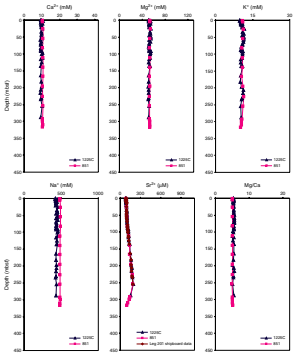
RESULTS

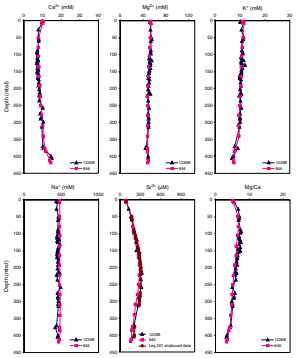
For 259 of 306 total samples, Sr^{2+} concentrations (Table **T1**) are within 3% of Sr^{2+} concentrations measured during Leg 201 (Fig. **F2**). This suggests that samples are mostly pristine despite extended storage and transport. Samples with a >3% difference in shore-based and shipboard Sr^{2+} concentrations are noted (Table **T1**) but are not discussed further, nor are they included in subsequent figures because they have presumably been altered during storage. The Sr^{2+} concentrations and profiles (Figs. **F3, F4, F5, F6, F7, F8**) are not discussed either, as they are essentially identical to those presented in the Leg 201 *Initial Reports* volume (D'Hondt, Jørgensen, Miller, et al., 2003).

Major cation concentrations at all six sites (Table **T1**) show generally smooth profiles with depth (Figs. **F3, F4, F5, F6, F7, F8**). The profiles are comparable to those obtained from earlier work during Legs 112 and 138 (Suess, von Huene, et al., 1998; Mayer, Pisias, Janecek, et al., 1992), suggesting good accuracy and precision for the major cations.

The equatorial sites (Sites 1225 and 1226) show little downhole variation in major cation concentrations (Table **T1**; Figs. **F3, F4**). At Site 1225, dissolved Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+} remain at 10 ± 1 mM, 53 ± 3 mM, 10 ± 2 mM, and 440 ± 20 mM, respectively, from the seafloor to the base of the hole at 291 meters below seafloor (mbsf). At Site 1226, dissolved Ca^{2+} decreases from 10 mM at the seafloor to 7 mM at ~120 mbsf and then increases to 15 mM at the bottom of the hole at 410 mbsf. Dissolved Mg^{2+} and K^{+} show slight but fairly steady decreases to 44 and 7 mM, respectively, through the sediment column, whereas dissolved Na^{+} remains at 467 ± 39 mM.







Pore waters from the Peru shelf sites (Sites 1227–1229) show more downhole variability in major ion concentrations than those from the equatorial sites (Table T1; Figs. F5, F6, F7). Although major ion profiles differ in terms of absolute concentrations with depth, they are similar in shape. Dissolved Ca^{2+} ranges from 7 to 40 mM, with concentrations rapidly decreasing to 7–8 mM at shallow depths (<5–20 mbsf) and then steadily increasing to the bottom of the drilled sections (144–188 mbsf). Dissolved Mg^{2+} displays a somewhat similar profile at Sites 1228 and 1229, with concentrations dropping slightly from >52 to <48 mM within the upper 30 m and then increasing to 100 and 120 mM, respectively, with depth. The initial drop in Mg^{2+} is not obvious at Site 1227, although this ion reaches 25 mM at 145 mbsf. Potassium concentrations increase from ~10 mM to 14 mM through the sediment column at Sites 1228 and 1229 but reach 23 mM at 145 mbsf at Site 1227. Dissolved Na^+ also increases with depth at all three sites, with Site 1229 having the highest concentration of 1000 mM at 188 mbsf.

Major cation concentrations show relatively smooth profiles at Site 1230 (Table T1; Fig. F8). Dissolved Ca^{2+} decreases from 10 mM near the seafloor to 5 mM at ~20 mbsf and then increases to 7 mM at the bottom of the drilled section at 260 mbsf. Dissolved Mg^{2+} behaves differently than at other sites investigated during Leg 201, with an increase in concentration to 76 mM at 64 mbsf and then a decline to 40 mM at ~260 mbsf. Dissolved K^+ concentrations are highly variable and do not display a systematic variation. Similar to the equatorial sites, dissolved Na^+ shows little variation in depth and remains at 440 ±10 mM. It is noteworthy that Site 1230 contains sediment intervals with methane gas hydrate because gas hydrate dissociation during core recovery can release fresh water (e.g., Egeberg and Dickens, 1999), and some pore waters examined on the ship have anomalously low dissolved ion concentrations (D'Hondt, Jørgensen, Miller, et al., 2003). However, pore waters from these intervals were not collected for major cation analyses.

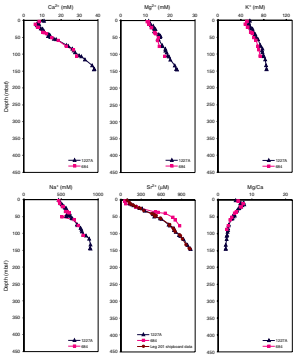
PRELIMINARY INTERPRETATIONS

The equatorial sites have relatively constant profiles for the major cations. This suggests that microbiological (or other) activity at these sites only minimally affects these species.

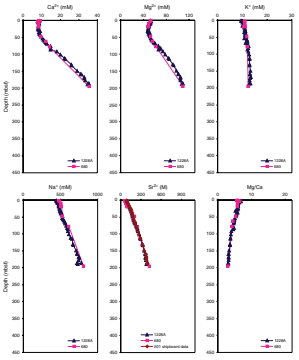
The three shelf sites (1227, 1228, and 1229) have the most variation in major cation chemistry. These sites show significant increases in the concentrations of all major cations with depth, consistent with the influence of a brine at depth (Kastner et al., 1990; D'Hondt, Jørgensen, Miller, et al., 2003). Also, dissolved Ca^{2+} and Mg^{2+} noticeably decrease in the upper 30 m. This suggests the precipitation of a Ca-Mg–bearing phase in these shallow sediments, such as dolomite.

Site 1230 also has a significant drop in Ca^{2+} in shallow pore fluids. The primary drop occurs at the sulfate–methane transition, suggesting that anaerobic methane oxidation at this site leads to authigenic carbonate formation (e.g., Rodriguez et al., 2000). Interestingly, however, Mg^{2+} increases in shallow sediment, unlike on the shelf. Given the extreme dissolved ammonium concentrations at this site (D'Hondt, Jørgensen, Miller, et al., 2003), this may signify release of Mg^{2+} to pore waters because of increased exchange with the ammonium ion (Von Breymann and Suess, 1988).

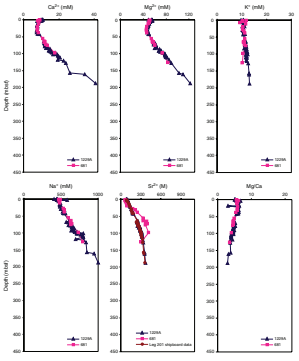
F5. Major cation concentrations, Hole 1227A and Site 684, p. 11.



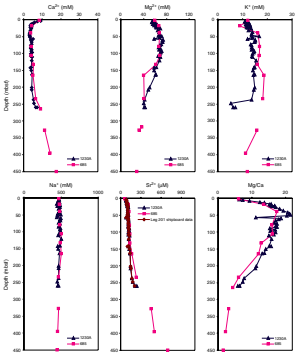
F6. Major cation concentrations, Hole 1228A and Site 680, p. 12.



F7. Major cation concentrations, Hole 1229A and Site 685, p. 13.



F8. Major cation concentrations, Hole 1230A and Site 685, p. 14.



ACKNOWLEDGMENTS

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REFERENCES

D'Hondt, S.L., Jørgensen, B.B., Miller, D.J., et al., 2003. *Proc. ODP, Init. Repts.,* 201 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA. [**HTML**]

Egeberg, P.K., and Dickens, G.R., 1999. Thermodynamic and pore water halogen constraints on gas hydrate distribution at ODP Site 997 (Blake Ridge). *Chem. Geol.,* 153:53–79.

Gieskes, J.M., Gamo, T., and Brumsack, H., 1991. Chemical methods for interstitial water analysis aboard *JOIDES Resolution. ODP Tech. Note,* 15 [Online]. Available from World Wide Web: <**http://www-odp.tamu.edu/publications/tnotes/tn15/f_chem1.htm**>.

Kastner, M., Elderfield, H., Martin, J.B., Suess, E., Kvenvolden, K.A., and Garrison, R.E., 1990. Diagenesis and interstitial-water chemistry at the Peruvian continental margin—major constituents and strontium isotopes. *In* Suess, E., von Huene, R., et al., *Proc. ODP, Sci. Results,* 112: College Station, TX (Ocean Drilling Program), 413–440.

Mayer, L., Pisias, N., Janecek, T., et al., 1992. *Proc. ODP, Init. Repts.,* 138 (Pts. 1 and 2): College Station, TX (Ocean Drilling Program).

Rodriguez, N.M., Paull, C.K., and Borowski, W.S., 2000. Zonation of authigenic carbonates within gas hydrate-bearing sedimentary sections on the Blake Ridge: offshore southeastern North America. *In* Paull, C.K., Matsumoto, R., Wallace, P.J., and Dillon, W.P. (Eds.), *Proc. ODP, Sci. Results,* 164: College Station, TX (Ocean Drilling Program), 301–312. [**HTML**]

Suess, E., von Huene, R., et al., 1988. *Proc. ODP, Init. Repts.,* 112: College Station, TX (Ocean Drilling Program).

