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WATER AND SEDIMENT MEASUREMENTS IN SAN FRANCISCO BAY, CALIFORNIA

U. S. GEOLOGICAL SURVEY

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Open-File Report 78-973

Prepared as part of continuing
San Francisco Bay estuarine study

February 1979

WATER AND SEDIMENT MEASUREMENTS IN SAN FRANCISCO BAY, CALIFORNIA

By Laurence E. Schemel[1/], Andrea E. Alpine[1/], Brian E. Cole[1/], Lee A. Dedini[1/], and Elliott C. Spiker[2/]

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UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

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ABSTRACT

Water samples collected in San Francisco Bay, the Gulf of the Farallones, and the delta of the Sacramento and San Joaquin rivers were analyzed for salinity, temperature, partial pressure of carbon dioxide (pCO_2), chlorophyll *a*, alkalinity, particulate organic carbon (POC), and the stable carbon isotope ratio ($\delta^{13}C$) of the POC and total CO_2. Water sampling occurred between January 1976 and March 1977. Bottom sediments for total organic carbon isotopic analyses ($\delta^{13}C(TOC)$) were collected during August 1973. Numerical values are tabulated, sampling locations are identified, and the analytical methods are briefly described.

Introduction

This report presents the numerical values for measurements made at locations established in the deep channels of San Francisco Bay, the delta of the Sacramento and San Joaquin rivers, and the Gulf of the Farallones (Tables 1-18). Distributions of these data are discussed by Spiker and Schemel (in press).

Methods

Water samples were taken with a submersible pumping system and through a hull fitting near the bow of the vessel at a depth of 2 m. Details of the water-sampling and continuous-measurement systems are discussed by Schemel and Dedini (1979). Near-surface sediments were sampled with a Van Veen sampler.

Salinity, temperature, and the partial pressure of CO_2 (pCO_2), of the pumped water were continuously measured. In situ temperatures were measured at the submersible pump and hull-fitting intakes. Continuous salinity measurements were checked by comparison with discrete samples analyzed with a laboratory salinometer calibrated with standard sea water. Results are expressed in parts per thousand ($^{o}/oo$). Temperature sensors are linearized thermistor elements. Circuitry was frequently calibrated at the ice-point and near 25^{o}C.

The partial pressure of CO_2 in the water (pCO_2) was estimated by equilibrating a circulating volume of air with the flow of sample water and measuring the pCO_2 of the dried air with an infrared analyzer. The method is similar to those described by Gordon and Park (1972) and Broecker and Takahashi (1966).

Partial pressures are expressed as parts per million (ppm) by volume of dry air, which is numerically equivalent to partial pressure at a total pressure of 1 atmosphere. The temperature of the pumped water was within 0.3°C of the *in situ* temperature. Values were not corrected for the difference, which would incur a maximum error of approximately 1.5 percent in sea water (Gordon and Jones, 1973).

Discrete samples were collected for chlorophyll *a*, alkalinity, particulate organic carbon, and stable carbon isotope analyses. Alkalinity was determined by the method of Anderson and Robinson (1946) as described by Strickland and Parsons (1972). Values were calculated from the pH of a 50-mL filtered sample after addition of an aliquot of 0.001N HCl solution. Results are expressed in milliequivalents per liter (meq./L). Chlorophyll *a* was determined by the spectrophotometric method described by Strickland and Parsons (1972). Calculations are based on the trichromatic equation recommended by SCOR-UNESCO Group 17 (1966). Results are expressed in milligrams per cubic meter (mg/m^3).

Particulate organic carbon was determined by a modification of the dissolved organic carbon method described by Menzel and Vaccaro (1964). Particulate matter was collected on precombusted glass-fiber filters under low vacuum. CO_2 resulting from the oxidation of the organic fraction was measured with an infrared analyzer. Results are expressed in micro-moles of carbon (as CO_2) per liter (μM C/L).

Water samples for stable carbon isotope measurements of the inorganic carbon ($\delta^{13}C(\Sigma CO_2)$) were pressure filtered with nitrogen at 5 psi through Whatman GF/C glass-fiber filters directly into 500-mL bottles, poisoned with 2 mL of a saturated $HgCl_2$ solution, sealed, and refrigerated. CO_2 was extracted from the acidified samples on a vacuum line. The particulate organic carbon for $\delta^{13}C(POC)$ analysis was collected on precombusted glass-fiber filters and frozen. Near-surface sediment samples for $\delta^{13}C$ total organic carbon (TOC) analysis were stored in plastic tubs, refrigerated, and dried at 50°C. Carbonate was removed from POC and sediment samples by acidification with dilute HCl in precombusted porcelain boats and oven drying at 50°C. Samples were combusted in a vacuum line and the resulting CO_2 was purified before isotopic analysis by a method modified after that of Craig (1953) and Degens (1969).

