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ATLANTIC OCEANOGRAPHIC LABORATORY

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Dartmouth, Nova Scotia
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FLUORIDE IN THE SOUTH ATLANTIC AND PACIFIC OCEANS

by

J. M. BEWERS

AOL REPORT 1971-4

MAY 1971

PROGRAMMED BY
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ABSTRACT

Fluoride analyses have been carried out on sea water samples from 24 stations in the South Atlantic and 22 stations in the Pacific. The mean fluoride concentration in both oceans was found to be 1.31 mg/l. Larger variations in fluoride concentration were observed in the South Atlantic than in the Pacific but the similarity in the variability of the fluoride to chloride ratio suggests that fluoride is conservative. The mean fluoride to chloride ratios in both oceans are slightly but insignificantly lower than similar ratios in the North Atlantic.

INTRODUCTION

Considerable interest in oceanic fluoride has been stimulated by the observations of Greenhalgh and Riley (1963) and Riley (1965) that anomalously high concentrations of fluoride can exist in deep waters at some locations. Determinations of oceanic fluoride and its relationship to chlorinity have been listed by Carpenter (1968). The mean fluoride to chloride (F/Cl) ratio for surface and normal deep waters of the North Atlantic has been variously given as $(6.7 \pm 0.1) \times 10^{-5}$ (Riley, 1965; Kester, 1970), $(6.9 \pm 0.1) \times 10^{-5}$ (Brewer, Spencer and Wilkniss, 1970) and $(6.82 \pm 0.12) \times 10^{-5}$ (Bewers, 1970). There are, however, little recent data concerning fluoride in the Pacific and South Atlantic oceans.

The cruise of S.S. *Hudson* in 1970, during which the American continents were circumnavigated, provided an opportunity to determine fluoride in the South Atlantic and Pacific. The results of analyses of samples collected during this cruise are presented here.

METHODS

Fluoride samples were obtained from standard oceanographic casts of teflon-coated stainless steel Knudsen bottles and stored in sealable polyethylene bottles. The method of Greenhalgh and Riley (1961) was used to determine fluoride in the unfiltered samples. The coefficient of variation for this method based on six analyses of a sea water sample was found to be 0.3%. All blanks and standards were made from Millipore 'Super Q' water having in excess of 18 MΩ/cm resistivity. Chlorinity was derived from inductive salinometer measurements on independent samples stored in glass salinity bottles.

RESULTS

South Atlantic

The data for 69 samples from 26 stations in the South Atlantic are given in table 1. For these stations the mean fluoride concentration is 1.31 to ± 0.03 mg/l and the mean F/Cl ratio is $(6.59 \pm 0.11) \times 10^{-5}$.

Pacific

Table 2 shows data for 65 samples from 22 stations in the Pacific where the mean fluoride concentration is 1.31 ± 0.02 mg/l and the mean F/Cl ratio is $(6.66 \pm 0.11) \times 10^{-5}$.

DISCUSSION

Statistically, the mean values for fluoride and F/Cl ratio in the South Atlantic and Pacific oceans obtained here are not different from those of Riley (1965), Kester (1970) and Bowers (1970) for North Atlantic water. Nevertheless, these results suggest that the fluoride concentration and the F/Cl ratio in the South Atlantic and Pacific may be slightly lower than those in the North Atlantic.

There is a marked degree of uniformity in the values for fluoride in the Pacific, similar to that obtained by at least one author (Bowers, 1970) for many North Atlantic stations, in relation to those in the South Atlantic. However, the variability of the F/Cl ratios is similar in all these oceans which illustrates the conservative character of dissolved oceanic fluoride. This can be further demonstrated by comparing the high salinity surface water with the deeper waters in equatorial and tropical latitudes of the South Atlantic. The 50-metre samples from stations between the equator and 38°S , which from density/depth profiles can be inferred to be similar to surface waters, have a mean fluoride concentration and F/Cl ratio of 1.34 ± 0.03 mg/l

and $(6.52 \pm 0.15) \times 10^{-5}$ respectively. The deeper samples have about a 3% lower mean fluoride concentration, 1.30 ± 0.02 mg/l, while the F/Cl ratio is virtually unchanged at $(6.58 \pm 0.12) \times 10^{-5}$.

