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HYDROCARBONS IN THE WATERS AND SEDIMENTS OF SHATT AL-ARAB ESTUARY AND NORTH-WEST ARABIAN GULF

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ABSTRACT

The objective of this study was to gather base-line data concerning the presence, origin, type and distribution of hydrocarbons in the waters and sediment of Shatt Al-Arab estuary. In summer 1993 dissolved, particulate phases of water with sediment samples were collected from seven stations along Shatt Al-Arab river and its estuary in the North-West region of the Arabian Gulf. The samples were extracted and concentration of petroleum hydrocarbons were determined spectrofluorometrically. The distribution of n-alkanes in the water and sediment samples were determined by high resolution capillary gas chromatography. Higher amount of hydrocarbons was found in the particulate phase than in dissolved ones, and sediment was likely to act as a sink for these hydrocarbons. The n-alkanes may have originated from biogenic sources such as algal form, diatoms, bacterial activity, and higher plants. Petroleum from the oil refinery in Abadan may represent anthor source of n-alkanes in Shatt Al-Arab system. The concentration pattern of hydrocarbons decreased from "upstream to downsteram", due to many factors of purification such as mixing, flashing, weathering and bacterial degradation within the estuary system which might lead the reduction of hydrocarbon levels in downstream of the estuary.

INTRODUCTION

One of the fates of petroleum hydrocarbons in the aquatic environment is adsorp on or incorporation into particulate matter and final deposition and incorporation the surface sediment. The precise characterization of these phases may provide information not only about the origins but also about the transport paths and f organic compounds in the sea.

Esturaine or deltaic system are of special interest because they consistute areas transport and deposition of continental inputs into the coastal environments (Al et al.,1984). Hydrocarbons present in Shatt Al-Arab estuary may be of natural anthropogenic origin (Bedair & Al-Saad 1992). Hydrocarbons may enter the est at low levels from domestic and industrial effluents, agricultural run-off, navig and transportation, and also from atmospheric fall-out, while the biogenic activ flora, fauna, and/or bacteria may release hydrocarbons into the water of Shatt (Bedair & Al-Saad 1992). These biogenic and anthropogenic hydrocarbons are t in the form of dissolved and particulate organic matter, within the water colun they undergo intense mixing as well as biodegredation or photo-oxidation and recycled into the food web, incorporated onto the underlying sediment or tran toward the open sea (Al-Saad & Al-Timari 1993a).

The knowledge of dissolved and particulate organic matter in Shatt Al-Arab e rather limited to the northern part (Bedair & Al-Saad 1992), while the souther rather neglected. The present study is aimed at providing necessary informat the assessment and the impact of the major oil pollution incidents through the establishment of base-line data for the concentration, distribution and source hydrocarbons in dissolved, particulate and sediments of the Shatt Al-Arab est North-West Arabian Gulf. These data are first of its kind in the region.

DESCRIPTION OF THE STUDY AREA

The Shatt Al-Arab river originates from the confluences of the two major rivers in Iraq (Tigris and Euphrates) at Qurna. Karun river, the only tributary of Shatt Al-Arab river, joins its eastern bank south of Basrah city' (Fig.1). The lenght of the river from Qurna where it originates, to its mouth in the Arabian Gulf is extends about 175Km. Its width varies at different points ranging from 0.4Km at Basrah city to 1.5Km at its mouth. The water depth increases in general toward the Gulf with a maximum of 12.5m. The water level is ,however affected by the tidal rhythm of the Arabian Gulf where the average tidal range is about 1.7m. The Shatt Al-Arab waters are well mixed with limited vertical stratification of temperature and chlorinites. The annual discharge of the river is about $5x10^9 m^3$ of nutrient rich water into the head of the Arabian Gulf.

MATERIALS AND METHODS

Seven sampling sites have been selected from Shatt Al-Arab estuary and North-West Arabian Gulf (Fig.1) for the study of hydrocarbons residues and n-alkanes in dissolved, particulate and sediments. The sampling programme was carried out during summer 1993. Water samples (50L) from each station were obtain from the approximately the 1m of the water column in well-washed glass aspriator bottles. Sediment samples were collected by a Van veen grab sampler, and undisturbed, uncontaminated and replicate sample were taken. The sediment was sampled with a spatula, and all the samples were kept at -20°C until analysis.

