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DISTRIBUTION OF CALCIUM IN INDIAN OCEAN*

S. M. SHAH AND S. R. RAO

Health Physics Division, Bhabha Atomic Research Centre, Bombay, India

ABSTRACT

Calcium content was determined titrimetrically in about 150 samples of sea water collected from coastal stations (Veraval, Bombay, Ratnagiri, Mangalore, Cochin and Madras) and from IIOE offshore stations. The calcium to chlorinity was found to vary from 0.01756 to 0.02073.

INTRODUCTION

THE concentration of calcium is reported to be a function of the chlorinity of sea water, the ratio being expressed by a relatively constant number. However, differences in the calcium to chlorinity ratios have been observed and Gripenberg (1937) has differentiated the types of river waters flowing into the Baltic Sea from these differences. Moberg and Revelle (1937) have attributed the vertical difference in calcium to chlorinity ratio to the biological activity. Interest in the concentration of calcium has also arisen out of the question of the solubility of calcium carbonate in sea water and the factors that control precipitation and solution. Moreover knowledge of the calcium concentration is important in understanding the carbon dioxide system in the sea and the distribution and uptake of chemically similar element strontium which has got the hazardous fission product, strontium-90.

In the present work the sea water samples collected during the International Indian Ocean Expedition were analysed for calcium content and the values are discussed in relation to the chlorinity data.

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SAMPLE COLLECTION

Offshore surface sea water samples were collected on board I. N. S. 'KISTNA' during the cruises of International Indian Ocean Expedition. Inshore sea water samples were collected from six coastal stations — Veraval, Bombay, Ratnagiri, Mangalore, Cochin and Madras. Samples were filtered through Whatman No. 1 filter paper before analysis.

METHOD

Calcium in sea water was determined by the method recommended by Robertson and Webb (1939). In this procedure calcium in sea water is precipitated as oxalate and to this precipitate known excess quantity of standard ceric sulphate

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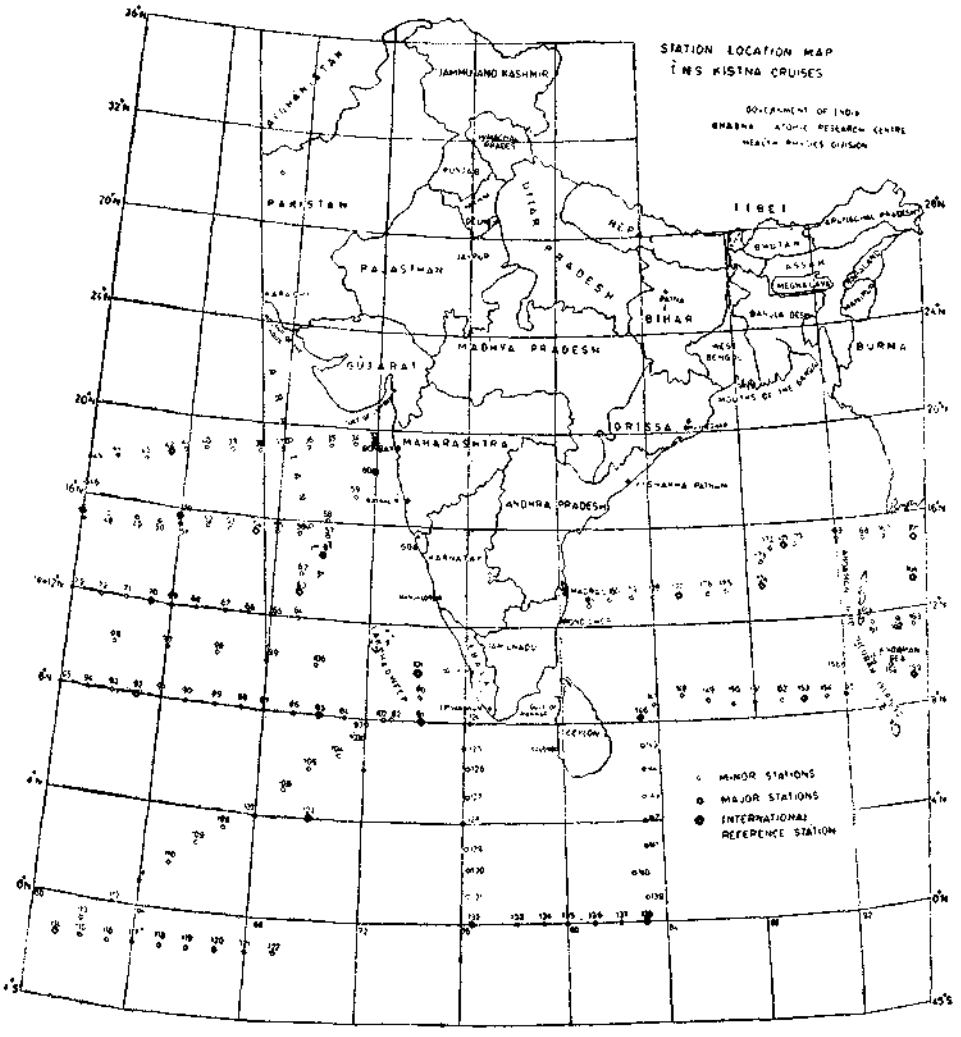
is added. Excess of ceric sulphate is titrated against a standard solution of ferrous ammonium sulphate. From the titre value, calcium content is calculated. Recovery experiments were carried out and the recovery values were found around 99%. All the analysis were carried out in duplicate.