The $^{13}C/^{12}C$ ratio of the CO_2 was measured with a 15-cm, 60°-sector ratio mass spectrometer and expressed as the parts per thousand deviation from the PDB reference standard:

$$\delta^{13}C(^{o}/oo) = \frac{(R_s - R_{st}) \times 10^3}{R_{st}}$$

where R_s and R_{st} are the $^{13}C/^{12}C$ ratio of the sample and standard, respectively (Craig, 1957). A δ-value of -10 °/oo means the $^{13}C/^{12}C$ value of the sample is 10 per mil lower than that of the standard.

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Table 1. San Francisco Bay Permanent Stations.

Number	Name	Latitude (N)	Longitude (W)
RV	Rio Vista	38° 8.9'	121°41.3'
TL	Tolands Landing	38 5.2	121 44.8
1	Winter Is.	38 2.4	121 50.4
2	Chain Is.	38 3.8	121 51.3
3	Pittsburg	38 3.0	121 52.7
4	Simmons Pt.	38 2.9	121 56.1
5	Middle Ground	38 3.6	121 58.8
6	Roe Is.	38 3.9	122 2.1
7	Avon Pier	38 2.9	122 5.8
8	Martinez	38 1.8	122 9.1
9	Benicia	38 3.0	122 10.4
10	Crockett	38 3.6	122 13.5
11	Mare Is.	38 3.7	122 15.8
12	Hercules	38 3.1	122 18.7
13	N.of Pt. Pinole	38 1.9	122 21.9
14	W.of Pt. Pinole	38 0.5	122 24.1
15	Pt. San Pablo	37 58.2	122 26.2
16	Red Rock	37 54.9	122 27.0
17	Raccoon Str.	37 52.9	122 25.6
19	Golden Gate	37 49.1	122 28.3
20	Blossom Rock	37 49.0	122 24.3
21	Bay Bridge	37 48.0	122 22.2
22	Potrero Pt.	37 45.7	122 21.5
23	Hunters Pt.	37 43.6	122 20.2
24	Candlestick Pt.	37 42.0	122 20.3
25	Oyster Pt.	37 40.3	122 19.5
26	San Bruno Shoal	37 38.2	122 19.0
27	SFO	37 37.1	122 17.5
28	N.San Mateo Br.	37 36.0	122 16.2
29	S.San Mateo Br.	37 34.9	122 14.8
30	Redwood Cr.	37 33.3	122 11.5
31	Coyote Hills	37 31.8	122 9.4
32	Ravenswood Pt.	37 31.1	122 8.1
33	Dumbarton Br.	37 30.6	122 7.4
34	Newark Slough	37 29.6	122 5.3
35	Palo Alto	37 28.9	122 4.7
36	Calaveras Pt.	37 28.3	122 3.8

Table 2. Additional water-sampling locations in San Francisco Bay, Gulf of the Farallones, and San Joaquin River.

Date	Station	Sampling Location	
		Latitude(N)	Longitude(W)
16 MAR 76	1	37°43.0'	122°51.4'
16 MAR 76	2	37°44.8'	122°45.3'
16 MAR 76	3	37°45.5'	122°44.0'
16 MAR 76	4	37°47.2'	122°37.2'
16 MAR 76	5/19	37°49.1'	122°28.5'
08 SEP 76	6	37°42.7'	122°58.6'
08 SEP 76	7	37°44.5'	122°57.8'
08 SEP 76	8	37°45.8'	122°44.4'
08 SEP 76	9	37°47.4'	122°35.5'
08 SEP 76	5/19	37°49.1'	122°28.3'
09 SEP 76	0808	37°57.5'	122°26.4'
09 SEP 76	1038	38°03.8'	122°13.8'
09 SEP 76	1155	38°02.4'	122°07.1'
10 SEP 76	0901	38°05.1'	121°40.7'
10 SEP 76	0957	38°01.4'	121°43.6'

Table 3. Measurements and observations in San Francisco Bay, 27 January 1976.