The water samples were suction filtered as soon as possible (within 5h) through preweighed 0.45µm pore size whatman GF/F glass fiber filter preignited at 450°C. Materials passing through the filters were considered as "dissolved" and the retained as "particulate". Dissolved hydrocarbons were extracted by solvent extraction following the procedure of UNESCO (1976). One hundred milliliters of CCL4 was used in two successive 50ml extractions and the extracts were combined. To the combined extracts

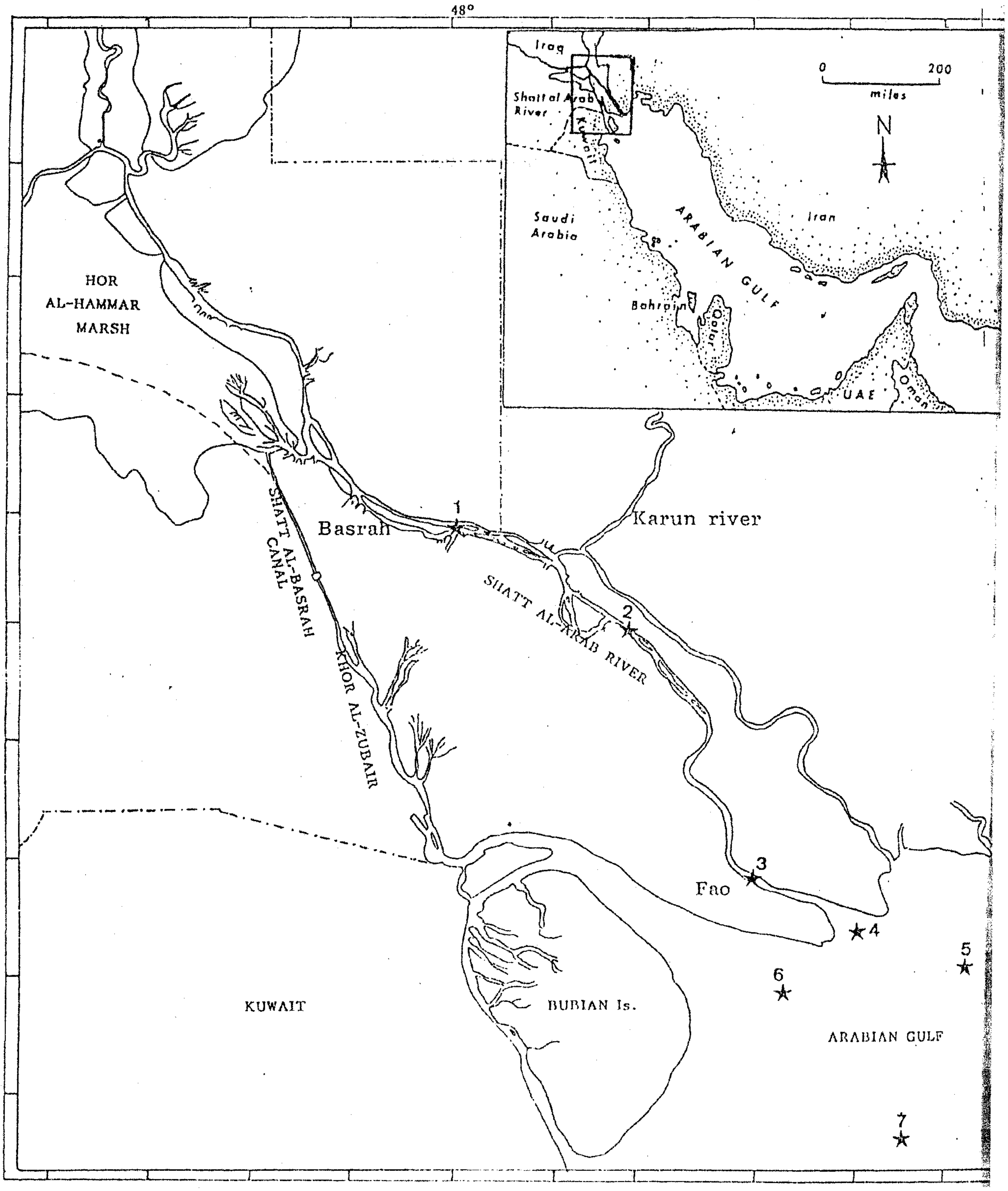

Fig. 1 Sampling locations.