Von Breymann, M.T., and Suess, E., 1988. Magnesium in the marine environment: Mg-NH_4 ion exchange. *Chem. Geol.,* 70:359–371.

Figure F1. A. General area of Leg 201 drill sites with close up areas of equatorial Pacific (area B) and Peru shelf (area C). (Continued on next page.)

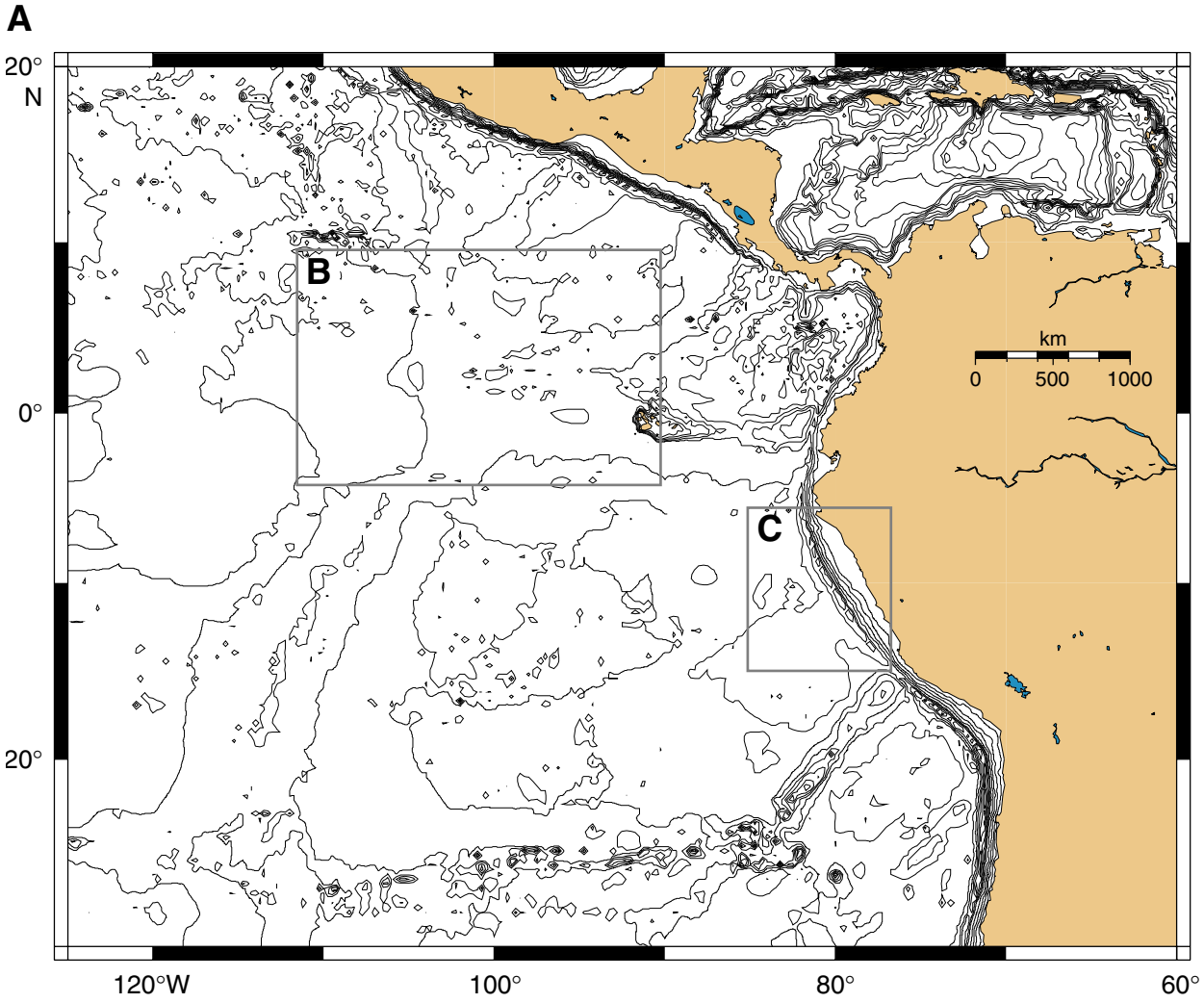

Figure F1 (continued). **B.** Locations of Sites 1225 and 1226 (previous ODP designations in parentheses). **C.** Locations of Sites 1227–1229 (previous DSDP/ODP site designations in parentheses) (from D'Hondt, Jørgensen, Miller, et al., 2003).

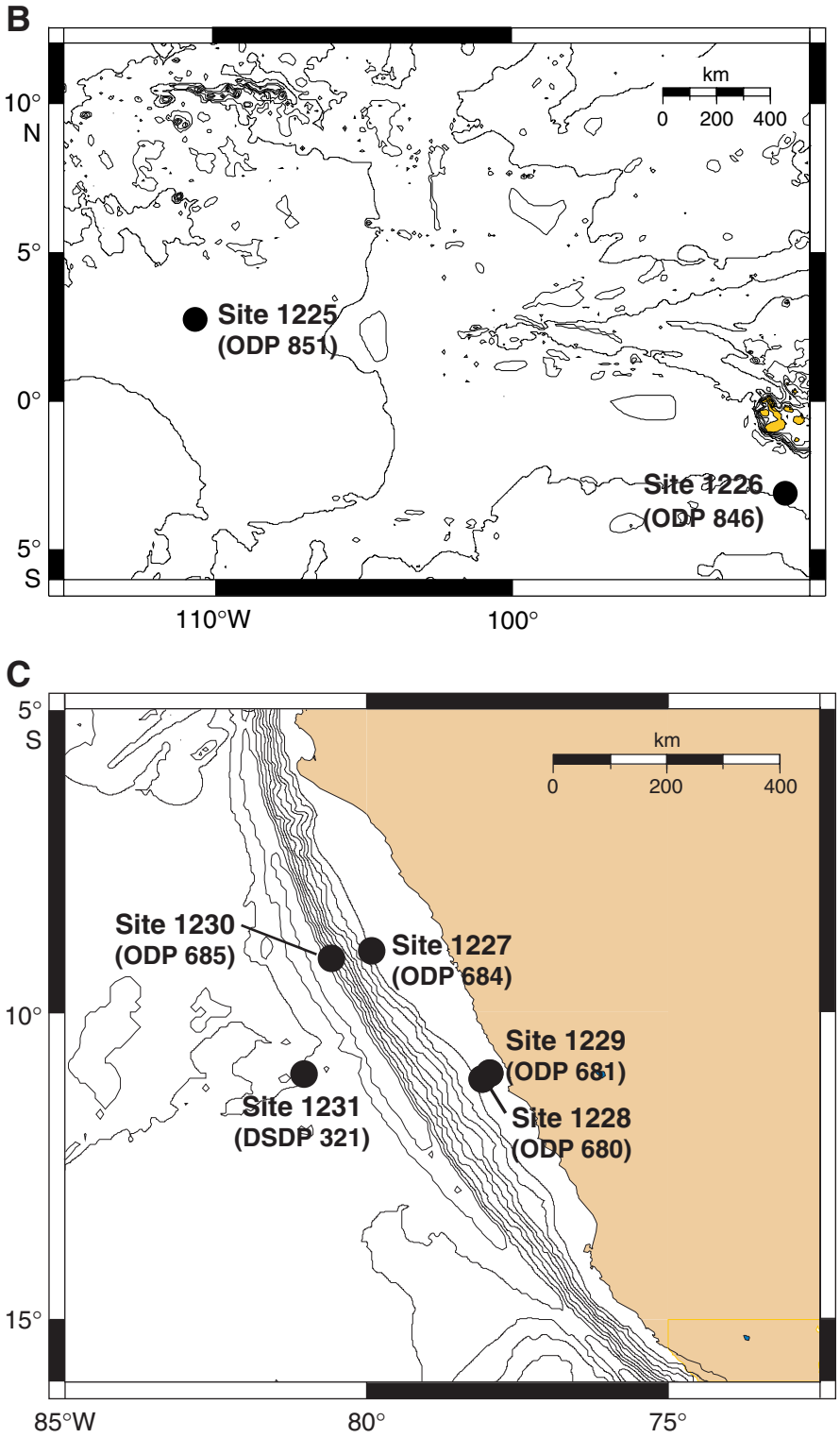

Figure F2. Comparison of shipboard- and onshore-gathered strontium (Sr^{2+}) data, Sites 1225–1230.