Sampling Location		Depth	Salinity	Temper.	pCO_2
Latitude(N)	Longitude(W)	(m)	(^{o}/oo)	(^{o}C)	(ppm)
37^{o}57.6'	122^{o}26.4'	2	27.3	10.1	630
38 02.3	122 20.9	2	23.5	10.2	642
38 03.2	122 18.6	2	23.7	10.2	673
38 03.3	122 17.2	2	19.4	10.1	672
38 03.4	122 11.8	2	17.5	10.4	705
38 02.8	122 06.3	2	12.4	10.3	758
38 03.6	122 02.1	2	8.2	10.0	798
38 03.6	122 00.1	2	5.6	10.1	871

Table 4. Measurements and observations in San Francisco Bay, 1 March 1976.

Station	Depth (m)	Salin. (^{o}/oo)	Temper. (^{o}C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll a (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (^{o}/oo)	$\delta^{13}C$(POC) (^{o}/oo)
36	0	24.57	12.5	736		14.6			
36	2	24.63	12.7	726	2.32		184	-4.3	-24.1
36	4	25.62	12.9	669		13.3			
35	2	25.93	13.0	615					
34	2	26.02	12.9	593		10.1			
33	2	26.7	12.9	563		7.0			
32	0	27.05	12.9	555		6.7			
32	2	27.12	12.5	556	2.42		61	-2.8	-24.0
32	5	27.28	12.6	555		4.8			
31	2	27.15	12.8	559		5.5			
30	0	28.00	12.3	568		3.0			
30	2	28.00	12.4	572	2.31		63	-2.2	-22.0
30	5	28.00	12.3	568					
30	10	28.04	12.2	566		3.1			
29	2	28.44	12.4	552		2.9			
28	2	29.02	12.2	600		3.1			
27	0	29.00	12.0	597		3.1	44		
27	2	28.95	11.9	595	2.27			-1.3	-22.8
27	5	29.10	11.9	605					
27	8	29.11	11.9	612		3.1			
26	2	29.08	12.2	600					
25	2	29.45	12.2	576		3.6			

Table 5. Measurements and observations in San Francisco Bay, 1 March 1976.

Station	Depth (m)	Salin. (^{o}/oo)	Temper. (^{o}C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll a (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (^{o}/oo)	$\delta^{13}C(POC)$ (^{o}/oo)
24	0	29.67	11.9	581		3.5			
24	2	29.67	11.8	575	2.22		52	-0.9	
24	5	29.79	12.0	580					
24	9	29.80	11.9	578		4.7			
23	2	29.95	12.0	574		4.0			
22	2	30.27	12.0	557					
21	0	29.98	11.7	545		4.1			
21	2	29.96	11.7	551	2.22		62	-0.6	-22.9
21	5	30.04	11.8	551					
21	10	30.01	11.7	546					
21	15	29.97	11.6	547		4.9			
20	2	30.33	11.8	532		5.2			

Table 6. Measurements and observations in San Francisco Bay, 2 March 1976.

Station	Depth (m)	Salin. (^{o}/oo)	Temper. (^{o}C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll a (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (^{o}/oo)	$\delta^{13}C(POC)$ (^{o}/oo)
17	0	29.60	10.8	477					
17	2	29.60	10.7	482	2.14		42	-0.7	-20.6
17	5	29.10	10.8	494					
17	10	29.25	10.8	499					
17	20	29.97	11.0	509					
16	2	27.35	11.7	535		3.3			
15	0	24.79	10.9	526		3.5			
15	2	25.04	11.0	526	2.07		56	-2.9	-24.4
15	5	25.75	11.0	523					
15	10	26.03	11.0	522					
15	15	26.28	10.9	523					
14	2	25.41	11.8	533		3.2			
13	2	23.68	11.9	547					
12	0	19.90	10.9	575		3.9			
12	2	20.01	10.9	574	1.90				-24.0
12	5	20.45	11.2	570					
11	2	18.60	11.8	576		4.3			
10	2	15.00	11.7	548					
9	0	13.42	11.0	503		9.4			
9	2	13.47	11.1	510	1.65		92	-4.0	-24.5
9	5	15.02	11.2	536					
9	10	16.65	11.2	566					
9	15	17.20	11.3	580				-3.3	-23.8