anhydrous sodium sulphate was added to break any emulsion and to remove excess water. The CCL4 extracts were reduced in volume to less than 10ml using a rotary evaporator and then carefully pipetted into a precleaned 10ml volumetric flask in order to insure that any residual particles of sodium sulphate were excluded. The extract was then evaporated to dryness by a stream of purified nitrogen. The flask was then rinsed with fresh solvent and the rinsing was used to make the sample volume up to 5ml. Hydrocarbons were isolated by column chromatography. Twenty milligrams of 5% deactivated florisil was added to the glass column. The extract was then applied to the head of a column and eluted with 50ml of hexane to isolated the aliphatic, while 50ml of benzen for isolated the aromatic.

The particulate fractions (GF/F) filters and 100g dry homogenous sediment were soxhlet extracted for 24h with a 1:1 mixture of methanol and benzen following a method of Goutx and Saliot (1980). At the end of this period, the extract was reduced in volume to ca. 10ml using rotary evaporater. Then the extract was saponified for 2h with a solution of 4N KOH in 1:1 methanol:benzen. The unsaponified matter was extracted with hexane. The sample was passed through a chromatographic column containing 5% deactivated florisil, each sample was applied to a column with a very small volume of hexane. The aliphatic fraction were then eluted by the addition 50ml of hexane, while the aromatic were eluted by 50ml of benzen.

Considerable caution was taken to minimize contamination of the sample. Procedure blanks consisting of reagents, glasswares and equipments were checked regularly. Recoveries were calculated by comparing the peaks area of an internal standard of n-alkanes with a reference solution. However, the recovery rates were always 90% or higher. Determination of total hydrocarbon residues was carried out using Shimadzu RF 540 spectrofluorometer. Emission spectra (Exciatation 310nm) were recorded for each sample, and fluorescence intensities were measured at 360nm. Blank determination was achieved for each sample. Kuwait crude oil, chosen as an arbitrary standard for comparison, was supplied by American Petroleum Institute (API). Chrysen standard was employed to calibrate the spectrofluorometer and check the quantification of the analytical results. The identification of aliphatic hydrocarbons (n-alkanes) was performed with a Perkin-Elmer Sigma 300 capillary gas chromatograph, equipped with Flame Ionization Detector (FID), and a splitless injection port was used. Quantification of peaks and identification of n-alkanes in the chromatograms was achieved by a perkin-Elmer computing integrator (model LC-100). The fused silica capillary column used was a wall coated open tubular (WCOT) 50mX0.25 mm i.d SE-30(methylsilicone) Perkin-Elmer. Helium was used as a carrier gas with a linear velocity 1.5 ml min^{-1}. Operating temperatures for detector and injector were $310^{\circ}C$ and $300^{\circ}C$ respectively. The column was operated under temperature programed condition ($4^{\circ}C$ min^{-1}) for $60^{\circ}C$ to $280^{\circ}C$ with an isothermal peroid of 30min at the end. The unresolved complex mixture (UCM) was measured by planimetry.

Total organic carbons determined by treating subsamples with phosphoric acid to remove carbonates, then dried at $60^{\circ}C$ to constant weight and combusted using a Perkin-Elmer model 240B Elemental analyzer.

RESULTS AND DISCUSSIONS

Total hydrocarbon concentrations (Kuwait crude oil equivalents) determined in the present study are summarized in Table.1. The amount of oil residues in dissolved form were ranging from 1.70 μgl^{-1} at station 7 to 18.92 μgl^{-1} at station 2, while particulate hydrocarbons residues were ranging from 1.67 to 10.97 μgg^{-1} and that for sediment were ranging from 4.43 to 40.47 μgg^{-1}.

Its is evident, however that all sites were contaminated to some extent with hydrocarbo

The highest concentrations were always observed at station 2, near Abadan oil refinery on the Shatt Al-Arab estuary, while the lowest concentrations at station 7, in the open water of the Arabian Gulf.

The wide variations of total hydrocarbon concentrations observed in these waters and sediments may be attributed to the fact that oil pollution in the region has possibly originated from diverse sources (Al-Saad & Al-Timari 1993b).

