CHAPTER

X

NATURE OF TIDAL SEDIMENTS

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GENERAL

The muddiness of the Gulf has been observed and recorded by most workers. It has also been reported that strong tidal currents have been responsible for the transport and redistribution of these suspended sediments. The present author in the earlier pages of this thesis has provided some details of the pattern of sediment transport and the deposits made up of these sediments in different onshore and offshore areas of the Gulf.

His studies based on suspended sediment samples collected from representative locations have furnished information on the following aspects:

1. Concentration of suspended sediment load
2. Grain size variations
3. Mineralogical characteristics

For the purposes of sample collections, the author had selected eleven (11) observation points (Fig.X.1) which broadly represent the whole for the Gulf and collected high tide water samples for the same period four times during the year 1985 and 1986 (April '85, July '85, October '85 and January '86). For each station, 10 liters of water sample were collected, and following analyses were made for the sediments contained in the Gulf water:

1. Total bulk weight
2. Grain size
3. X-ray studies
   a) Bulk mineralogy
   b) Clay mineralogy

TOTAL BULK WEIGHT

The quantities of suspended sediments in the tidal water for different stations collected at different seasons were estimated and recorded by allowing the sediments to settle down over a period of a few days.

The process of separation of the suspended sediment from the tidal water consisted of the following steps:

i) Complete settling of the sediments and subsequent careful decantation of clean water.

ii) Addition of distilled water, agitation and allowing for resettling

iii) decantation of clean water

iv) repetition of procedure ii) and iii) several times until it got free from dissolved salts.

After the last decantation the sediment was kept for drying in an oven at about 40°C till complete dryness. The total quantity of sediment was then weighted which gave the total bulk weight of the suspended sediment in 10 liters of Gulf water for a particular location. Table 10.1 gives the weight of sediments in 10 liters of water at the various stations for different seasons.

GRAIN SIZE

Previously weighed sample was taken and soaked in excess quantity of distilled water. After proper stirring the sample was allowed to pass through ASTM 230 mesh sieve to separate sand from silt + clay fraction. The sand fraction retained on the sieve was collected and weighed. The sample that passed through the sieve was collected and was subjected to particle size analysis by using a small quantity of sediment. For this analysis the author used SA-CP2 Centrifugal Particle Size Analyser (Shimadzu). This instrument gives the automatic print out of the size fractions from 150 μ to 0.1 μ. The sample preparation procedure, instrument setting, and the sample feeding procedure has already been described in Chapter VIII.

TABLE 10.1 TOTAL BULK WEIGHT OF SUSPENDED SEDIMENTS IN TIDAL WATER AT DIFFERENT LOCATIONS IN DIFFERENT SEASONS

Sr. No.	Location	April '85		July' 85		October'85		January '86	
		Total wt/ 10 litres of water	Load * concent-ration	Total wt/ 10 litres of water	Load* concentration	Total wt/ 10 litres of water	Load* concentration	Total wt/ 10 litres of water	Load* concentration
1	Methla	6.71	Slight	12.63	Moderate	5.63	Slight	6.40	Slight
2	Gopnath	8.86	Slight	12.57	Moderate	2.27	Slight	3.16	Slight
3	Piram West	31.23	Heavy	18.75	Moderate	15.91	Moderate	6.74	Slight
4	Piram East	5.16	Slight	16.41	Moderate	19.90	Moderate	24.76	Moderate
5	Ghogha	20.91	Moderate	11.09	Moderate	4.13	Slight	2.37	Slight
6	Bhavnagar Jetty	9.12	Slight	16.66	Moderate	2.21	Slight	5.55	Slight
7	Dholera	32.97	Heavy	40.87	Heavy	28.7	Heavy	29.5	Heavy
8	Khambhat	41.31	Heavy	30.87	Heavy	33.13	Heavy	24.34	Moderate
9	Devjagam Temple	12.34	Moderate	14.22	Moderate	15.34	Moderate	10.63	Moderate
10	Dahej	8.24	Slight	21.28	Moderate	20.89	Moderate	8.58	Slight
11	Hazira	6.05	Slight	8.17	Slight	8.31	Slight	8.83	Slight

* Please refer p. 225 in chapter IX.

