

Petroleum Hydrocarbon Contamination along Oil Tanker Routes in the Arabian Sea

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Concentrations of petroleum hydrocarbons in seawater from the oil tanker route region between 0°-25° N and 45°-75° E were estimated using UV-absorbance and fluorescence techniques. Concentrations in surface waters averaged $9.2 \pm 1.18 \mu\text{g l}^{-1}$ and in waters from 10 and 20 m averaged 3.9 ± 0.59 and $1.8 \pm 0.4 \mu\text{g l}^{-1}$ respectively. No significant concentrations could be detected in deeper waters. There was considerable variability in the concentrations suggesting that the distribution of oil in seawater is quite patchy, especially in surface waters.

Petroleum hydrocarbons, which enter marine environment from a number of sources are major pollutants in the oceans. The first step to assess the seriousness of oil pollution in the ocean involves determination of the magnitude and variability of petroleum hydrocarbon concentrations in seawater. Such data from different areas of the Northern Indian Ocean are available¹⁻⁴. All reports indicate that hydrocarbon concentrations in oceanic waters are in the range of a few micrograms per litre while in polluted coastal areas concentrations can be as much as 2 orders of magnitude higher.

Two of the world's largest oil tanker routes originate in the Gulf countries. One route is via Mozambique Channel, round South Africa to the western hemisphere and the other is along the exclusive economic zone (EEZ) of India to the Far East and Japan⁵. Since these 2 oil tanker routes in the northern Indian Ocean are of direct concern to India, it is felt that periodic monitoring of petroleum hydrocarbons will be useful in determining the extent of oil pollution occurring along these shipping routes.

This paper presents data on petroleum hydrocarbons collected during several cruises of *R V Gaveshani* and *R V Sagar Kanya* during 1978 to 1983 in the oil tanker route region between 0°-25° N and 45°-75° E.

A total of about 410 water samples were collected during different cruises at 3 depths (0, 10 and 20 m) and the concentrations were measured using UV-absorbance and fluorescence spectroscopy. Sampling, preservation and extraction were carried out following the method described in the Manuals and Guides⁶. Samples were extracted with hexane on board. The hexane extracts were analysed using a Beckman ACTA C-III double beam recording spectrophotometer and a Turner spectrofluorometer in the shore laboratory. Some samples were analysed on board *R V Sagar*

Kanya using a Farrand spectrofluorometer. All samples were cleaned by silica-gel column chromatography to remove biogenic hydrocarbons. In case of spectrophotometry, absorption spectra of samples were obtained by scanning in the region 350-190 nm whereas in spectrofluorometry, extract was excited at 310 nm and the fluorescence emission was measured at 360 nm, the conditions under which most crude and fuel oils produce the strongest fluorescence response when dissolved in hexane. Hexane was used as a blank and an Arabian crude oil was taken as arbitrary standard. Both these were treated the same way as the samples. Several replicate runs of the same samples gave a coefficient of variation as $\pm 0.6\%$ and $\pm 1.6\%$ with spectrophotometer and spectrofluorometer respectively.

Table 1 gives the range of petroleum hydrocarbons during different cruises. The range of hydrocarbons varied from not detectable to $41.6 \mu\text{g l}^{-1}$. Average concentrations at 0, 10 and 20 m were respectively 9.2 ± 1.18 , 3.9 ± 0.58 and $1.8 \pm 0.4 \mu\text{g l}^{-1}$. The region

Table 1—Petroleum Hydrocarbons at Different Depths in the Arabian Sea during Different Cruises

(Values expressed: petroleum hydrocarbons $\mu\text{g l}^{-1}$)

Cruise No.	Month/Year	Depth		
		0m	10m	20m
A31	March 1978	0.6-22.9	0.9-18.1	—
A46	Dec. 1979	18.6-41.6	16.9-34.5	10.4-24.9
A69	Feb. 1980	6.4-9.0	3.1-6.3	2.4-4.5
A86 & 87	Jan. 1981	4.0-9.5	ND-2.5	—
A115	Jan. 1983	9.7-24.2	6.7-13.2	2.2-7.2
B1	July 1983	3.0-8.9	ND-1.2	ND-1.0
B2	Sept. 1983	7.4-16.2	3.4-8.5	ND-1.2
B3	Oct. 1983	5.7-10.6	2.1-5.4	ND-1.1
B4	Nov. 1983	5.1-12.4	1.4-6.1	ND-1.6