The significant of these data is best appreciated, however, by comparing them with

Table-1-

Concentration of total petroleum hydrocarbons in dissolved (µg/l), particulate (µg/g) water, and sediment (µg/g) in Shatt Al-Arab estuary and North-West Arabian Gulf during summer 1993

STATION	NO.OF SAMPLES	CONCENTRATION RANGE	MEAN	STANDARD ERROR
DISSOLVED				
1	8	3.18-5.62	4.23	± 0.264
2	8	10.39-18.92	14.13	± 1.018
3	8	4.19-7.20	5.55	± 0.396
4	8	5.72-8.01	6.54	± 0.350
5	8	2.80-4.68	3.72	± 0.262
6	8	2.90-4.10	3.33	± 0.225
7	8	1.76-3.42	2.60	± 0.204
PARTICULATE				
1	3	2.88-3.58	3.21	± 0.202
2	3	8.88-10.97	9.83	± 0.609
3	3	4.86-6.10	5.49	± 0.358
4	3	3.10-5.11	4.28	± 0.608
5	3	2.55-3.16	2.82	± 0.179
6	3	1.98-3.82	2.60	± 0.608
7	3	1.67-2.30	1.93	± 0.190
SEDIMENT				
1	3	8.78-10.45	9.69	± 0.488
2	3	36.86-40.47	38.33	± 1.093
3	3	12.98-14.11	13.40	± 0.355
4	3	9.79-12.08	10.66	± 0.714
5	3	6.57-7.19	6.87	± 0.179
6	3	4.95-6.48	5.78	± 0.446
7	3	4.43-5.22	4.92	± 0.247

values of petroleum hydrocarbons found in other part of the world (El-Samra,1989). The present results indicate that the level of oil residues encountered in waters and sediments af the Shatt Al-Arab estuary and North-West region of the Arabian Gulf lie within the range of values reported for comparable areas (El-Samra, 1989).

The most common component of n-alkanes in dissolved, particulate fraction and sediments are listed in Tables 2,3, and 4. The concentration of n-alkanes in dissolved fraction varied from 0.94 at station 7 to $4.97 \mu g l^{-1}$ at atation 2, and for particulate fraction from 1.78 to $5.31 \mu g g^{-1}$, while for the sediment it varied from 8.79 to $55.67 \mu g g^{-1}$. In general the concentration of n-alkanes were much higher in the particulate than in the dissolved phases (Fig.2), and is in agreement with the result obtained by Bedair & Al-Saad (199

The n-alkanes distribution of dissolved,particulate and sediment are characterized by two modes, the first in the range of C13 to C23 with high C17 and Pristane and a slight predominance of even carbon n-alkanes and the second in the range >C23 with the predominance of odd carbon n-alkanes. This mode had also been observed previousl in sediments from the area (Grimalt et al.,1985, Al-Saad & Al-Timari 1993b).

Odd carbon number n-alkanes lower than C21 such as C15,C17 and C19 are commonly found in algae (Goutx & Saliot 1980), C20 to C28 model n-alkanes without carbon numb preference, maximizing around C23 may be produced by bacterial activity (Grimalt et a 1985) and C25 to C34 odd carbon number n-alkanes are indicative of higher plants (Kennicutt et al., 1987). This may be considered to be evidence for the aquatic bioger origin of n-alkanes in the Shatt Al-Arab estuary and North-West Arabian Gulf.

Many aquatic plants are abundant in Shatt Al-Arab estuary and are likely to be the ma source of n-alkanes in the estuary (Bedair & Al-Saad 1992).

The contribution of other sources of n-alkanes in the present samples may be due to higher land-based vegetation under the effect of aeoline contributions, and terrestrial input from plant materials (Al-Saad & Al-Timari 1993b).