A synoptic view of the grain-size percentage variation in the suspended sediments is given in Fig. X.1. The seasonwise plots of size fractions on triangular diagram (Fig.X-2). The two figures are illustrative of the fact that the nature of the suspended sediment load is practically the same and no significant variation trends of different fractions are noticed locationwise or seasonwise.

X-RAY DIFFRACTION

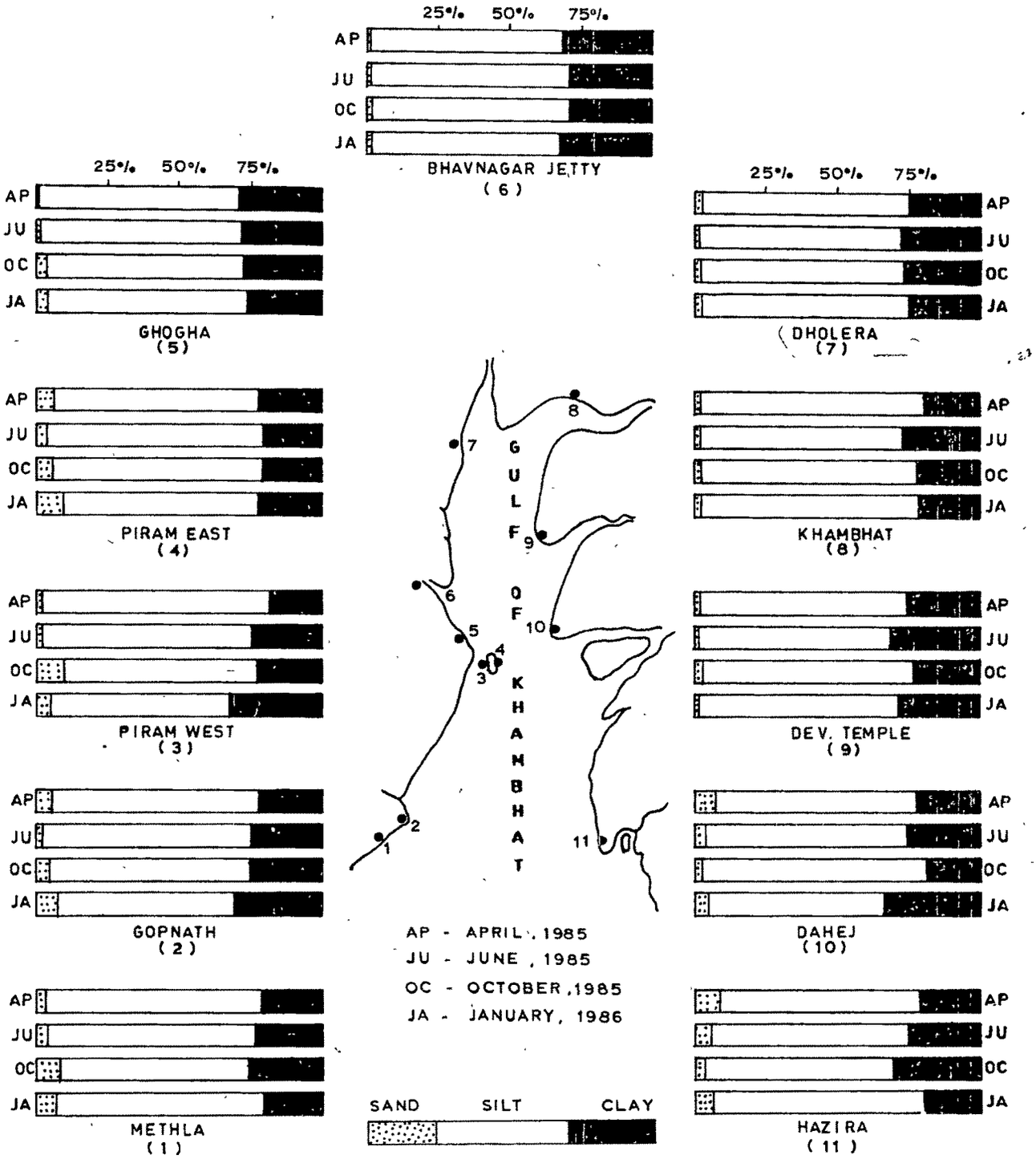
For the purposes of identification of different minerals the author carried out X-ray analysis for bulk mineralogy. After separating the clay fraction (<2μ), again X-ray studies were conducted to identify and determine the percentages of clay minerals present.