Table 7. Measurements and observations in San Francisco Bay, 2 March 1976

Station	Depth (m)	Salin. (°/oo)	Temper. (°C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll *a* (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (°/oo)	$\delta^{13}C(POC)$ (°/oo)
8	2	13.30	11.6	516					
7	2	11.30	11.6	508		15.3			
6	0	7.68	11.0	410		31.8			
6	2	7.93	11.0	468	1.59		140	-5.4	-25.2
6	5	8.40	11.8	486					
5	2	5.01	11.8	538		36.3			
4	2	3.32	11.7	627					
3	0	2.23	10.9	677		31.0			
3	2	2.43	10.9	679	1.31		196	-7.5	-26.3
3	5	2.60	11.0	685					
3	10	2.93	10.7	654					
2	2	2.06	11.7	704					
TL	0	0.15		730					
TL	2	0.16	10.8	729	1.14	7.6		-9.1	-26.9
TL	5	0.17	10.8	730					
RV	0	0.12	10.6	709		5.9			
RV	2	0.13	10.6	707	1.20		54	-8.9	-28.4
RV	4	0.12	10.6	711					

Table 8. Measurements and observations in the Gulf of the Farallones, 16 March 1976

Station Table 2.	Depth (m)	Salin. (°/oo)	Temper. (°C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll *a* (mg/m^3)	POC (μM C/l)
1	40	33.8	10.5	641			29
1	20	33.5	11.3	399		1.8	
1	10	33.5	11.3	360			
1	5	33.6	11.4	345			
1	2	33.5	11.5	337	2.30	2.5	37
2	40	33.9	10.5	675		0.8	
2	20	34.0	11.0	524			
2	10	33.9	11.0	542			
2	2	33.8	11.1	612	2.30	0.8	23
3	30	33.9	10.6	666			
3	20	33.9	10.9	634		1.0	
3	10	33.9	11.1	688			
3	5	33.6	11.3	565			
3	2	33.1	11.8	442	2,31		49
4	8	33.6	11.3	562		4.0	
4	5	33.2	11.6	450			
4	2	33.0	12.0	430	2.31		40
5/19	60	31.2	12.2	464		6.7	
5/19	40	31.2	12.4	454			
5/19	20	31.3	12.4	454			
5/19	10	31.3	12.5	458			
5/19	5	31.3	12.4	455		8.3	
5/19	2	31.2	12.3	458	2.25		

Table 9. Measurements and observations in San Francisco Bay, 7 September, 1976

Station	Depth (m)	Salin. (°/oo)	Temper. (°C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll a (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (°/oo)	$\delta^{13}C(POC)$ (°/oo)
36	0	30.9	21.9	1102					
36	2	31.1	21.9	1068	2.79	2.6		-3.3	-24.3
36	5	31.4	21.5	1026				-4.2	
35	2	31.9	21.4	952					
34	2	32.0	21.4	893		2.5			
33	2	32.2	21.5	890					
32	0	32.5	21.4	897					
32	2	32.4	21.3	904	2.58	2.1			-24.6
32	5	32.4	21.1	907					
32	10	32.4	21.1	917					
31	2	32.5	21.3	902					
30	0	32.5	22.0	951					
30	2	32.4	21.8	948	2.59	2.4		-2.1	-25.2
30	5	32.5	21.5	935					
30	8	32.5	21.1	961					
29	2	32.7	21.0	918					
28	2	32.8	20.9	814					
27	0	32.9	22.3	801					
27	2	32.8	20.6	799	2.41	2.9		-0.6	-23.7
27	5	32.8	20.4	794					
27	10	32.8	20.3	798					-24.0
26	2	32.6	20.6	769					
25	2	32.9	21.1	799					

Table 10. Measurements and observations in San Francisco Bay, 7 September 1976.

Station	Depth (m)	Salin. (°/oo)	Temper. (°C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll *a* (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (°/oo)	$\delta^{13}C(POC)$ (°/oo)
24	0	32.6	20.9	788					
24	2	32.5	21.2	787	2.37	3.3			-23.5
24	5	32.7	21.0	775					
24	8	32.7	21.0	774					
23	2	32.1	20.5	774					
22	2	32.6	19.0	701					
21	0	31.7	18.8	678					
21	2	31.6	18.7	681	2.28	5.0		-0.7	-22.9
21	5	31.7	18.7	686					
21	10	31.7	18.7	679					
21	12	31.7	19.0						
20	2	32.0	18.4						

Table 11. Measurements and observations in the Gulf of the Farallones, 8 September 1976.

