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30. *DATA REPORT:* CHEMICAL AND ISOTOPIC COMPOSITIONS OF PORE FLUIDS IN SEDIMENTS OF THE CASCADIA ACCRETIONARY COMPLEX[1]

Miriam Kastner[2] and Henry Elderfield[3]

ABSTRACT

To complement the shipboard pore fluid chemical data from the Cascadia accretionary complex, Sites 888 to 892, the chemical and isotopic data reported here were carried out in our shore-based laboratories. The data include: (1) lithium and strontium concentrations and strontium and oxygen isotope ratios for all sites drilled, both off Vancouver Island and off central Oregon; (2) calcium, magnesium, potassium, and sodium concentrations for Hole 892D pore fluid samples; and (3) strontium and oxygen isotope ratios of a pure massive gas hydrate sample from Hole 892D. Shipboard Cl concentrations are included for better sample identification. The data reflect fluid-rock reactions and, at least at Site 892, advection of fluid from deeper in the accretionary complex.

INTRODUCTION

The existence of large-scale fluid flow and fluid expulsion at convergent margins is demonstrated by (1) tectonically induced rapid porosity reduction of accretionary complexes; (2) regionally variable heat flow; (3) pore-fluid chemical, isotopic, and temperature anomalies that can only be maintained by rapid fluid flow; and (4) widespread diffuse and/or channelized fluid venting through mud volcanoes or along thrusts. These fluids sustain prolific benthic biological communities and cause carbonate deposition, primarily from methane oxidation. High pore fluid pressures are pervasive in convergent margins. These fluids play a central role in the deformational, thermal, and chemical evolution of convergent margins, and enhance diagenetic and metamorphic reactions. Fluids released from these reactions may be important for global geochemical budgets; H_2O and CO_2 may expedite partial melting at greater depths.

The expelled fluids are characterized by variable chemical and isotopic compositions. Fresher-than-seawater fluids are ubiquitous in accretionary complexes; seawater dilutions of 10%–64% have been recorded. In the Cascadia accretionary complex a maximum seawater dilution of 37% was observed at Site 889, and a 22% seawater dilution was recorded in Hole 892D. Mostly gas hydrate dissociation contributes to the observed Cl dilution at both sites.

Deciphering the origin(s) of the geochemically complex pore fluids in sediments of accretionary complexes requires an array of chemical and isotopic data. Accordingly, the geochemical and isotopic data reported here provide new insights into the origin and flow of fluids in the Cascadia accretionary complex.

MATERIALS AND METHODS

All pore fluids analyzed were obtained by routine shipboard squeezing of whole-round sediment samples immediately after retrieval. The sediments were squeezed in titanium squeezers at ambient temperature and at pressures of 135–205 MPa (140–210 kg/cm^2). The pore fluid samples were analyzed on board ship for a range of constituents. The shore-based pore fluid analyses emphasized lithium and strontium concentrations and strontium and oxygen isotope ratios, summarized in Tables 1 through 9. Because of some shipboard problems with the atomic absorption spectrophotometer, all pore fluid samples were analyzed for Li concentrations at the Scripps Institution of Oceanography (SIO) laboratories, including the samples from the three holes (889A, 891A, and 891B) analyzed for Li on board ship. Pore fluids from Hole 892D were also analyzed for Ca, Mg, K, and Na concentrations using the shipboard methods described in Gieskes et al. (1991). Lithium and strontium concentrations were measured by atomic absorption spectroscopy. The precision for Sr was <3.0% and for Li only 10% because of the low Li concentrations. Strontium and oxygen isotope ratios were determined by mass spectrometry. For the pore fluid oxygen isotope analysis, the method of Bottinga and Craig (1969) was used with a precision of 0.08‰. Strontium isotopes were determined by the previously described method (e.g., Elderfield and Gieskes, 1982). The 2σ errors are given in Tables 6 through 9. Measured $^{87}Sr/^{86}Sr$ ratios were normalized to a particular value (to $^{86}Sr/^{88}Sr = 0.1194$) for a standard; the value obtained for the National Bureau of Standards (NBS) 987 standard measured in the SIO laboratory is 0.710255, with a 2σ error of 18.

GENERAL RESULTS

The data indicate the uniqueness of Site 892 pore-fluid geochemistry relative to the other drilled sites on Leg 146 at the Cascadia accretionary complex. At Site 892, the Li and Sr concentrations are two to three times higher (Figs. 1, 2) and the $^{87}Sr/^{86}Sr$ significantly less radiogenic (Fig. 3). The pore-fluid Sr isotope data of all sites are less radiogenic than modern or contemporary seawater Sr isotopic values (e.g., Burke et al., 1982; see Tables 6–9 and Fig. 3). The slightly negative oxygen isotope values in Tables 6–9 and Figure 4 reflect in-situ low-temperature formation of diagenetic minerals of either carbonates and/or silicates.

