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16. Data Report: Oxygen Isotopic Composition of Interstitial Water, Demerara Rise[1]

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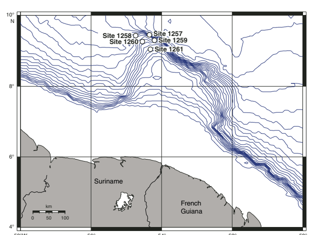
ABSTRACT

We determined oxygen isotopic compositions of interstitial water (IW) recovered during Ocean Drilling Program Leg 207. Five sites were cored (3200- to 1900-m water depth) on Demerara Rise off Suriname, South America, recovering a Cenomanian–Paleogene sedimentary sequence consisting of black shales and chalks. A total of 115 IW oxygen isotopic analyses are presented.

INTRODUCTION

During Ocean Drilling Program (ODP) Leg 207, Sites 1257–1261 were cored in water depths ranging from 3200 to 1900 m on Demerara Rise off Suriname, South America (Fig. F1). The sedimentary sequence recovered consists of Cenomanian–Turonian black shales; Campanian–Maastrichtian chalk; and Paleocene, lower Eocene, and middle Eocene chalk. Shipboard analysis of interstitial water (IW) documented a varied and active geochemical and diagenetic system (Erbacher, Mosher, Malone, et al., 2004; Mosher et al., 2007). Interstitial brine (Cl = 62% > seawater) was observed at three locations (Sites 1257, 1259, and 1261), and seawater Na/Cl ratios at all three sites indicate that the brine does not result from dissolution of halite evaporites. The IW chloride profile at Site 1257 suggests that the thick Cretaceous black shale sequence may act as an aquifer for the brine (Erbacher, Mosher, Malone, et al., 2004). In contrast, low salinity and chloride anomalies were documented at Sites 1258 and 1260. Despite being deposited more than ~90 m.y. ago, the

F1. Leg 207 site locations, p. 4.



[1] Malone, M.J., and Slowey, N., 2007. Data report: oxygen isotopic composition of interstitial water, Demerara Rise. *In* Mosher, D.C., Erbacher, J., and Malone, M.J. (Eds.), *Proc. ODP, Sci. Results,* 207: College Station, TX (Ocean Drilling Program), 1–11. doi:10.2973/odp.proc.sr.207.116.2007

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Cretaceous black shales still dominate biogeochemical processes throughout the sedimentary system recovered (e.g., Arndt et al., 2006). In addition, the black shale sequences host a varied array of diagenetic carbonates. As part of the effort to better understand and characterize the geochemical and diagenetic reactions occurring in the Demerara Rise sediments, interstitial fluids were analyzed for oxygen isotopic compositions.

METHODS

IW samples were collected by routine shipboard squeezing of whole-round sediment samples immediately after retrieval. Additional details on shipboard analyses and data are reported in Erbacher, Mosher, Malone, et al. (2004). Oxygen isotopic analyses were performed at Lamont Doherty Earth Observatory of Columbia University using the CO_2-water equilibration method (e.g., Epstein and Mayeda, 1953; Fairbanks, 1982) with an automated preparation system (Multiprep) on a VG Prism III stable isotope ratio mass spectrometer. Oxygen isotope ratios are reported as permil deviation of the sample from that of Vienna standard mean ocean water. Measurement precision based on replicate measurements of standards was 0.03‰ (1σ). For the 115 samples analyzed, 56 contained sufficient volume of sample to run duplicate analyses. The mean difference of the duplicate runs was 0.04‰ with a standard deviation of 0.03‰.

RESULTS

Results of isotopic analyses of IW are compiled for Sites 1257–1261 in Tables T1, T2, T3, T4, and T5, respectively. In addition to the data, ODP sample identifier and depth (meters below seafloor and meters composite depth) of each sample are also tabulated. Data are depicted graphically vs. depth in Figures F2 and F3 along with IW chloride depth profiles for reference.

ACKNOWLEDGMENTS

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T1. Site 1257 IW oxygen isotopic composition, p. 7.

