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2. DATA REPORT: ISOTOPIC COMPOSITION OF PORE FLUIDS, NEW JERSEY SHELF AND SLOPE[1]

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ABSTRACT

An investigation of the isotopic composition of the interstitial waters was conducted at Sites 1071, 1072, and 1073 on the New Jersey continental shelf and slope during Ocean Drilling Program Leg 174A. Sites 1071 and 1072 are closely spaced drill holes on the continental shelf located ~130 km from the shoreline in 88 and 98 m of water, respectively. Site 1073 is located on the continental slope in 640 m water and penetrated a total of 664 m of sediment of which ~520 m is Quaternary age. A total of 125 oxygen and hydrogen isotopic analyses of pore fluids are presented from all three sites. Twelve strontium isotopic ratios are reported from Site 1071.

INTRODUCTION

The majority of previous investigations of marine interstitial water chemistry during the Deep Sea Drilling Project and Ocean Drilling Program (ODP) have been conducted on fluids recovered from pelagic and hemipelagic sediments. Most interstitial water studies on continental shelves have been limited to the upper meters of the sediment column principally because of the difficulties of drilling in shallow waters. This has been particularly true on the New Jersey shelf because of potential shallow-gas hazards. One attempt at shelf drilling was initiated by the United States Geological Survey Atlantic Margin Coring Project (AMCOR) (Hathaway et al., 1979). In widely spaced, shallow holes across the New Jersey continental shelf, AMCOR researchers noted a fresh to

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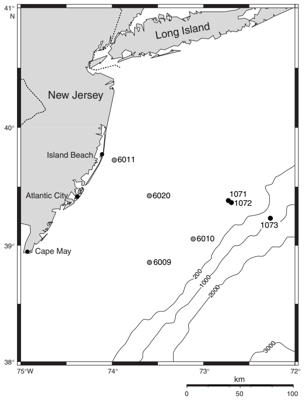
brackish water plume (low Cl^-) extending at least 100 km offshore. They believed this fluid to be relict Pleistocene water and suggested that its presence is an impediment to seawater infiltration of mainland freshwater aquifers (Hathaway et al., 1979; Kohout et al., 1988). The drilling of two closely spaced sites on the outer shelf ~130 km from the shoreline (Site 1071 in 88 m water depth and Site 1072 in 98 m water depth) (Austin, Christie-Blick, Malone, et al., 1998) provided the opportunity to further explore the origin and distribution of the low Cl^- plume (Fig. **F1**).

F1. Location of Sites 1071–1073 drilled during Leg 174A, p. 5.



Most notably, McDuff (1985), Schrag and DePaolo (1993), Schrag et al. (1996), and Burns and Maslin (1999) have observed an effect of sea-level fluctuations on pore-water chemistry. They observed positive excursions in Cl^- and $\delta^{18}O$ at shallow depths (~50 meters below seafloor [msbf]), which are consistent with increases in salinity and $\delta^{18}O$ of seawater during the last glacial maximum (LGM). However, the positive excursions in Cl^- and $\delta^{18}O$ have only been observed at shallow depths (i.e., for the LGM) because at greater depths any signal is dampened by diffusive smoothing. High-resolution interstitial water sampling was undertaken at Site 1073 (640 m water depth) on the New Jersey slope to examine such variability (Austin, Christie-Blick, Malone, et al., 1998) (Fig. **F1**). Postcruise stable isotopic analyses were performed to supplement shipboard data.

METHODS

Pore-fluid samples were collected using routine shipboard squeezing of whole-round sediment samples immediately after retrieval. Additional details on shipboard analyses and data are reported in Austin, Christie-Blick, Malone, et al. (1998). Oxygen and hydrogen isotopic analyses were performed in duplicate at Mountain Mass Spectrometry (Evergreen, Colorado, U.S.A.) using an automated preparation system. Oxygen isotopic ratios were determined using the CO_2-water equilibration method of Epstein and Mayeda (1953). Hydrogen isotopic ratios were determined using the equilibration method of Horita (1988, 1989), whereby the water sample is equilibrated with hydrogen gas with the aid of Hokka bead platinum catalysts. Replicate analyses of the standard through the course of the analyses yielded a standard deviation of 0.04‰ for $\delta^{18}O$ and 0.4‰ for δD.