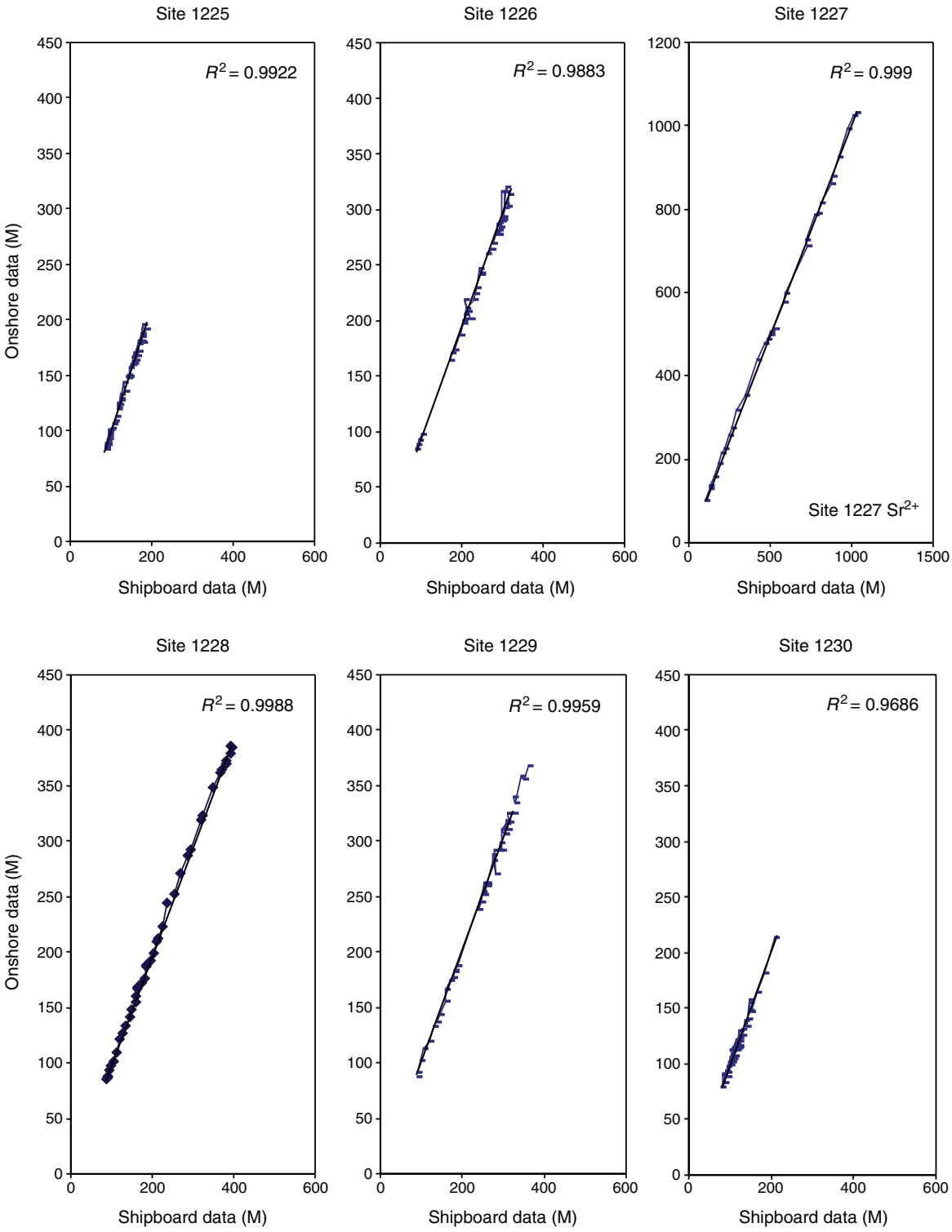

Figure F3. Major cation concentrations in Hole 1225C and Site 851.

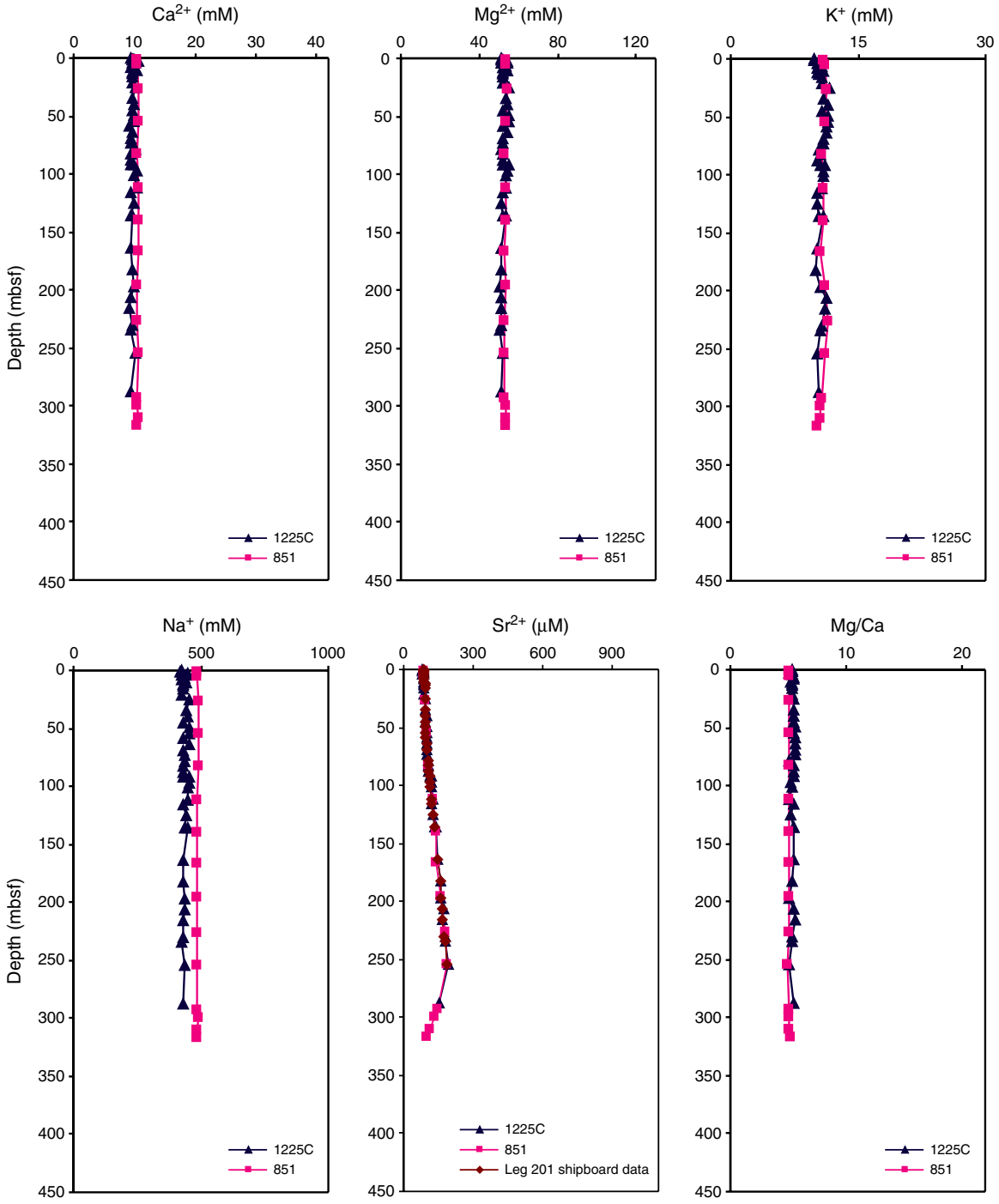

Figure F4. Major cation concentrations in Hole 1226B and Site 846.