BULK MINERALOGY

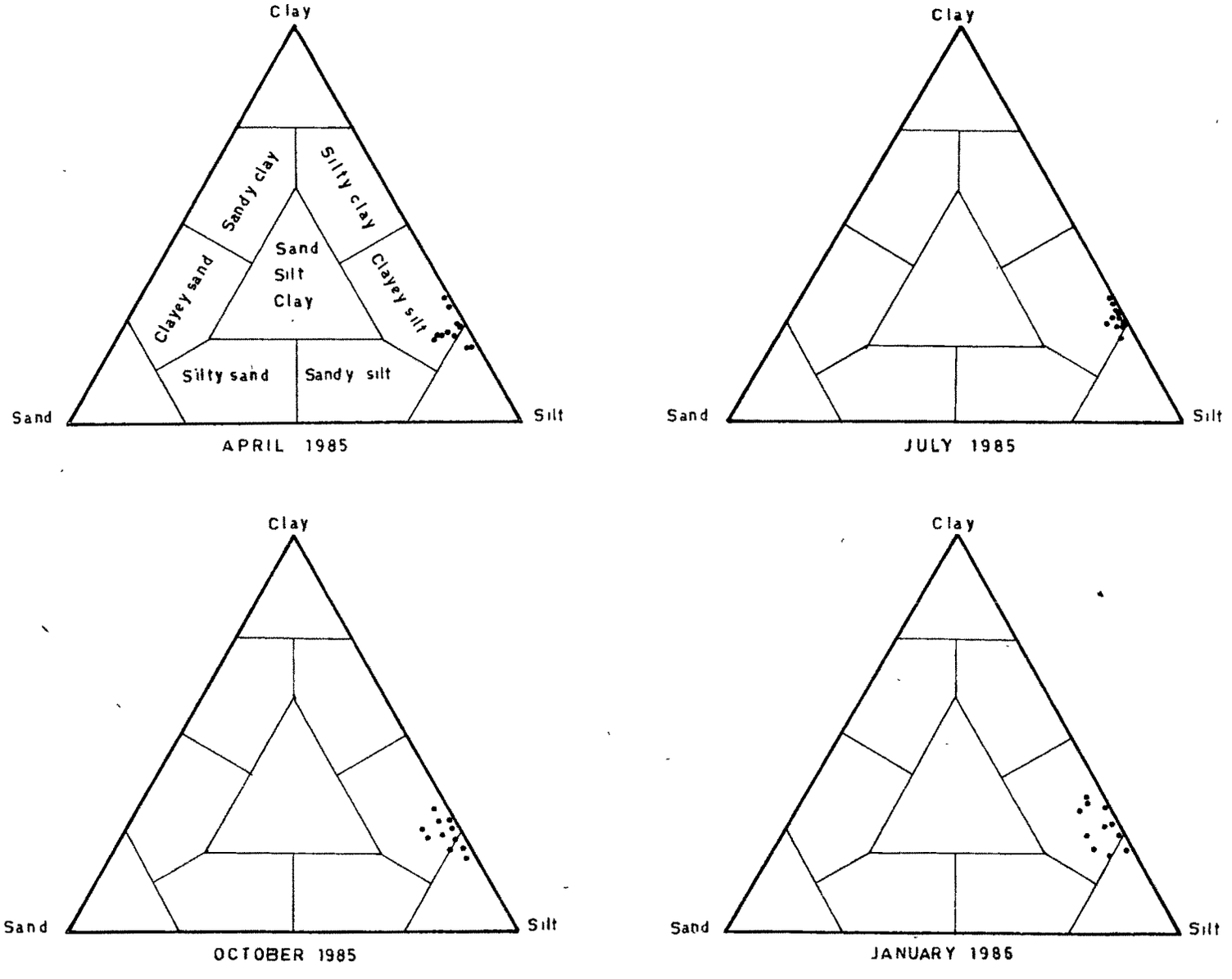
The bulk sediment was kept in an oven at 40°C and powdered in an agate mortar. The powder was then mounted on X-ray diffraction slide and diffractograms obtained, keeping the instrument setting as described in Chapter VIII.