Sr isotope measurements were made on ~150 µL of pore water, which was pipetted into Teflon containers and completely dried. The resulting salts were dissolved in 50 µL of 3.5-N HNO_3. Strontium was separated from this solution with Sr-selective crown ether resin, following a technique modified from Pin and Bassin (1992). The Sr blank for the technique is 100 pg. The separated Sr was loaded onto tungsten filaments and analyzed in the Department of Geology at the University of Florida for $^{87}Sr/^{86}Sr$ isotope ratios using a VG Micromass 354 triple collector thermal ionization mass spectrometer in dynamic mode. Instrumental mass fractionation was corrected to a $^{86}Sr/^{88}Sr$ ratio of 0.1194. Numerous replicate measurements of the NIST-987 standard over the past several years have yielded a $^{87}Sr/^{86}Sr$ value of 0.710235, with an external precision of ±0.000023 (2σ). This external precision represents the minimum uncertainty assigned to any individual sample.

RESULTS

Results of isotopic analyses of interstitial waters are compiled for Sites 1071, 1072, and 1073 in Tables **T1, T2,** and **T3,** respectively. In addition to the data, ODP sample identifier and depth (in mbsf) of each sample are also tabulated. Data are depicted graphically vs. depth in Figures **F2, F3,** and **F4.**

ACKNOWLEDGMENTS

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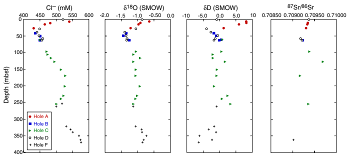
T1. Isotopic composition of interstitial waters, Site 1071, p. 9.

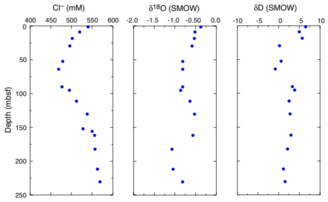
T2. Isotopic composition of interstitial waters, Site 1072, p. 10.

T3. Isotopic composition of interstitial waters, Site 1073, p. 11.

F2. Interstitial water isotopic data vs. depth, Site 1071, p. 6.



F3. Interstitial water isotopic data vs. depth, Site 1072, p. 7.



F4. Interstitial water isotopic data vs. depth, Site 1073, p. 8.

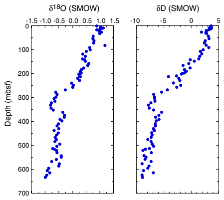


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Figure F1. Location of Sites 1071–1073 drilled during Leg 174A. Bathymetry is given in meters. In addition, AMCOR sites drilled offshore New Jersey (Hathaway et al., 1979) are also shown (6009–6011 and 6020).

