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Research Article

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Levels of Petroleum Hydrocarbons in Sediment Samples from Al-Hodeidah Area along the Red Sea Coast of Yemen

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Abstract Sediment samples were collected from the coastal area of Al-Hodeidah Red Sea. The sediment samples were analyzed to determine the degree of petroleum hydrocarbons contamination. The average level of Total Petroleum Hydrocarbons (TPH) concentration in the study area was ranged between 4.07µg/g dry wt. at St. 9 to 18.88µg/g dry wt. at St. 3 In order to give a better evaluation of the petroleum hydrocarbon levels in the sediments, the total organic carbon (TOC) percentage and grain size analyses were done. The mean percent TOC estimations ranged from 0.70% at Station 9 to 2.65% at Station 6.The result shows low degree of petroleum hydrocarbons pollution in Al-Hodeidah Red Sea Coast.

Keywords Hydrocarbons, sediment, Hodeidah coast, Red sea, Yemen.

Introduction

The Red Sea is an enclosed sea, particularly vulnerable to pollutants from its surrounding countries [1].
Al-Hodeidah is one of the main cities on the Red Sea which suffered from increasing in population, urbanization and industrial activities.
The aquatic sediments can consequently provide not only a historic record of the sedimentary environment, but also hold back the feature of the average sedimentary environmental constituent's nature. Also, it may disclose a possible source of a chemical in the coastal waters [2]. Thus, sediments act as a reservoir for many pollutants.
On the other hand, the distribution of petroleum hydrocarbons in surface layer of the sediment, particularly the top 0-5 cm segment, is of great importance to studies of oil contamination and in understanding the sequential variations in aquatic environment [3].
Experimental evidences suggested that about 56% of the spilled oil in seas becomes adsorbed onto bottom sediments [4],where oxidation processes may take place for several years.
After World War II, scientific researches on the impacts of oil pollution greatly increased [5].These impacts not only affect the biological factors of the ecosystem but also can affect the water resource quality and threat the human health [6].
In order to give a better evaluation of the petroleum hydrocarbon levels in the sediments, the total organic carbon (TOC) percentage and grain size analyses were done by granulometry technique on selected slips of the sediments obtained for this purpose.
The present study deals with the levels of TPH in sediment from Al-Hodeidah area along the Red Sea Coast of Yemen, in order to use this information as a baseline study for further investigations.

Materials and Methods

Sediment samples were collected from Al-Hodeidah area along the Red Sea coast of Yemen during the summer of 2001 (Fig. 1). Twelve stations were selected in this area. Surficial sediment samples were collected by means of a Van Veen grab sampler. Petroleum hydrocarbons analysis was performed on the<63 µm fraction of the sediment which had been separated by sieving after drying and grinding. The extraction method of petroleum hydrocarbons was based upon that of Wade *et al.* (1988) [7], in which a total of 50 g of dried sediment was Soxhlet–extracted with methylene chloride for 24 h and concentrated by using a rotary evaporator. The extracts were then fractionated by using a column chromatograph containing alumina–silica gel (80-100 mesh). Following this, the extracts were in an order eluted from the column with 50 ml of hexane for aliphatic fraction and with 200 ml of 1:1 (v/v) n-hexane: dichloromethane for aromatic fraction. The extracts were concentrated for analysis by spectrofluorometry. The determination of petroleum residues in the sediment samples was carried out following the spectrofluorometric method, based upon that adopted for the IOC project (1982) [8].

Total organic carbon (TOC) and grain size analysis were performed on some selected slips of the sediment samples from each of the Stations 1–12. This is in order to give a better assessment of the petroleum hydrocarbons in the sediments of the study area. Percentage of total organic carbon (TOC %) was determined according to the procedure used by El-Wakeel and Riley (1957) [9]. The granulometry analysis was conducted by the combination of dry sieve and pipette method described by Folk (1974) [10].