GAS HYDRATE

Gas hydrate was recovered between 2 and 5 and ~19 mbsf in Holes 892A, 892D, and 892E. Most of it occurs as individual, dis-

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[2]Scripps Institution of Oceanography, La Jolla, CA 92093-0212, U.S.A.
[3]Department of Earth Sciences, University of Cambridge, Cambridge CB2 3EQ, United Kingdom.

persed, platy-to-prismatic 1- to 1.5-cm-long white crystals or in crystal clusters. Only one 2- to 3-cm-thick massive gas hydrate layer was obtained in Core 146-892D-3X; it was immediately frozen in liquid nitrogen. This is a CH_4-H_2S gas hydrate, with ~10% H_2S; it also contains minor amounts of ethane and CO_2. The $\delta^{13}C$ value of the methane is –67.5 (‰, PDB), suggesting a biogenic or possibly a mixed biogenic-thermogenic source. This is remarkably similar to the $\delta^{13}C$ value of methane reported by Suess and Whiticar (1989) from the Oregon Cascadia margin, suggesting a similar or common source. The $\delta^{18}O$ value of the H_2O which includes ~6% admixed seawater is +2.77(‰, SMOW); the $\delta^{18}O$ value of the pure hydrate H_2O, assuming 0‰ for the seawater, is thus 2.9‰. This value is similar to the experimentally determined oxygen isotope fractionation factor of 1.0026 in a gas hydrate-water system (Davidson et al., 1983) and basically the same as the experimentally determined oxygen isotope fractionation factor in the ice-water system (Craig and Hom, 1969; Suzuki and Kimura, 1973).

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Table 1. Chemical composition of pore fluid samples from Site 888.

Core, section, interval (cm)	Depth (mbsf)	Cl (mM)	Ca/Cl (10^{-2})	Li (μM)	Li/Cl (10^{-4})	Sr (μM)	Sr/Cl (10^{-4})
146-888B-							
1H-2, 143–150	2.9	545	1.88	23.7	0.43	91.0	1.67
1H-3, 105–110	4.0	546	1.89	30.6	0.56		
2H-2, 145–150	8.5	552	2.08	11.3	0.20	101.6	1.84
2H-3, 53–58	9.1	551	2.12	23.7	0.43	85.2	1.55
3H-2, 145–150	18.0	562	2.16	23.7	0.42	81.1	1.44
4H-4, 145–150	30.4	561	2.20	10.0	0.18	91.4	1.63
5H-4, 143–150	39.9	564	2.27	16.8	0.30	98.4	1.74
6H-5, 140–150	50.9	565	2.08	10.0	0.18	96.0	1.70
7H-3, 140–150	57.4	568	1.84	13.4	0.24	92.1	1.62
8H-4, 140–150	68.4	571	1.71	23.7	0.42	48.4	0.85
9H-3, 140–150	76.4	559	1.65	22.5	0.40	48.4	0.87
10H-4, 140–150	87.4	560	1.69	20.3	0.36	56.6	1.01
11H-3, 142–152	95.3	559	1.50	10.0	0.18	93.4	1.67
12H-2, 139–149	103.4	558	1.31	23.7	0.42	97.5	1.75
14H-4, 140–150	124.0	556	1.84	19.9	0.36	105.5	1.90
15H-4, 138–150	133.5	554	1.96	24.8	0.45	85.2	1.54
16H-5, 138–150	144.5	554	1.73	16.8	0.30	91.4	1.65
17H-4, 140–150	152.5	553	1.49	10.0	0.18	75.0	1.36
18X-2, 135–150	159.0	545	1.40	16.8	0.31	105.7	1.94
19X-5, 1–15	171.6	543	1.55	10.0	0.18	83.2	1.53
24H-1, 135–150	214.3	552	1.23	16.8	0.30	101.6	1.84
25H-3, 135–150	221.8	552	1.22	29.4	0.53	123.7	2.24
26H-3, 135–150	231.3	550	1.17	20.3	0.37	112.2	2.04
27H-5, 140–150	241.6	546	1.09	19.7	0.36	114.0	2.09
30H-4, 130–150	266.6	547	1.05	19.9	0.36	109.1	1.99
31H-5, 130–150	275.1	554	1.02	27.2	0.49	108.1	1.95
34H-1, 130–150	293.7	548	1.19	23.7	0.43	107.8	1.97
36H-2, 70–80	312.2	550	1.03	30.6	0.56	107.8	1.96
40H-5, 130–150	355.3	552	1.17	30.6	0.55	103.5	1.88
44X-4, 1–15	389.5	556	1.44	30.6	0.55	128.3	2.31
45X-1, 135–150	396.4	559	1.44	32.0	0.57	122.1	2.18
48X-CC,	423.5	563	1.23	23.7	0.42	116.0	2.06
53X-CC, 3–18	460.5	563	1.62	27.5	0.49	120.4	2.14
54X-1, 130–150	470.7	563	1.71	61.5	1.09	105.7	1.88
57X-1, 130–150	497.5	556	2.19	44.3	0.80	116.0	2.09
58X-3, 1–20	508.1	551	2.42			107.8	1.96
59P-1, 2–14	514.0	545	2.47	51.5	0.94	113.9	2.09
60X-1, 30–40	515.3	563	2.39				
61X-1, 1–10	522.8	556	2.24	55.0	0.99	105.7	1.90
62X-2, 130–150	534.5	564	2.66	46.4	0.82	121.5	2.15
63X-2, 130–150	543.2	562	2.90	37.9	0.67	120.1	2.14
64X-1, 130–150	550.5	562	3.07			111.9	1.99
65X-5, 1–25	564.1	562	2.83	32.3	0.57	126.2	2.25

Table 2. Chemical composition of pore fluid samples from Sites 889 and 890.