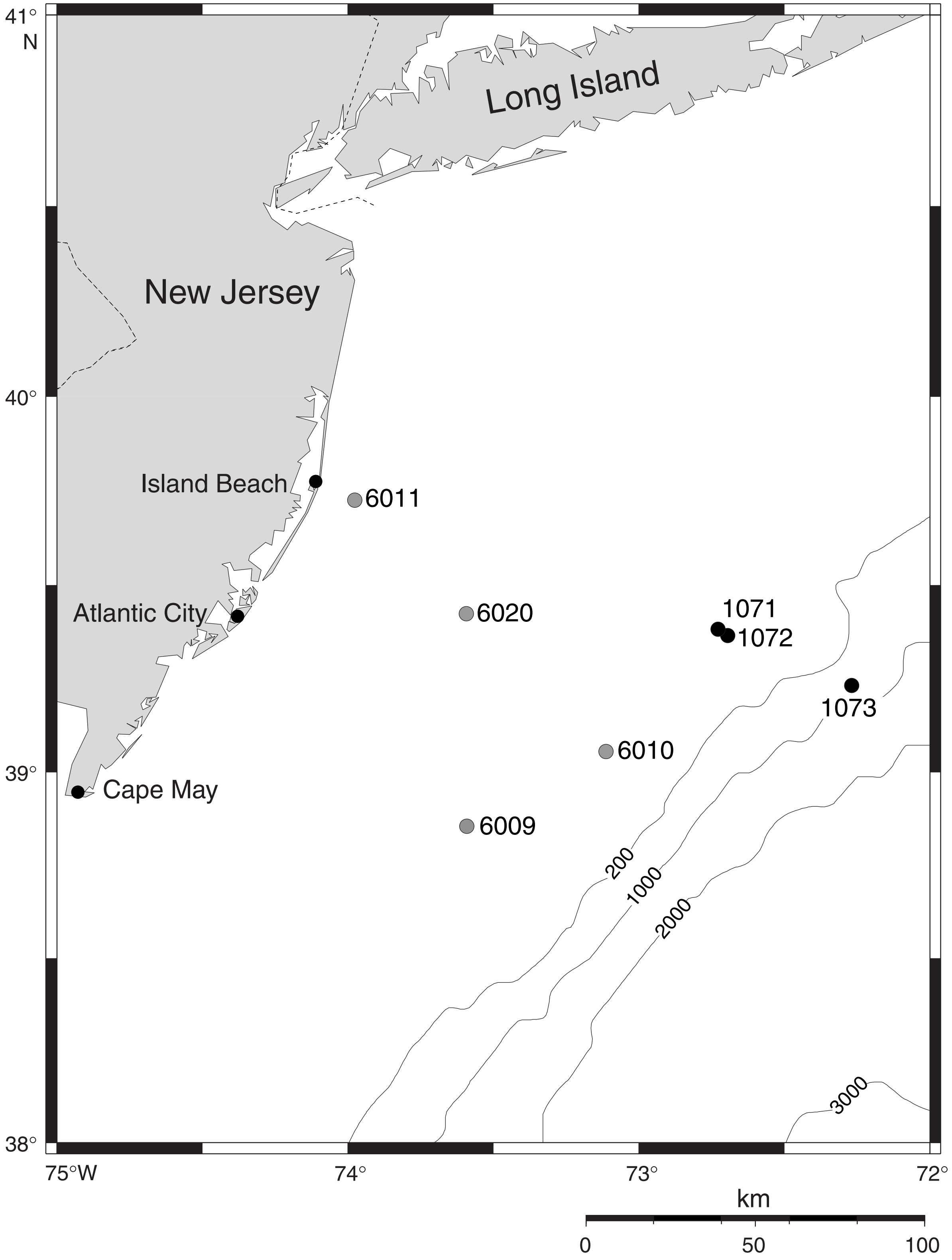

Figure F2. Interstitial water isotopic data from Site 1071 vs. depth. Pore-water Cl^- data vs. depth are also shown (Austin, Christie-Blick, Malone, et al., 1998). SMOW = standard mean ocean water.