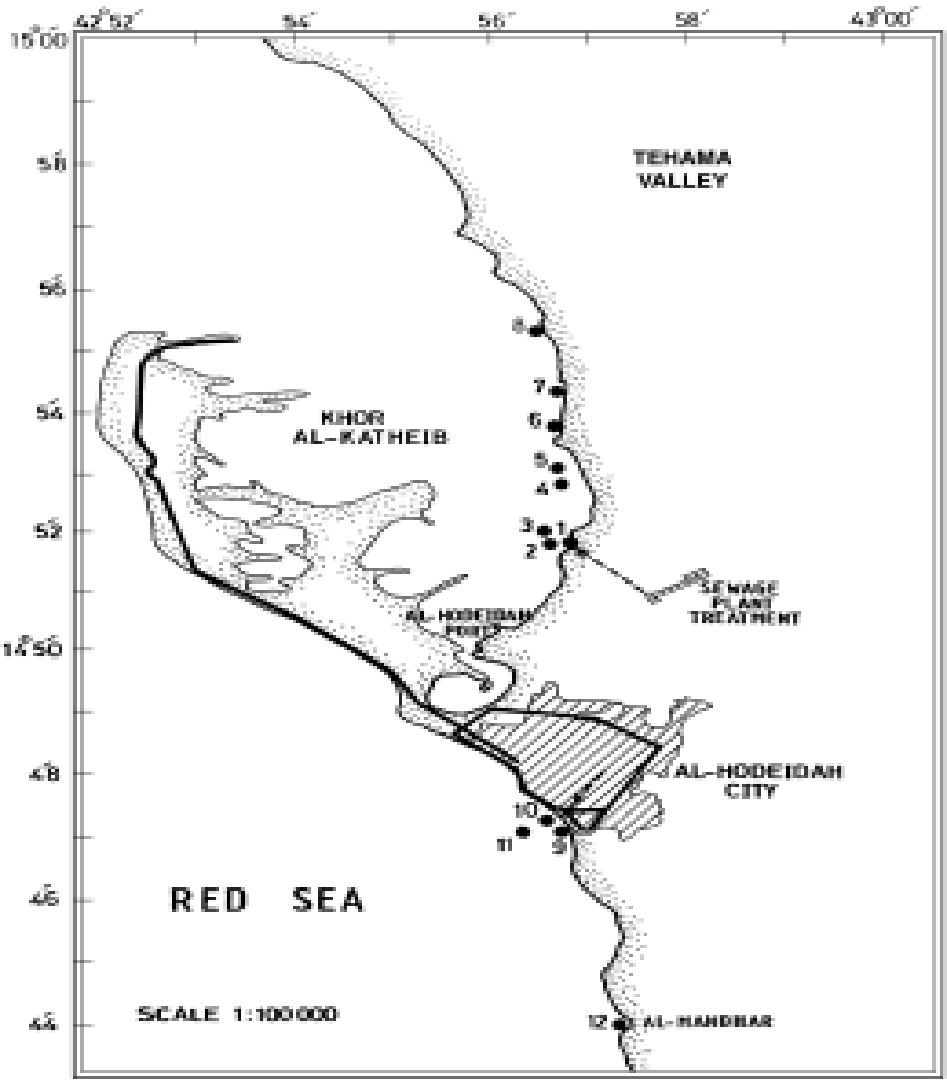

Figure 1: Locations of samples.

Results and Discussion

The distribution of Total petroleum Hydrocarbons (TPH) in sediment samples of all stations obtained in the present investigation are shown in Table (1).

The lower value concentration of total petroleum hydrocarbons was observed at station 9, while higher value was observed at station 3, which were 4.07µg/g. dry weight and 18.88µg/g. dry weight, respectively.

According to Al-Saad (1995) [11], this may indicate the presence of highly condensed aromatic ring hydrocarbons, which are typically found in the

crude oils. The pollution in this area was affected by the input of intense shipping, land traffic and industrial activities.

Table 1: Range, mean concentrations (µg/g dry wt.) and standard deviations (SD ±) of Total Petroleum Hydrocarbons of the sediment samples from Al-Hodeidah Red Sea Coast.

Stations No.	Conc. (µg/g)	Range (µg/g)	Mean (µg/g)	SD ±
	12.65			
1	12.85	12.65 – 13.21	12.90	0.284
	13.21			
	15.68			
2	15.92	14.38 – 15.92	15.33	0.829
	14.38			
	20.12			
3	18.23	18.23 – 20.22	18.88	1.077
	18.28			
	6.28			
4	6.93	5.98 – 6.93	6.40	0.486
	5.98			
	7.93			
5	7.21	6.98 – 7.93	7.37	0.496
	6.98			
	5.28			
6	6.23	5.10 – 6.23	5.54	0.607
	5.10			
	4.48			
7	4.69	4.32 – 4.69	4.50	0.186
	4.32			
	9.23			
8	8.15	7.23 – 9.23	8.20	1.001
	7.23			
	4.21			
9	4.03	3.98 – 4.21	4.07	0.121
	3.98			
	14.52			
10	15.21	14.52 – 15.21	14.76	0.387
	14.56			
	5.58			
11	5.96	4.68 – 5.96	5.41	0.657
	4.68			
	6.28			
12	5.96	5.96 – 6.78	6.34	0.413
	6.78			