The chlorosity values for offshore sea water samples were calculated from the chlorinity values made available by planning and data centre, National Institute of Oceanography. For the coastal sea water samples, chlorosity values were

calculated from chlorinity values determined by titrating sea water samples with silver nitrate as described by Strickland and Parson (1960).

RESULTS AND DISCUSSION

Fig. 1 gives the locations of the stations from where sea water samples were collected. Details of the collection of offshore sea water samples from Indian Ocean are given in Table 1. Tables 2 and 3 represent respectively the calcium and chlorosity values of the offshore sea water samples. Table 4 gives the calcium to chlorinity atom ratios calculated for the offshore sea water samples.

TABLE 1. *Details of collection of sea water samples from Indian Ocean*

Station No.	Cruise No.	Period	Area		No. of samples
			Latitude	Longitude	
33–60	1	13.10.62 to 21.10.62	15°–19°N	60°–72°E	25
61–79	2	3.11.62 to 14.11.62	12°–15°N	55°–69°E	19
80–101	3	26.11.62 to 6.12.62	08°–10°N	60°–74°E	22
102–123	4	17. 1.63 to 29. 1.63	02°S–08°N	61°–70°E	22
124–146	5	5. 2.63 to 15. 2.63	00°–09°N	76°–83°E	12
147–181	6	21. 2.63 to 9. 3.63	08°–15°N	81°–95°E	9

From the observation of Tables 2, 3 and 4 it is evident that the area of Indian Ocean from where surface sea water samples were collected can be differentiated into four different regions.

TABLE 2. *Calcium content of surface sea water in the Indian Ocean*

Station No.	Range µg/ml	Mean µg/ml	Std. Devn.
33–60	430–463	443	9.118
61–79	423–454	440	7.055
80–101	375–468	439	27.910
102–123	366–446	419	17.230
124–146	412–459	443	14.350
147–181	406–435	417	13.450

In the area covered by 12°-19°N and 55°-72°E, calcium and chlorinity values were found high and standard deviation for calcium, chlorinity and calcium to chlorinity atom ratio were found low. This shows that the water mass in this region is more saline and the proportion of major cations to salinity in this sea water is almost uniform. The high calcium to chlorinity values may be due to the intensive evaporation from surface (Sabinin, 1964) or due to the intrusion of high saline water from Persian Gulf or Red sea into this area (Panikkar and Jayaraman, 1966). High variations among the calcium and chlorinity values in the region between 2° S - 10° N and 60° - 74°E were observed. Even the fluctuation of calcium to chlorinity ratio was found maximum in this region. This indicated that in this region the proportion of the concentrations of major cations to salinity is slightly disturbed. This may be mainly attributed to the area covered by Stn. Nos. 101, 80, 81, 82, 102 and

103 where low calcium, chlorinity and calcium to chlorinity atom ratios have been observed. This area of Laccadive Sea is characterised by a surface layer of variable temperature and salinity (Karl Banse, 1968).