Station Table 2.	Depth (m)	Salin. (^{o}/oo)	Temper. (^{o}C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll *a* (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (^{o}/oo)	$\delta^{13}C(POC)$ (^{o}/oo)
6	30	33.6	11.7	452					
6	10	33.6	12.4	394					
6	5	33.6	12.7	369					
6	2	33.6	13.0	363	2.33	3.4		+2.2	-21.2
7	27	33.7	12.5	361					
7	10	33.7	13.9	367					
7	5	33.7	14.0	294					
7	2	33.6	14.2	294	2.30	4.9			
8	30	33.7	10.3	550					
8	10	33.7	13.8	294					
8	5	33.7	14.0	274					
8	2	33.6	14.4	272	2.34	2.5		+2.5	-21.3
9	10	33.1	14.2	523					
9	5	33.2	14.4	523					
9	2	33.1	15.0	509	2.33	6.6			
5/19	30	32.9	15.4	529				+0.3	-20.6
5/19	10	32.7	16.3	556					
5/19	5	32.5	16.7	568					
5/19	2	32.4	16.5	571	2.33	5.3		+0.5	-21.6

Table 12. Measurements and observations in San Francisco Bay, 9 September 1976.

Station	Depth (m)	Salin. (°/oo)	Temper. (°C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll a (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (°/oo)	$\delta^{13}C(POC)$ (°/oo)
18	2	31.8	17.8	668					
17	2	29.9	18.9	666	2.26	4.7			
16	2	29.0	19.2	699					
0808[1/]	2	26.6	19.8	731	2.16				
15	0	28.1	19.7	730					
15	2	28.1	19.6	725	2.18	1.8	27	-1.7	-24.3
15	5	28.3	19.6	729					
15	10	28.4	19.5	723					
15	14	28.8	19.4	716				-1.4	-23.7
14	2	27.4	19.8	730					
13	2	25.8	20.1	726					
12	0	23.2	20.6	738					
12	2	24.0	20.3	737	2.09	1.8	52	-1.5	-24.7
12	5	24.5	20.3	728					-24.7
11	2	20.7	20.6	792	1.96				
1038[1/]	2	17.7	20.7	843	1.87		46		
10	2	16.1	20.9	835					
9	0	15.2	20.9	861					
9	2	15.3	20.9	868		4.2	53	-3.8	-25.2
9	5	15.3	20.9	869					
9	10	16.0	20.9	869					
9	20	19.0	20.7	851				-3.5	-25.4
8	2	12.8	21.1	828					
1155[1/]	2	11.7	21.6	786	1.66		63		

1/ See Table 2.

Table 13. Measurements and observations in the Sacramento-San Joaquin River Delta, 9 September 1976 and 10 September 1976.

Station	Depth (m)	Salin. (^{o}/oo)	Temper. (^{o}C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll a (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma C)_2$ (^{o}/oo)	$\delta^{13}C$(POC) (^{o}/oo)
7	2	11.4	21.5	794					
6	0	8.3	22.1	804					
6	2	8.7	21.8	823	1.60	8.2	97	-5.6	-25.4
6	5	8.8	21.7	831					-25.8
5	2	5.7	22.5	863	1.55		96		
4	2	4.1	22.4	942					
3	0	2.8	23.5	936					
3	2	3.0	22.5	1049	1.54	7.3	86	-8.3	-26.6
3	5	3.3	22.4	1053					
3	10	3.4	22.4	1048					-26.4
2	2	2.6	22.9	1073					
TL	0	0.3	23.1	1170					
TL	2	0.6	22.5	1211				-9.6	-27.4
TL	5	0.6	22.4	1200					
RV	0	0.1	23.5	1457					
RV	2	0.1	23.5	1497	1.57	5.4	64	-10.2	
10 September 1976 (see Table 2.)									
0901	2	0.6	23.0		1.46		67	-9.9	-28.4
0957	2	1.3	23.7		1.51		89		

Table 14. Measurements and observations in San Francisco Bay, 29 March 1977.

Station	Depth (m)	Salin. (°/oo)	Temper. (°C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll a (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\leq CO_2)$ (°/oo)	$\delta^{13}C(POC)$ (°/oo)
36	0	25.8	12.9	547					
36	2	26.0	12.6	584			144	-4.7	-25.0
36	4	26.3	12.6	590					
35	2	26.8	12.9	583	2.60				
34	0	27.2	13.3	590					
34	2	27.0	13.1	592	2.64		172		
33	2	27.7	13.1	613	2.58				
32	0	27.7	12.9	593					
32	2	27.6	12.7	608	2.60		112	-3.4	-23.7
32	5	28.3	12.6	624					
31	2	28.6	13.1		2.56				
30	0	29.1	12.8	598					
30	2	29.1	12.8	596	2.48		104	-2.6	-23.4
30	5	29.3	12.6	589					
30	10	29.6	12.7	586					
29	2	29.9	13.2	583	2.45				
28	2	29.5	13.3	600					
27	0	29.7	13.3	592					
27	2	29.6	13.0	590	2.41				
27	5	29.8	12.9	597					
26	2	29.8	13.1	573	2.35				
25	2	30.1	13.3	576	2.36				

Table 15. Measurements and observations in San Francisco Bay, 29 March 1977.