Core, section, interval (cm)	Depth (mbsf)	Cl (mM)	Ca/Cl (10^{-2})	Li (μM)	Li/Cl (10^{-4})	Sr (μM)	Sr/Cl (10^{-4})
146-890B-							
1H-2, 145–150	3.0	544	1.27	26.2	0.48	76.1	1.40
1H-3, 145–150	4.5	541	0.94	21.7	0.40	69.0	1.28
2H-2, 63–68	9.4	532	0.62	28.6	0.54	64.3	1.21
2H-3, 53–58	10.8	526	0.63	28.6	0.54	61.4	1.17
2H-6, 145–150	16.5	522	0.42	27.9	0.53	58.0	1.11
3H-2, 143–150	19.7	515	0.30	21.7	0.42	53.9	1.05
3H-5, 150–155	24.2	508	0.37	24.4	0.48	52.3	1.03
5H-5, 0–10	43.9	473	0.30	32.1	0.68	51.7	1.09
146-889A-							
1H-2, 1–6	21.6	528	0.66	19.8	0.38	74.7	1.41
1H-4, 145–150	26.0	521	0.57	22.7	0.44	71.8	1.38
2H-5, 145–150	35.5	499	0.61	22.7	0.45	66.5	1.33
3H-5, 1–6	45.0	488	0.59	22.7	0.47	59.8	1.23
4H-5, 143–150	56.0	462	0.44	22.7	0.49	52.0	1.13
5H-3, 143–150	62.5	456	0.27	22.7	0.50	52.0	1.14
6H-5, 145–150	75.0	442	0.50	26.6	0.60	54.4	1.23
7H-2, 143–150	80.0	432	0.61	31.5	0.73	56.7	1.31
8H-3, 140–150	91.0	424	0.73	31.5	0.74	56.7	1.34
9H-6, 137–150	103.4	412	0.88	31.5	0.76	54.4	1.32
10H-4, 140–150	109.9	405	0.95	35.8	0.88	52.0	1.28
11H-1, 140–150	115.0	401	0.99	40.2	1.00	52.0	1.30
11H-2, 130–150	116.4			40.2		38.4	
12H-4, 140–150	125.0	398	0.99	41.0	1.03	52.0	1.31
13H-CC, 0–5	128.0	391	1.04	44.6	1.14	52.0	1.33
14H-1, 153–158	128.5	378	1.07	50.0	1.32	50.1	1.33
15P-1, 6–13	129.1	363	1.21			38.1	1.05
17X-2, 70–80	132.4	379	0.96				
18X-4, 36–46	144.5	388	0.87	49.0	1.26	50.4	1.30
22X-7, 0–20	179.8	378	1.06	49.0	1.30	46.3	1.22
24X-5, 120–140	195.1	366	1.19	57.9	1.58	61.5	1.68
25X-2, 0–20	198.8	364	1.07	62.4	1.71	52.7	1.45
26X-4, 130–150	212.7	370	1.13	66.5	1.80	59.2	1.60
28X-4, 80–100	222.6	372	1.11	66.5	1.79	56.7	1.52
30X-4, 130–150	233.7	358	1.13	66.5	1.86	49.7	1.39
31X-5, 140–160	244.0	352	1.07	70.0	1.99	53.2	1.51
32X-1, 130–150	248.0	360	1.14	78.8	2.19	56.1	1.56
36X-1, 99–114	267.7	364	1.17	71.7	1.97	58.7	1.61
40X-4, 45–65	306.6	365	1.20	107.9	2.96	60.5	1.66
41X-3, 130–150	316.4	362	1.39	108.4	2.99	60.8	1.68
43X-2, 0–5	329.9	367	1.56			62.6	1.71
44X-1, 0–15	337.3	376	1.49				
146-889B-							
3R-1, 79–94	216.5	368	0.98				
4R-2, 45–60	227.3	380	1.17	79.9	2.10	63.3	1.67
5R-1, 26–36	235.1	370	1.20	84.0	2.27	52.5	1.42
6R-1, 54–69	244.9	365	1.17	84.7	2.32	58.7	1.61
7R-1, 103–126	255.0	362	1.16	90.6	2.50	59.8	1.65
8R-2, 130–150	265.6	372	1.15	84.0	2.26	54.5	1.47
9R-1, 130–150	274.3	370	1.12	99.2	2.68		
10R-2, 0–20	282.0	371	1.29			56.6	1.53
12R-1, 130–150	299.6	364	1.21	110.3	3.03	59.1	1.62
13R-2, 35–55	309.1	365	1.30	105.9	2.90		
14R-1, 111–136	317.0	375	1.35			66.8	1.78
15R-1, 125–150	326.0	368	1.50	127.8	3.47	62.7	1.70
17R-1, 0–15	342.2	379	1.56			70.9	1.87
18R-1, 0–10	351.1	369	1.41	106.0	2.87	60.7	1.64
20R-CC, 0–3	377.6	366	1.74	195.2	5.33	77.6	2.12

Table 3. Chemical composition of pore fluid samples from Site 891.

