

CHEMISTRY OF SHELF SEDIMENTS ON THE WEST COAST OF INDIA *

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INTRODUCTION

IN November-December 1964, an Expedition to Angria Bank in the Arabian Sea was jointly undertaken by the Department of Fisheries, Maharashtra, and Bhabha Atomic Research Centre. The Bank, which is of considerable importance to the commercial fisheries, is situated outside the continental shelf off Ratnagiri (Lat. $16^{\circ} 59' N$, Long. $73^{\circ} 16' E$). Data on sea-water characteristics (*viz.*, salinity, temperature, phosphate content, etc.) in the region have been reported by Vijayakrishnan Nair *et al.*¹ The present paper deals with the elemental and the adsorbed components of the sediments collected from the region during the expedition.

ANALYTICAL TECHNIQUES

Grab samples of the sediments were obtained from 13 stations between Bombay and Ratnagiri (Fig. 1). They were dried at $105^{\circ} C$.

Calcium carbonate was estimated from the difference between the loss of weight of sediment at $1,000^{\circ} C$ and $400^{\circ} C$ respectively. Organic matter was determined by oxidation with chromic acid and organic matter content was calculated using the conversion factor given by Walkley and Black.³ This method is not affected by the presence of calcium carbonate and also able to discriminate between elemental carbon and soil organic matter, but is sensitive to the presence of chloride. The chloride content of the marine sediment was determined (leachable chloride obtained from 0.5 g sediment in contact with 100 ml distilled water for 24 hours) titrimetrically using silver nitrate. Higher contact time did not improve the leachable chloride value. Organic matter content was calculated after making suitable corrections for chloride interference.

5 gm of sediment was digested with 100 ml of concentrated hydrochloric acid for four hours. The solution was filtered, the residue along with the filter-paper was ashed, treated with a few ml of HF and taken up in conc. HCl. This was combined with the previous filtrate and the volume was made to 100 ml. Aliquots of this solution were taken for the estimations of major and trace elements in the sediments (total decomposition).

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5 gm of sediment was ashed at $500^{\circ} C$ and the sediment was extracted once with 3 N HCl. If the sediment contained more calcium carbonate additional quantity of 3 N HCl was added till all the calcium carbonate was dissolved. The solution was then filtered and the filtrate made to 100 ml with distilled water. This acid-soluble fraction of the sediment too was analysed for the same major and trace elements (3 N HCl leach).