The diffractograms have been interpreted following the ASTM powder standard charts and cards. The data pertaining to the minerals present in each season at different stations, are given in the Table No.10.2,3,4 & 5.

FIG. X.1



SEASONAL VARIATION IN SIZE FRACTIONS OF SUSPENDED SEDIMENTS IN PERCENTAGES



SEASONAL TRIANGULAR GRAIN SIZE VARIATION DIAGRAM OF SUSPENDED SEDIMENTS

FIG. X.2

TABLE. 10.2 X-RAY ANALYSES OF SUSPENDED SEDIMENTS
APRIL 1985

	MINERALS	SAMPLE NO. AW										
		1	2	3	4	5	6	7	8	9	10	11
CLAY MINERALS	Mo	O	O	O	O	O	O	O	O	O	O	O
	Ka	O	O	—	O	—	O	O	O	—	O	O
	Ha	—	O	O	O	O	O	O	O	O	—	O
	Na	—	—	—	—	O	—	O	O	O	O	—
	Di	—	—	—	—	—	—	—	—	—	—	—
	I	O	O	O	O	O	O	O	O	O	O	O
	Bi	—	O	—	—	—	O	O	—	—	O	—
	Mu	O	—	O	O	O	O	O	O	O	O	O
	Zi	—	—	—	—	—	—	O	—	—	—	—
	Ch	O	O	—	O	O	O	O	O	O	O	O
	Pa	—	—	—	—	—	—	O	—	—	—	—
	Se	—	O	O	—	—	O	O	O	O	O	O
NONCLAY MINERALS	Q	O	O	O	O	O	O	O	O	O	O	O
	Ca	O	O	—	O	O	—	—	O	O	O	O
	Ar	—	—	—	—	—	—	—	—	—	—	—
	Ze	O	—	—	—	—	—	—	O	—	—	—
	Ab	O	—	—	O	—	—	—	O	—	—	O
	Mgh	—	—	—	—	—	O	—	—	O	O	—
	Goe	—	—	—	—	—	—	—	—	—	—	—
	Gib	O	O	O	—	—	—	O	O	O	O	—
	Ba	—	—	—	—	—	—	—	—	—	—	—

'O' Present, '—' Absent / Under detectable limit

(For sample locations please refer Fig.X.1)