The relatively high C17 may indicates that photo-synthetic organisms are the main sour of n-alkanes in this estuary. Other evidence on the aquatic biogenic origin of n-alkane

Table-2-

Concentration of dissolved n-alkanes (μg/l) in water of Shatt Al-Arab estuary and North-West Arabian Gulf during Summer 1993

CARBON NUMBER	STATION 1	2	3	4	5	6	7
C13	0.01	0.02	0.02	0.01	0.02	—	0.01
C14	0.02	0.16	0.05	0.02	0.01	—	0.01
C15	0.04	0.19	0.08	0.02	0.04	0.02	0.06
C16	0.06	0.18	0.09	0.13	0.03	0.01	0.06
C17	0.20	0.25	0.08	0.19	0.06	0.17	0.09
C18	0.08	0.27	0.12	0.18	0.09	0.16	0.03
C19	0.18	0.23	0.10	0.17	0.09	0.08	0.09
C20	0.06	0.18	0.17	0.16	0.08	0.08	0.08
C21	0.14	0.28	0.21	0.17	0.07	0.09	0.07
C22	0.06	0.31	0.17	0.16	0.19	0.07	0.06
C23	0.19	0.36	0.28	0.14	0.10	0.09	0.09
C24	0.04	0.29	0.19	0.15	0.09	0.04	0.04
C25	0.16	0.39	0.28	0.14	0.19	0.06	0.06
C26	0.06	0.28	0.19	0.15	0.13	0.07	0.05
C27	0.20	0.42	0.26	0.14	0.13	0.06	0.06
C28	0.04	0.30	0.19	0.13	0.05	0.04	0.03
C29	0.19	0.25	0.17	0.10	0.04	0.04	0.03
C30	0.05	0.26	0.09	0.09	0.03	0.03	0.02
C31	0.03	0.19	0.07	0.06	—	—	—
C32	0.02	0.16	0.06	0.06	—	—	—
TOTAL	1.83	4.97	2.87	2.37	1.44	1.11	0.94

= Not detected.

Table-3-

Concentration of Particulate n-alkanes (μg/g) in water of Shatt Al-Arab estuary and North-West Arabian Gulf during Summer 1993

CARBON NUMBER	STATION 1	2	3	4	5	6	7
C13	0.01	—	0.01	0.01	0.01	—	—
C14	0.01	—	0.01	0.01	0.01	—	—
C15	0.09	0.02	0.02	0.02	0.01	0.02	0.01
C16	0.08	0.02	0.02	0.04	0.09	0.02	0.01
C17	0.14	0.37	0.14	0.21	0.12	0.17	0.10
C18	0.20	0.42	0.21	0.23	0.16	0.03	0.09
C19	0.21	0.28	0.19	0.27	0.16	0.10	0.08
C20	0.16	0.43	0.15	0.20	0.16	0.14	0.09
C21	0.18	0.52	0.31	0.24	0.19	0.15	0.09
C22	0.17	0.36	0.23	0.18	0.14	0.14	0.17
C23	0.16	0.28	0.15	0.28	0.17	0.16	0.18
C24	0.15	0.16	0.12	0.21	0.20	0.18	0.15
C25	0.23	0.53	0.32	0.19	0.23	0.16	0.19
C26	0.12	0.24	0.18	0.21	0.14	0.14	0.17
C27	0.22	0.79	0.45	0.18	0.17	0.16	0.20
C28	0.11	0.20	0.20	0.17	0.14	0.13	0.10
C29	0.08	0.22	0.16	0.17	0.09	0.12	0.09
C30	0.05	0.20	0.14	0.14	0.03	0.10	0.06
C31	0.02	0.17	0.13	—	—	0.06	—
C32	0.02	0.10	0.05	—	—	0.02	—
TOTAL	2.41	5.31	3.19	2.96	2.22	2.00	1.78

— = Not detected

Table-4-

Concentration of n-alkanes (μg/g) in sediment of Shatt Al-Arab estuary and North-West Arabian Gulf during 1993 with TOC%