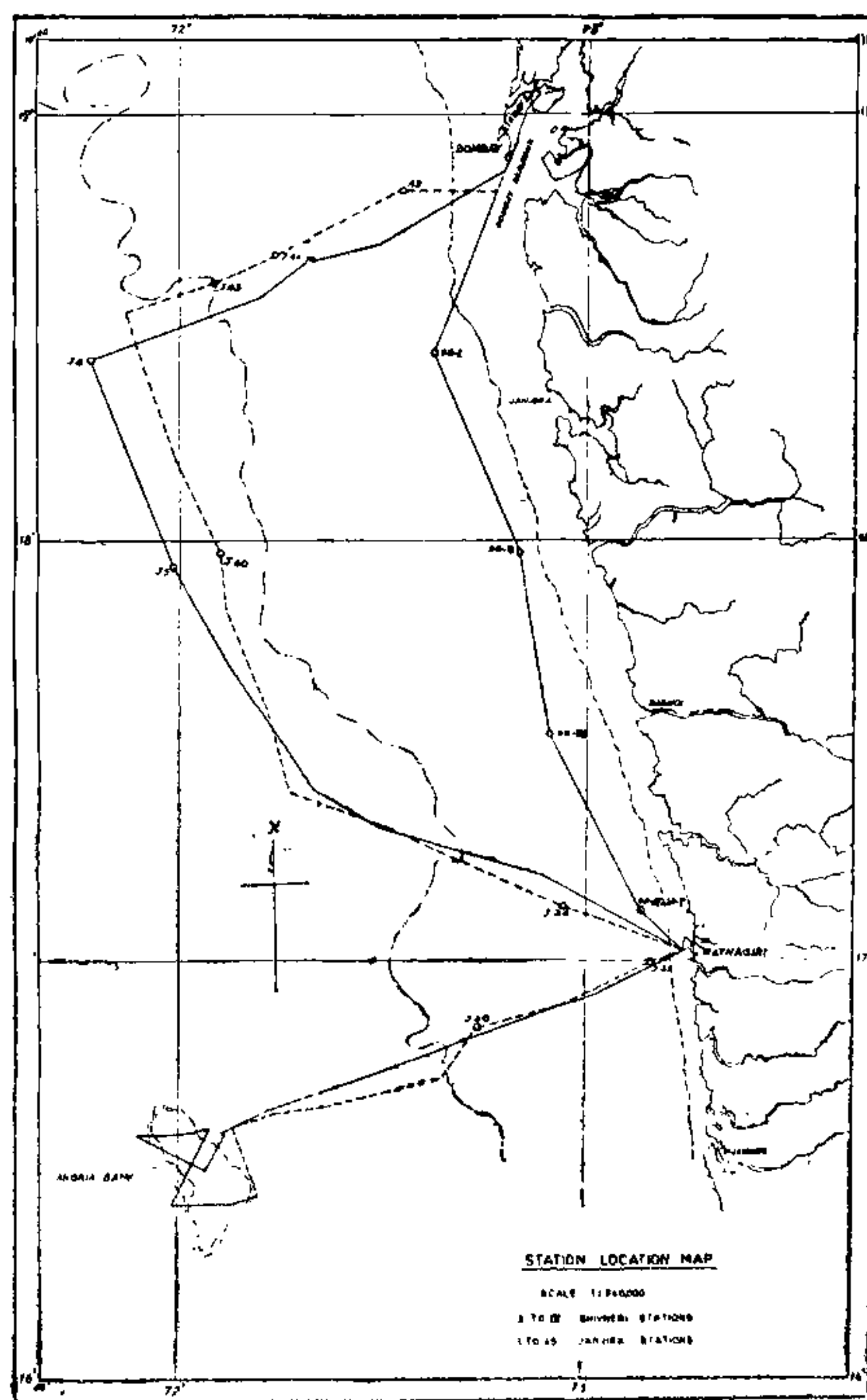


FIG. 1

Elemental concentrations in sediments obtained by total decomposition and the 3 N HCl leach respectively were compared in order to have an idea of the acid-soluble fraction of the sediments.⁴

Elemental concentrations were determined in these solutions as follows:

Potassium was precipitated as cobalt nitrite, dissolved in known volume of ceric sulphate

and the excess ceric sulphate determined titrimetrically.⁵ Calcium and magnesium were determined by titration with EDTA and magnesium solution.⁵ For the estimation of iron, the colorimetric reaction with 2:2' dipyridyl was employed.⁶ Cobalt was determined spectrophotometrically by the nitroso-R-salt method.⁶ Copper was estimated spectrophotometrically through its diethyldithiocarbamate complex.⁶ Zinc was estimated spectrophotometrically in carbon tetrachloride extract of its dithizonate complex.⁶ Manganese was oxidised with potassium periodate to permanganic acid and determined colorimetrically.⁶ For the estimation of total phosphorus the acid extract was passed through an anion exchange resin (Dowex-1, 50-100 mesh) in 10 N HCl for removal of iron and the phosphate in the effluent was estimated through the molybdenum blue reaction.⁷

In case of chromium, 0.5 g of the sediment was fused with five times its weight of sodium and potassium carbonate (1:1) mixture. The fused mass was extracted with hot distilled water and filtered. The chromium content in the filtrate was estimated spectrophotometrically through its diphenylcarbazide complex.⁶

RESULTS AND DISCUSSION

Details of stations occupied off Bombay and Ratnagiri are given in Station Location Map (Fig. 1).

