Short Communications

Distributions of Some Elements in the Sediments of Gulf of Kutch

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Distribution patterns of calcium carbonate, aluminium, titanium, iron, manganese, nickel, cobalt, copper and zinc have been studied in the unconsolidated sediments of the Gulf of Kutch. Sediments are generally terrigenous in nature. With the exception of calcium carbonate and cobalt, relatively high concentrations of all other elements are associated with fine grained sediments as compared to coarse grained sediments. While the calcium carbonate in these sediments is of biogenic origin, all other elements seem to be of terrigenous origin. The similarity between the sediments of the Gulf of Kutch with those from the adjacent shelf region north of the Gulf in their chemistry indicates that the sediments coming from the north are brought into the Gulf.

DURING the 2nd cruise of *RV Gaveshani* in February-March 1976, a reconnaissance survey of the Gulf of Kutch was carried out and a number of sediment samples were collected. As a part of the comprehensive studies that are being conducted at NIO on these samples, their chemistry has been studied with a view to understanding (i) their nature, (ii) the overall distribution patterns of various elements in them and (iii) how they compare with the adjacent shelf sediments. Some of the results obtained are presented in this short communication.

During the survey, 26 stations for snapper and 3 stations for dredging were occupied along 7 cross sections. Of the 26 snapper stations, there was practically no recovery of sediments at 5 stations and at another 5 stations small quantities of rock and coral fragments were obtained. Locations of 16 stations from where the sediments were obtained for the present study are given in Fig. 1. Dredge stations were not included in the study.

Representative samples were obtained from the collections made at each station and all the samples were digested with hydrofluoric acid and perchloric acid following the method of Chester and Hughes[1].

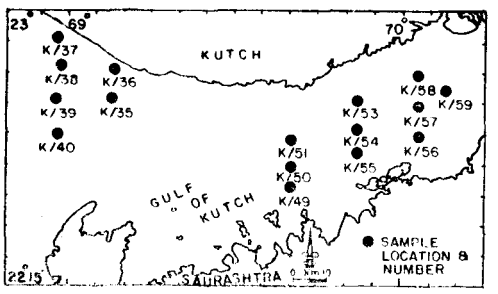

Fig. 1 — Station locations in the Gulf of Kutch

Aluminium and titanium were estimated colorimetrically using the methods described by Riley[2]. Iron, manganese, nickel, cobalt, copper and zinc were determined on Hilger & Watts Atom Speck H 1550. Calcium carbonate was estimated following the method of Muller[3]. Data obtained are presented in Table 1 along with the other essential details such as texture of sediments, water depth, etc. Interrelationships worked out among the various elements are given in Table 2.

Data presented in Tables 1 and 2 allow the following inferences on the distribution of various elements and the interrelationship between them: (1) Texturally, sediments fall under 3 broad categories — (i) silty-clays and clayey-silts, (ii) sand-silt-clay and (iii) silty-sands, clayey-sands etc. (2) Calcium carbonate content varies between 10 and 50% in these sediments. It follows broadly the texture of sediments — fine-grained sediments (silty-clays and clayey-silts) are characterized by very low carbonate content while coarser sediments (sand-silt-clay, silty-sands, etc.) have relatively a high content of calcium carbonate. (3) With the exception of cobalt, higher concentrations of all other elements are associated with fine-grained sediments than those with coarse-grained sediments. The same trend is maintained even on carbonate free basis. (4) Interrelationships among various elements indicate that with the exception of cobalt, all other elements covary with each other in a significant manner.

Coarse fraction studies by Hashimi *et al.*[2] have revealed among other things (i) that its percentage varies very widely in these sediments (1-74%); (ii) it is composed of terrigenous minerals such as quartz, felspar and other light coloured minerals; ferromagnesian minerals; mica; rock fragments (calcareous sandstones and phyllites); foraminifera, molluscs, etc. and (iii) all components of the coarse fraction noted above are present in all samples and their relative percentages vary widely from sample to sample. Higher content of calcium carbonate associated with coarse-grained sediments and uniformly low carbonate content associated with fine grained sediments suggest that the carbonate contents of sediments are of biogenic origin and are largely contributed by carbonate materials found in foraminifera, molluscs, etc. in the coarse fraction of sediments. A close correspondence between percentage of the carbonate material present in the coarse fraction reported by Hashimi *et al.*[4] and the carbonate content of the sediments lends support to this finding.