CARBON NUMBER	STATION 1	2	3	4	5	6	7
C13	0.18	0.97	0.32	0.49	0.31	0.09	0.11
C14	0.36	1.87	0.48	0.36	0.32	0.38	0.46
C15	0.82	2.43	0.59	0.66	0.63	0.44	1.03
C16	0.97	2.63	0.63	0.76	0.84	0.57	1.06
C17	1.27	3.48	1.98	1.07	1.56	0.88	1.08
C18	0.98	3.30	1.03	1.02	1.64	0.78	0.66
C19	0.86	2.36	0.83	0.85	0.89	0.72	0.52
C20	0.73	3.87	0.89	0.87	0.93	0.68	0.38
C21	0.82	3.48	0.88	1.38	0.54	0.69	0.58
C22	0.64	3.21	0.93	1.06	0.65	0.77	0.45
C23	0.52	2.80	1.08	1.22	0.33	0.51	0.40
C24	0.31	2.23	0.85	0.89	0.39	0.46	0.36
C25	0.67	3.70	1.31	0.91	0.34	0.43	0.34
C26	0.52	2.30	0.63	0.78	0.45	0.42	0.36
C27	0.87	2.32	1.96	0.98	0.28	0.40	0.35
C28	0.45	3.56	0.80	0.69	0.22	0.38	0.32
C29	0.96	2.74	0.92	0.86	0.10	0.38	0.18
C30	0.88	2.14	0.68	0.53	0.16	0.23	0.15
C31	0.86	1.86	0.55	0.46	——	——	——
C32	0.63	1.69	0.42	0.46	——	——	——
C33	0.45	1.42	0.31	0.31	——	——	——
C34	0.13	1.31	0.28	0.28	——	——	——
TOTAL	14.88	55.67	18.35	16.89	10.58	9.21	8.79
TOC%	0.64	0.85	0.72	0.69	0.52	0.44	0.38