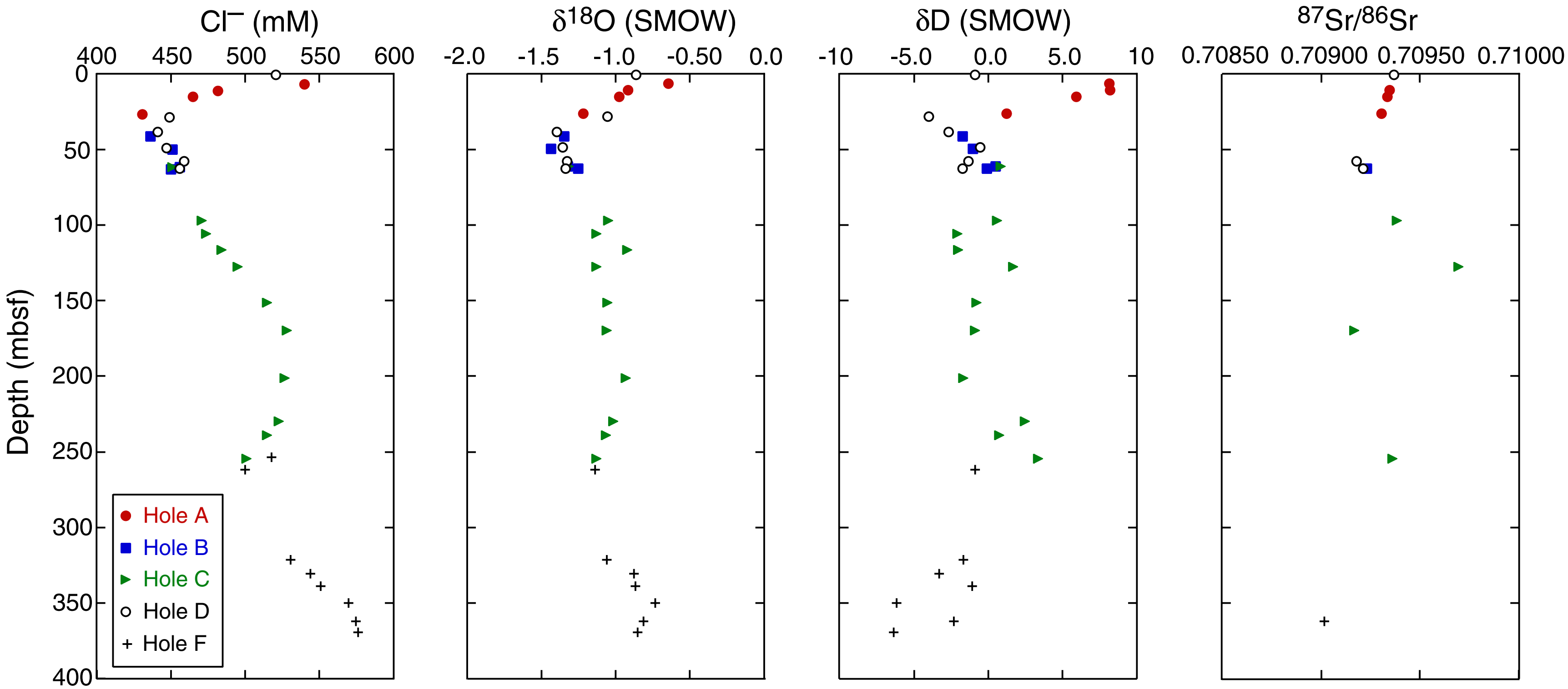

Figure F3. Interstitial water isotopic data from Site 1072 vs. depth. Pore-water Cl⁻ data vs. depth are also shown (Austin, Christie-Blick, Malone, et al., 1998). SMOW = standard mean ocean water.