Data on the distribution of calcium carbonate and organic matter contents in sediments are given in Table I. Sediments near shore in general contain less calcium carbonate than those further offshore. An inverse relationship (correlation coefficient $r = -0.80$) is apparent between

TABLE I
Organic matter and calcium carbonate contents of sediments

Sample	Lat. °N	Long. °E	Organic matter %	Calcium carbonate %
J4	1825	7147	0.21	92.3
J5	1756	7159	2.61	80.1
J30	1650	7244	1.54	71.2
J32	1650	7310	3.30	25.0
J34	1707	7257	4.54	38.7
J40	1758	7206	2.57	84.7
J43	1836	7205	1.55	79.9
J44	1840	7214	1.29	58.3
J45	1849	7233	1.91	31.1
SH1	1826	7237	2.04	34.7
SH3	1732	7255	2.34	79.3
SH4	1707	7308	4.48	28.7
*SH5	2.63	52.4

* Collected during the return cruise in the vicinity of SH4.

between calcium carbonate and decomposable organic matter (Fig. 2). This is understandable since the sediments nearer shore contain more organic matter due to land runoff.⁸

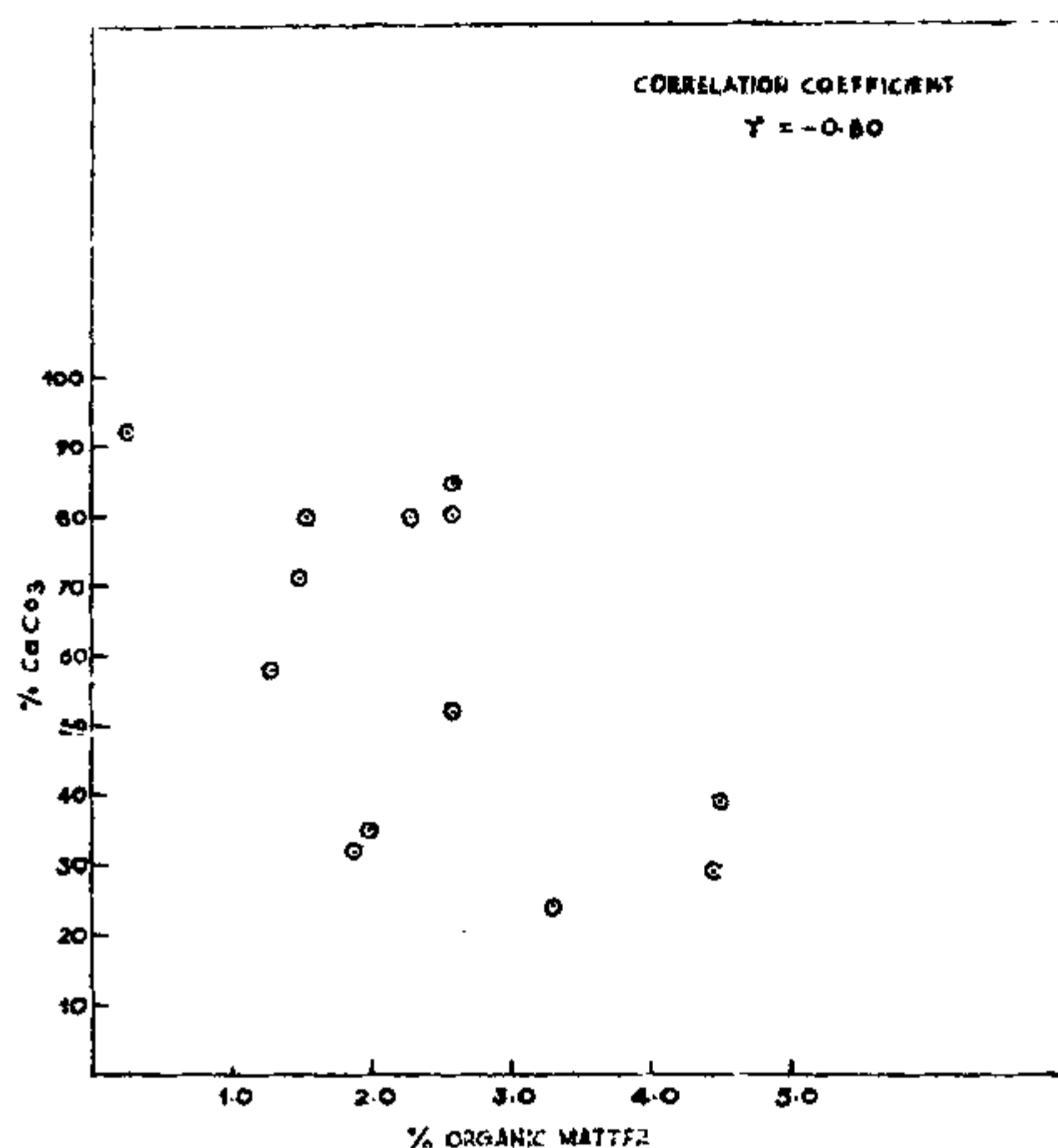


FIG. 2. Correlation of organic matter with calcium carbonate.