—— = Not detected

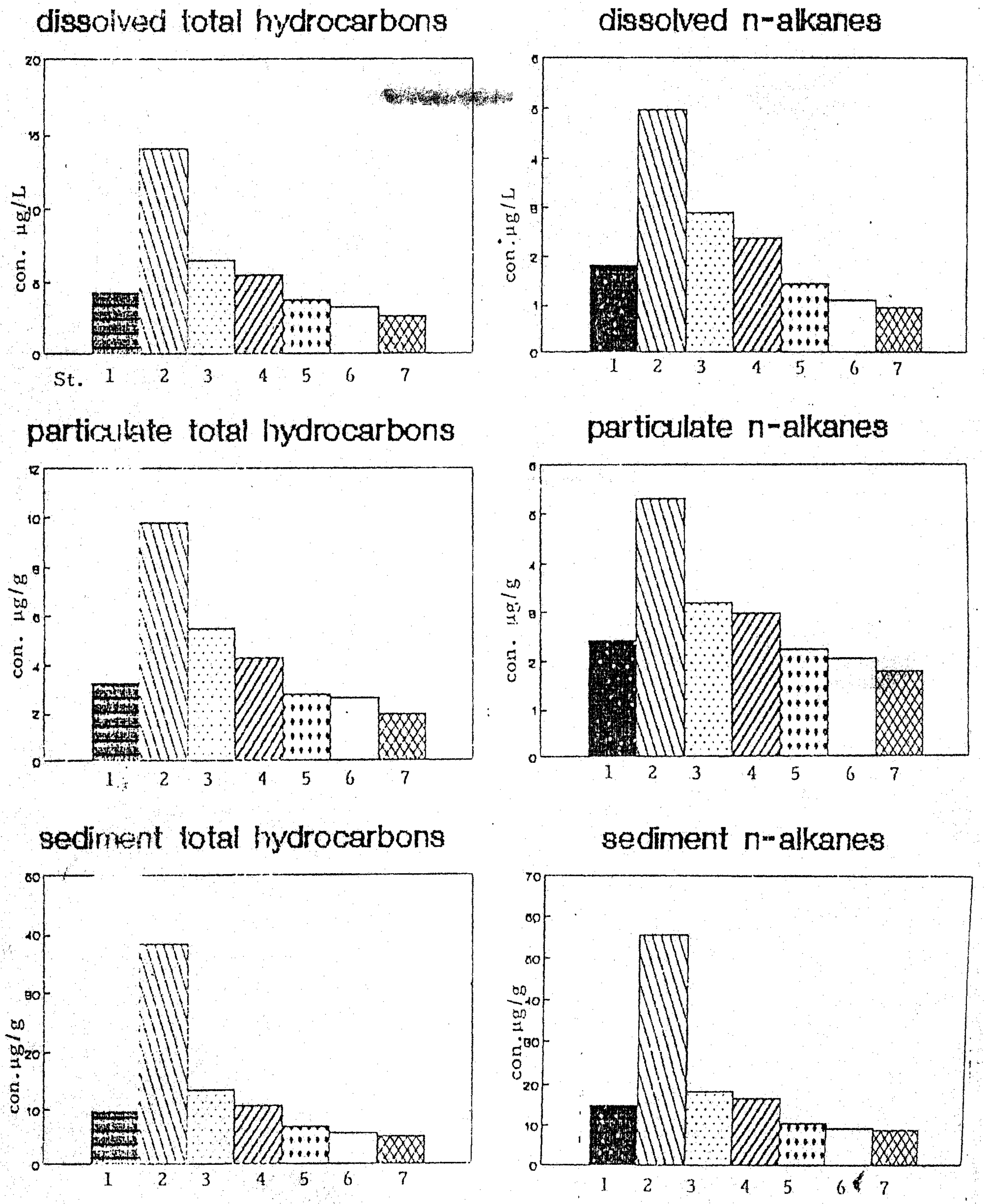

Fig. 2 Distribution histograms for the total hydrocarbons and n-alkanes in dissolved, particulate and sediment of Shatt Al-Arab estuary.

may be derived from diatom populations which contain a range of n-alkanes from C15 to C31. Diatoms have been found to be the most dominant group of phytoplankton in the Shatt Al-Arab estuary (Al-Saboonchi & Al-Saad 1988) and North-West region of the Arabian Gulf (Al-Handal 1988). Therefore it may be concluded that diatoms are the most likely source of n-alkanes with even to odd carbon predominance encountered in the Shatt Al-Arab estuary and North-West Arabian Gulf. Therefore, the distribution of such alkanes can be utilized as a potential marker for defining diatoms as contributors to marine sediments.

All samples contain pristane and phytane, the former may originate from zooplankton or from decomposition of algae, while the latter may originate from several type of bacteria or from deposition of algae (Simoneit 1978). Also pristane and phytane are natural by-products of weathered petroleum products. The ratio of these isoprenoid with C17 to pristane and C18 to phytane for dissolved, particulate and sediment are listed in Table 5. These ratios involve both biogenic and anthropogenic compounds, and confirm the strong biodegradation of hydrocarbons occurring in this area(Siron et al.,1987). Squalane also present in some samples which may be originated from living organism or from artifical sources (Al-Saad 1990).

The sources of unresolved complex mixture (UCM) is synthesized by some anaerobic nonphotosynthetic bacteria (Han & Galvin 1969) and green algae which are widely distributed in natural environment (Brooks et al.,1977). At the same time microbial oxidation of hydrocarbons in either the sediment or water will reduce the n-alkanes contents relative of UCM. In general the presence of UCM is normally associated with petroleum contamination (Shaw et al.,1985) and this can be releated to the production, the use and transportation of petroleum products around the port area of Abadan (DouAbul 1984, Grimalt et al.,1985).

The odd/even carbon ratios, or carbon preference index (CPI) as shown in Table 5 was substantially greater than one, which indicates more complex biogenic sources, while

Table-5-

Ratio of various parameters for dissolved,particulate water and sediment of Shatt Al-Arab Estuary and North-West Arabian Gulf during summer 1993.

STATION	PRI	PHY	PRI/PHY	C17/PRI	C18/PHY	SQUALANE	CPI	UCM
Dissolved								
1	0.19	0.10	1.90	1.05	0.80	——	2.73	0.06
2	0.17	0.20	0.85	1.47	1.35	0.13	1.07	0.21
3	0.09	0.08	1.12	0.88	1.50	0.01	1.17	0.08
4	0.12	0.09	1.33	1.58	2.00	0.02	0.92	0.12
5	0.05	0.04	1.25	1.20	2.25	——	1.05	0.03
6	0.12	0.13	0.92	1.41	1.23	——	1.72	0.02
7	0.06	0.05	1.20	1.50	0.60	——	1.47	0.03
Particulate								
1	0.09	0.20	4.50	1.55	1.00	0.02	1.25	0.13
2	0.33	0.40	0.82	1.12	1.05	0.63	1.49	1.82
3	0.09	0.11	0.81	1.55	1.90	0.02	1.43	0.42
4	0.21	0.23	0.91	1.00	1.00	0.02	1.12	0.32
5	0.10	0.11	0.90	1.20	1.45	——	1.07	0.23
6	0.13	0.09	1.44	1.30	0.33	——	1.22	0.09
7	0.14	0.18	0.77	0.71	[illegible]50	——	1.11	0.06
Sediment								
1	1.20	0.96	1.25	1.05	1.02	0.31	1.25	4.18
2	2.65	2.98	0.88	1.31	1.10	1.86	0.98	14.68
3	1.02	1.00	1.02	1.94	1.03	0.79	1.40	3.26
4	0.98	0.87	1.12	1.09	1.17	0.63	1.19	3.97
5	0.56	0.43	1.30	2.78	3.81	0.32	0.88	2.31
6	0.83	0.62	1.33	1.06	1.25	0.54	0.97	2.93
7	0.93	0.42	2.21	1.16	1.57	0.21	1.09	2.76