Core, section, interval (cm)	Depth (mbsf)	Cl (mM)	Ca/Cl (10^{-2})	Li (μM)	Li/Cl (10^{-4})	Sr (μM)	Sr/Cl (10^{-4})
146-891A-							
1H-1, 140–150	2.9	545	1.05	26.2	0.48	93.4	1.71
1H-3, 103–113	4.0	527	1.17	21.7	0.41	95.5	1.81
2H-1, 109–119	5.8	546	0.92	21.7	0.40	87.2	1.60
3H-2, 53–68	9.3	551	1.01	21.7	0.39	108.7	1.97
146-891B-							
3X-CC	20.8	532	1.72	38.4	0.72	89.3	1.68
4X-CC, 0–5	29.6	533	1.69			93.4	1.75
8X-1, 15–20	65.4	537	1.81	23.1	0.43	93.4	1.74
11X-2, 16–21	92.3	540	1.85	26.6	0.49	89.3	1.65
14X-1, 54–64	110.0	540	1.83	23.2	0.43	95.5	1.77
15X-1, 82–90	119.2	545	1.72	34.2	0.63	90.7	1.66
16X-1, 57–67	127.9	545	1.60	30.6	0.56	97.5	1.79
18X-CC, 26–37	148.4	546	1.80	18.9	0.35	105.7	1.94
19X-1, 0–10	153.9	541	1.80	21.7	0.40	102.3	1.89
20X-1, 28–38	163.0	545	1.81	15.9	0.29	112.5	2.06
21N-CC, 0–5	172.1	546	1.74			105.7	1.94
22X-1, 55–67	176.7	546	1.62	21.7	0.40	97.5	1.79
23X-1, 50–60	181.1	545	1.54				
25X-CC, 13–20	198.9	555	1.01	10.0	0.18	89.3	1.61
26X-1, 42–46	207.5	554				97.5	1.76
27X-1, 15–25	216.1	561	0.90	27.3	0.49	107.4	1.91
28X-1, 32–50	225.0	557	0.92	14.3	0.26	101.6	1.82
29X-1, 22–29	233.8	556	0.96	3.1	0.06	103.7	1.86
30X-1, 75–83	238.4	557	0.99	18.2	0.33	101.6	1.83
31X-1, 135–150	243.8	562	0.97	21.7	0.39	95.5	1.70
32X-1, 11–17	251.5	561	0.99	25.1	0.45		
33X-1, 0–17	260.2	561	1.14	36.5	0.65	108.6	1.94
34X-1, 100–115	264.1	563	0.90	10.0	0.18		
35X-1, 16–28	269.2	558	0.91			99.6	1.79
36P-1, 0–6	277.8	557	1.02	28.6	0.51		
38X-2, 0–18	287.9	555	1.03	40.7	0.73	108.6	1.96
39X-1, 101–118	296.1	552	1.01	50.4	0.91	103.7	1.88
40X-1, 0–11	304.0	557	1.02	39.1	0.70	103.7	1.86
41X-1, 110–135	314.1	556	1.32	53.8	0.97	110.3	1.98
41X-1 135–150	314.2	553	1.47	52.1	0.94	116.0	2.10
42X-1, 0–18	321.6	560	2.04	19.6	0.35	103.6	1.85
43X-1, 10–27	330.5	562	1.12	18.2	0.32	109.8	1.95
45X-1, 6–14	348.3	554		18.2	0.33		
47X-1, 95–110	367.1	559	1.20	48.1	0.86	137.5	2.46
48X-1, 0–15	375.0	561	1.09			126.2	2.25
49X-1, 23–29	384.1	550				114.2	2.08
50X-1, 17–20	393.0	555				128.3	2.31
52X-1, 7–21	410.6	553	1.68	31.5	0.57	140.9	2.55
55X-2, 130–150	439.0	546	1.72	50.2	0.92	123.7	2.27
56X-1, 72–89	446.5	546	1.06	44.5	0.81	116.0	2.12
58X-2, 15–27	464.6	557	1.10	34.5	0.62	116.4	2.09

Table 4. Chemical composition of pore fluid samples from Hole 892A.