An inverse relationship (correlation coefficient $r = -0.96$) between potassium and calcium carbonate is obtained suggesting that potassium is associated with the clay mineral, illite (Fig. 3). Welby⁹ in his studies, in the Gulf of Mexico, found similar correlation between potassium and calcium carbonate.

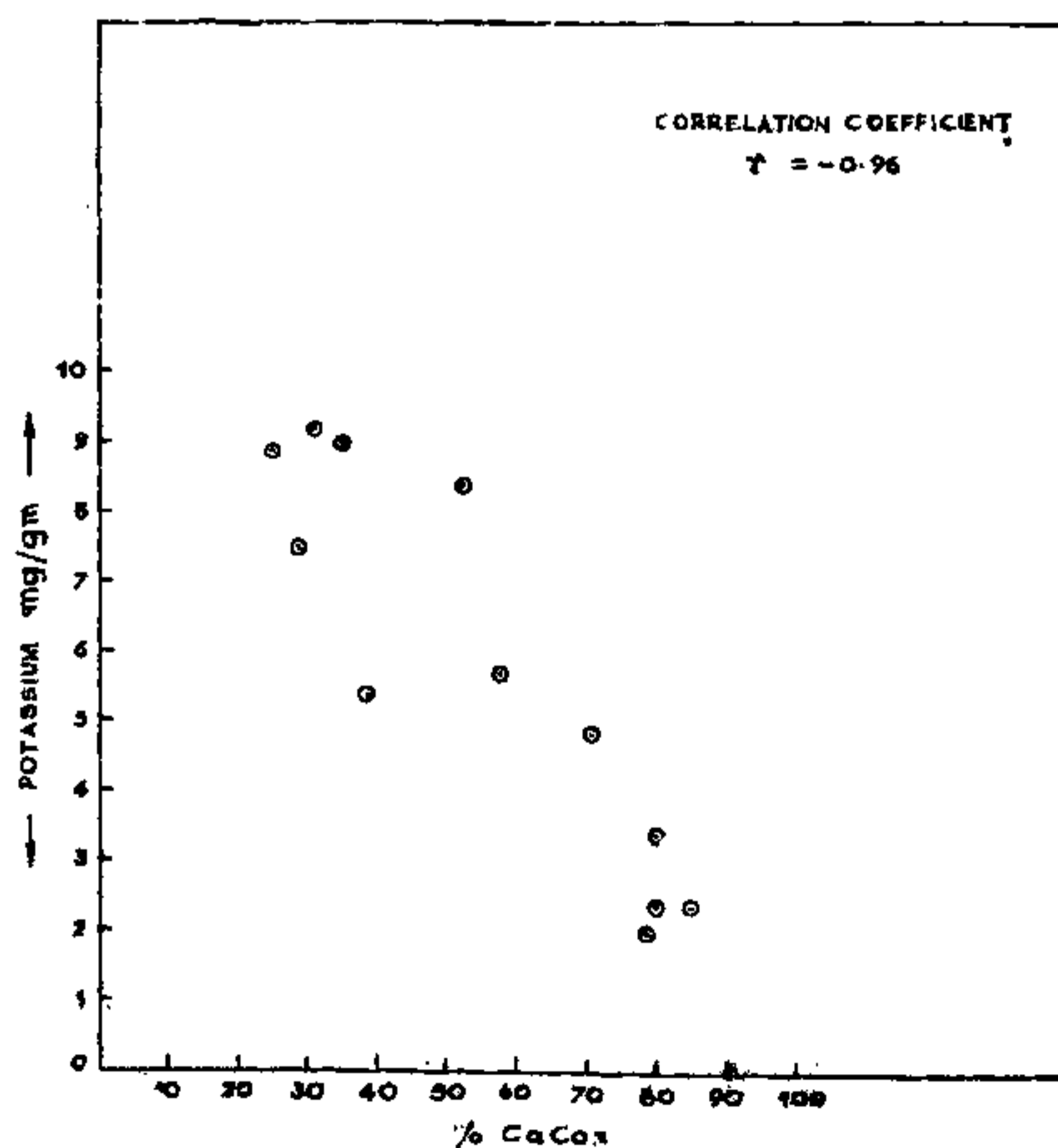


FIG. 3. Correlation of potassium with calcium carbonate.