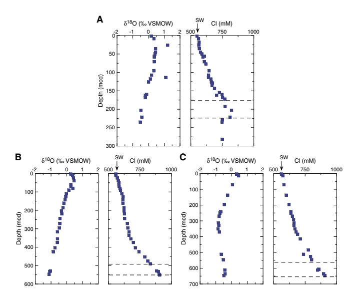
T2. Site 1258 IW oxygen isotopic composition, p. 8.

T3. Site 1259 IW oxygen isotopic composition, p. 9.

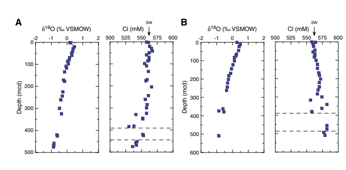
T4. Site 1260 IW oxygen isotopic composition, p. 10.

T5. Site 1261 IW oxygen isotopic composition, p. 11.

F2. Sites 1257, 1259, and 1261 IW oxygen isotopic data, p. 5.



F3. Sites 1258 and 1260 IW oxygen isotopic data, p. 6.



REFERENCES

Arndt, S., Brumsack, H.-J., and Wirtz, K.W., 2006. Cretaceous black shales as active bioreactors: a biogeochemical model for the deep biosphere encountered during ODP Leg 207 (Demerara Rise). *Geochim. Cosmochim. Acta,* 70(2):408–425. **doi:10.1016/j.gca.2005.09.010**

Epstein, S., and Mayeda, T., 1953. Variation of O^{18} content of waters from natural sources. *Geochim. Cosmochim. Acta,* 4(5):213–224. **doi:10.1016/0016-7037(53)90051-9**

Erbacher, J., Mosher, D.C., Malone, M.J., et al., 2004. *Proc. ODP, Init. Repts.,* 207: College Station, TX (Ocean Drilling Program). **doi:10.2973/odp.proc.ir.207.2004**

Fairbanks, R.G., 1982. The origin of continental shelf and slope water in the New York Bight and Gulf of Maine: evidence from $H_2{}^{18}O/H_2{}^{16}O$ ratio measurements. *J. Geophys. Res.,* 87:5796–5808.

Mosher, D.C., Erbacher, J., and Malone, M.J., 2007. Leg 207 synthesis: extreme warmth, organic-rich sediments, and an active deep biosphere, Cretaceous–Paleogene paleoceanographic depth transect at Demerara Rise, western tropical Atlantic. *In* Mosher, D.C., Erbacher, J., and Malone, M.J. (Eds.), *Proc. ODP, Sci. Results,* 207: College Station, TX (Ocean Drilling Program), 1–26. **doi:10.2973/odp.proc.sr.207.101.2007**

Figure F1. Leg 207 site locations on Demerara Rise. Contour interval = 200 m.