In marked contrast to the distribution pattern of calcium carbonate, relatively high concentrations of all other elements are associated with fine grained sediments rather than with coarse sediments both on the bulk sample basis as well as on the carbonate free basis. Undoubtedly a part of the contribution to these concentrations comes from minerals present in the coarse fraction, their distribution indicates that they are largely associated with finer fractions of sediments — probably silt and largely clay. With a few exceptions uniformly high concentration

TABLE 1 — CHEMISTRY OF SEDIMENTS OF GULF OF KUTCH

Sl No.	Stn No.	Water depth m	Texture	Al_2O_3%		TiO_2%		Fe%		Mn ppm		Ni ppm		Cu ppm		Zn ppm		Co ppm		$CaCO_3$%
				A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
1	K-35	20	—	5·55	11·1	0·16	0·32	1·59	3·18	902	1804	55	110	24	48	53	106	34	68	50
2	K-36	15	Silty clay	12·32	13·69	0·41	0·46	3·92	4·36	1018	1131	71	79	28	31	99	110	40	44	10
3	K-37	14	do	14·68	16·49	0·45	0·51	4·7	5·28	954	1072	72	81	39	44	111	125	25	28	11
4	K-38	15	Clayey silt	12·11	13·61	0·42	0·48	4·31	4·84	989	1111	66	74	33	37	104	117	40	45	11
5	K-39	26	Silty clay	14·42	16·02	0·45	0·5	4·65	5·17	902	1002	82	91	35	39	113	125	39	43	10
6	K-40	42	Sand-silt-clay	11·93	13·87	0·42	0·49	3·92	4·56	873	1015	71	86	38	44	105	122	21	24	14
7	K-49	36	do	8·96	13·57	0·42	0·64	4·71	7·14	902	1367	68	103	42	64	78	118	45	68	34
8	K-50	38	Silty clay	13·11	14·57	0·46	0·51	4·69	5·2	844	938	84	33	46	51	97	108	52	58	10
9	K-51	41	Sand-silt-clay	8·19	10·37	0·32	0·41	3·54	4·48	756	957	61	77	29	37	73	92	46	58	21
10	K-53	30	Silty sand	4·69	6·25	0·24	0·32	2·06	2·75	582	776	45	60	18	24	48	64	37	49	25
11	K-54	39	Sandy clay	5·71	8·04	0·24	0·34	2·88	4·03	611	860	44	62	24	34	57	80	36	51	29
12	K-55	32	Clayey silt	0·91	12·12	0·45	0·5	4·75	5·23	902	1002	78	87	48	53	97	108	37	41	10
13	K-56	22	Sand-silt-clay	7·34	12·23	0·3	0·5	3·58	5·97	698	1163	55	92	38	63	71	118	54	90	40
14	K-57	21	do	11·93	13·4	0·47	0·53	4·59	5·16	902	1013	84	94	39	44	95	107	42	47	11
15	K-58	21	do	11·21	12·45	0·45	0·5	4·3	4·78	873	970	63	70	33	36	85	94	39	43	10
16	K-59	14	Clayey silt	11·18	13·11	0·48	0·53	4·83	5·37	1018	1131	84	93	47	52	105	117	43	48	10

A = concentration in the bulk sample; B = concentration on calcium carbonate-free basis.

of aluminium associated with these sediments with a correspondingly low calcium carbonate content associated with them indicate the terrigenous nature of these sediments. Further, the significant correlation obtained between alumina and other elements on the one hand and interrelationship between other elements among themselves indicate that the source for all these elements (with the exception of cobalt) is the sample, i.e. terrigenous source. While it is so, minor variations found in the concentrations of various elements in these sediments may be attributed to the compositional difference of individual samples than to any change in environment. The apparent antipathic relationship of cobalt with other elements appears to be due to its possible association more with the organic phase of the sediments rather than with other phases as revealed by the partition studies carried out in these sediments[5].

Rao *et al.*[6] reported that the fine-grained sediments in the shelf region north of the Gulf of Kutch are chemically different from those south of the Gulf of Kutch. In order to understand how sediments in the Gulf of Kutch compare with sediments of the adjacent shelf region, some of the chemical data pertaining to the sediments collected from adjacent shelf region along 4 sections across the shelf (Fig. 2) are analysed and given in Table 3. The texture of the sediments and water depth are also included in the table. Comparison of present

TABLE 2 — CORRELATION COEFFICIENT (r) VALUES BETWEEN VARIOUS ELEMENTS

Correlation between	r value	Correlation between	r value
Alumina and iron	+0·84	Iron and copper	+0·84
Alumina and titanium	+0·89	Iron and cobalt	+0·15
Alumina and manganese	+0·72	Iron and nickel	+0·82
Alumina and nickel	+0·85	Iron and zinc	+0·8531
Alumina and copper	+0·62	Manganese and titanium	+0·69
Alumina and zinc	+0·97	Manganese and nickel	+0·7
Alumina and cobalt	−0·15	Manganese and copper	+0·49
Iron and manganese	+0·58	Manganese and cobalt	−0·2
Iron and titanium	+0·96	Manganese and zinc	+0·74