Data on the elemental concentrations in sediments by the total decomposition and 3 N HCl leach are given in Tables II and III respectively. The contents of all the elements are higher by the total decomposition method. Only calcium was leached to the extent of 90-100% of the total by 3 N HCl. In the case of other elements like cobalt, zinc, manganese and phosphorus leach values constituted 40-80% of the total. These variations may be due to individual sample differences. Copper content was very high in total sediment and the leach constituted only 10-15% of the total. This indicates that copper is not associated with calcium carbonate phase.

Table IV gives the differences in the elemental concentration of sediments off Bombay

contour diagrams of Schott and Von Stackelberg,¹⁰ it is seen that the sediments in area 'B' are predominantly chalky. Further south, nearer 'R' sediments show high content of potassium suggesting the presence of clay mineral illite as a dominant constituent in them. This clay mineral illite in this region constitutes 40-60% of the sediment particles less than 0.001 mm diameter.¹¹ Choudhuri and Banerji¹² confirmed by X-ray diffraction and differential thermal analyses that some of the samples J-32, J-45, SH-1 and SH-4 are clayey in nature with the major phase identified as illite. This clay mineral fraction of the sediment adsorbs trace elements from sea-water to a good extent.^{13,14} Sediments showing high potassium values show markedly higher

TABLE II
Elemental concentration in sediments (Total decomposition)

Sample	K	Ca	Mg	Fe	Co	Cu	Zn	Mn	P	Cr
	mg/g					µg/g				
J-5	3.41	283	18.6	17.9	11.6	219	16.5	..	416	120
J-30	4.92	238	20.7	22.0	..	111	13.5	294	300	125
J-32	8.88	18	20.4	23.2	44.8	1372	14.5	450	364	224
J-34	5.40	..	25.0	23.2	28.8	250	24.0	294	416	265
J-40	2.40	313	24.0	15.3	9.2	64	12.0	110	448	119
J-43	2.40	289	..	20.8	9.6	125	7.0	..	404	79
J-44	5.70	202	16.7	22.4	21.2	535	..	500	304	121
J-45	9.20	28	21.2	24.0	46.0	390	23.5	654	376	695
SH-1	9.00	45	20.1	23.0	35.0	102	..	574	344	264
SH-3	2.00	329	7.9	14.6	11.6	81	7.0	204	300	57
SH-4	7.50	..	15.2	13.8	33.6	340	12.0	460	448	163
SH-5	8.40	193	17.6	14.5	19.6	282	17.5	584	323	214

TABLE III
Elemental concentration in sediments (3 N HCl leach)

Sample	K	Ca	Mg	Co	Cu	Zn	Mn	P
	mg/g			µg/g				
J-4	1.64	375	..	15.6	14.0	20.0	60	336
J-5	2.40	255	9.0	11.6	17.5	8.0	200	324
J-30	2.52	215	21.0	24.6	17.5	8.0	120	..
J-32	5.28	20	22.5	17.8	54.0	..	200	288
J-34	3.78	55	24.0	12.4	28.0	10.0	160	372
J-40	2.27	300	12.0	10.0	18.0	..	80	108
J-43	2.52	275	24.0	6.4	21.0	6.0	160	216
J-44	3.91	215	18.0	17.8	29.6	21.0	220	252
J-45	..	28	18.6	12.4	52.5	17.0	40	216
SH-1	4.28	48	15.0	17.2	48.0	22.0	470	96
SH-3	1.76	300	..	11.6	17.5	2.0	160	..
SH-4	3.53	40	15.0	10.0	40.0	16.0	..	276
SH-5	3.66	165	6.0	9.2	18.0	16.0	460	228