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TABLE 1
HUDSON 70
SOUTH ATLANTIC LEG
FLUORIDES

Date	Position		Sample Depth m	F mg/l	Salinity ‰	F/Cl x 10 ⁵
02/12/69	4.91°S	30.01°W	50	1.31	36.120	6.40
			4937	1.29	34.690	6.56
05/12/69	12.43°S	30.11°W	50	1.33	36.849	6.36
			2124	1.29	34.930	6.53
			5199	1.30	34.693	6.61
06/12/69	14.91°S	30.11°W	50	1.35	37.138	6.42
			2113	1.33	34.929	6.73
			5011	1.27	34.682	6.46
07/12/69	17.53°S	30.02°W	50	1.38	37.244	6.55
			2106	1.30	34.917	6.57
			4759	1.28	34.697	6.51
08/12/69	20.03°S	30.69°W	50	1.37	37.129	6.52
			2124	1.26	34.928	6.36
			4774	1.27	34.673	6.46
09/12/69	22.50°S	29.97°W	50	1.30	36.926	6.21
10/12/69	25.03°S	30.03°W	50	1.37	36.580	6.60
			2228	1.29	34.919	6.51
			4788	1.28	34.722	6.50
23/12/69	27.53°S	30.12°W	50	1.35	36.000	6.61
			2267	1.29	34.893	6.52
			5255	1.33	34.717	6.76
24/12/69	30.07°S	29.04°W	50	1.37	35.809	6.76
			2026	1.28	34.828	6.48
			3020	1.35	34.897	6.83
25/12/69	32.42°S	30.16°W	50	1.32	35.823	6.51
			2077	1.29	34.816	6.54
			3657	1.29	34.833	6.54
26/12/69	35.00°S	30.08°W	50	1.34	35.744	6.62
			2002	1.32	34.786	6.70
			3102	1.33	34.896	6.73

Table 1 continued

Date	Position		Sample Depth m	F mg/l	Salinity ‰	F/Cl x 10 ⁵
27/12/69	37.47°S	29.99°W	50	1.34	35.496	6.67
			2210	1.32	34.813	6.69
			3805	1.30	34.718	6.61
28/12/69	39.92°S	29.88°W	50	1.34	35.225	6.72
			2081	1.30	34.798	6.59
			4175	1.31	34.704	6.66
29/12/69	42.50°S	29.96°W	50	1.34	34.902	6.78
			1961	1.32	34.768	6.70
			4323	1.29	34.674	6.57
30/12/69	45.12°S	29.98°W	50	1.28	34.309	6.58
			2100	1.30	34.812	6.59
			4757	1.30	34.692	6.61
31/12/69	47.58°S	29.89°W	49	1.27	34.080	6.57
			2120	1.31	34.786	6.65
			4930	1.29	34.679	6.56
01/01/70	49.06°S	29.81°W	50	1.28	34.098	6.62
			2003	1.30	34.786	6.59
			5291	1.29	34.645	6.56
02/01/70	50.59°S	29.59°W	48	1.27	33.924	6.60
			1990	1.31	34.712	6.66
			4165	1.30	34.670	6.62
03/01/70	52.06°S	30.06°W	50	1.28	33.941	6.65
			2110	1.27	34.688	6.46
			2519	1.30	34.676	6.62
04/01/70	53.45°S	29.99°W	50	1.30	34.056	6.74
			2154	1.29	34.661	6.57
			3551	1.30	34.640	6.62
05/01/70	54.91°S	29.39°W	50	1.24	34.078	6.57
			992	1.27	34.677	6.62
			7316	1.27	34.642	6.62
10/01/70	47.98°S	39.99°W	50	1.31	34.382	6.73
			2190	1.30	34.812	6.59
			5370	1.30	34.649	6.62
11/01/70	47.06°S	40.08°W	50	1.30	34.464	6.66
			2284	1.30	34.771	6.60
			5312	1.30	34.670	6.62
13/01/70	41.78°S	46.44°W	50	1.32	34.887	6.68
			2138	1.30	34.805	6.59
			4661	1.33	34.673	6.77