TABLE 3. *Chlorosity of surface sea water in the Indian Ocean*

Station No.	Range g/l	Mean g/l	Std. Devn.
33–60	20.52–21.75	21.12	0.3142
61–79	20.07–21.37	21.00	0.2162
80–101	17.95–21.36	20.59	0.9401
102–123	18.87–20.68	20.23	0.4501
124–146	19.68–20.63	20.31	0.3561
147–181	18.91–19.84	19.21	0.4509

Between 0°-8° N and 76°-83° E high calcium and calcium to chlorinity atom ratios were observed. In the region of Bay of Bengal between 8°-15°N and 81°-95°E, low calcium and chlorinity values and high calcium to chlorinity atom ratios have been noticed. The low values of calcium and chlorinity are due to the inflow of fresh water into the sea from the river on the East Coast of India (Panikkar and Jayaraman, 1966).

TABLE 4. *Calcium to chlorinity atom ratios of sea water in the Indian Ocean*

Station No.	Range	Mean	Std. Devn.
33–60	0.01757-0.01974	0.01857	4.74x10-4
61–79	0.01789-0.01942	0.01856	3.90x10-4
80–101	0.01747-0.01898	0.01891	5.87x10-4
102–123	0.01716-0.01918	0.01821	5.63x10-4
124–146	0.01858-0.01972	0.01928	4.10x10-4
147–181	—	0.01921	—

In the first two regions, low calcium to chlorinity atom ratios compared to other two regions may be attributed to the high biological activities in these regions. High biological activities in the Arabian Sea compared to other regions of Indian Ocean is reported by Ryther *et al* (1966).

Values of calcium content, chlorinity and calcium to chlorinity atom ratios for sea water samples collected from the coastal stations of Veraval, Bombay, Ratnagiri, Mangalore, Cochin and Madras are given in Table-5. The low calcium and chlorinity values and high calcium to chlorinity atom ratio for the sample No, MV-8 is due to the collection of this sample from the river mouth.

TABLE 5. *Concentration of Calcium in Coastal Water*

Station No.	Place of collection	Date of Collection	Calcium µg/ml	Chlorosity g/litre	*Calcium* Chlorinity atom ratio
MV-1	Veraval	2.10.63	442	20.60	0.01898
MV-2	,,	,,	435	20.56	0.01871
MV-3	,,	,,	422	19.81	0.01884
MV-4	,,	25.12.63	425	19.19	0.01959
MV-5	,,	3.3.64	432	20.43	0.01871
MV-7	,,	4.3.64	432	20.70	0.01846
MV-8	,,	5.3.64	288	12.12	0.02102
MV-10	,,	1.10.64	411	20.56	0.01768
CO-1	Cochin	25.1.64	430	19.74	0.01927
CO-2	,,	30.10.64	409	19.51	0.01855
CO-3	,,	30.1.64	422	18.40	0.02029
CO-5	,,	2.2.64	423	19.40	0.01929
CO-6	,,	5.2.64	425	18.67	0.02015
M-1	Mangalore	11.1.64	426	19.78	0.01904
M-3	,,	28.3.64	436	20.32	0.01898
M-4	,,	,,	435	20.43	0.01884
R-1	Ratnagiri	26.2.64	427	19.95	0.01892
R-2	,,	27.2.64	432	19.98	0.01912
B-1	Bombay	21.2.62	418	19.40	0.01905
B-2	,,	24.4.62	435	29.27	0.01898
B-3	,,	,,	440	20.17	0.01930
MD-1	Madras	3.10.63	411	19.80	0.01835
MD-2	,,	,,	410	19.41	0.01864

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