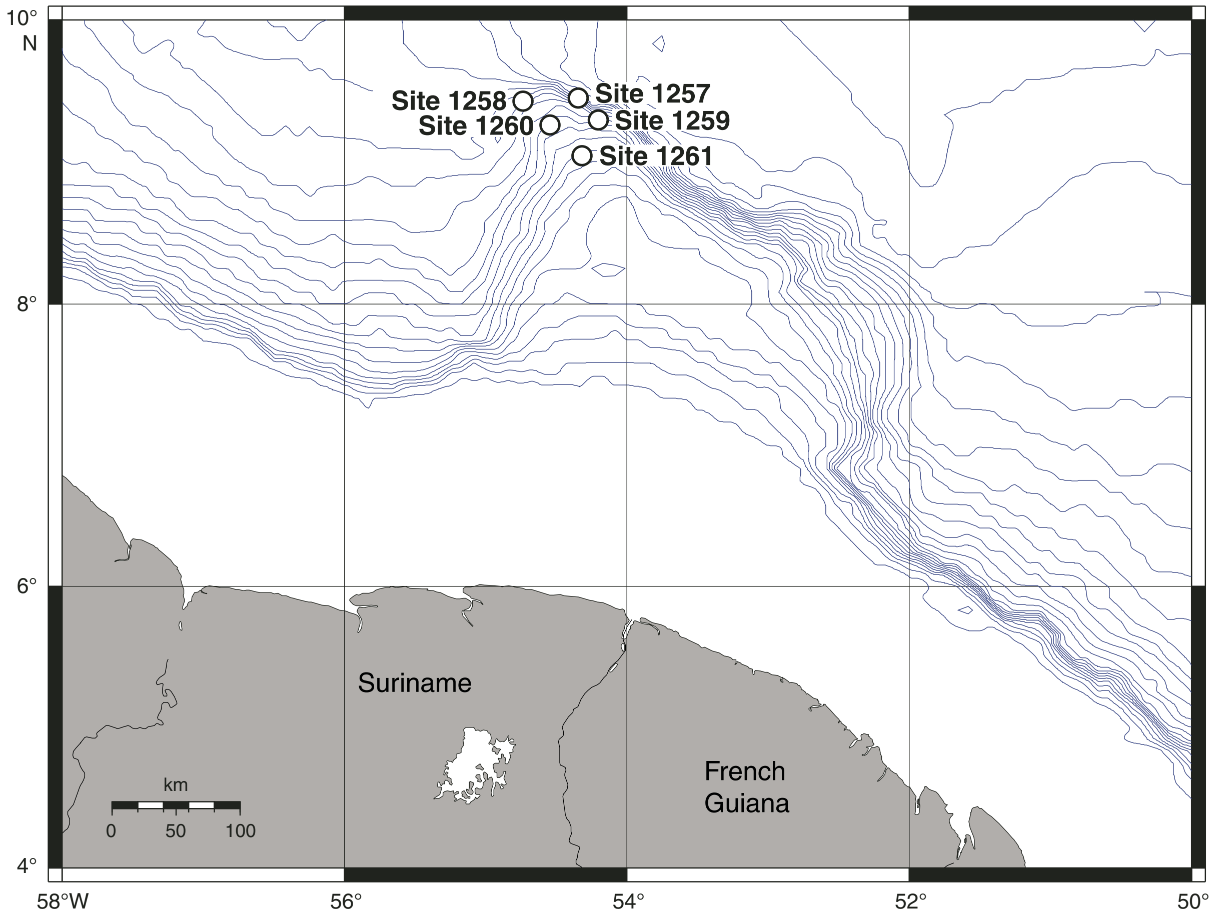


Figure F2. IW oxygen isotopic data from Sites (**A**) 1257, (**B**) 1259, and (**C**) 1261 vs. depth. IW Cl data vs. depth are also shown for these brine sites (Erbacher, Mosher, Malone, et al., 2004). Dotted lines = top and bottom of black shales. VSMOW = Vienna standard mean ocean water, mcd = meters composite depth, SW = seawater Cl value.