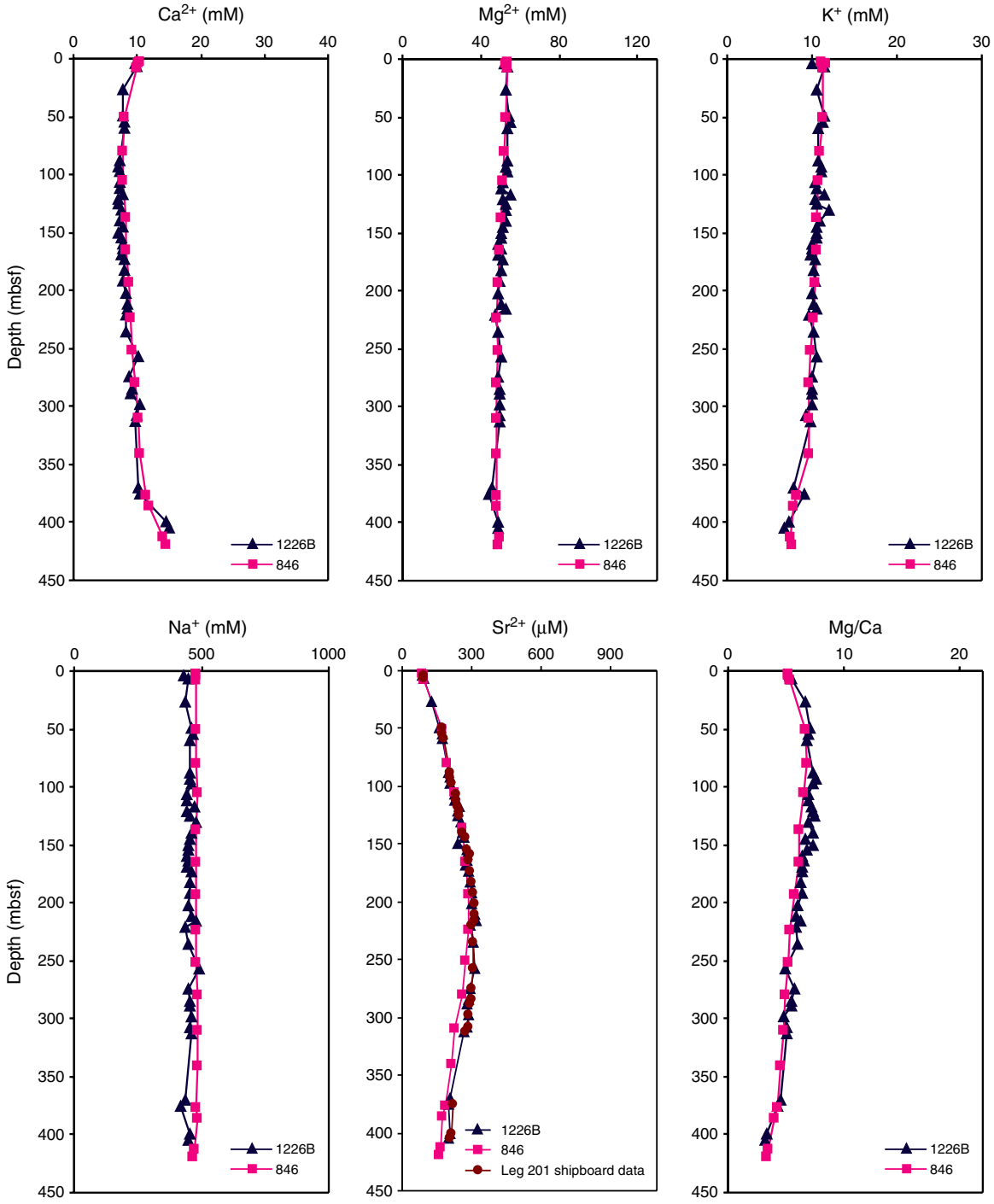

Figure F5. Major cation concentrations in Hole 1227A and Site 684.

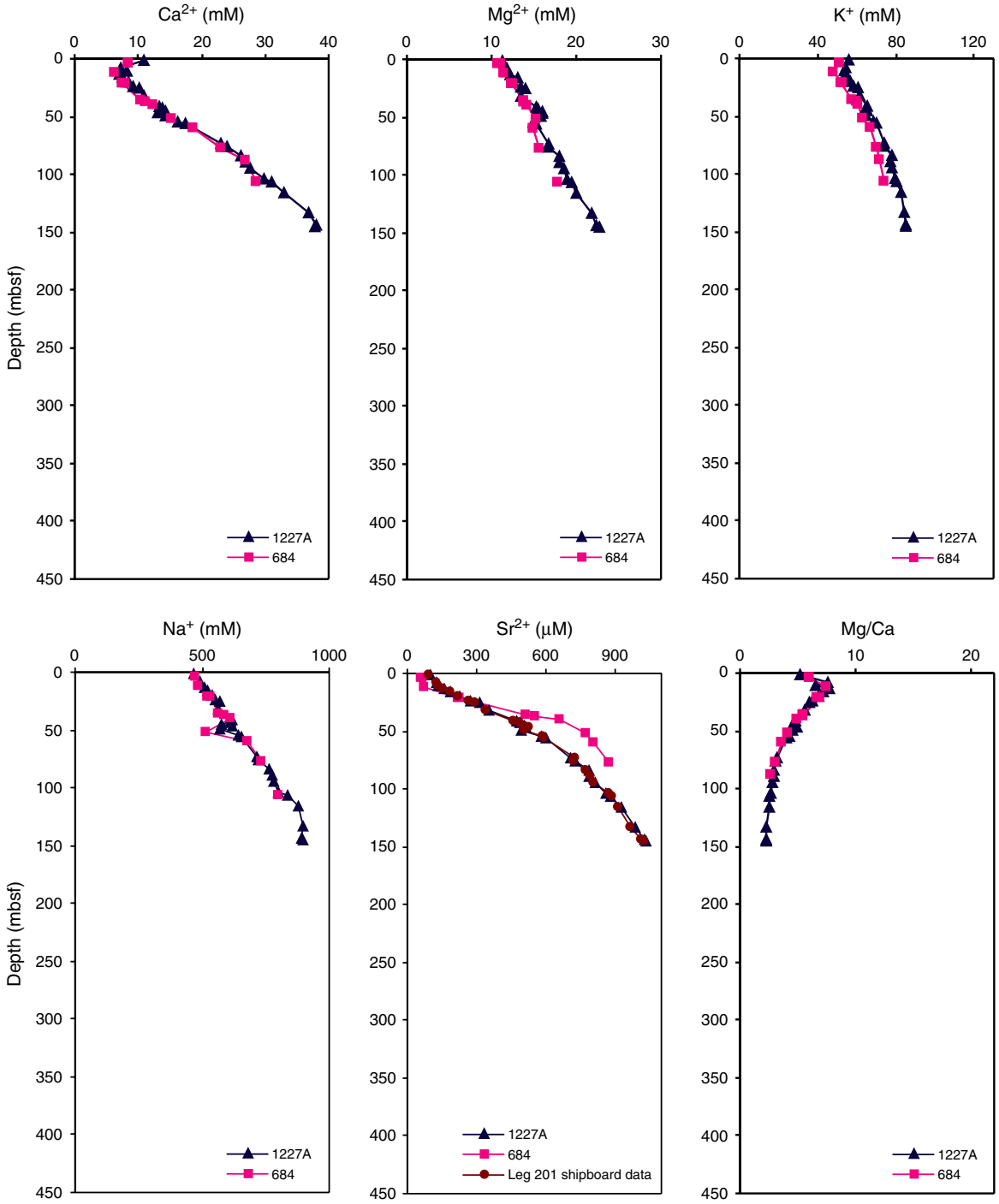

Figure F6. Major cation concentrations in Hole 1228A and Site 680.

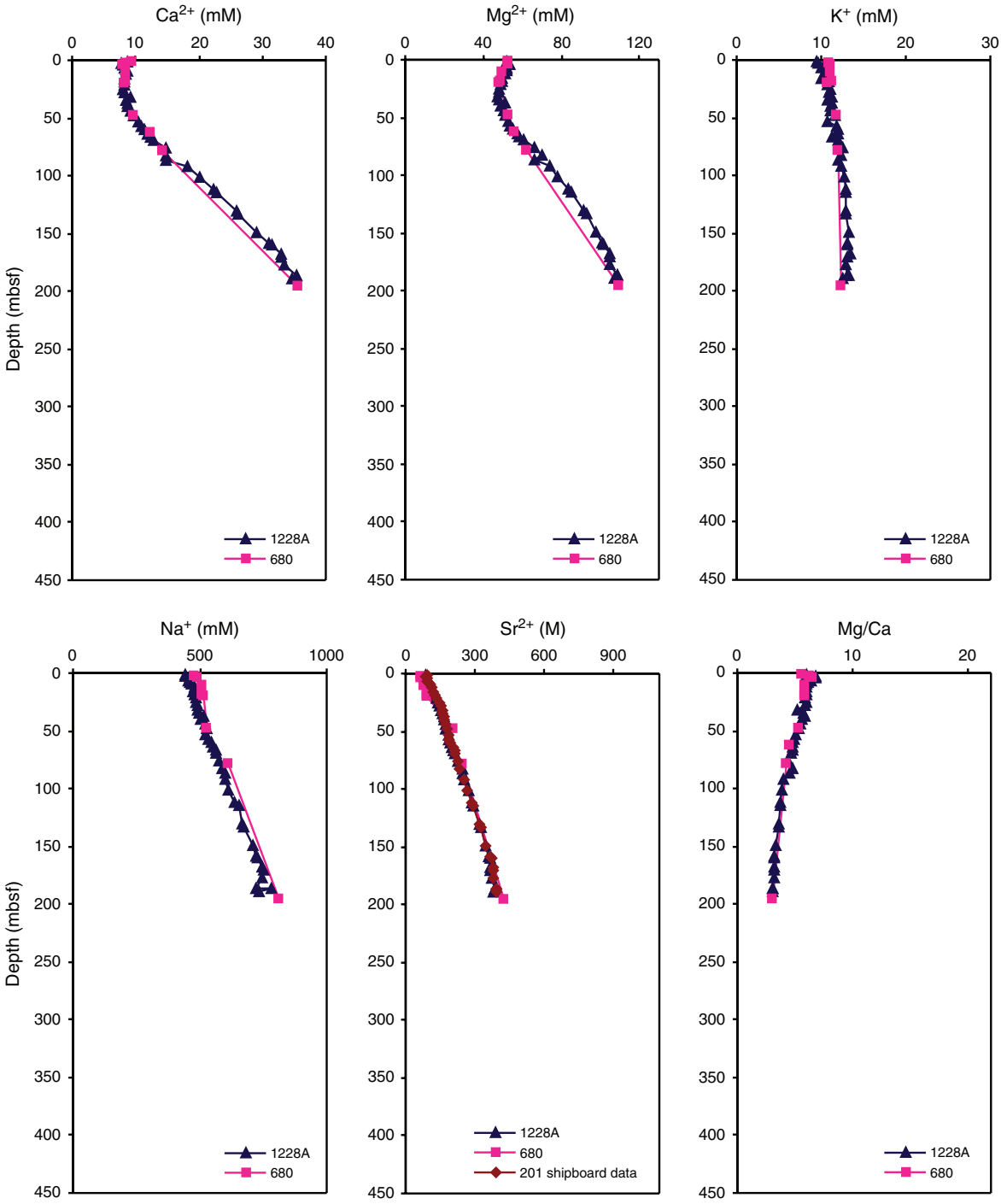

Figure F7. Major cation concentrations in Hole 1229A and Site 681.