Core, section, interval (cm)	Depth (mbsf)	Cl (mM)	Ca/Cl (10^{-2})	Li (μM)	Li/Cl (10^{-4})	Sr (μM)	Sr/Cl (10^{-4})
146-892A-							
1X-5, 10–13	6.1	483	0.70	28.4	0.59	70.7	1.46
2X-3, 0–11	12.6	468	0.90	28.7	0.61	75.4	1.61
3X-2, 0–10	20.6	557	1.00	66.7	1.20	164.3	2.95
3X-3, 0–10	22.1	552	0.80	71.6	1.30	159.6	2.89
4X-2, 0–10	30.1	523	1.00	84.3	1.61	169.0	3.23
6X-2, 0–10	40.6	544	1.00	110.3	2.03	192.4	3.54
6X-2, 10–30	40.7	545	1.10	116.4	2.14	199.4	3.66
7X-5, 140–150	55.9	507	1.20	143.4	2.83	208.7	4.12
8X-3, 0–10	61.0	534	1.20	155.8	2.92	229.8	4.30
9X-1, 69–74	68.2	480	1.30			232.7	4.85
11X-2, 0–10	79.6	517	1.30	176.3	3.41	267.2	5.17
11X-2, 70–95	80.3	516	1.40	186.8	3.62	262.5	5.09
12X-1, 0–7	87.5	489	1.50			245.0	5.02
13X-4, 0–25	101.6	504	1.40	188.4	3.74	259.4	5.15
13X-6, 69–82	105.3	501	1.40	161.6	3.23	213.2	4.26
14X-1, 35–38	106.9	491	1.60	215.3	4.38	234.8	4.78
15X-1, 88–100	116.9	497	1.40	168.5	3.39	223.7	4.50
16X-1, 34–43	125.8	493	1.40	168.3	3.41	260.2	5.28
17X-2, 3–13	136.6	481	1.40	156.3	3.25	207.5	4.31
18X-1, 115–140	145.8	487	1.40	167.9	3.45	264.9	5.44
18X-1, 140–150	146.0	487	1.40	161.0	3.31	260.2	5.34
20X-2, 0–10	165.1	489	1.40	156.9	3.21	278.9	5.70
20X-3, 0–10	166.5	496	1.40	154.0	3.11	261.4	5.27

Table 5. Chemical composition of pore fluid samples from Hole 892D.

Core, section, interval (cm)	Depth (mbsf)	Cl (mM)	Ca (mM)	Ca/Cl (10^{-2})	Mg (mM)	K (mM)	Na (mM)	Li (μM)	Li/Cl (10^{-4})	Sr (μM)	Sr/Cl (10^{-4})
146-892D-											
1X-1, 9–12	0.1	547	9.68	1.80	49.42	13.10	474	33.3	0.61	87.1	1.59
2X-1, 145–150	10.0	539	3.37	0.60	39.93	12.62	461	31.2	0.58	80.1	1.49
2X-2, 140–150	11.4	447	2.90	0.70	30.75	10.62	388	27.8	0.62	63.7	1.43
3X-1, 40–45	18.4	433	3.26	0.80	31.81	10.70	376	28.8	0.67	54.2	1.25
4X-2, 4–11	29.0	575				10.87		82.0	1.43	161.7	2.81
4X-2, 21–30	29.2	505	5.07	1.00	32.93	10.01	441	61.0	1.21	131.3	2.60
4X-3, 80–88	30.8	570				10.85		84.1	1.48	180.7	3.17
5X-2, 140–150	39.9	560	5.56	1.00	33.97	10.23	495	104.3	1.86	197.0	3.52
6X-4, 140–150	52.4	550	5.91	1.10	32.52	9.70	479	126.7	2.30	211.1	3.84
7X-3, 142–150	58.2	551	3.66	0.70	31.92	9.40	486	147.2	2.67	234.5	4.26
8X-3, 0–10	64.7	541	4.10	0.80	28.97	9.05	481	154.7	2.86	239.1	4.42
9X-4, 0–15	73.8	500	4.64	0.90	23.71	7.66	448	163.0	3.26	250.8	5.02
10X-4, 0–15	104.5	496				5.90		175.2	3.53	273.7	5.52
11X-1, 130–150	110.9	505	4.67	0.90	21.31	6.67	459	170.7	3.38	277.0	5.49
12X-3, 130–150	123.4	488	4.20	0.90	21.48	6.55	445	165.2	3.39	260.2	5.33
13X-CC, 22–24	128.5	484								272.9	5.64
14X-1, 115–130	139.2	490	3.94	0.80	21.59	6.53	447	156.8	3.20	267.2	5.45
15X-2, 110–135	148.6	489	4.81	1.00	21.85	6.88		160.5	3.28	246.2	5.03
15X-2, 135–150	148.9	492	4.00	0.80	21.45	6.50	451	147.7	3.00	267.2	5.43
16X-3, 135–150	161.4	484	3.56	0.70	21.96	6.47	442	141.0	2.91	267.2	5.52
16X-5, 135–150	164.4	485	3.78	0.80	21.43	6.36	444	136.4	2.81	267.2	5.51

Table 6. Strontium concentration and strontium and oxygen isotope ratios of pore fluids, Site 888.

Core, section, interval (cm)	Depth (mbsf)	Sr (μM)	$^{87}Sr/^{86}Sr$	2σ	$\delta^{18}O$ (‰SMOW)
146-888B-					
2H-2, 140–150	8.5	101.6	0.708904	18	0.04
5H-4, 143–150	39.9	98.4	0.708364	18	0.30
8H-4, 140–150	68.4	48.4	0.708524	21	0.20
12H-2, 140–150	103.4	97.5	0.708340	18	–0.19
15H-4, 138–150	133.5	85.2	0.707825	23	–0.51
19X-5, 0–15	171.6	83.2	0.707831	17	–0.51
25H-3, 135–150	221.8	123.7	0.707779	16	–0.65
34H-1, 130–150	293.7	107.8	0.708059	15	–0.62
45X-1, 135–150	396.4	122.1	0.708380	23	–0.79
53X-1, 3–18	460.5	120.4	0.708159	25	–0.88
59P-1, 2–14	514.0	113.9	0.707813	16	–1.23
61X-1, 0–10	522.8	105.7	0.707941	17	–1.04
64X-1, 130–150	550.5	111.9	0.707590	25	–1.07

Table 7. Strontium concentration and strontium and oxygen isotope ratios of pore fluids, Sites 889 and 890.