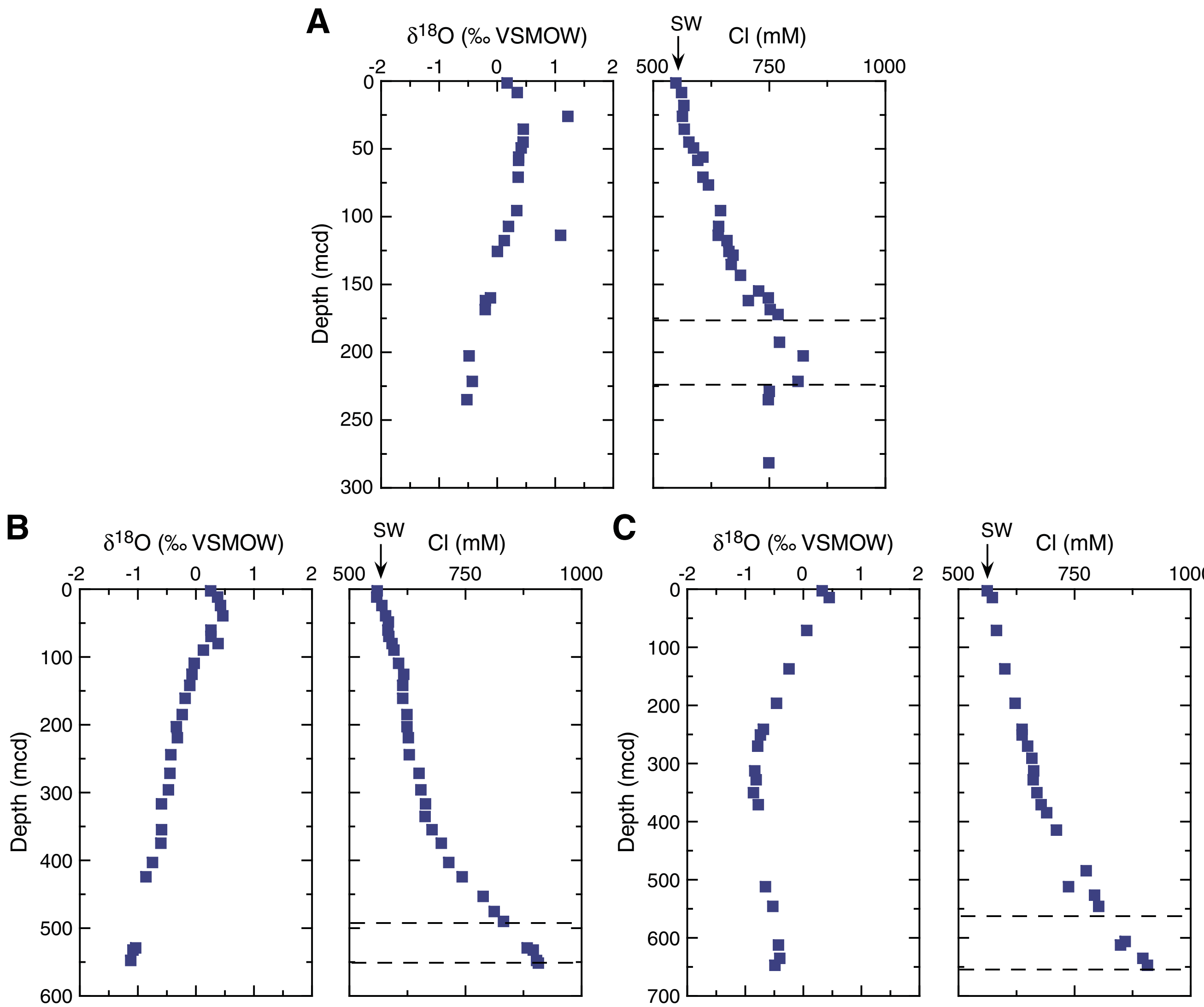


Figure F3. IW oxygen isotopic data from Sites (**A**) 1258 and (**B**) 1260 vs. depth. IW Cl data vs. depth are also shown for these sites that do not contain interstitial brine (Erbacher, Mosher, Malone, et al., 2004). Dotted lines = top and bottom of the black shales. VSMOW = Vienna standard mean ocean water, mcd = meters composite depth, SW = seawater Cl value.