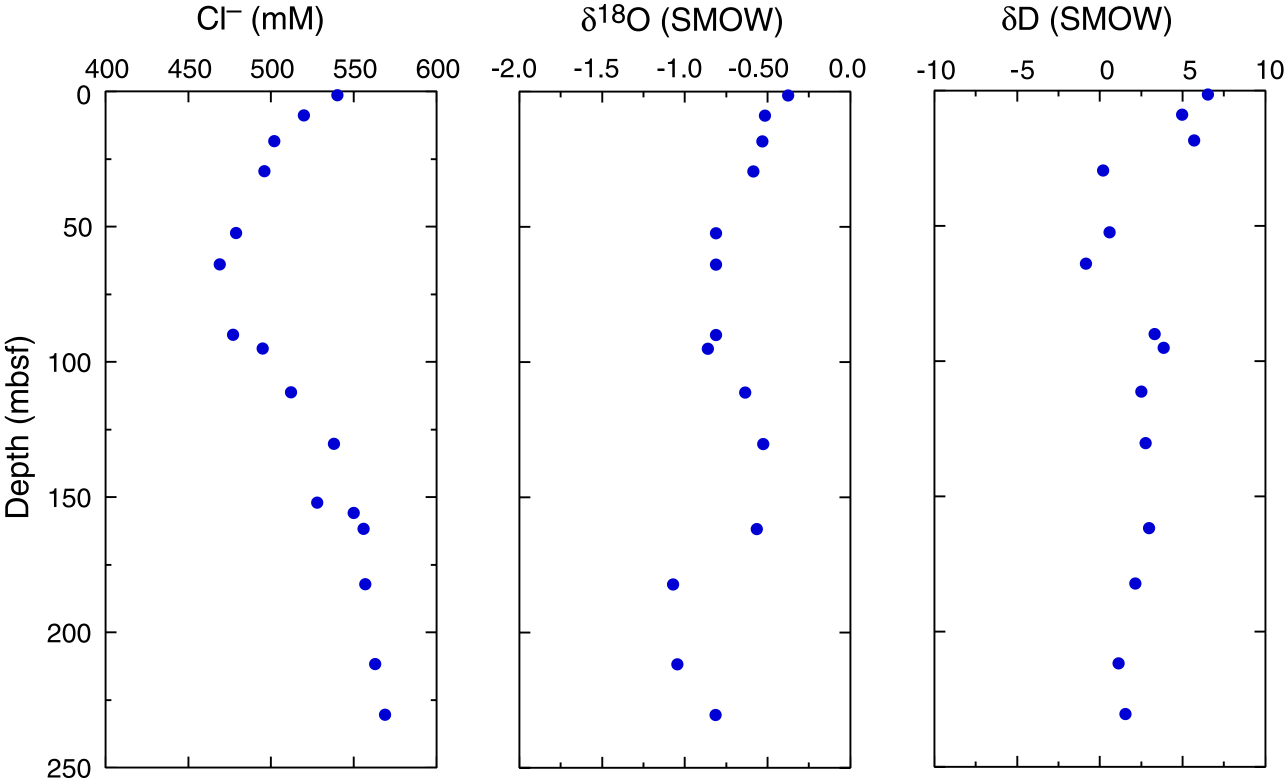

Figure F4. Interstitial water isotopic data from Site 1073 vs. depth. SMOW = standard mean ocean water.

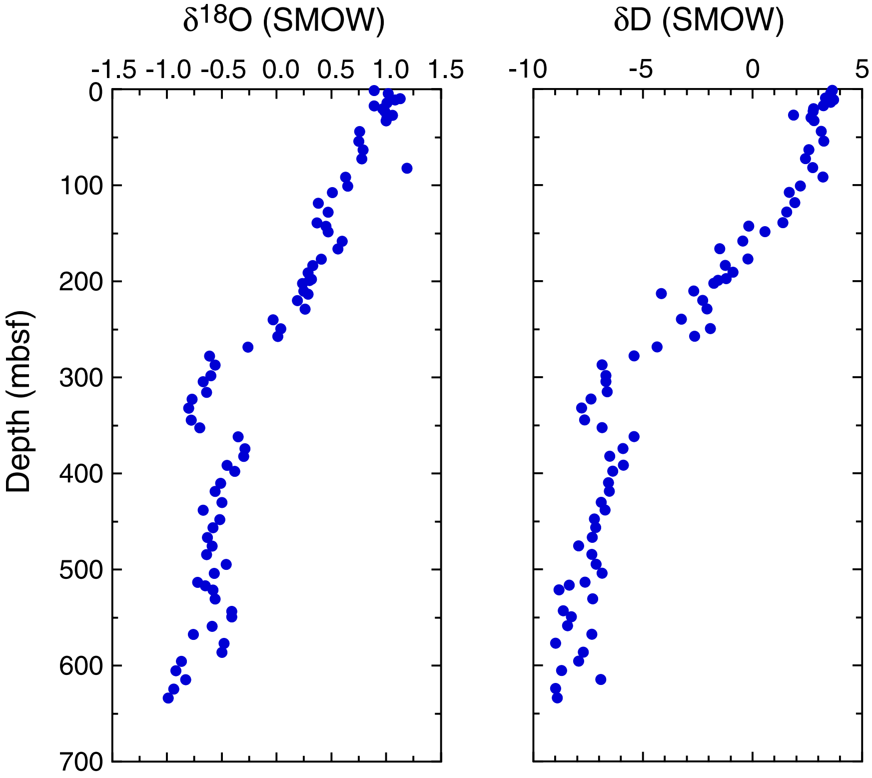

Table T1. Isotopic composition of interstitial waters, Site 1071.