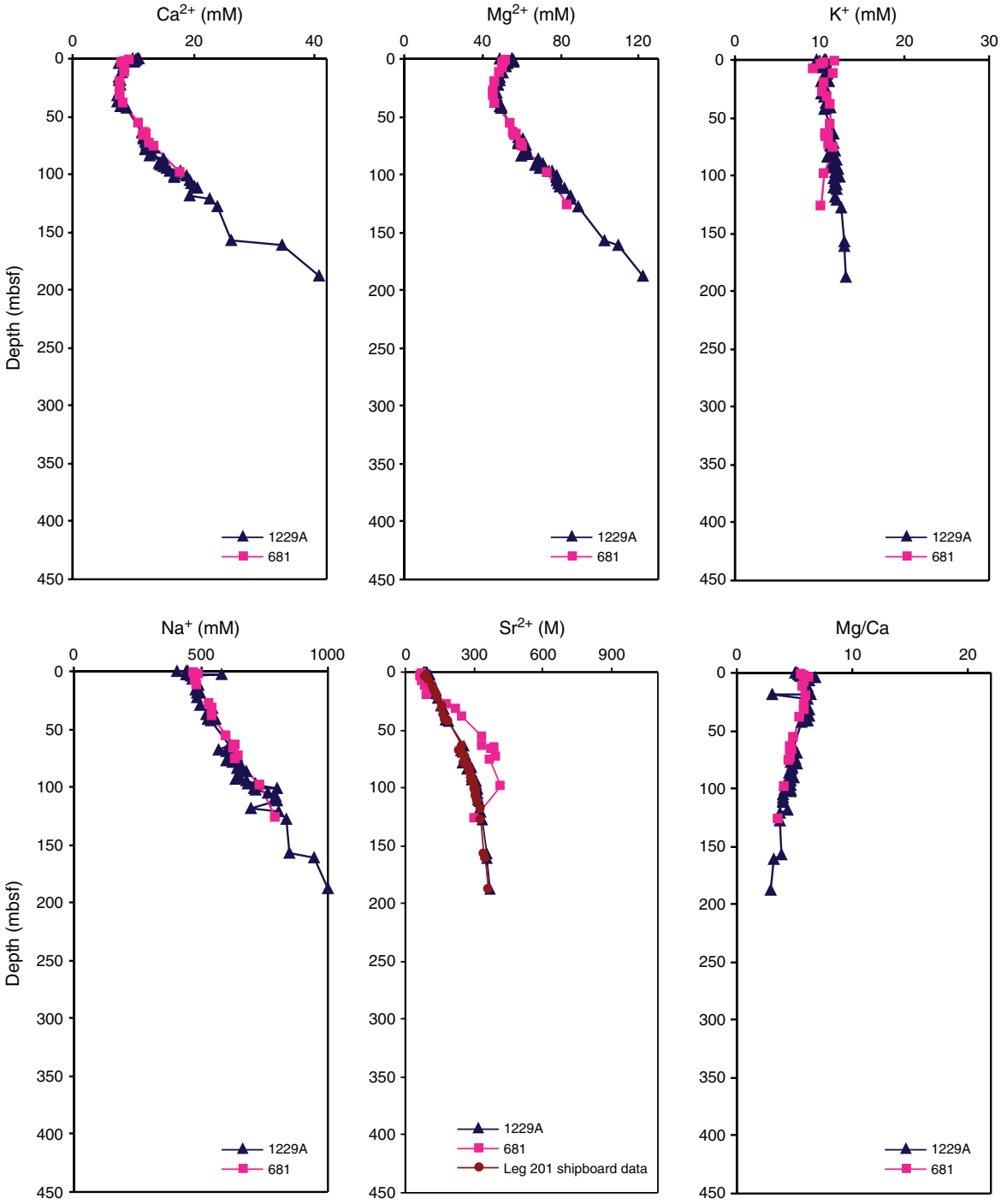

Figure F8. Major cation concentrations in Hole 1230A and Site 685.

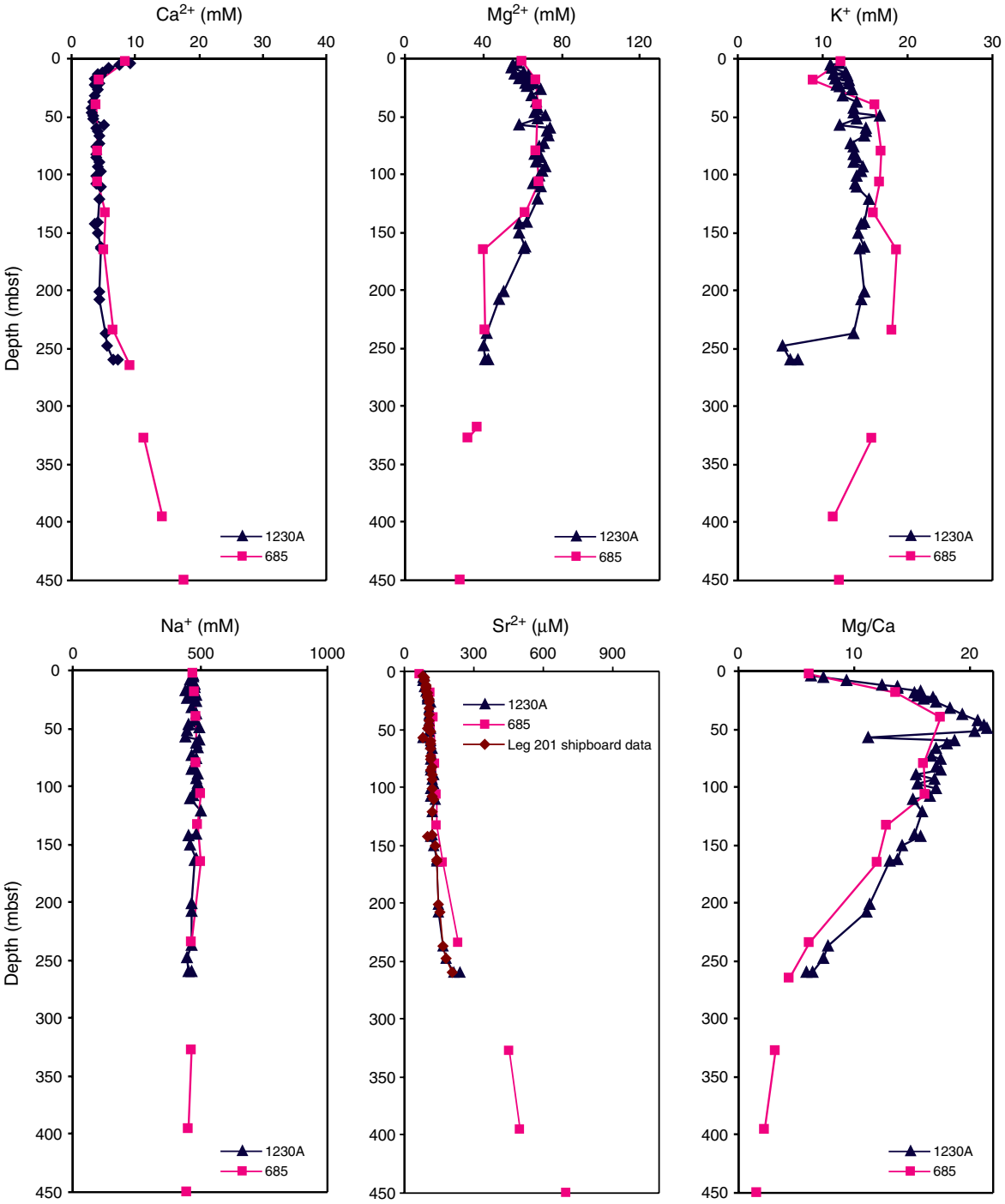

Table T1. Major ion concentrations for Sites 1225–1230 obtained at Rice University. (**See table notes.** Continued on next four pages.)