TABLE 10.3 X-RAY ANALYSES OF SUSPENDED SEDIMENTS
JULY 1985

	MINERALS	SAMPLE NO JW										
		1	2	3	4	5	6	7	8	9	10	11
CLAY MINERALS	Mo	O	O	O	O	O	O	O	O	O	O	O
	Ka	O	O	O	—	O	O	O	O	O	O	O
	Ha	O	—	O	O	—	O	—	O	—	—	—
	Na	—	—	—	—	—	—	—	—	—	—	—
	Di	—	—	—	—	—	—	O	—	—	—	—
	I	O	O	O	O	O	O	O	O	O	O	O
	Bi	—	O	O	O	—	—	O	—	—	O	O
	Mu	O	O	O	O	O	O	O	O	O	O	O
	Zi	—	O	—	O	—	—	—	O	—	—	—
	Ch	O	O	O	O	O	O	O	—	O	O	O
	Pa	—	—	—	—	—	—	—	—	—	—	—
	Se	O	O	—	—	O	—	—	—	O	O	—
NONCLAY MINERALS	Q	O	O	O	O	O	O	O	O	O	O	O
	Ca	O	—	O	O	O	O	O	O	O	O	O
	Ar	—	—	—	—	—	—	—	—	—	—	—
	Ze	O	—	O	O	—	—	O	—	—	—	—
	Ab	—	O	O	—	O	—	—	—	—	O	O
	Mgh	O	—	—	—	—	O	O	—	O	—	—
	Goe	—	—	—	—	—	—	—	—	—	—	—
	Gib	O	O	—	O	O	—	—	O	O	O	O
	Ba	—	—	—	—	—	O	O	—	—	—	—

'O' Present, '—' Absent / Under detectable limit
(For sample locations please refer Fig. X 1.)

TABLE NO 10 4 X RAY. ANALYSES OF SUSPENDED SEDIMENTS
OCTOBER 1985

	MINERALS	SAMPLE NO. OW										
		1	2	3	4	5	6	7	8	9	10	11
CLAY MINERALS	Mo	O	O	O	O	O	O	O	O	O	O	O
	Ka	O	O	O	—	O	O	O	O	O	O	O
	Ha	O	O	O	—	—	O	—	O	—	O	—
	Na	—	—	—	—	—	—	—	—	—	O	O
	Di	—	—	—	—	—	—	—	—	—	—	—
	I	O	O	O	O	O	O	O	O	O	O	O
	Bi	O	O	—	O	—	O	O	—	O	—	—
	Mu	O	O	O	O	O	—	O	O	O	O	O
	Z'i	—	—	—	O	—	—	—	O	—	—	—
	Ch	O	O	O	O	O	O	O	O	O	O	O
	Pa	—	—	—	—	—	—	O	—	—	—	—
	Se	—	—	O	O	—	—	O	—	O	O	O
NONCLAY MINERALS	Q	O	O	O	O	O	O	O	O	O	O	O
	Ca	O	O	O	O	O	O	O	O	—	O	—
	Ar	—	—	—	—	—	—	—	—	—	—	—
	Ze	—	—	O	—	O	—	—	O	—	—	—
	Ab	—	O	O	O	—	O	O	—	O	—	O
	Mgh	—	—	O	—	—	—	O	O	—	O	—
	Goe	—	—	—	—	—	—	—	—	—	—	—
	Gib	O	O	O	O	O	—	O	O	O	O	D
	Ba	—	—	—	—	—	—	—	—	—	O	—

O Present, — Absent / Under detectable limit
(For location please refer Fig X.1)

TABLE. 10.5 X-RAY ANALYSES OF SUSPENDED SEDIMENTS
JANUARY 1986

	MINERALS	SAMPLE NO. JAW										
		1	2	3	4	5	6	7	8	9	10	11
CLAY MINERALS	Mo	O	O	O	O	O	O	O	O	O	O	O
	Ka	O	O	O	O	O	O	O	O	O	O	O
	Ha	O	O	—	—	—	O	—	—	—	—	—
	Na	—	—	—	—	—	—	—	—	—	—	O
	Di	—	—	—	—	—	—	—	—	—	—	—
	I	O	O	O	O	O	O	O	O	O	O	O
	Bi	O	O	—	O	—	O	—	O	O	O	O
	Mu	O	O	O	O	O	O	O	O	—	O	O
	Zl	—	—	—	—	—	—	—	—	—	—	—
	Ch	O	O	O	O	O	O	O	O	O	O	O
	Pa	—	—	—	—	O	O	—	—	—	—	—
	Se	—	O	O	—	—	O	O	—	O	O	O
NONCLAY MINERALS	Q	O	O	O	O	O	O	O	O	O	O	O
	Ca	O	O	O	O	O	O	O	—	O	O	O
	Ar	—	O	—	—	—	—	—	—	—	—	O
	Ze	O	—	O	O	—	O	—	O	—	O	—
	Ab	O	—	O	—	—	—	O	—	O	—	O
	Mgh	—	—	O	—	O	—	O	—	—	—	—
	Goe	—	—	—	—	—	—	—	—	—	—	—
	Gib	O	O	—	O	O	—	O	O	O	O	O
	Ba	—	—	—	—	—	—	—	O	—	—	—