and Ratnagiri. Sample Nos. J-4, J-5, J-40, J-43 and J-44 are from the area 'B' nearer Bombay and the sample Nos. J-30, J-32, J-34, SH-4 and SH-5 are from area 'R' nearer Ratnagiri. Sediments in 'B' contain more calcium carbonate and calcium than sediments in 'R', but their content of organic matter is low. From the

values of manganese, chromium, cobalt, zinc and copper (Table IV) while sediments containing low potassium values show significantly lower values of these trace elements. The over-all picture of the scatter diagram (Fig. 4) suggests that these trace elements are associated with potassium containing clay mineral

rather than in the calcium carbonate phase. Chromium and manganese in particular showed good correlation with the samples having high potassium containing clay mineral illite as observed by Froehlich¹⁵ and Hirst.¹⁶

TABLE IV
Differences in chemical composition of
sediments off Bombay and Ratnagiri

No.	Elements	Units	'B'		'R'	
			Total	Leach	Total	Leach
1	K	mg/g	3.4	2.6	8.1	3.8
2	Ca	mg/g	272	263	103	84
3	Mg	mg/g	19.9	15.7	19.6	17.7
4	Co	μg/g	13.0	12.3	32.0	14.8
5	Cu	μg/g	236	20.0	431	31.8
6	Zn	μg/g	11.8	11.6	17.4	12.5
7	Mn	μg/g	305	190	417	337
8	P	μg/g	393	225	371	291
9	Fe	mg/g	19.1	..	19.3	..
10	Cr	μg/g	100	..	198	..
11	Organic matter	%	1.65	..	3.29	..
12	Calcium carbonate	%	79.1	..	43.2	..