Core, section, interval (cm)	Depth (mbsf)	Ca (mM)	K (mM)	Mg (mM)	Na (mM)	Sr (μM)	Mg/Ca
201-1225C-							
1H-1, 37–47	0.42	9.50	9.77	51.13	422.33	82.88	5.38
1H-1, 85–95	0.90	9.61	9.80	51.72	422.91	84.84	5.38
1H-2, 0–15	1.51	9.65	9.85	51.34	420.20	82.91	5.32
1H-3, 0–15	3.08	10.65	10.63	53.99	447.53	86.85	5.07
1H-3, 60–65	3.63	9.58	10.14	51.39	421.59	83.21	5.37
1H-4, 0–15	4.58	10.08	10.31	54.06	444.40	87.21	5.37
1H-5, 0–15	6.08	9.75	10.72	53.46	439.07	86.26	5.48
1H-6, 0–15*	7.58	9.46	10.19	51.74	425.41	83.48	5.47
1H-6, 0–15	7.58	10.68	11.20	53.20	449.89	89.64	4.98
2H-1, 135–150	10.23	10.46	10.85	54.04	443.23	88.00	5.16
2H-2, 135–150	11.73	9.71	10.14	51.98	427.32	88.40	5.35
2H-3, 135–150	13.23	9.76	10.30	52.06	429.00	86.47	5.34
2H-5, 135–150	16.23	9.71	10.66	52.11	429.51	87.41	5.37
3H-2, 135–150	21.23	9.60	10.67	51.80	426.88	88.01	5.40
3H-5, 135–150	25.73	10.18	11.58	55.03	456.79	94.48	5.41
4H-5, 135–150	35.23	9.66	10.93	53.36	441.84	91.15	5.53
5H-2, 135–150	40.23	9.98	11.38	54.02	451.51	97.22	5.42
5H-5, 135–150	44.73	9.55	10.72	51.92	430.87	92.79	5.44
6H-2, 135–150	49.73	9.91	11.50	55.05	456.87	99.31	5.55
6H-5, 135–150	54.23	9.94	11.37	54.80	455.40	100.44	5.52
7H-2, 135–150	59.23	9.20	11.34	51.63	429.82	97.61	5.61
7H-5, 135–150	63.73	9.79	11.35	54.60	453.84	100.83	5.58
8H-2, 135–150	68.73	9.34	10.90	51.90	431.21	99.78	5.56
8H-5, 135–150	73.23	9.37	10.90	52.04	433.48	101.79	5.55
9H-2, 135–150	78.23	10.20	10.32	51.39	438.23	105.19	5.04
9H-5, 135–150	82.73	9.38	10.49	51.87	430.73	105.31	5.53
10H-2, 135–150	87.73	9.44	10.14	52.06	430.47	107.69	5.51
10H-5, 135–150	92.23	9.50	10.48	51.78	429.30	111.68	5.45
10H-5, 135–150	92.23	9.97	11.10	54.85	455.77	120.61	5.50
11H-2, 135–150	97.23	10.43	10.91	54.32	454.29	119.28	5.21
11H-5, 135–150	101.73	9.92	10.84	53.50	449.00	120.55	5.40
12H-2, 135–150†	106.73	10.37	11.15	54.49	457.38	123.55	5.26
12H-5, 135–150	111.23	10.55	10.64	53.54	451.33	126.20	5.07
13H-2, 135–150	116.23	9.41	10.23	51.91	431.66	122.46	5.52
13H-5, 135–150†	120.73	9.86	10.69	54.71	454.24	131.69	5.55
14H-2, 135–150	125.73	9.98	10.22	51.45	440.81	127.89	5.15
14H-5, 135–150†	130.23	10.05	10.98	55.88	465.67	142.64	5.56
15H-2, 135–150	135.23	9.47	10.34	52.11	433.40	134.22	5.50
15H-2, 135–150	135.23	9.74	10.82	53.81	449.55	142.18	5.52
16H-2, 135–150†	144.73	10.63	10.48	54.12	438.51	146.80	5.09
16H-5, 135–150†	149.23	9.88	10.38	52.92	441.20	147.60	5.36
17H-3, 121–136†	154.97	10.66	10.37	54.19	456.53	148.63	5.08
17H-5, 135–150†	157.97	9.66	10.90	54.10	453.11	150.18	5.60
18H-2, 135–150	163.73	9.42	10.21	51.19	429.06	148.42	5.43
18H-5, 135–150†	168.23	9.62	10.81	53.55	447.59	155.86	5.57
19H-2, 135–150†	173.23	9.72	10.53	53.34	446.15	158.35	5.49
19H-5, 135–150†	177.58	9.86	10.64	53.70	449.60	161.54	5.45
20H-2, 135–150	182.73	9.69	9.94	51.28	428.90	160.71	5.29
20H-5, 135–150†	187.23	9.73	10.95	53.66	451.26	165.27	5.51
21H-2, 135–150†	192.23	9.68	10.70	53.46	449.73	169.68	5.53
21H-5, 135–150	196.73	9.93	10.54	50.46	433.97	162.89	5.08
22H-5, 135–150	206.23	9.29	11.28	51.35	433.53	170.37	5.53
23H-2, 135–150†	211.23	9.69	10.54	51.39	432.65	177.05	5.31
23H-5, 135–150	215.73	9.13	11.09	50.86	427.90	167.54	5.57
24H-2, 135–150†	220.73	10.39	11.17	53.14	452.47	180.45	5.11
24H-5, 135–150†	225.23	9.58	10.66	50.97	430.16	178.48	5.32
25H-2, 135–150	230.23	9.57	10.70	50.95	429.19	180.73	5.32
25H-5, 135–150	234.73	9.49	10.49	50.65	426.36	179.01	5.34
26H-2, 135–150†	239.73	9.77	10.67	52.04	437.81	183.62	5.33
26H-5, 135–150†	244.23	9.99	11.07	53.74	452.88	194.98	5.38
27H-2, 135–150†	249.23	9.62	10.72	51.51	433.44	183.96	5.36
27H-5, 135–150	253.73	10.07	10.11	51.67	433.64	191.50	5.13
28H-2, 135–150†	258.73	9.82	11.44	53.75	455.63	186.87	5.48
28H-5, 135–150†	263.23	9.85	11.22	52.46	447.10	183.82	5.33
29H-2, 135–150†	268.23	10.10	11.10	52.83	449.33	186.71	5.23
30H-5, 135–150†	282.23	9.38	11.80	53.64	456.11	166.56	5.72
31H-2, 135–150	287.23	9.35	10.37	51.45	432.21	156.22	5.50
31H-5, 135–150†	291.73	9.68	10.78	53.91	452.11	158.61	5.57

Table T1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Ca (mM)	K (mM)	Mg (mM)	Na (mM)	Sr (µM)	Mg/Ca
201-1226B-							
1H-1, 130–150†	1.40	9.33	9.95	51.60	421.96	84.13	5.53
1H-3, 114–116	4.14	9.76	10.04	51.69	428.11	87.80	5.30
2H-2, 130–150	7.30	9.84	11.39	53.80	450.89	91.79	5.47
2H-5, 130–150†	11.80	9.31	11.05	52.61	440.22	97.81	5.65
4H-2, 130–150	26.30	7.85	10.52	52.75	434.80	126.06	6.72
6H-5, 130–150	49.80	7.77	11.39	54.60	461.06	163.31	7.03
7H-2, 130–150	54.80	7.91	11.36	54.87	464.63	170.18	6.93
7H-5, 130–150	59.30	7.89	10.68	53.54	454.68	173.27	6.79
10H-2, 130–150†	83.30	7.01	10.93	52.53	447.47	196.65	7.50
10H-5, 130–150	87.80	7.37	10.76	53.82	457.49	200.91	7.30
11H-2, 130–150	92.80	7.03	11.03	52.99	456.40	205.49	7.53
11H-5, 130–150	97.30	7.28	11.12	53.29	461.45	209.91	7.32
12H-2, 130–150†	102.30	7.06	10.67	52.17	447.55	217.95	7.39
12H-5, 130–150	106.80	7.30	10.28	50.91	444.89	223.83	6.97
13H-2, 130–150	111.80	7.21	10.60	50.25	443.50	229.66	6.97
13H-5, 130–150*	117.60	7.95	11.38	55.84	485.85	247.01	7.02
13H-5, 130–150	117.60	7.67	11.43	55.40	473.49	246.24	7.23
14H-2, 130–150	121.30	6.98	10.28	50.83	442.07	241.72	7.28
14H-5, 130–150	125.80	7.08	10.57	52.48	453.00	240.67	7.42
15H-2, 130–150	130.80	7.55	11.96	52.85	476.25	254.99	6.99
16H-2, 130–150	140.30	7.20	10.83	52.48	458.25	259.45	7.29
16H-5, 130–150	144.80	7.64	10.47	51.04	454.00	264.18	6.68
17H-2, 130–150	149.80	6.98	10.50	50.79	447.14	242.06	7.27
17H-5, 130–150	154.30	7.42	10.62	50.56	450.21	278.50	6.82
18H-2, 130–150	159.30	7.66	9.97	49.07	441.77	280.33	6.41
18H-5, 135–150	163.80	7.72	10.07	50.43	445.49	277.45	6.54
19H-2, 130–150	168.80	7.53	9.83	48.46	440.16	274.08	6.44
19H-5, 130–150	173.30	8.00	10.35	51.10	458.93	287.57	6.39
20H-5, 130–150	182.80	8.03	10.24	50.80	456.30	292.24	6.33
21H-5, 130–150	192.30	7.77	10.35	50.01	452.49	301.21	6.44
22H-6, 130–150	202.10	8.20	9.97	48.73	445.74	301.82	5.94
23H-5, 130–150	211.50	8.60	10.14	50.42	458.00	312.84	5.87
24H-2, 130–150	216.30	8.41	10.59	52.95	479.94	319.64	6.30
24H-5, 130–150	220.80	8.15	9.68	47.31	438.50	290.77	5.80
26H-2, 130–150	235.30	8.20	10.24	48.76	446.51	304.76	5.95
28H-2, 130–150	257.10	10.14	10.53	50.23	490.44	316.01	4.95
28H-5, 130–150†	260.30	9.19	11.14	55.20	505.77	315.78	6.01
30X-2, 130–150	274.80	8.62	9.97	48.95	450.76	291.82	5.68
30X-5, 130–150†	279.30	8.53	9.77	49.28	451.66	276.92	5.78
31X-2, 130–150	284.40	9.13	9.93	49.90	457.18	288.37	5.47
31X-5, 120–121	288.70	9.01	9.95	49.66	455.37	283.32	5.51
32X-5, 130–150	298.20	10.43	9.98	49.59	459.44	286.02	4.75
33X-5, 130–150	307.90	9.92	9.27	49.92	454.98	281.36	5.03
34X-2, 130–150	313.10	9.79	9.82	49.31	458.07	269.54	5.04
40X-1, 130–150*	369.50	10.29	7.80	45.54	435.09	205.84	4.56
40X-1, 130–150	369.50	10.29	9.08	44.34	418.41	200.86	4.21
41X-2, 110–150	375.00	10.53	9.07	44.30	418.41	200.86	4.20
45X-1, 130–150†	401.20	15.89	8.82	50.35	491.21	217.79	3.17
45X-2, 110–150	400.00	14.46	7.30	48.88	452.38	207.93	3.38
45X-5, 130–150	404.60	15.03	6.68	48.60	446.48	199.33	3.23
46X-2, 110–150†	409.60	15.33	7.35	46.17	436.23	186.54	3.01
201-1227A-							
1H-1, 135–150	1.43	10.86	11.22	56.07	467.26	99.67	5.16
2H-2, 135–150	8.53	7.18	11.76	54.45	489.45	129.53	7.58
2H-3, 135–150	10.03	8.24	11.68	53.47	491.96	136.23	6.49
2H-5, 135–150	13.03	7.01	12.13	54.30	506.54	157.77	7.75
3H-1, 135–150	16.53	7.58	13.01	54.75	518.63	189.70	7.22
3H-2, 135–150†	18.03	8.01	12.91	56.53	546.90	212.48	7.05
3H-3, 135–150	19.53	8.38	12.50	56.81	540.13	224.53	6.78
3H-5, 135–150†	22.53	8.91	13.14	58.01	547.73	257.11	6.51
3H-6, 135–150	24.03	9.22	13.47	58.31	551.59	272.34	6.32
4H-1, 102–117	25.70	10.23	13.97	60.88	571.04	315.46	5.95
4H-5, 95–110	31.29	10.91	13.40	61.27	566.34	351.32	5.62
5H-2, 135–150†	37.03	12.59	14.29	64.23	595.81	435.38	5.10
5H-5, 135–150	41.53	13.40	15.34	65.06	616.72	475.73	4.85
5H-6, 135–150	43.03	13.75	15.40	64.76	612.18	486.88	4.71
6H-1, 135–150†	45.03	14.36	16.03	65.02	572.80	504.93	4.53
6H-2, 135–150	46.53	13.00	16.07	64.09	620.77	511.38	4.93