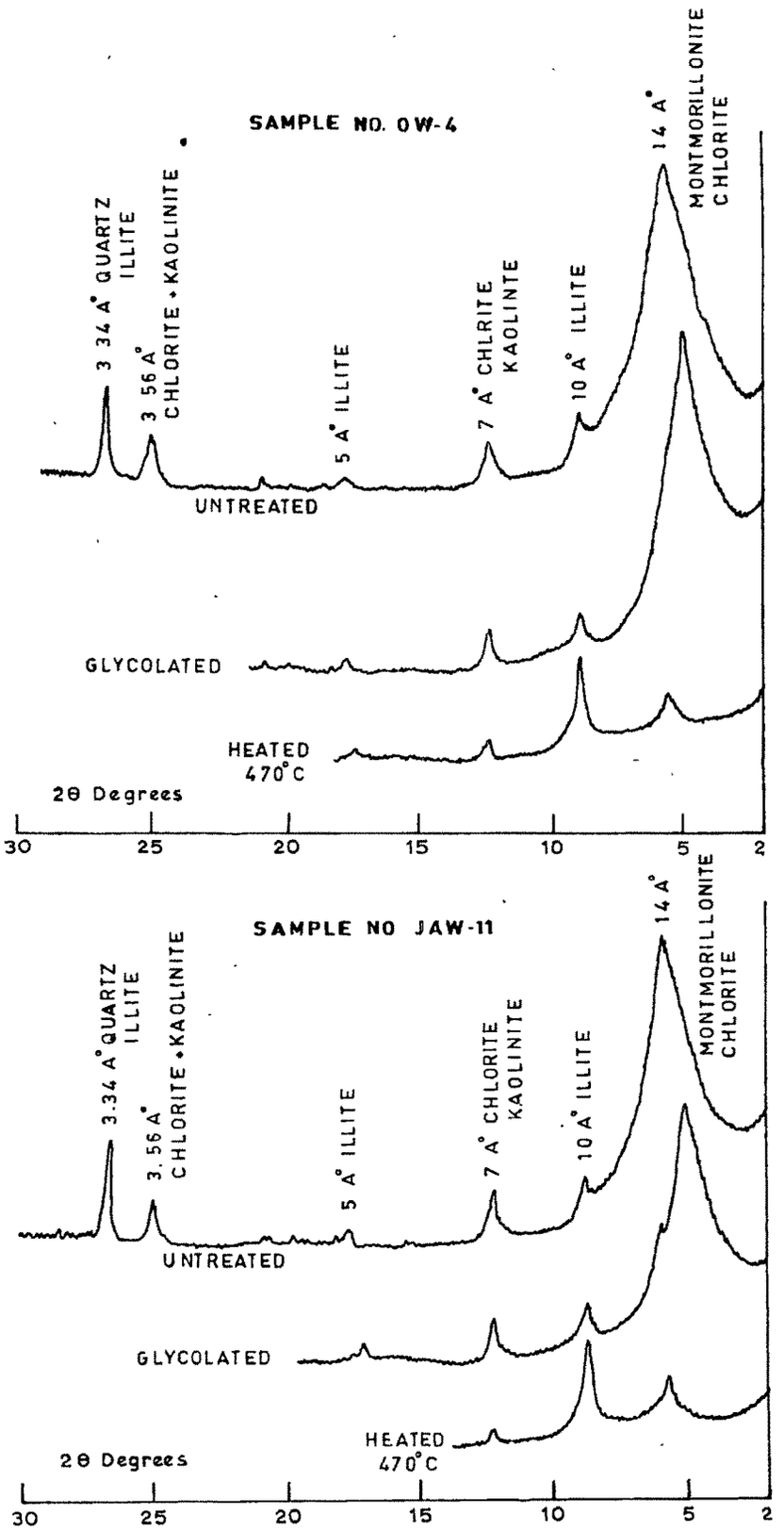
'O' Present, '—' Abset / Under detectable limit
(For sample locationsplease refer Fig.X.1.)