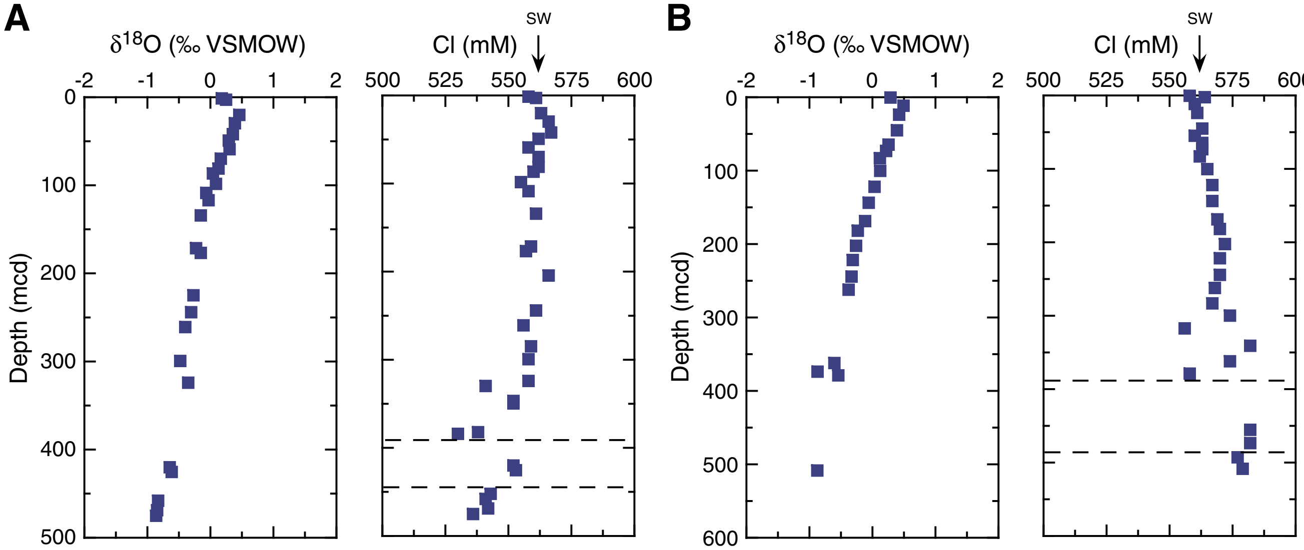


Table T1. Oxygen isotopic composition of interstitial water, Site 1257.

Hole, core, section, interval (cm)	Depth (mbsf)	Depth (mcd)	$\delta^{18}O$ (‰ VSMOW)	Duplicate difference (‰)
207-				
1257A-1H-1, 145–150	1.45	1.45	0.17	0.04
1257A-2H-4, 145–150	8.55	8.55	0.35	0.04
1257A-3H-4, 145–150	18.05	18.05	NM	
1257A-4H-3, 145–150	26.05	26.05	1.22	0.01
1257A-5H-3, 145–150	35.55	35.55	0.45	0.05
1257A-6H-3, 145–150	45.05	45.05	0.45	0.06
1257A-7X-3, 145–150	49.35	49.35	0.42	0.02
1257B-3R-2, 145–150	52.75	56.12	0.37	0.01
1257A-8X-3, 145–150	58.55	58.55	0.37	0.05
1257B-4R-3, 143–150	63.82	70.93	0.36	0.00
1257B-7R-2, 143–150	91.23	95.60	0.34	0.01
1257B-8R-4, 142–150	103.79	107.22	0.20	
1257B-9R-3, 140–150	112.02	113.79	1.09	
1257A-14X-4, 140–150	117.70	117.70	0.12	
1257B-10R-4, 140–150	123.10	125.68	0.01	0.04
1257C-8R-6, 90–100	157.50	159.95	–0.12	
1257A-18X-4, 140–150	156.16	161.96	–0.20	0.08
1257C-9R-6, 51–61	166.15	168.56	–0.21	
1257C-13R-2, 140–150	200.20	202.75	–0.48	0.01
1257C-15R-3, 17–27	218.98	221.53	–0.43	0.05
1257C-16R-6, 20–30	233.87	235.03	–0.52	0.01

Note: mbsf = meters below seafloor, mcd = meters composite depth, VSMOW = Vienna standard mean ocean water, NM = not measured.

Table T2. Oxygen isotopic composition of interstitial water, Site 1258.