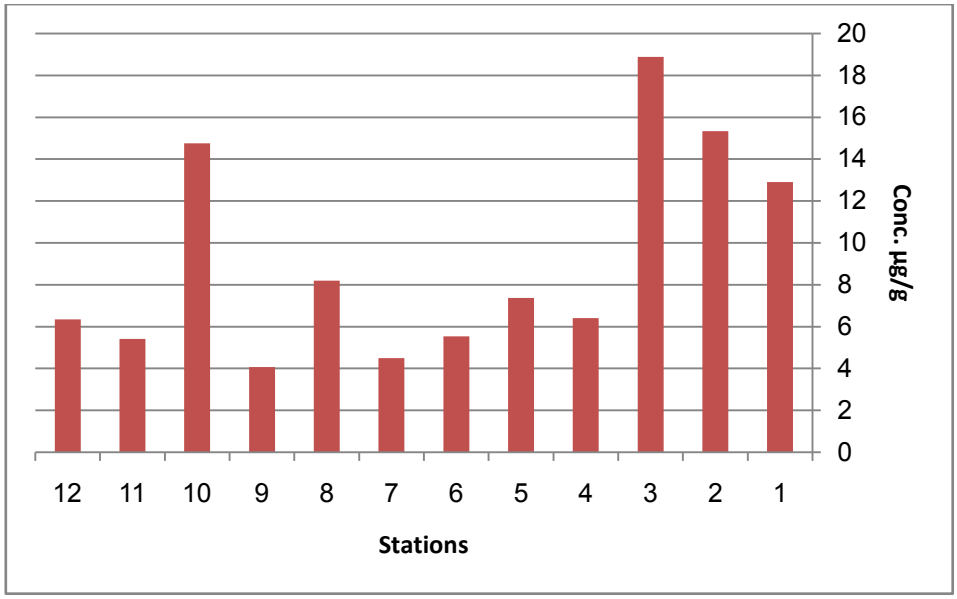

Figure 2: Mean Concentrations of Total Petroleum Hydrocarbons (µg/g d.wt.) of the sediment samples from Al-Hodeidah Red Sea Coast.

Small transport and fishing boats are common in the study area, and these boats usually use mixture of gasoline and lubricating oils as fuel source. Such studies indicated that the highest values were found near ports, industrial areas and oil refineries, where boating activities, loading and waste disposals are commonly practiced [12].

High concentrations of TPH were observed in front of Al-Hodeidah City, which could be due to the anthropogenic activities. In addition, the levels of TPH concentration in the sediments of the study area relatively moderate compared to chronically oil-contaminated area in coastal and shorelines around the world [13].However,The present study showed a relatively low degree of hydrocarbon pollution in comparison to chronically oil-contaminated area in coastal and shorelines around the world (Table 2).In the water column, it is estimated that 70% of petroleum hydrocarbons are precipitated to the bottom sediment [4].The residue of TPH in the sediments is affected by a different factor such as the rate of biodegradation, which interfere with other factors such as temperature, photo-oxidation, nutrients and sediment texture [14].

Table (3) showed the grain size and total organic carbon (TOC) in sediment samples along Al-Hodeidah coast . Higher value of TOC % was2.65 % that recorded at St. 6, while lower value was 0.70 % that recorded at St. 9.

Table 2: Comparison of petroleum hydrocarbon residues in sediment samples from some regional and international locations

Location	Mean Conc. (µg/g)	References
Saudi Arabia	13.0-540.0	[15]
Mediterranean	82.0-122.0	
Saudi Arabia	60.0-1400.0	
Bahrain	6.0-14.0	[16]
Oman	1.0-12.0	
Arabian Gulf	2.46-38.33	[11]
Coast of Kuwait	7.43-485.61	[17]
UAE	7.0	[18]
Gulf of Aden	0.12-201.0	[19]
Red Sea	1.12-6.94	[2]
Aden Coast	0.30-25.72	[12]

Table 3: Grain size analysis and total organic carbon (TOC) in sediment samples along Al-Hodeidah coast [20].

Stations No.	Sand %	Silt %	Clay %	Total Organic Carbon (TOC) %
1	55.70	30.65	13.00	2.33
2	48.50	46.20	5.25	1.43
3	30.50	56.85	10.30	1.35
4	15.40	70.30	13.35	1.65
5	47.40	46.05	7.35	1.65
6	77.45	18.50	3.30	2.65
7	42.20	38.90	17.80	2.10
8	52.95	36.55	9.85	1.85
9	91.15	7.05	0.20	0.70
10	86.40	9.05	4.64	1.93
11	44.85	52.85	1.50	1.05
12	6.10	89.55	3.90	0.85

Hydrocarbons that are adsorbed onto the sediment particles are governed mainly by the sediments grain size and by its total organic carbon content.On comparison between TOC % in the sediments of this study and other studies, it is appear that the present results are higher than those previously reported in the same area such as (DouAbul and Bedair (1986) [21] at Kuwaiti International Waters (0.67%); Massoud*et al.* (1998) [22] at Arabian Gulf (0.33-1.92%); Ibraheem (2004) [23] at Shatt Al-Arab (0.57-1.05%)).

The terms sand, silt, and clay refer to relative size of the soil particles [24]. The grain varied in their percentage from station to another according to the geological origin and the effluent discharges. Generally, according to the texture compounds percentage, the sediments of study area can be considered as silt-loam sediments. Human and animal wastes play an important role in increasing the contents of Total Organic Carbon (TOC) in the sediments. Zhibo*et al.* (2009) [25] found that the organic matters pollution was mainly from the direct discharge of domestic waste water. Total organic carbon has a major influence on both the chemical and biological processes that take place in sediments [24].

As a conclusion this study represents available data as abaseline for coming research in the future.

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