Core, section, interval (cm)	Depth (mbsf)	Sr (μM)	$^{87}Sr/^{86}Sr$	2σ	$\delta^{18}O$ (‰SMOW)
146-890B-					
2H-2, 63–68	9.4	64.3	0.709002	17	–0.22
3H-5, 150–155	24.2	52.3	0.709018	16	–0.34
5H-5, 0–10	43.9	51.7	0.708887	19	
146-					
889A-3H-5, 1–6	45.0	59.8	0.708977	19	
889A-4H-5, 143–150	56.0	52.0	0.708899	16	–0.63
889A-5H-3, 143–150	62.5	52.0	0.708826	18	–0.77
889A-6H-5, 145–150	75.0	54.4			–1.07
889A-8H-3, 140–150	91.0	56.7	0.708637	20	–1.19
889A-11H-1, 140–150	115.0	52.0	0.708521	18	–1.37
889A-12H-4, 140–150	125.0	52.0	0.708544	18	
889A-13H-CC, 0–5	128.0	52.0			–1.49
889A-15P-1, 6–13	129.1	38.1	0.708622	17	
889A-17X-2, 70–80	132.4		0.708514	15	
889A-18X-4, 36–46	144.5	50.4	0.708497	17	–1.44
889A-24X-5, 120–140	195.1	61.5	0.708507	16	–1.32
889A-26X-4, 130–150	212.7	59.2			–1.44
889A-28X-4, 80–100	222.6	56.7	0.708492	16	–1.30
889B-4R-2, 45–60	227.3	63.3	0.708554	18	–1.38
889A-30X-4, 130–150	233.7	49.7	0.708438	18	
889A-32X-1, 130–150	248.0	56.1	0.708402	16	
889B-8R-2, 130–150	265.6	54.5	0.708477	19	
889A-36X-1, 99–114	267.7	58.7			–1.42
889B-9R-1, 130–150	274.3		0.708449	15	
889A-40X-4, 45–65	306.6	60.5	0.708237	18	–1.43
889A-43X-2, 0–5	329.9	62.6	0.708224	16	–1.40
889B-18R-1, 0–10	351.1	60.7	0.708213	18	–1.53
889B-20R-CC, 0–3	377.6	77.6	0.707766	19	–1.38

Table 8. Strontium concentration and strontium and oxygen isotope ratios of pore fluids, Site 891.

Core, section, interval (cm)	Depth (mbsf)	Sr (μM)	$^{87}Sr/^{86}Sr$	2σ	$\delta^{18}O$ (‰SMOW)
146-891A-					
2H-1, 109–119	5.8	87.2	0.708561	18	−0.12
146-891B-					
4X-CC, 0–5	29.6	93.4	0.709076	18	−0.07
14X-1, 54–64	110.0	95.5	0.708993	17	−0.24
20X-1, 28–38	163.0	112.5			−0.09
23X-1, 50–60	181.1		0.708144	25	
25X-CC, 13–20	198.9	89.3	0.708079	35	−0.08
26X-1, 42–46	207.5	97.5	0.708099	37	−0.16
27X-1, 15–25	216.1	107.4			−0.25
29X-1, 22–29	233.8	103.7	0.708199	41	−0.56
31X-1, 135–150	243.8	95.5	0.708270	18	−0.58
33X-1, 0–17	260.2	108.6	0.708308	17	−0.50
34X-1, 100–115	264.1		0.708325	20	−0.69
35X-1, 16–28	269.2	99.6	0.708349	17	−0.52
38X-2, 0–18	287.9	108.6			−0.69
42X-1, 0–18	321.6	103.6	0.708135	18	−0.73
47X-1, 95–110	367.1	137.5	0.708037	14	−0.51
50X-1, 17–20	393.0	128.3	0.708300	21	−0.77
55X-2, 130–150	439.0	123.7	0.708207	31	−1.17
56X-1, 72–89	446.5	116.0	0.708316	20	−1.28
58X-2, 15–27	464.6	116.4	0.708153	23	−0.69

Table 9. Strontium concentration and strontium and oxygen isotope ratios of pore fluids, Site 892.