Table T1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Ca (mM)	K (mM)	Mg (mM)	Na (mM)	Sr (µM)	Mg/Ca
6H-4, 135–150	49.53	14.20	15.77	64.94	568.84	496.45	4.57
7H-1, 135–150	54.53	16.21	14.87	68.48	642.77	576.88	4.23
7H-2, 135–150	56.03	17.50	15.23	69.98	653.72	596.87	4.00
9H-1, 135–150	73.53	23.09	16.79	73.85	713.85	709.28	3.20
9H-3, 135–150	76.53	24.06	16.74	74.10	719.58	725.85	3.08
10H-2, 135–150	84.53	26.25	18.01	77.67	763.09	784.20	2.96
10H-5, 91–106	88.59	26.83	17.94	77.00	773.43	788.76	2.87
11H-2, 135–150	94.03	27.56	18.48	77.96	780.43	813.61	2.83
12H-2, 135–150	103.53	29.81	18.94	79.46	797.71	858.46	2.67
12H-4, 135–150	106.53	30.99	19.41	80.55	835.97	878.48	2.60
13H-4, 135–150	116.03	32.96	19.98	82.44	876.22	924.02	2.50
17H-1, 85–100	133.03	36.82	21.79	84.57	897.56	989.07	2.30
18H-2, 85–100	144.38	37.97	22.32	85.28	891.43	1023.71	2.25
18H-3, 0–20	144.55	37.87	22.81	84.91	898.80	1030.69	2.24
201-1228A-							
1H-1, 126–141	1.34	8.78	9.51	52.27	443.47	86.90	5.95
1H-2, 135–150	2.84	7.67	9.67	52.09	443.92	85.41	6.79
1H-3, 135–150	4.36	7.88	10.31	53.62	461.20	88.77	6.80
2H-1, 135–150	6.33	8.20	9.99	52.12	454.99	93.84	6.36
2H-3, 0–15	7.98	8.47	10.65	52.15	463.47	97.83	6.16
2H-3, 135–150	9.33	8.65	10.47	52.27	465.16	101.20	6.04
2H-5, 135–150	12.33	8.54	10.92	51.54	476.00	109.89	6.04
3H-1, 135–150	15.83	8.26	10.01	49.59	469.77	121.80	6.00
3H-3, 135–150	18.83	8.24	10.84	49.72	477.17	126.91	6.03
3H-5, 135–150	21.83	8.28	10.68	49.13	484.86	133.34	5.93
4H-1, 135–150	25.33	8.03	11.02	48.02	486.36	141.95	5.98
4H-3, 135–150	28.33	8.17	10.97	47.83	489.69	148.50	5.85
4H-5, 135–150	31.33	9.13	11.26	47.66	491.37	154.52	5.22
5H-1, 135–150	34.83	8.37	10.72	47.84	497.30	159.71	5.72
5H-3, 135–150	37.83	8.69	11.33	51.25	513.19	166.90	5.90
5H-4, 135–150	39.33	8.69	11.02	48.91	504.40	167.59	5.63
6H-1, 135–150	44.33	9.23	11.15	50.61	519.15	171.81	5.48
6H-3, 135–150	47.33	9.59	11.64	51.47	524.94	175.96	5.37
7H-1, 135–150	53.83	10.43	10.77	52.46	521.86	187.85	5.03
7H-3, 135–150	56.83	10.81	11.84	53.58	535.85	186.74	4.96
7H-5, 135–150	59.83	11.40	12.01	55.41	546.52	192.87	4.86
8H-1, 135–150	63.33	11.98	12.02	57.40	548.63	199.41	4.79
8H-3, 135–150	66.33	12.34	11.32	58.61	562.24	209.42	4.75
8H-5, 135–150	69.33	12.81	12.08	60.60	562.81	212.65	4.73
9H-3, 135–150	75.83	14.90	12.52	65.80	574.00	223.38	4.42
10H-1, 135–150	82.33	14.68	12.32	70.28	590.84	243.94	4.79
10H-4, 135–150	86.83	14.77	12.01	66.49	601.91	245.75	4.50
11H-1, 85–100	91.33	18.15	12.37	73.78	598.37	252.60	4.07
12H-1, 88–110	100.89	20.13	12.79	78.33	614.28	271.01	3.89
14H-1, 135–150	111.83	22.26	12.85	83.46	634.63	287.56	3.75
14H-3, 135–150	114.83	22.74	12.85	84.84	656.22	292.49	3.73
16H-1, 135–150	129.83	25.82	12.87	91.74	669.67	318.59	3.55
16H-3, 135–150	132.83	26.22	12.89	92.68	673.56	323.69	3.53
18H-1, 135–150*	148.83	29.45	14.37	94.78	746.55	355.23	3.22
18H-1, 135–150	148.83	29.09	13.25	97.51	710.19	348.00	3.35
19H-1, 79–94	157.77	31.13	13.05	100.93	724.08	362.00	3.24
19H-2, 135–150	159.27	31.42	13.18	101.40	726.95	364.66	3.23
20H-1, 135–150	167.68	32.86	13.39	104.73	748.44	369.96	3.19
20H-3, 135–150	170.68	32.97	13.15	104.42	754.06	369.67	3.17
21H-1, 135–150	177.33	33.45	12.99	105.11	744.68	372.18	3.14
22H-1, 120–135	186.68	35.43	13.08	108.55	723.91	385.60	3.06
22H-1, 135–150	186.83	35.35	13.20	108.38	779.07	384.81	3.07
22H-3, 60–77	189.09	34.76	12.45	107.32	733.83	379.06	3.09
201-1229A-							
1H-1, 0–12	0.06	9.83	9.63	49.21	403.69	82.46	5.01
1H-1, 12–24	0.14	10.95	10.71	55.53	446.87	90.99	5.07
1H-1, 25–35	0.55	10.70	10.53	55.12	442.45	89.39	5.15
1H-1, 40–50	0.85	10.49	10.55	55.34	447.40	88.26	5.28
1H-1, 50–60	1.05	10.52	10.69	55.99	451.36	88.96	5.32
1H-1, 97–112	2.02	10.19	10.44	55.92	449.60	87.83	5.49
1H-1, 135–150	2.78	9.85	10.70	55.26	449.76	87.26	5.61
1H-1, 142–150	2.88	9.83	10.56	54.87	443.96	87.23	5.58
1H-3, 0–10	3.15	9.54	9.91	54.41	584.09	104.93	5.70