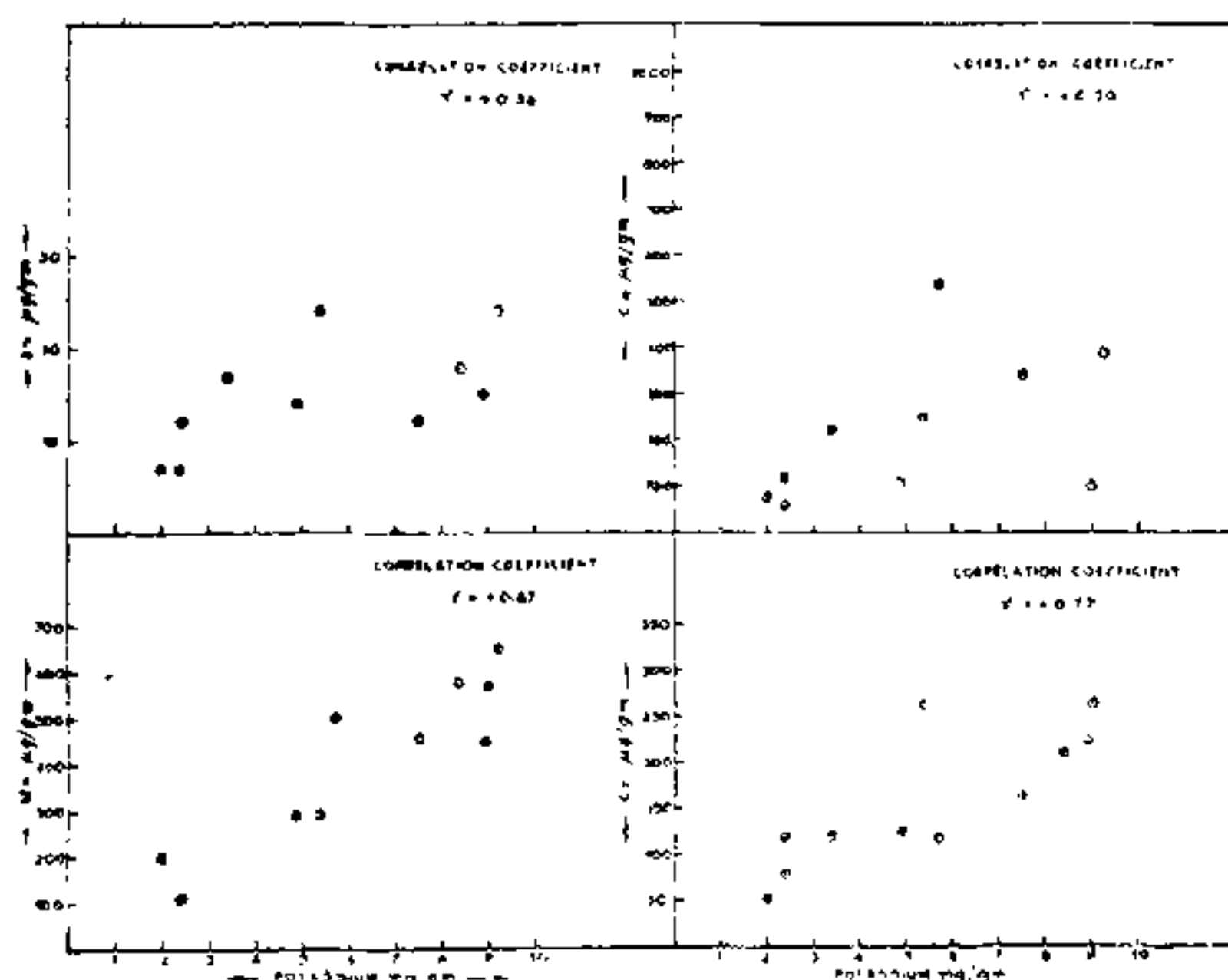


FIG. 4. Association of trace elements with potassium.

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- Vijayakrishnan Nair, K., Bhattathiri, P. M. A. and Chhapparg, B. F., "Angria Bank Expedition, I, General Hydrographic and Chemical features. *AEET/HP/PM-3*, Bombay, 1965.
- Thomson, T. G. and Chow, T. J., "The Sr/Ca atom ratio in carbonate secreting marine organisms," *Deep Sea Research*, Suppl., 1955, 3, 20.
- Walkley, A. and Black, T. A., In *Soil. Chemical Analysis*, Edited by Jackson, M. L., Prentice Hall, Indian Edition, 1962.
- Barnes, H., *Apparatus and Methods of Oceanography Part I, Chemical*, George Allen and Unwin Ltd., London, 1959.
- Vogel, A. L., *A Text-Book of Quantitative Inorganic Analysis—Theory and Practice*, Longman, London, 1951.
- Sandell, E. B., *Colorimetric Determination of Traces of Metals*, 3rd Edition, Interscience Publishers, New York, 1959.
- Hansen, A. L. and Robinson, R. J., *Journal Marine Research*, 1953, 12, 16.
- Sverdrup, H. U., Johnson, M. W. and Fleming, R. H., *The Ocean*, Prentice Hall, Inc., New York, 1942.
- Welby, C. W., *J. Sediment Petro.*, 1958, 28, 431.
- Schott, W. and Von Stackleberg, U., "Recent sedimentation in the Indian Ocean; its significance for the origin of hydrocarbonaceous sediments (First Review)," Paper No. 254 in Vol. IV of *Collected Reprints of International Indian Ocean Expedition*, UNESCO, Paris, 1965.
- Gorhunova, Z. N., "Distribution of clay minerals in the sediments of the Indian Ocean," Paper No. 251 in Vol. IV of *Collected Reprints of Indian Ocean Expedition*, UNESCO, Paris, 1966.
- Choudhuri, R. and Banerji, K. C., "Some studies on Shelf Sediments from the Western Coast of Bombay and Ratnagiri," *Technology*, 1968, 5 (3).
- Chester, R., "Elemental geochemistry of marine sediments," in *Chemical Oceanography*, Edited by Riley, J. P. and Skirrow, C., Academic Press, London and New York 1965, Vol. 2.
- Krauskopf, K. B., *Geochim. et Cosmochim. Acta*, 1956, 9, 1.
- Froehlich, F., *Ibid.*, 1960, 20, 215.
- Hirst, D. M., *Ibid.*, 1962 b, 26, 1187.

TOTIPOTENCY OF GAMETIC CELLS AND THE PRODUCTION OF HAPLOIDS IN RICE

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IT has long been realized that if male or female gametes could be stimulated to grow into embryos and give rise to haploid plants,

it would greatly facilitate the task of obtaining pure lines by doubling the chromosome complement of the haploid with colchicine. Moreover, haploids also offer possibilities for inducing mutations and realizing them in a homozygous state, and for investigating various

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