Core, section, interval (cm)	Depth (mbsf)	$\delta^{18}O$ SMOW	δD SMOW	$^{87}Sr/^{86}Sr$
174A-1071A-				
2H-1, 145-150	6.55	–0.65	8.15	
3H-2, 145-150	10.80	–0.92	8.23	0.709347
4H-2, 145-150	14.90	–0.98	5.92	0.709334
6H-1, 75-80	26.45	–1.22	1.23	0.709306
174A-1071B-				
2X-1, 140-150	41.20	–1.35	–1.74	
3X-CC, 0-50	49.64	–1.44	–1.07	
5X-2, 145-150	61.35	–1.32	0.50	
5X-3, 140-150	62.80	–1.26	–0.12	0.709230
174A-1071C-				
2X-2, 140-150	61.30	–1.32	0.84	
6X-CC, 21-29	97.09	–1.05	0.60	0.709382
7X-CC, 13-23	105.73	–1.13	–2.06	
8X-CC, 17-27	116.34	–0.92	–2.02	
9X-2, 140-150	127.40	–1.13	1.69	0.709701
Replicate	127.40	–1.13	1.69	0.709686
12X-2, 140-150	151.40	–1.06	–0.81	
15X-5, 140-150	169.80	–1.06	–0.89	0.709167
19X-CC, 0-16	201.16	–0.93	–1.69	
22X-1, 140-150	229.80	–1.02	2.46	
23X-1, 140-150	239.10	–1.07	0.76	
25X-2, 140-150	254.50	–1.13	3.36	0.709361
174A-1071D-				
1R-1, 52-62	0.52	–0.86	–0.88	0.709364
Replicate	0.52	–0.86	–0.88	0.709374
4R-CC, 6-12	28.36	–1.06	–4.00	
5R-1, 24-30	38.24	–1.40	–2.70	
6R-1, 97-107	48.67	–1.36	–0.57	
7R-1, 33-43	57.73	–1.33	–1.34	0.709181
8R-1, 17-27	62.57	–1.34	–1.76	0.709214
174A-1071F-				
1R-1, 140-150	253.40			
2R-1, 39-45	261.79	–1.14	–0.87	
6R-1, 118-128	321.38	–1.06	–1.69	
7R-1, 90-100	330.50	–0.88	–3.33	
8R-1, 0-10	339.00	–0.86	–1.08	
9R-2, 74-86	350.04	–0.74	–6.18	
10R-3, 140-150	362.30	–0.81	–2.36	0.709018
11R-2, 58-68	369.48	–0.85	–6.39	

Note: SMOW = standard mean ocean water.

Table T2. Isotopic composition of interstitial waters, Site 1072.

Core, section, interval (cm)	Depth (mbsf)	$\delta^{18}O$ SMOW	δD SMOW
174A-1072A-			
1R-1, 134-144	1.34	–0.38	6.53
2R-1, 140-150	8.90	–0.52	4.99
3R-1, 140-150	18.40	–0.53	5.71
4R-2, 140-150	29.60	–0.59	0.19
7R-1, 140-150	52.40	–0.81	0.60
9R-2, 140-150	63.90	–0.81	–0.84
15R-1, 33-43	90.03	–0.81	3.32
16R-1, 104-114	95.04	–0.86	3.86
19R-2, 140-150	111.30	–0.64	2.50
22R-2, 140-150	130.30	–0.53	2.77
29R-1, 140-150	161.70	–0.57	2.97
33R-1, 140-150	182.20	–1.07	2.14
39R-3, 140-150	211.70	–1.05	1.14
43R-1, 140-150	230.50	–0.82	1.55

Note: SMOW = standard mean ocean water.

Table T3. Isotopic composition of interstitial waters, Site 1073.