Core, section, interval (cm)	Depth (mbsf)	Sr (μM)	$^{87}Sr/^{86}Sr$	2σ	$\delta^{18}O$ (‰SMOW)
146-					
892D-1X-1, 9–12	0.1	87.1			−0.07
892D-1X-1, 145–150	10.0	80.1	0.708878	19	−0.17
892D-2X-2, 140–150	11.4	63.7	0.708560	18	0.33
892A-2X-3, 0–11	12.6	75.4	0.708411	20	−0.04
892A-3X-2, 0–10	20.6	164.3	0.707718	18	−0.11
892A-4X-2, 0–10	30.1	169.0	0.707589	18	−0.11
892A-6X-2, 0–10	40.6	192.4	0.707461	16	−0.26
892D-6X-4, 140–150	52.4	211.1	0.707461	20	
892A-7X-5, 140–150	55.9	208.7	0.707277	18	−0.30
892A-8X-3, 0–10	61.0	229.8	0.707289	21	−0.33
892D-8X-3, 0–10	64.7	239.1	0.707268	18	−0.49
892A-9X-1, 69–74	68.2	232.7	0.707168	18	−0.32
892D-9X-4, 0–15	73.8	250.8	0.707137	17	−0.31
892A-11X-2, 0–10	79.6	267.2	0.707116	20	−0.48
892A-13X-4, 0–25	101.6	259.4	0.707095	18	−0.52
892A-15X-1, 88–100	116.9	223.7	0.707094	16	
892D-12X-3, 130–150	123.4	260.2	0.707043	22	
892A-16X-1, 34–43	125.8	260.2	0.707115	18	−0.61
892D-13X-CC, 22–24	128.5	272.9	0.707076	15	−0.56
892A-17X-2, 3–13	136.6	207.5	0.707098	18	−0.68
892D-14X-1, 115–130	139.2	267.2			−0.67
892A-18X-1, 115–140	145.8	264.9	0.707126	15	−0.15
892D-15X-2, 135–150	148.9	267.2	0.707088	21	−0.72
892D-16X-3, 135–150	161.4	267.2			−0.75
892D-16X-5, 135–150	164.4	267.2	0.707069	18	
892A-20X-2, 0–10	165.1	278.9	0.707109	17	−0.82

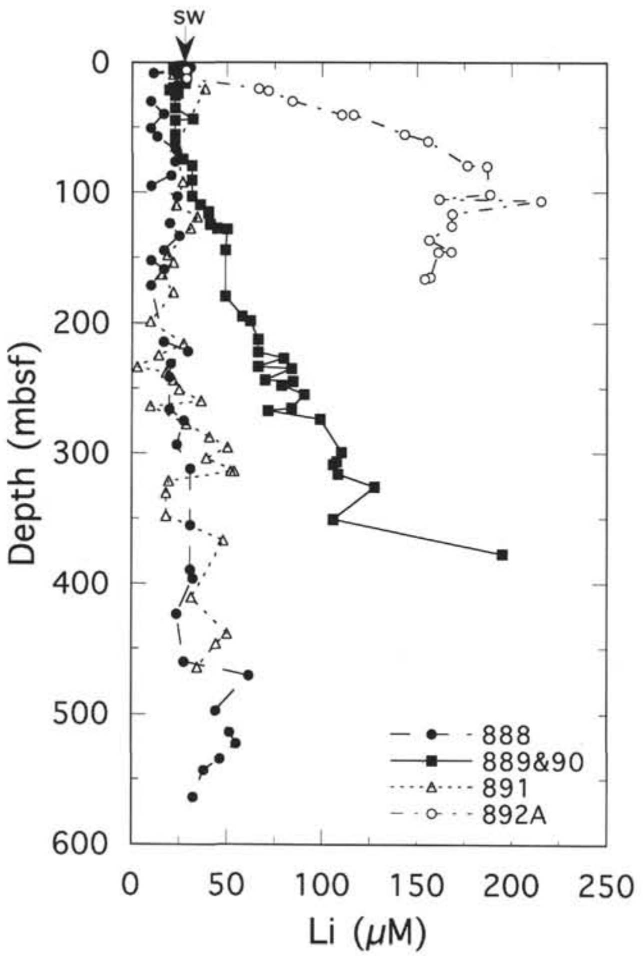

Figure 1. Depth profiles of lithium concentrations in pore fluids from Sites 888, 889/890, 891, and 892. The arrow indicates seawater (SW) concentration.