From the above data it is obvious that mineralogically the tidal sediments are in no way different from those of tidal flats.

CLAY MINERALOGY

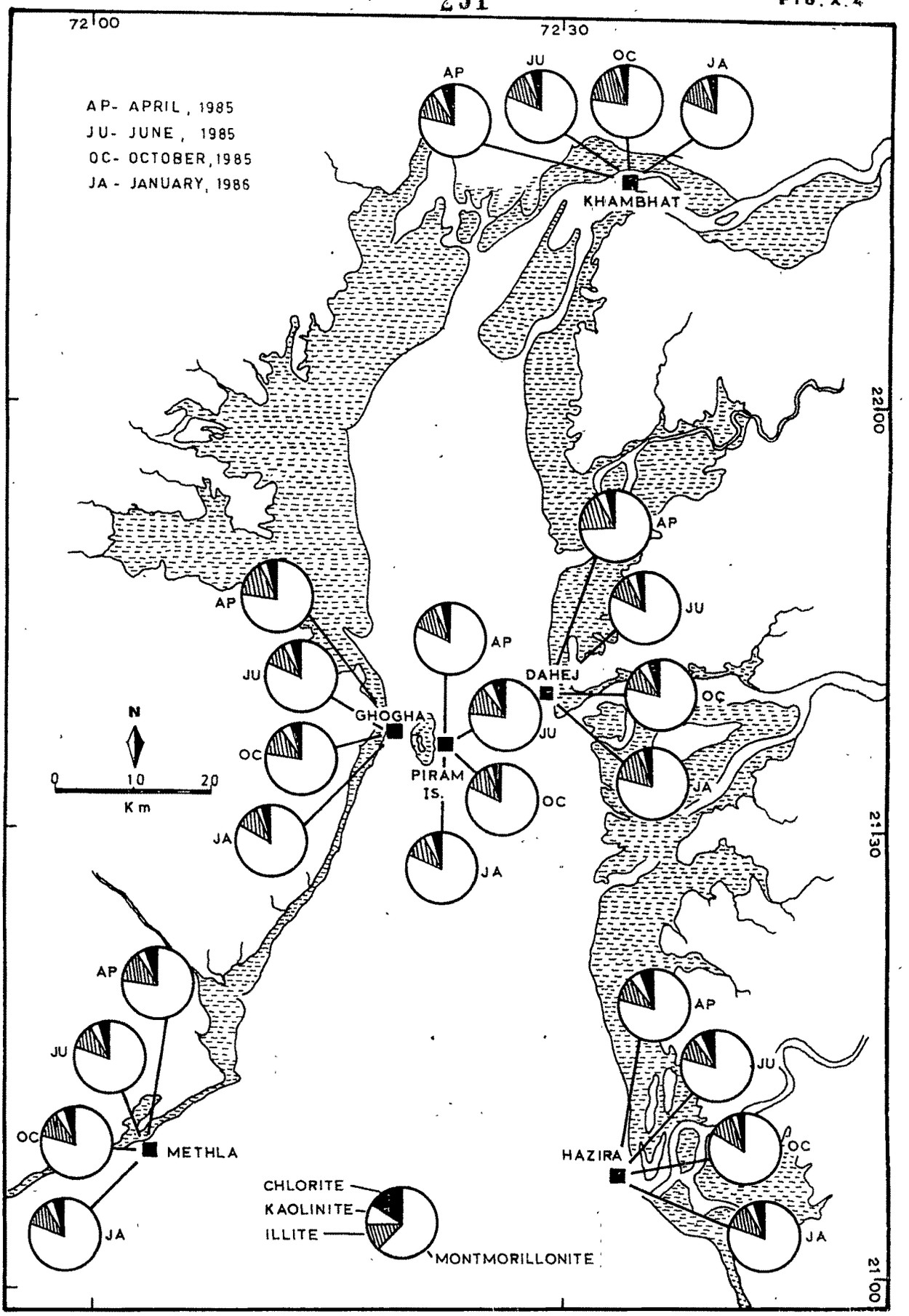
To understand the clay content and mineralogical variation in different parts of the Gulf the author carried out semi-quantitative estimation for four major clay minerals present (montmorillonite, illite, chlorite and kaolinite). 24 samples were selected from six representative stations for four different periods. The procedure for separation of the clay minerals from the bulk sample and the parameters selected for the clay mineral analyses, have already been described in Chapter VIII. Fig.X.3 shows two typical diffractograms of samples treated under different sets of conditions. Table 10.6 gives the percentage of clay minerals present in each sample whereas the areal distribution of these clay minerals at different station around the Gulf is given in Fig.X.4.