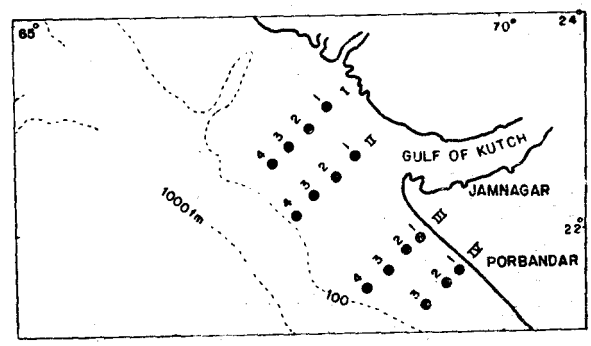

Fig. 2 — Station locations in the adjacent continental shelf

TABLE 3 — CHEMISTRY OF SEDIMENTS OF THE ADJACENT SHELF

Sl No.	Stn No.	Water depth m	Texture	Al_2O_3%		Fe%		TiO_2%		Mn in ppm		$CaCO_3$%
				A	B	A	B	A	B	A	B	
			SECTION I: NORTH OF GULF OF KUTCH									
1	1	20	Clay	13·42	14·91	3·45	3·83	0·42	0·47	1024	1138	10
2	2	27	Silty clay	13·06	14·35	3·56	3·91	0·43	0·47	791	869	9
3	3	41	Clay	12·95	14·23	5·62	6·71	0·41	0·45	558	613	9
4	4	94	Silty clay	12·36	15·45	5·53	6·91	0·41	0·51	268	335	20
			SECTION II: NORTH OF GULF OF KUTCH									
5	1	—	do	13·64	15·15	5·53	6·14	0·45	0·5	529	588	10
6	2	60	Clayey sand	8·46	14·1	2·96	4·93	0·3	0·5	442	737	40
7	3	85	Silty sand	6·3	13·4	1·37	3·19	0·26	0·55	529	1125	53
8	4	100	do	7·51	12·11	3·23	5·21	0·42	0·67	1059	1708	38
			SECTION III: SOUTH OF GULF OF KUTCH									
9	1	30	Silty clay	12·62	14·24	6·19	6·87	0·55	0·61	709	788	10
10	2	54	Clayey silt	10·73	12·77	5·54	6·59	0·64	0·76	709	844	16
11	3	65	Silty clay	9·17	12·23	3·62	4·83	0·61	0·81	721	961	25
12	4	90	do	8·99	12·31	3·56	4·88	0·59	0·81	669	916	27
			SECTION IV: SOUTH OF GULF OF KUTCH									
13	1	29	do	12·27	13·34	5·61	6·09	0·57	0·62	686	746	8
14	2	42	do	12·63	13·88	6·42	7·06	0·69	0·76	768	844	9
15	3	69	do	5·74	9·26	3·01	4·85	0·44	0·71	593	956	38

A = concentrations in the bulk sample; B = concentrations on carbonate-free basis.

data with data from the Gulf sediments shows greater similarity with the sediments of the northern region than with those of the southern region. It is very well marked in the case of titanium, but it is not so in the case of iron; actually the behaviour of both aluminium and iron are similar. This implies that the sediments of the shelf region coming from the north are not transported up to the southern part of the Gulf to a great extent but are deflected into the Gulf as a result of some physical processes and this may be the reason for the sediments in the shelf region north of Gulf of Kutch being chemically different from those found south of the Gulf of Kutch. It may be mentioned here that the similarity observed between the Gulf sediments and the sediments of the northern region of the adjacent shelf could not be due to sediments coming from adjacent land masses to the Gulf because the supply from the streams opening into the Gulf is probably negligible in view of the fact that they are small, estuarine in nature and running through the surrounding land mass which is an arid zone.

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Sandstones in the Coastal Area Between Visakhapatnam & Bhimunipatnam, East Coast of India

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The 2 highly ferruginous sandstone units found are elongate, parallel to the coast line and are unfossiliferous. The sandstones are coarse grained, well sorted and negatively skewed. Textural characters, areal pattern and mineralogical composition suggest that the sandstones have been derived from the eolian red sands and deposited during one of the sea level fluctuations on the east coast of India. The sandstones are considered to be post-Pleistocene in age in view of their position above the late Pleistocene red sandy sediments.

TERTIARY sandstones are known from the coastal tracts of West and East Godavari Districts of Andhra Pradesh[1,2]. However, their extension further north has not been reported except the occurrence of sandstones in Ranasthalam area of Srikakulam District[3]. This patch of sandstones is considered to be an equivalent of Rajahmundry sandstones of Miocene age. During a study on the red sandy sediments in the coastal area between Visakhapatnam and Bhimunipatnam, 2 sandstone patches overlying the red sands have been observed near Vadapalem (Fig. 1). No outcrops of such rocks are found in other parts of the basin or in the adjacent areas. The 1st sandstone (S_1) is located at