ND—not detectable: A—*R V Gaveshani* and B—*R V Sagar Kanya*

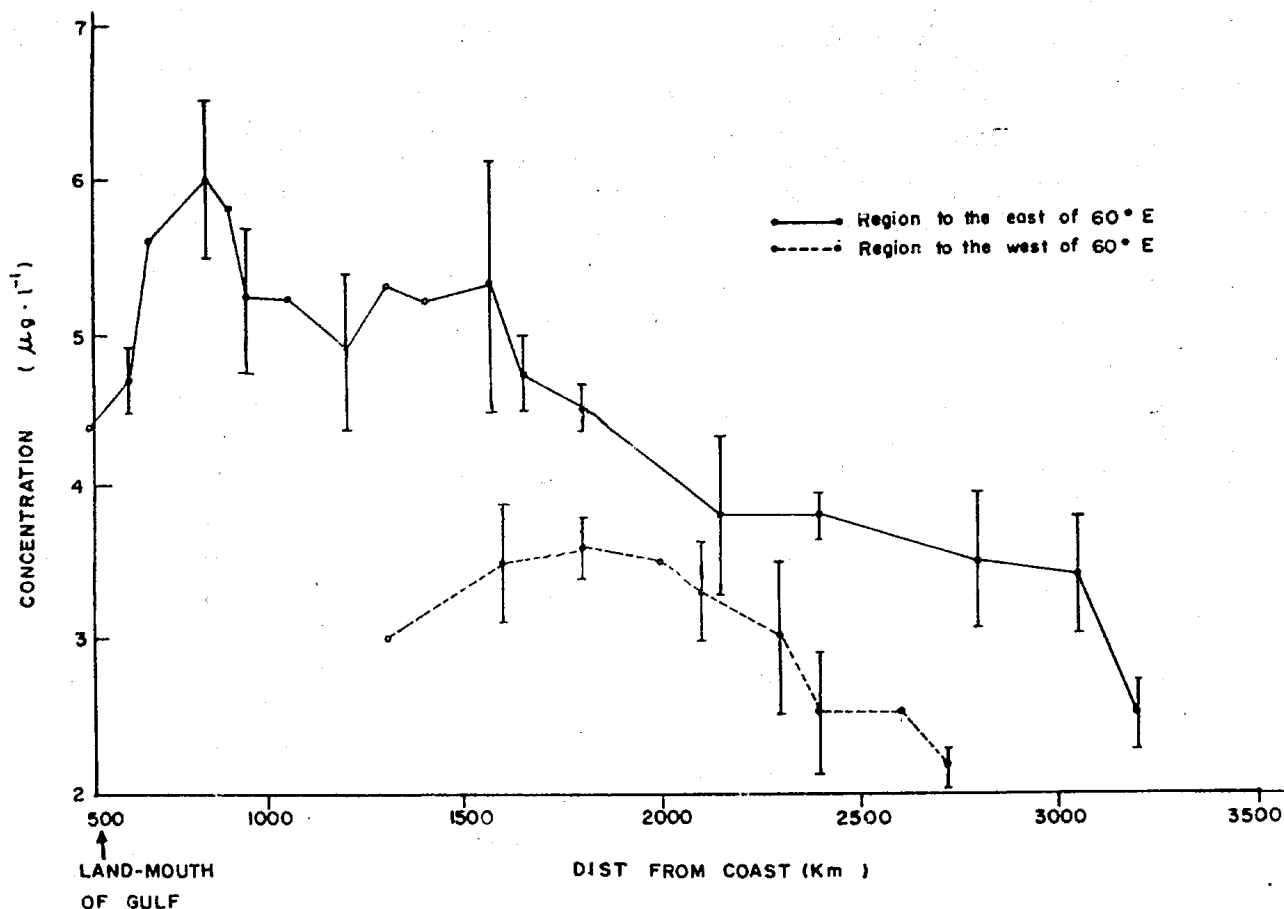


Fig. 1 Petroleum hydrocarbon distribution in regions (i) east of 60°E and (ii) west of 60° E.

covered during different cruises was divided in 2 groups, viz. region to the east of 60° E and region to the west of 60° E.

Region to the east of 60° E—This region covers a major part of the tanker route. Petroleum hydrocarbons varied from not detectable to 41.6 µg l⁻¹. Average (359 observations) concentrations at 0, 10 and 20 m were 12.8 ± 2.4, 5.3 ± 1 and 2.6 ± 0.3 µg l⁻¹ respectively. Petroleum hydrocarbons in this region showed a gradient with depth, the highest concentrations being near the surface. This might be due to land-based discharges and losses of crude and refined petroleum products. Fig. 1 gives distribution of petroleum hydrocarbons (average values of 3 depths) from the main oil tanker traffic source (mouth of the Gulf) in both the regions. Near the source the concentrations are higher and they decrease as the distance from the source increases. Higher values in this region suggest that this region of the Arabian Sea is a place of intense occurrence of oil slicks and the source of these oil slicks is mostly the bilge washings of the tankers. Another evidence is given by the tar ball distribution in this region. Near the source, hardly any

tar balls are observed whereas away from the source, tar balls presence is observed.

Region to the west of 60° E—This region appears to be less affected than the region east of 60° E. One of the reasons may be the lesser number of observations. Petroleum hydrocarbon concentrations ranged from not detectable to 8.9 µg l⁻¹. The average (51 observations) concentrations at 0, 10 and 20 m were 5.6 ± 0.42, 2.5 ± 0.38 and 1.0 ± 0.34 µg l⁻¹ respectively. A gradient with depth was also observed in this region. In general, concentrations of petroleum hydrocarbons are lower (Fig. 1), and unlike the first one, the region away from the source was less contaminated. The higher values observed at some of the stations may be due to shipping traffic near ports. Lower concentrations at the other stations in the same region away from the ports lend support to this view. This can be supported also by the near-absence of floating tar balls in this area.

Considerable variability in petroleum hydrocarbon concentrations observed suggest that the distribution of oil in seawater is quite patchy which again signifies the seasonal variations and the intensity of tanker

traffic at the time of the observations. However, the concentrations of oil observed here are far less than those observed in other parts of the world ocean⁷⁻¹². The Arabian Sea is an area of negative water balance where evaporation exceeds the precipitation and runoff by 7-10 km³ every year¹³. This together with the biodegradation of oil, might be the factor contributing to the lower values of petroleum hydrocarbons in this area inspite of the very large global oil transport which passes through this area.

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