Hole, core, section, interval (cm)	Depth (mbsf)	Depth (mcd)	$\delta^{18}O$ (‰ VSMOW)	Duplicate difference (‰)
207-				
1258A-1R-1, 145–150	1.45	1.45	0.18	0.01
1258A-1R-2, 145–150	2.95	2.95	0.25	0.08
1258A-3R-4, 145–150	20.15	20.15	0.46	0.03
1258A-4R-4, 145–150	29.75	29.75	0.39	0.04
1258A-5R-3, 145–150	37.65	42.15	0.36	0.05
1258A-6R-4, 145–150	48.75	49.27	0.29	0.07
1258A-7R-4, 145–150	58.15	59.14	0.31	0.00
1258A-8R-4, 140–150	68.07	69.92	0.17	0.08
1258A-9R-6, 140–150	80.80	81.05	0.13	0.01
1258A-10R-3, 140–150	86.00	86.63	0.04	0.08
1258A-11R-5, 135–145	98.65	98.35	0.09	0.05
1258A-12R-4, 140–150	108.30	108.69	–0.07	0.00
1258A-13R-4, 140–150	116.40	117.01	–0.03	0.00
1258B-14R-4, 140–150	133.80	134.22	–0.15	0.03
1258B-18R-3, 140–150	170.90	171.49	–0.23	0.04
1258A-17R-4, 140–150	154.95	176.79	–0.15	
1258A-22R-3, 140–150	201.50	224.93	–0.27	
1258A-24R-3, 139–150	220.69	244.12	–0.31	0.11
1258A-26R-2, 140–150	238.50	260.95	–0.40	
1258A-30R-2, 140–150	277.10	299.47	–0.48	0.06
1258A-32R-5, 140–150	300.90	324.11	–0.35	
1258B-33R-4, 140–150	307.00	329.81	NM	
1258B-45R-2, 75–85	399.25	420.08	–0.65	0.00
1258B-46R-1, 31–44	403.41	425.47	–0.62	0.00
1258B-52R-2, 70–80	433.71	458.03	–0.83	0.00
1258B-54R-3, 0–10	444.38	468.86	–0.84	0.01
1258B-55R-3, 58–68	448.27	475.13	–0.86	0.09

Note: mbsf = meters below seafloor, mcd = meters composite depth, VSMOW = Vienna standard mean ocean water, NM = not measured.

Table T3. Oxygen isotopic composition of interstitial water, Site 1259.

Hole, core, section, interval (cm)	Depth (mbsf)	Depth (mcd)	$\delta^{18}O$ (‰ VSMOW)	Duplicate difference (‰)
207-				
1259A-1R-2, 105–110	2.55	2.55	0.25	
1259A-2R-2, 145–150	11.75	11.75	0.37	
1259A-3R-4, 145–150	24.25	24.25	0.43	
1259A-5R-2, 145–150	39.35	39.35	0.47	
1259A-6R-2, 145–150	48.45	48.45	NM	
1259A-7R-4, 145–150	60.55	60.55	0.26	0.00
1259A-8R-4, 145–150	69.75	69.75	0.26	0.00
1259A-9R-5, 145–150	80.35	80.35	0.38	
1259A-10R-5, 145–150	90.00	90.00	0.13	0.00
1259A-12R-5, 145–150	109.40	109.40	–0.03	0.01
1259A-14R-3, 145–150	125.70	125.70	–0.07	0.02
1259A-16R-1, 140–150	142.00	142.00	–0.11	0.04
1259A-18R-2, 135–145	161.15	161.15	–0.19	0.06
1259A-20R-4, 130–140	185.00	185.00	–0.24	0.02
1259A-22R-3, 140–150	202.90	202.90	–0.34	0.00
1259A-24R-1, 132–142	219.12	219.12	–0.32	0.06
1259A-26R-5, 140–150	244.30	244.30	–0.43	0.01
1259A-29R-4, 140–150	271.70	271.70	–0.45	0.06
1259A-32R-2, 133–143	296.03	296.03	–0.47	
1259A-34R-2, 140–150	316.92	316.77	–0.59	0.07
1259A-38R-1, 140–150	354.00	354.83	–0.59	
1259A-40R-3, 90–100	375.70	374.85	–0.60	
1259A-43R-1, 140–150	402.10	403.27	–0.75	
1259A-45R-2, 140–150	422.90	424.38	–0.86	
1259C-16R-5, 137–150	525.65	529.18	–1.04	
1259C-17R-1, 136–146	529.26	532.38	–1.08	
1259C-18R-4, 140–150	543.40	547.73	–1.12	

Note: mbsf = meters below seafloor, mcd = meters composite depth, VSMOW = Vienna standard mean ocean water, NM = not measured.