CPI= Carbon Preference index.

UCM= Unresolved complex mixture.

—— = Not detected.

in station 2 ,the pattern is easily obscured by petroleum contamination which tend to reduce CPI to unity. On the other hand, the solubility of hydrocarbons to water is very small among common biological organic constituents and thus hydrocarbons should usually be associated with suspended particles in water, because much of hydrocarbons in water samples are found in particulate fractions, hydrocarbons may therefore settle out preferentially from aqueous layer onto the bottom sediments together with particulate materials. Thus high hydrocarbons and TOC values (r=0.78) for the sediments should be ascribed for the preferential deposition of hydrocarbons and/or selective degradation of organic materials in the estuary (Matsumoto 1983).

Hydrocarbons in the Shatt Al-Arab estuary reflect the mixing and removal processes that take place in the water column, so the estuary act as a sink for dissolved, particulate hydrocarbons, and of the total river-born load of several hydrocarbons only few concentration may reach the Gulf.

In general stations 2 to 7 showed a pattern of "North to South" (upstream to downstream) decrease in total concentrations of hydrocarbons and n-alkanes. Factors of purification within the estuary system, such as sinking, mixing, flashing, weathering, and bacterial degradation probably contribute to reduce hydrocarbons levels in that lower part of the estuary.

In summery all samples contained hydrocarbons, and higher amount was found in the particulate phases than in dissolved ones, and sediment was likely to act as a sink for these hydrocarbons. The n-alkanes in Shatt Al-Arab estuary may have originated from various aquatic biogenic sources, such as diatoms, algae and bacteria. Anthor source of n-alkanes in Shatt Al-Arab system were considered from anthropogenic petroleum pollution which is pronounced with the port area of Abadan. Factors of purification within the estuary system might lead the reduction of hydrocarbon levels in that the lower part of the estuary and North-West Arabian Gulf.

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الهايدروكاربونات في مياه ورواسب مصب شط العرب وشمال غرب الخليج العربي

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المستخلص

تضمنت الدراسة الحالية تواجد واصل وتوزيع ومصادرالهايدروكاربونات في مصب شط العرب وشمال غرب الخليج العربي . ففي صيف عام ١٩٩٢ اخذت عينات تمثل االجزء الذائب والعالق من المياه مع الرواسب من سبعة محطات متوزعة على طول مصب شط العرب وشمال غرب الخليج العربي ، استخلصت كمية الهايدروكاربونات النفطية من هذه العينات وتم قياسها بواسطة جهاز التفلور ، بينما تم قياس توزيع مركبات الالكانات الاعتيادية لعينات المياه والرواسب باستخدام تقنية جهاز الغاز الكروموتوغرافي المزود بالعمود الشعري . وجد ان اعلى التراكيز للهايدروكاربونات في الجزء العالق منه عن الجزء الذائب وان الرواسب تعتبر كمخزن لهذه الهايدروكاربونات ، ووجد ان مصادر الالكانات متعدده معظمها من مصادر طبيعية (حيوية) من الطحالب ، الدايتومات ، الفعاليات الميكروبية والنباتات . وجد ايضا بان مصادر الالكانات في مصب شط العرب يعانى من مصافي عبادان وان تراكيز الهايدروكاربونات تقل من اعلى المصب الى اسفله وتاتي هذه الظاهرة نتيجة لعوامل التقنية الذاتية التي تحدث في المصب من مزج وتجويف وتكسير ميكروبي التي تؤدي بدورها الى تقليل لكميات الهايدروكاربونات في المصب .