Table T1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Ca (mM)	K (mM)	Mg (mM)	Na (mM)	Sr (µM)	Mg/Ca
1H-3, 135–148	4.42	7.73	10.19	52.78	457.87	91.44	6.83
2H-1, 135–150	6.33	8.31	10.34	52.09	466.29	101.77	6.27
2H-3, 135–150†	9.35	8.60	10.77	52.24	480.23	112.01	6.07
2H-5, 135–150	12.33	8.22	10.98	50.62	488.39	119.39	6.15
3H-1, 135–150	15.83	7.69	10.36	48.51	481.78	132.21	6.30
3H-3, 0–48	18.12	7.70	10.22	49.02	486.08	133.89	6.37
3H-3, 135–150	18.83	7.93	11.12	48.29	498.38	136.38	3.09
3H-5, 135–150	23.18	7.87	10.56	48.40	487.01	143.12	6.15
4H-3, 135–150	29.68	7.62	10.19	47.13	495.12	154.43	6.18
4H-5, 135–150	31.33	7.50	10.56	46.96	544.31	164.94	6.26
5H-3, 135–150	37.83	7.44	10.73	46.68	520.04	173.01	6.27
5H-4, 135–150	40.68	8.47	11.20	49.47	557.12	181.87	5.84
5H-5, 135–150	40.83	7.88	10.73	48.64	529.12	176.73	6.17
6H-1, 135–150	41.33	8.26	10.85	49.48	540.42	183.22	5.99
6H-3, 0–15	42.98	8.81	10.56	49.42	538.64	186.82	5.61
8H-3, 135–150	63.33	11.52	11.59	56.73	612.54	253.34	4.92
8H-5, 135–150	67.68	11.73	11.30	58.21	572.11	238.29	4.96
9H-1, 135–150	69.83	11.83	11.20	60.82	599.53	244.90	5.14
9H-2, 135–150	71.33	12.08	11.65	58.06	621.66	261.62	4.81
9H-3, 135–150	72.83	12.22	11.33	58.42	640.31	259.67	4.78
9H-4, 135–150	74.33	12.11	11.36	61.92	624.93	260.76	5.11
9H-5, 135–150	77.18	13.45	11.55	62.32	599.63	262.15	4.63
9H-6, 135–150	77.93	11.93	11.74	62.63	621.47	251.30	5.25
10H-1, 135–150	80.83	12.99	11.26	61.56	649.45	281.54	4.74
10H-2, 135–150	82.33	13.18	11.62	62.71	659.54	286.86	4.76
10H-3, 135–150	83.83	12.79	10.86	60.25	642.13	269.45	4.71
10H-4, 135–150	86.68	14.96	12.04	68.26	676.56	290.65	4.56
11H-1, 135–150	90.33	14.36	11.74	70.92	646.87	291.60	4.94
11H-2, 135–150	91.83	14.58	12.00	66.95	652.81	297.16	4.59
11H-3, 135–150	93.33	14.97	11.27	70.71	634.61	291.05	4.72
11H-4, 135–150	94.83	15.53	12.12	69.51	675.90	309.48	4.47
11H-5, 135–150	97.68	17.82	12.09	74.19	716.65	305.33	4.16
11H-6, 135–150	97.83	16.06	11.79	75.40	682.54	306.35	4.70
12H-1, 135–150	101.18	18.86	12.31	77.74	801.08	315.89	4.12
12H-2, 135–150	101.33	16.78	11.79	77.90	709.61	311.32	4.64
12H-3, 135–150	102.83	16.84	11.70	78.18	712.76	309.50	4.64
12H-4, 135–150	105.68	19.46	11.74	78.16	765.57	314.90	4.02
12H-5, 135–150	107.18	19.66	12.00	79.07	796.61	317.76	4.02
13H-1, 135–150	110.68	20.15	11.68	79.48	796.18	316.53	3.94
13H-2, 135–150	112.18	20.72	11.99	81.65	797.10	323.91	3.94
14H-1, 135–150	118.83	19.24	11.74	85.27	696.59	324.51	4.43
14H-2, 135–150*	121.68	20.11	12.46	81.96	704.75	338.95	4.08
14H-2, 135–150	121.68	22.66	11.98	85.45	807.62	328.11	3.77
15H-1, 49–64	127.93	24.02	12.47	89.17	834.09	334.05	3.71
18H-1, 135–150	156.83	26.10	12.90	102.64	848.86	358.03	3.93
18H-3, 135–150	161.18	34.67	12.87	109.75	944.24	355.23	3.17
22H-1, 135–150	187.68	40.74	13.05	121.88	998.47	366.77	2.99
201-1230A-							
1H-1, 135–150†	2.78	10.43	12.32	57.81	488.99	88.56	5.54
1H-2, 135–150	4.28	9.23	11.97	57.26	475.50	89.90	6.20
1H-3, 144–160	5.96	7.52	10.96	55.25	474.23	83.17	7.35
2H-1, 135–150	7.58	5.84	11.00	54.66	463.28	82.89	9.36
2H-4, 135–150	12.08	4.86	12.73	60.57	478.93	93.64	12.46
2H-5, 135–150	13.58	4.11	11.33	56.23	460.20	88.42	13.69
2H-6, 135–150	15.08	4.57	12.95	62.77	481.04	97.65	13.73
3H-1, 135–150	17.08	3.72	11.42	58.69	445.20	92.02	15.76
3H-2, 135–150	18.58	4.24	13.02	64.71	478.85	101.41	15.26
3H-3, 135–150	20.88	4.30	13.14	66.23	487.17	104.03	15.41
3H-4, 135–150	21.58	3.90	11.88	61.55	481.72	101.15	15.77
3H-5, 135–150	23.08	3.75	11.58	62.78	469.39	99.10	16.76
3H-6, 135–150	24.58	3.88	12.08	62.22	450.55	101.00	16.05
4H-3, 135–150	27.18	4.03	13.51	69.08	483.45	111.98	17.13
4H-5, 135–150	32.58	3.55	12.27	64.85	468.70	104.65	18.26
5H-2, 135–150	37.58	3.46	13.96	66.92	486.92	105.37	19.36
5H-5, 135–150	42.08	3.26	13.56	67.63	477.20	105.88	20.73
6H-2, 135–150	47.26	3.12	13.67	66.04	451.54	104.23	21.15
6H-3, 135–150	48.74	3.33	16.77	71.49	496.91	110.20	21.48
6H-5, 135–150	51.66	3.30	14.00	67.44	450.44	107.03	20.45
8H-1, 135–150*†‡	57.08	5.37	12.43	61.71	455.42	77.55	11.48

Table T1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Ca (mM)	K (mM)	Mg (mM)	Na (mM)	Sr (μM)	Mg/Ca
8H-1, 135–150†‡	57.08	5.21	12.04	58.57	440.16	78.54	11.24
8H-3, 135–150†	60.08	4.00	15.04	74.45	495.59	116.18	18.64
8H-5, 135–150	63.08	4.02	15.14	72.43	484.62	116.43	18.00
9H-1, 135–150†	63.58	4.36	15.16	75.95	505.30	121.60	17.41
9H-4, 125–140	66.68	4.29	14.90	73.08	489.69	116.78	17.04
9H-6, 135–150†	69.68	3.86	15.02	73.29	496.00	105.25	19.01
10H-1, 135–150	73.08	4.28	13.28	71.25	466.93	116.83	16.65
10H-3, 135–150	76.08	3.94	13.61	68.74	483.15	113.65	17.47
11H-1, 135–150	82.58	3.89	13.67	66.48	472.35	113.78	17.10
11H-3, 135–150	85.58	3.95	13.97	69.18	467.37	111.87	17.50
11H-5, 135–150	88.58	4.36	13.69	67.00	491.12	125.47	15.38
12H-2, 135–150*	93.58	4.82	16.96	75.22	546.80	133.50	15.60
12H-2, 135–150	93.58	4.22	14.78	71.36	485.70	120.41	16.91
12H-5, 135–150	97.68	4.53	14.62	69.80	490.71	124.29	15.40
13H-1, 135–150	101.58	3.99	13.95	68.29	482.48	116.33	17.13
13H-5, 135–150	107.58	3.98	13.86	65.63	470.96	115.69	16.50
14H-1, 135–150	111.08	4.61	13.97	69.26	459.50	130.82	15.02
14H-5, 135–150†	117.15	3.87	14.66	66.00	481.20	114.15	17.05
15H-2, 135–150	120.90	4.29	15.37	68.08	500.72	119.34	15.86
15H-5, 85–98†	124.39	4.38	14.65	65.67	484.72	129.15	14.99
17H-1, 135–150†	132.08	4.17	14.02	62.53	462.52	128.92	15.00
18H-1, 135–150	141.50	4.08	14.92	62.17	482.64	121.93	15.23
18H-2, 135–150*	143.08	3.17	12.49	51.84	403.86	99.44	16.31
18H-2, 135–150	143.08	3.71	14.57	58.46	452.98	111.56	15.76
19H-3, 0–34	150.79	4.12	14.14	58.36	461.80	125.29	14.17
21H-3, 135–150	163.06	4.52	14.86	61.80	487.75	138.99	13.69
21H-4, 69–84	163.24	4.64	14.41	60.55	476.53	139.97	13.05
22H-1, 75–90†	169.88	4.35	13.70	55.83	445.18	133.08	12.83
24H-1, 135–150†	190.08	4.82	15.28	54.43	458.11	157.12	11.28
24H-2, 0–98†	188.50	4.71	15.52	53.58	460.22	154.81	11.37
26H-1, 82–97	200.52	4.42	14.95	50.28	466.93	148.22	11.38
27H-1, 95–111	208.28	4.33	14.61	48.10	466.87	146.22	11.10
33X-1, 130–150	237.10	5.32	13.68	41.52	466.07	163.53	7.80
35X-1, 136–156	247.80	5.51	5.35	40.16	450.76	180.60	7.29
37X-1, 115–134	260.00	6.44	6.25	41.36	457.07	213.55	6.42
37X-1, 115–134	260.00	7.37	7.16	42.80	464.59	239.94	5.80

Notes: * = replicate analysis, † = samples with Sr^{2+} values >3% deviation from shipboard data (these values are not included in figures). ‡ = Sections 201-1230A-8H-1 through 8H-3 of Site 1230 were contaminated during drilling.