Station	Depth (m)	Salin. (^{o}/oo)	Temper. (^{o}C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll *a* (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (^{o}/oo)	$\delta^{13}C(POC)$ (^{o}/oo)
24	0	30.6	12.7	517					
24	2	30.6	12.6	519	2.31		40	-1.4	-23.1
24	5	30.7	12.6	518					
23	2	31.0	13.0	476	2.26				
22	2	31.0	12.8	448	2.23				
21	0	31.0	11.9	445					
21	2	30.9	11.9	460	2.23		51		
21	5	31.0	11.9	461					
21	10	31.1	11.8	476					
20	2	32.3	11.1	540	2.26				

Table 16. Measurements and observations in San Francisco Bay, 30 March 1977.

Station	Depth (m)	Salin. (°/oo)	Temper. (°C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll *a* (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (°/oo)	$\delta^{13}C(POC)$ (°/oo)
19	0	32.8	10.3	574					
19	2	32.7	10.2	568	2.16	3.0	25		
19	5	32.9	10.1	571					
19	10	32.9	10.0	574					
19	20	33.2	9.6	590					
19	30	33.2	9.7	601				-0.2	-22.1
17	0	31.2	11.6	470	2.16				
17	2	31.3	11.4	461		4.2			
17	5	31.9	11.4	487					
17	10	32.1	10.9	518					
16	2	31.8	11.4	501					
15	0	28.7	12.2	329					
15	2	29.5	12.1	350	2.16	9.0	78	-0.4	-20.7
15	5	29.7	11.7	369					
15	10	30.6	11.5	430					
15	15	30.5	11.5	434					
14	2	26.7	12.3	289					
13	2	26.5	12.8	289					
12	0	23.6	13.3	322					
12	2	24.9	12.3	333	2.06	11.9	96	-1.2	-21.2
12	5	27.5	12.0	367					
11	2	23.3	12.8	356					
10	2	21.3	13.6	417					

Table 17. Measurements and observations in San Francisco Bay, 30 March 1977.

Station	Depth (m)	Salin. (°/oo)	Temper. (°C)	pCO_2 (ppm)	Alkalin. (meq./l)	Chlorophyll *a* (mg/m^3)	POC (μM C/l)	$\delta^{13}C(\Sigma CO_2)$ (°/oo)	$\delta^{13}C(POC)$ (°/oo)
9	0	21.0	13.3	451					
9	2	19.5	13.4	486	1.97	5.9	88	-2.7	-23.9
9	5	20.7	13.3	482					
9	10	21.0	13.1	470					
8	2	17.7	13.8	579					
7	2	15.4	13.7	614					
6	0	11.8	13.4	684					
6	2	11.7	13.4	682	1.74	3.2	80	-4.9	-25.9
6	5	11.7	13.4	702					
5	2	8.5	14.2	696					
4	2	7.2	14.1	729					
3	0	5.0	14.1	721					
3	2	5.0	14.1	715	1.62	7.3	148		-26.5
3	5	5.2	13.9	727					
2	2	4.1	14.0	738					
TL	0	0.94	12.4						
TL	2	0.96	12.4	622	1.55	6.6	88	-8.1	-27.8
TL	5	1.07	12.5	630					
RV	0	0.2	12.7	528					
RV	2	0.18	12.7	534	1.53	13.8	96	-8.3	-29.9

Table 18. Surface sediment sampling locations and $\delta^{13}C$(TOC) measurements in San Francisco Bay and the Gulf of the Farallones, August 1973.

Sampling Location		$\delta^{13}C$(TOC)
Latitude(N)	Longitude(W)	(^{o}/oo)
38°03.05'	121°52.85'	-26.9
38°04.05'	122°05.90'	-26.7
38°02.85'	122°22.25'	-25.6
37°58.50'	122°26.25'	-25.1
37°46.00'	122°41.50'	-21.2
37°50.35'	122°24.35'	-23.7
37°44.20'	122°20.65'	-23.7
37°32.70'	122°10.80'	-23.8
37°28.45'	122°04.15'	-24.5