TABLE 2
HUDSON 70
PACIFIC LEG
FLUORIDES

Date	Position		Sample Depth m	F mg/l	Salinity ‰	F/Cl x 10 ⁵
28/04/70	59.90°S	149.94°W	49	1.34	34.152	6.92
			1968	1.33	34.710	6.75
			2556	1.31	34.708	6.66
30/04/70	54.93°S	149.83°W	2055	1.33	34.747	6.76
			3554	1.34	34.717	6.82
01/05/70	49.93°S	150.02°W	50	1.33	34.540	6.80
			2163	1.32	34.658	6.73
			4637	1.33	34.713	6.77
03/05/70	44.92°S	150.03°W	49	1.32	34.375	6.78
			2187	1.32	34.668	6.72
			5154	1.32	34.716	6.71
04/05/70	39.99°S	150.02°W	50	1.32	34.542	6.75
			2138	1.29	34.632	6.57
			5127	1.31	34.713	6.66
06/05/70	35.00°S	150.00°W	48	1.31	35.259	6.56
			2210	1.31	34.654	6.67
			5217	1.31	34.708	6.66
07/05/70	29.97°S	149.97°W	50	1.32	35.419	6.77
			2245	1.29	34.658	6.57
			4246	1.31	34.709	6.66
09/05/70	24.84°S	150.01°W	50	1.33	35.605	6.60
			2064	1.30	34.645	6.62
			4635	1.32	34.704	6.72
10/05/70	19.96°S	150.05°W	50	1.29	35.741	6.37
			2151	1.27	34.649	6.47
			4652	1.31	34.695	6.67
17/05/70	15.05°S	150.00°W	50	1.33	35.694	6.58
			2163	1.31	34.641	6.68
			4339	1.29	34.703	6.56

Table 2 continued

Date	Position		Sample Depth m	F mg/l	Salinity ‰	F/Cl $\times 10^5$
19/05/70	9.83°S	150.03°W	50	1.32	36.017	6.47
			1973	1.28	34.678	6.51
			3457	1.29	34.695	6.56
20.05/70	4.99°S	150.14°W	50	1.32	35.005	6.65
			2056	1.33	34.644	6.77
			6834	1.28	34.709	6.50
22/05/70	0.06°N	149.87°W	50	1.32	35.354	6.58
			1996	1.32	34.651	6.72
			4462	1.32	34.700	6.71
23/05/70	4.79°N	150.00°W	50	1.30	34.391	6.67
			2111	1.32	34.653	6.72
			5098	1.29	34.699	6.56
25/05/70	10.05°N	150.06°W	50	1.33	34.754	6.75
			2347	1.30	34.657	6.61
			5127	1.28	34.697	6.50
26/05/70	16.05°N	150.10°W	50	1.29	34.607	6.57
			2135	1.33	34.662	6.77
			5129	1.35	34.693	6.87
28/05/70	22.16°N	149.98°W	50	1.33	35.236	6.66
			2323	1.31	34.643	6.67
			5492	1.32	34.696	6.87
30.05/70	28.84°N	149.95°W	50	1.32	35.293	6.60
			2194	1.33	34.643	6.77
			5363	1.34	34.695	6.82
01/06/70	35.95°N	149.91°W	50	1.28	34.100	6.62
			2323	1.31	34.658	6.67
			5298	1.32	34.698	6.71
03/06/70	42.81°N	149.87°W	50	1.26	33.251	6.67
			2029	1.31	34.594	6.68
			5212	1.30	34.694	6.61
04/06/70	49.15°N	150.01°W	50	1.25	32.780	6.72
			2032	1.30	34.597	6.63
			4828	1.30	34.686	6.61
06/06/70	54.42°N	150.08°W	50	1.27	32.982	6.79
			1990	1.30	34.605	6.42
			2788	1.30	34.648	6.61