Table T4. Oxygen isotopic composition of interstitial water, Site 1260.

Hole, core, section, interval (cm)	Depth (mbsf)	Depth (mcd)	$\delta^{18}O$ (‰ VSMOW)	Duplicate difference (‰)
207-				
1260A-1R-1, 58–63	0.58	0.58	0.29	
1260A-2R-1, 145–150	2.45	2.45	NM	
1260A-3R-1, 145–150	11.75	11.75	0.49	
1260A-4R-3, 145–150	23.95	23.95	0.43	
1260A-6R-5, 100–105	45.20	45.20	0.39	
1260A-8R-5, 142–150	64.62	64.72	0.26	
1260A-9R-5, 142–150	74.32	73.32	0.22	
1260A-10R-5, 142–150	84.02	83.12	0.12	0.10
1260A-12R-4, 140–150	101.80	100.42	0.12	0.06
1260A-14R-6, 105–110	123.85	122.17	0.03	0.05
1260A-17R-1, 145–150	145.65	143.84	–0.06	
1260A-19R-5, 143–150	170.63	168.82	–0.12	
1260A-21R-1, 130–140	183.80	181.99	–0.23	
1260A-23R-2, 140–150	204.30	202.49	–0.26	
1260A-25R-2, 141–150	223.61	221.80	–0.31	
1260A-27R-4, 140–150	245.90	244.39	–0.33	
1260A-29R-3, 130–140	262.99	262.22	–0.38	
1260A-39R-4, 135–150	361.45	362.19	–0.60	
1260A-40R-4, 140–150	371.20	373.86	–0.87	
1260A-41R-1, 140–150	376.30	378.96	–0.54	
1260B-46R-3, 140–150	505.90	508.58	–0.87	

Note: mbsf = meters below seafloor, mcd = meters composite depth, VSMOW = Vienna standard mean ocean water, NM = not measured.

Table T5. Oxygen isotopic composition of interstitial water, Site 1261.

Hole, core, section, interval (cm)	Depth (mbsf)	Depth (mcd)	$\delta^{18}O$ (‰ VSMOW)	Duplicate difference (‰)
207-				
1261A-1R-1, 145–150	2.95	2.95	0.33	0.05
1261A-3R-1, 134–139	14.54	14.54	0.45	0.03
1261A-4R-1, 145–150	71.15	71.15	0.06	
1261A-5R-4, 140–150	137.30	137.30	–0.25	
1261A-6R-5, 140–151	196.50	196.50	–0.46	
1261A-7R-3, 140–150	241.30	241.30	–0.69	
1261A-8R-3, 140–150	250.90	250.90	–0.74	
1261A-10R-3, 140–150	270.20	270.20	–0.79	
1261A-14R-6, 90–100	312.80	312.80	–0.84	
1261A-16R-3, 140–150	328.00	328.00	–0.81	
1261A-18R-5, 139–150	350.29	350.29	–0.86	
1261A-20R-6, 130–140	370.90	370.90	–0.78	
1261A-35R-5, 0–15	512.10	512.10	–0.65	
1261A-37R-1, 135–150	526.65	526.65	NM	
1261A-39R-1, 135–150	545.95	545.95	–0.53	
1261A-45R-3, 136–152	606.34	606.31	NM	
1261B-11R-2, 147–157	619.37	612.38	–0.43	
1261A-48R-5, 136–150	638.31	635.37	–0.41	
1261B-14R-2, 130–140	648.00	647.25	–0.49	

Note: mbsf = meters below seafloor, mcd = meters composite depth, VSMOW = Vienna standard mean ocean water, NM = not measured.