From the data obtained it is noticed that there is an overall homogeneity present in the distribution of the clay minerals all over the coast in different seasons. This uniformity points to strong hydrodynamic conditions in the Gulf.



X-RAY DIFFRACTOGRAMS OF ORIENTED CLAY FRACTIONS OF SELECTED SAMPLES UNDER VARIOUS TREATMENTS

FIG. X.4



SEASONAL DISTRIBUTION OF CLAY MINEARLS IN THE SUSPENDED SEDIMENTS OF THE GULF OF KHAMBHAT (BASED ON PEAK AREA PERCENTAGES)

TABLE 10.6 CLAY MINERAL PERCENTAGES IN SUSPENDED SEDIMENT

Location	Month-Year	Sample No.	Montmorfi-llonite %	Illite %	Chlorite %	Kaolin-ite %
Methla	April '85	AW-1	75.99	13.93	5.98	4.10
	July ' 85	JW-1	78.96	11.69	5.20	4.15
	October'85	AW-1	77.77	13.23	4.40	4.6
	January'86	JAW-1	80.97	10.56	4.65	3.82
Ghogha	April '85	AW-5	75.90	14.28	5.01	4.81
	July ' 85	JW-5	82.05	10.25	3.89	3.8
	October'85	OW-5	76.55	13.66	4.8	4.99
	January'86	JAW-5	83.12	10.23	3.55	3.10
Piram East	April '85	AW-3	79.54	12.28	4.2	3.98
	July ' 85	JW-3	75.36	13.53	6.31	4.80
	October'85	OW-3	81.30	11.16	3.99	3.55
	January'86	JAW-3	82.88	9.92	3.61	3.59
Khambhat	April '85	AW-8	77.66	13.75	4.76	3.83
	July ' 85	JW-8	78.53	14.13	4.48	2.86
	October'85	OW-8	74.28	17.71	4.01	4.00
	January'86	JAW-8	78.59	13.83	3.48	4.10
Dahej	April '85	AW-10	73.27	18.3	4.23	4.20
	July '85	JW-10	79.74	11.96	4.20	4.10
	October'85	OW-10	77.88	13.21	4.5	4.41
	January'86	JAW-10	75.98	15.17	5.16	3.69
Hazira	April'85	AW-11	77.53	11.98	5.67	4.82
	July'85	JW-11	79.33	10.34	5.34	4.99
	October'85	OW-11	83.11	10.56	3.18	3.15
	January'86	JAW-11	82.35	9.42	4.75	3.48