Core, section, interval (cm)	Depth (mbsf)	$\delta^{18}O$ SMOW	δD SMOW
174A-1073A-			
1H-1, 140-150	1.4	0.89	3.64
1H-3, 140-150	4.4	1.02	3.58
2H-2, 140-150	9.5	1.13	3.33
2H-3, 140-150	11.0	1.08	3.70
2H-5, 140-150	14.0	1.01	3.56
3H-1, 130-140	17.4	0.89	3.24
3H-3, 130-140	20.2	0.97	2.80
3H-5, 130-140	23.0	0.99	2.77
4H-1, 130-140	26.9	1.06	1.88
4H-3, 130-140	29.8	1.01	2.68
4H-5, 130-140	32.7	1.00	2.81
5H-6, 140-150	44.1	0.76	3.14
6H-7, 130-150	54.1	0.75	3.25
7H-6, 140-150	63.0	0.79	2.57
8H-6, 140-150	72.5	0.78	2.42
9H-6, 140-150	82.0	1.19	2.74
10H-6, 140-150	91.5	0.63	3.21
11H-6, 140-150	101.0	0.65	2.18
12H-4, 140-150	107.5	0.51	1.68
13H-5, 140-150	118.5	0.38	1.93
14H-5, 140-150	128.0	0.47	1.56
15H-6, 140-150	139.0	0.37	1.38
16H-2, 140-150	142.5	0.45	–0.17
16H-6, 140-150	148.5	0.47	0.58
17H-6, 140-150	158.0	0.60	–0.44
18H-5, 140-150	166.0	0.56	–1.50
19H-6, 140-150	176.9	0.41	–0.22
20H-4, 140-150	183.4	0.33	–1.25
21H-4, 140-150	190.9	0.29	–0.88
22H-2, 140-150	197.5	0.32	–1.20
22H-3, 140-150	199.0	0.30	–1.57
22H-5, 140-150	202.1	0.24	–1.76
23H-5, 140-150	210.2	0.25	–2.68
24H-1, 134-146	213.1	0.29	–4.16
25X-3, 135-150	220.1	0.19	–2.27
26X-3, 140-150	228.8	0.26	–2.08
27X-4, 135-150	239.8	–0.03	–3.24
28X-4, 135-150	249.4	0.04	–1.92
29X-3, 135-150	257.4	0.01	–2.65
30X-3, 135-150	268.4	–0.26	–4.35
31X-4, 135-150	277.9	–0.61	–5.41
32X-3, 135-150	287.2	–0.56	–6.86
33X-5, 135-150	298.0	–0.60	–6.70
34X-3, 135-150	304.5	–0.67	–6.70
35X-4, 135-150	315.4	–0.64	–6.62
174A-1073A-			
36X-3, 135-150	322.8	–0.77	–7.38
37X-3, 135-150	332.2	–0.80	–7.79
38X-5, 135-150	344.6	–0.78	–7.67
39X-4, 135-150	352.5	–0.70	–6.87
40X-4, 135-150	361.9	–0.35	–5.40
41X-6, 135-150	374.3	–0.29	–5.92
42X-5, 135-150	382.2	–0.30	–6.52
43X-5, 135-150	391.7	–0.45	–5.89
44X-3, 135-150	398.0	–0.38	–6.38
45X-5, 135-150	409.9	–0.51	–6.58
46X-5, 135-150	418.7	–0.56	–6.53
47X-6, 135-150	430.4	–0.50	–6.91
48X-5, 135-150	438.3	–0.67	–6.73
49X-5, 135-150	447.8	–0.52	–7.22
50X-5, 135-150	456.5	–0.58	–7.16
51X-5, 135-150	466.7	–0.63	–7.30
52X-5, 135-150	475.6	–0.59	–7.94
53X-5, 135-150	484.3	–0.64	–7.33
54X-5, 135-150	494.6	–0.46	–7.13
55X-5, 135-150	504.0	–0.57	–6.86
56X-5, 135-150	513.3	–0.72	–7.64
57X-1, 135-150	516.7	–0.65	–8.37
57X-4, 135-150	521.2	–0.58	–8.83
58X-4, 135-150	530.7	–0.56	–7.29
59X-6, 135-150	543.2	–0.41	–8.64
60X-5, 135-150	549.2	–0.41	–8.27
61X-6, 135-150	558.8	–0.59	–8.45
62X-5, 135-150	567.5	–0.76	–7.33
63X-5, 135-150	576.8	–0.48	–8.98
64X-5, 135-150	586.2	–0.50	–7.72
65X-5, 135-150	595.6	–0.87	–7.93
66X-5, 135-150	605.2	–0.92	–8.72
67X-5, 135-150	614.6	–0.83	–6.92
68X-5, 135-150	624.2	–0.94	–8.98
69X-5, 135-150	633.7	–0.99	–8.92