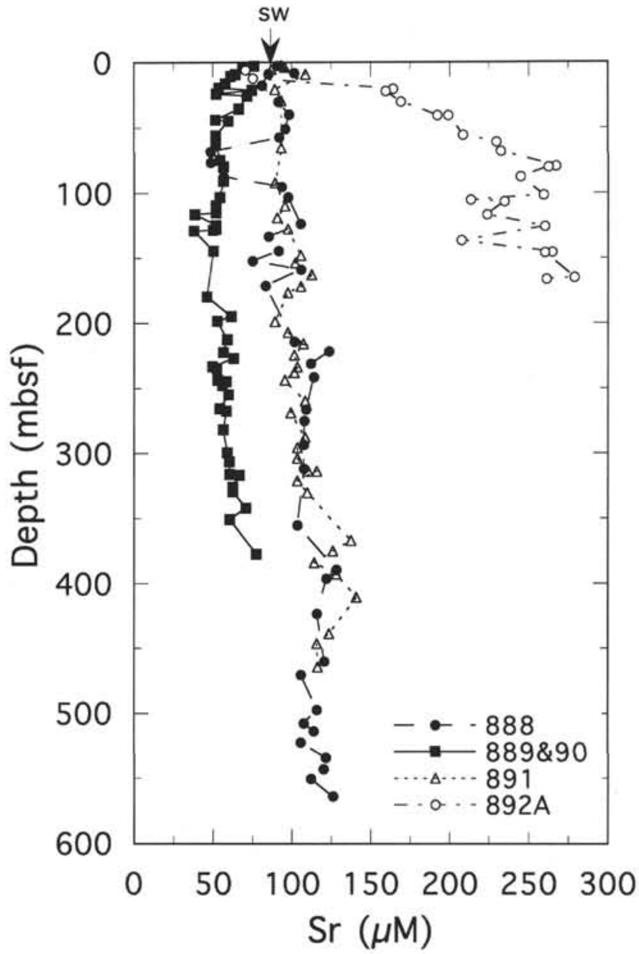

Figure 2. Depth profiles of strontium concentrations in pore fluids from Sites 888, 889/890, 891, and 892. The arrow indicates seawater (SW) concentration.

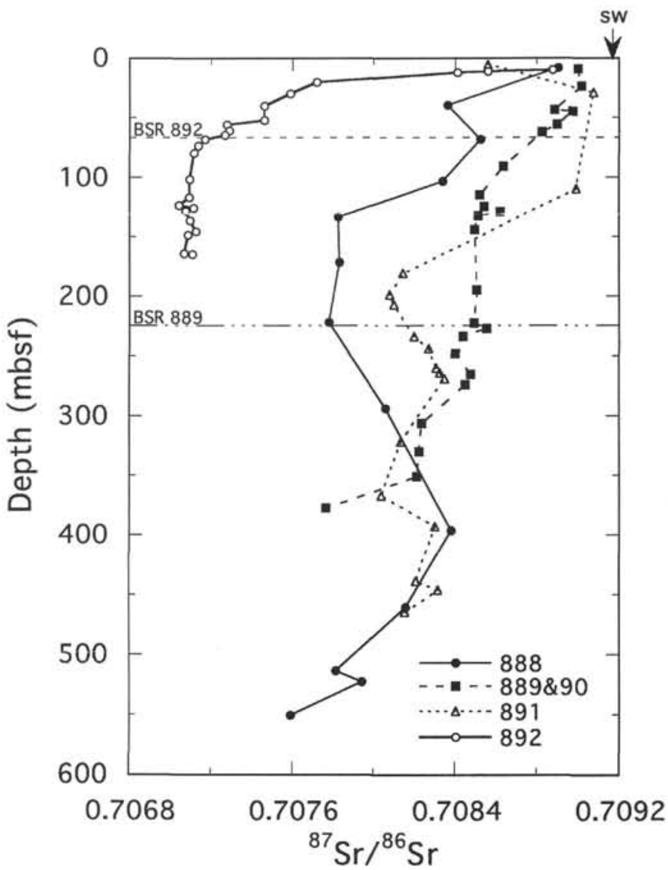

Figure 3. Depth profiles of strontium isotope ratios in pore fluids from Sites 888, 889/890, 891, and 892. The arrow indicates seawater (SW) concentration. BSR = bottom-simulating reflector.

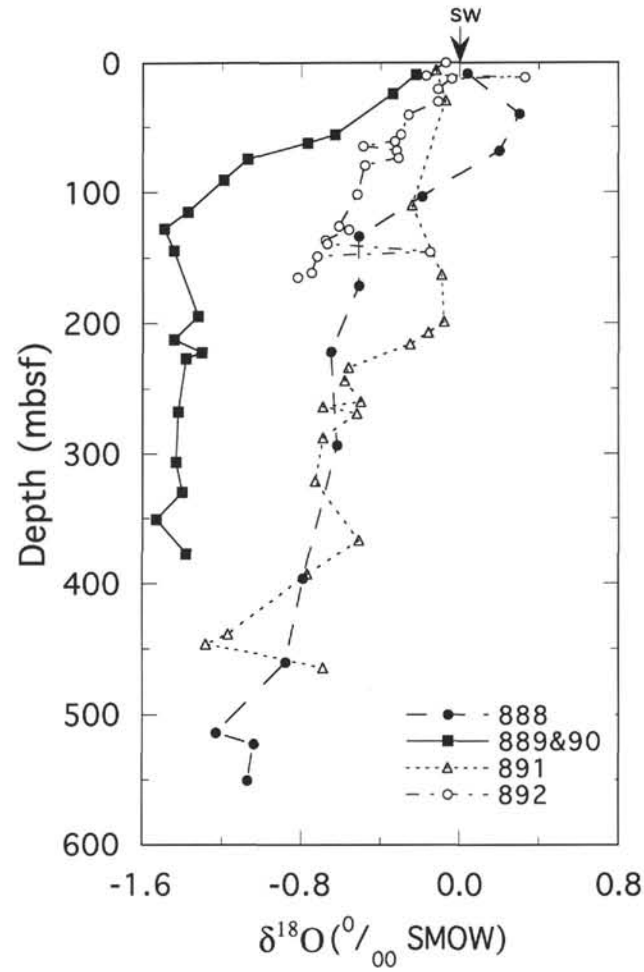

Figure 4. Depth profiles of oxygen isotope ratios in pore fluids from Sites 888, 889/890, 891, and 892. The arrow indicates seawater (SW) concentration.